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Contact us:
Singidunum University
32 Danijelova Street, 11010 Belgrade, Serbia
Phone No. +381 11 3093220, +381 11 3093290,
Fax. +381 11 3093294
E-mail: sinteza@singidunum.ac.rs
Web: sinteza.singidunum.ac.rs

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SINTEZA provides an ideal platform for the exchange of information and dissemination of best practices, ideas and advancements in the state-of-the-art and technical improvements in the domain of Information Technology and Data Related Research.

Rapid advances in Information Technologies (IT) in recent decades have had a huge impact on numerous facets of everyday life and have created tremendous opportunities for economic, technological and social gains at a global scale. In particular, the advances in data-science, block-chain technology and optimization techniques are becoming the driving force behind many changes in both technology and business. New technologies and scientific breakthroughs have altered the working and living environments making them safer, more convenient and more connected.

The conference seeks submissions from academics, researchers, and industry professionals presenting novel research on all practical and theoretical aspects in the field of Information Technology and Data Related Research and their applications in a range of business, engineering and research fields.

The most innovative papers presented at this year's international scientific conference SINTEZA will be recommended for publication in Serbian Journal of Electrical Engineering. The authors of the selected papers are obliged to submit an extended version of their paper that will be thoroughly reviewed in accordance with the criteria outlined by the editorial board of the journal. The papers that successfully undergo the review process shall appear in a regular issue of the journal.

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Veljko Pejović, PhD – *Assistant Professor at the Faculty of Computer and Information Science, University of Ljubljana, Slovenia*

Radomir Jakovljević, PhD – *Senior Software Engineering Manager at Microsoft*

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Aphrodite Ktena, PhD – *project manager ELEMEND*

Gordana Glišić Morganti – *head of HR department, Engineering Software Lab*

Keynote speakers:

Ying-Tan, PhD – *Professor and director of Computational Intelligence Laboratory at Peking University*

Aleksandar Kostić, PhD – *Full Member of the Serbian Academy of Sciences and Arts, Head of the SASA Audiovisual Archives and Digitalization Center Expert Council*

Miloš Mladenović – *Managing Director of SEEPEX*

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OPTIMISATION AND MODELING

OPTIMISATION AND MODELING

FUZZY MATHEMATICAL MODEL FOR DESIGNING CYBERSECURITY MANAGEMENT BODIES IN STRATEGIC PLANNING

Dragan Bojanić[1,*],
Vladimir Ristić[2],
Jan Marček[3]

[1]Strategic Research Institute,
University of Defence in Belgrade,
Belgrade, Serbia
[2]Military Academy,
University of Defence in Belgrade,
Belgrade, Serbia
[3]Faculty for Business Studies and Law,
University „Union Nikola Tesla",
Belgrade, Serbia

Abstract:
It is necessary for the design of organizational structure of cybersecurity systems or information security systems to meet the basic corporate goals and objectives. Thus, although cyber security is only an element of information security, it is its most important part. For that reason, it is essential for the organizational structure to be constantly perfected. The analysis of strengths, weaknesses, opportunities and threats (SWOT) is a method to formulate the strategy. The SWOT analysis successfully provides the key factors of the problem. In recent years, the multiple criteria decision making (MCDM) has removed some of the deficiencies. However, the nature of these decisions is usually very complex and using crisp data is not suitable. This paper presents a modification of the Saaty-s scale, in which fuzzy numbers have been used for determining weight values of criteria and alternatives. The method described here takes into account the level of uncertainty of the decision maker. After the application of the AHP method in this way, the values of the functions criteria for each considered alternative are obtained. FA'WOT is a hybrid method combining the well-known SWOT analysis and the Fuzzy AHP. This model is used in determining the development strategy for cybersecurity management bodies.

Keywords:
Cybersecurity, organizational structure design, fuzzy logic, multi-criteria decision making, fuzzy AHP.

1. INTRODUCTION

Cybersecurity is a major concern of organizations today. More and more organizations rely on cybersecurity to facilitate essential business processes. Cybersecurity covers the steps an organization must take to protect information that can be accessed via vulnerabilities in its networks and systems. However, there are many cybersecurity incidents and failures leading to substantial revenue losses. To solve these difficulties of cybersecurity, organizations must take not only information data and technology, but also managerial and operational aspects into consideration. Every task set for the management must be performed properly and reliably in all environmental conditions. Cybersecurity Management Systems (CSMS) are becoming more and more popular for the organizations that want to improve their cybersecurity levels. The CSMS is powered by

Correspondence:
Dragan Bojanić

e-mail:
dragan.bojanic@mod.gov.rs

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a set of controls. The effectiveness of the whole CSMS is directly decided by the effectiveness of the implemented cybersecurity in departments [1].

Different departments in an organization have different security responsibilities and thus adopt different controls in CSMS. With different responsibilities in the cybersecurity management, different departments are concerned with different aspects of cybersecurity. The departments with relation to security are Management Board, HR Department, Security Department, Information Protection Department, and Information System Management Department.

Organizational design is specific to every organization, and therefore a unitary organizational structuring cannot be established. Various approaches to organizational design are possible not only due to the differences between companies, but also because certain factors affect different companies in different ways.

In recent years, the methodological approaches of computational modelling and simulation are becoming increasingly popular among organizational researchers. Simulation, unlike mathematical modelling, allows researchers to reflect the natural complexity of organization systems as given. Computational modelling facilitates studies of more complex systems than traditional mathematical approaches.

Computational and mathematical models of organizational design may be found in the papers by Carley [2].

Kujacic and Bojovic [3] proposed a model for selecting the organizational structure using fuzzy multi-criteria analysis. The developed fuzzy multi-criteria methodology takes into consideration uncertainty and imprecision of the input data. Researchers in the field of computational organization theory use computational analysis methods to study both humans and organizations as computational entities. Human organizations can be viewed as intrinsically computational, as many of their activities involve sharing and transforming information from one form to another and also because organizational activity is often information-driven [4].

Some design approaches to organizational structure with emphasis on the basic characteristics of each of these models has been presented in the first part of the paper. In the continuation, a model for the selection of optimal variants of organization based on fuzzy logic has been developed starting from the relevant theory approach. Fuzzy AHP is applied in the SWOT analysis (FA'WOT model) to optimize the existing organizational structure of the management bodies of cybersecurity. The choice of organizational models is made using Fuzzy AHP and standard techniques of multi-criterion decision making [5]. The aforementioned model is shown in the following section of the paper.

2. FA'WOT MODEL

In the process of designing the organizational structure, certain decisions have to be made. It is worth pointing out that subjective evaluation of certain parameters differ from one decision-maker to another. Quite a convenient approach in quantifying these parameters is the fuzzy set theory introduced by Lotfi Zadeh [6].

Since fuzzification of the AHP method is primarily based on fuzzification of the grading scale, the following part of this paper will present approach to optimization of the dynamic grading scale [7,9]. Fuzzification of the basic AHP method has been done in such a way that triangle fuzzy numbers are used for determining the essential criteria values and fuzzy arithmetic for the whole procedure. Fuzzy numbers are intuitively easy to use when expressing the decision maker's qualitative assessments [8,9].

This way of defining the confidence interval does not take into account the level of uncertainty used for the evaluation of linguistic expressions. The level of uncertainty is represented by the length of the fuzzy number base. In other words, the greater uncertainty in assessment of the linguistic expression the bigger the length of the base (certainty interval) of the fuzzy number [9].

Unlike the above mentioned models, the one represented in this paper takes into account the level of uncertainty which is marked by parameter β. In this case, the greatest possible uncertainty is described by the value $\beta = 0$, while the value $\beta = 1$ corresponds the situation in which we are totally sure that the linguistic expression corresponds the given comparison of the optimality criteria. The value of the parameter β can be any number within the interval [0,1]. In this way, upper and lower limits of the confidence interval of the fuzzy number are chosen randomly for the given value of the parameter β, so that they are within the limits defined by the expression (1) [9]:

$$T=(t_1,t_2,t_3)=\begin{Bmatrix} t_1=\beta t_2, & t_1\le t_2, & t_1,t_2\in[1/9,9] \\ t_2=t_2, & & t_2\in[1/9,9] \\ t_3=(2-\beta)t_2, & t_3\le t_2, & t_2,t_3\in[1/9,9] \end{Bmatrix} \quad (1)$$

Application of the described procedure implies the realization of Saaty's scale fuzzification (Table 1) where fuzzy number $T=(t_1,t_2,t_3)=(x\beta,x,(2-\beta)x)$, $x\in[1,9]$ is defined as:

$$t_1=x\beta=\begin{cases}x\beta, & \forall\ 1\le x\beta\le x\\ 1, & \forall\ x\beta<1\end{cases} \tag{2}$$

$$t_2=x,\ \forall\ x\in[1,9] \tag{3}$$

$$t_3=(2-\beta)x=\begin{cases}(2-\beta)x, & \forall\ x\le(2-\beta)x\le 9\\ 9, & \forall\ (2-\beta)x>9\end{cases} \tag{4}$$

Table 1. Fuzzified Saaty's scale

Importance intensity	Definition	Fuzzified values	
		Fuzzy number	*Inversive fuzzy number*
1	Same importance	(1, 1, 1) compared with oneself, $(\beta,1,2-\beta)$ in other cases	$(1/\beta,1,1/(2-\beta))$ in other cases
3	Weak dominance	$(3\beta,3,(2-\beta)3)$	$(1(2-\beta)3,1/x,13\beta)$
5	Strong dominance	$(5\beta,5,(2-\beta)5)$	$(1(2-\beta)5,1/5,15\beta)$
7	Very strong dominance	$(7\beta,7,(2-\beta)7)$	$(1(2-\beta)7,1/7,17\beta)$
9	Absolute dominance	$(9\beta,9,(2-\beta)9)$	$(1(2-\beta)9,1/9,19\beta)$
$x=2,4,6,$	Inter-values	$(x\beta,x,(2-\beta)x)$	$(1(2-\beta)x,1/x,1\beta x)$

Inversive fuzzy number

$T^{-1}=(1/t_1,1/t_2,1/t_3)=(1/(2-\beta)x,1/x,1/\beta x)$, $x\in[1/9,1]$ is defined as:

$$1/t_1=1/(2-\beta)x=\begin{cases}1/(2-\beta)x, & \forall\ x<1/(2-\beta)x<1\\ 1, & \forall\ 1/(2-\beta)x>1\end{cases} \tag{5}$$

$$1/t_2=1/x,\ \forall\ 1/x\in[1/9,1] \tag{6}$$

$$1/t_3=1/\beta x=\begin{cases}1/\beta x, & \forall\ 1/9\le 1/\beta x\le 1/x\\ 1/9, & \forall\ 1/\beta x<1/9\end{cases} \tag{7}$$

In this way, the values of criteria functions for every considered alternative are obtained after the application of the AHP method. Certain value of parameter β corresponds to values of criteria functions obtained. It is possible to generate various sets of values of the criteria functions for various values of parameter β [9].

After defining the parameters of fuzzy Saaty's scale [7-10] conditions have been created to describe the steps for implementing FA'WOT model (Fig.3).

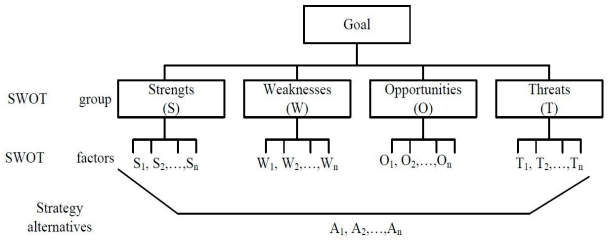


Fig. 1. The hierarchical presentation of FA'WOT analysis

FA'WOT model includes the following steps:

Step 1. Identify SWOT sub-factors and determine the alternative strategies according to the SWOT sub-factors. Determine the importance degrees of the SWOT factors.

Step 2. The Aggregation Principle. This is important for understanding the aggregation process of judgments made at two consecutive hierarchical levels, where criteria and sub-criteria are located. Here criteria and sub-criteria are aggregated by shifting criteria at the sub-criteria level. After the shift, the whole criteria level does not exist anymore. The aggregation principle is illustrated in (Fig. 2).

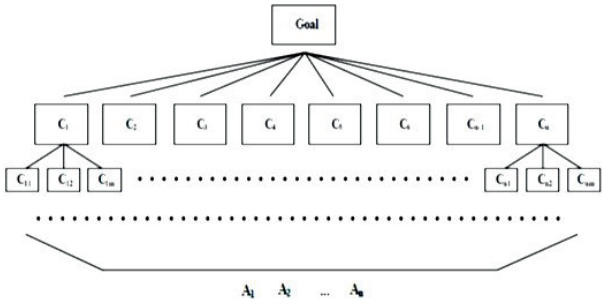


Fig. 2. Aggregation of criteria and sub criteria levels

Step 3. Evaluating Criteria. The ranking procedure starts with the determination of the importance of criteria with respect to the goal [10]. By using a fuzzified scale, a fuzzy reciprocal judgment matrix for criteria is determined as (8) [9]:

$$A=\begin{bmatrix}\tilde{a}_{11} & \cdots & \tilde{a}_{1n-m} & \cdots & \tilde{a}_{M}\\ \vdots & & & & \vdots\\ a_{k1} & \cdots & a_{kn-M} & \cdots & a_{kM}\\ \vdots & & & & \vdots\\ a_{K1} & \cdots & a_{Kn-M} & \cdots & a_{KM}\end{bmatrix} \tag{8}$$

where $a_{ij}=1$ for all $i=j$ $(i,j=1,2,...,M)$ and $a_{ij}=1/a_{ji}$.

By applying the fuzzy synthetic extent, the corresponding weights of criteria can be determined as (9):

$$w_i = \frac{\sum_{j=1}^{M} a_{ij}}{\sum_{k=1}^{M}\sum_{l=1}^{K} a_{kl}},\ \sum_{i=1}^{K} w_i = 1, w_i \in [0,1], i = 1,2,...M \qquad (9)$$

It should be noted that fuzzy extent (9) could be defined as the result of fuzzy arithmetic, or by using the extension principle. The second is slightly more difficult, but would lead to reduced uncertainty.

Step 4. Evaluating Sub-criteria. For the given criterion C_j, which splits into k_j sub-criteria, it is necessary to determine the relative importance of the sub-criteria with respect to this criterion. After that the fuzzy judgment matrix can be determined as (10) [9]:

$$A_j = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1k_j} \\ a_{21} & a_{22} & \dots & a_{2k_j} \\ \dots & \dots & \dots & \dots \\ a_{k_j 1} & a_{k_j 2} & \dots & a_{k_j k_j} \end{bmatrix} \qquad (10)$$

Final sub-criteria weights are derived through the aggregation of the weights at two consecutive levels [10]. Multiplying sub-criteria weights by respective criterion weight (9) yields (11):

$$w_j^p = \left(\frac{\sum_{l=1}^{k_j} a_{il}}{\sum_{i=1}^{k_j}\sum_{l=1}^{k_j} a_{il}} \right) \cdot w_j,\ j = 1,2,...M;\ p = 1,2,...,k_j \qquad (11)$$

where w_j^p are the aggregated fuzzy weights of sub-criteria. They are entries of the weight vector (11) with the total length K.

$$W = \left(w_1^1, w_1^2, ..., w_1^{k1}, w_2^1, w_2^2, ..., w_2^{k2}, ..., w_j^1, w_j^2, ..., w_j^{kj}, ..., w_M^1, w_M^2, ..., w_M^{kM} \right) \qquad (12)$$

Step 5. Evaluating alternatives. The provided N alternatives are pairwise compared with respect to each of the K sub-criteria [9]. After obtaining K fuzzy judgment matrices of type (12), the fuzzy extent (13) produces the decision matrix 16.

$$W_k = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1N} \\ a_{21} & a_{22} & \dots & a_{2N} \\ \dots & \dots & \dots & \dots \\ a_{N1} & a_{N2} & \dots & a_{NN} \end{bmatrix},\ k = 1,2,...,K \qquad (13)$$

After obtaining K fuzzy judgment matrices of type (12), the fuzzy extent (13) produces the decision matrix (14).

$$x_{ij} = \frac{\sum_{k=1}^{K} a_{ik}}{\sum_{l=1}^{N}\sum_{m=1}^{K} a_{lm}},\ i = 1,2,...N;\ j = 1,2,...,K \qquad (14)$$

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1N} \\ x_{21} & x_{22} & \dots & x_{2N} \\ \dots & \dots & \dots & \dots \\ x_{N1} & x_{N2} & \dots & x_{NN} \end{bmatrix},\ k = 1,2,...,K \qquad (15)$$

In the decision matrix X, x_{ij} represents the resultant fuzzy performance assessment of the alternative A_i (i=1,2,...,N) with respect to the jth sub-criterion (j=1,2,...,K).

Step 6. Performance matrix. An overall performance of each alternative across all sub criteria may be represented by the fuzzy performance matrix (16).

$$Z = \begin{bmatrix} x_{11}w_1 & x_{12}w_2 & \dots & x_{1N}w_K \\ x_{21}w_1 & x_{22}w_2 & \dots & x_{2N}w_K \\ \dots & \dots & \dots & \dots \\ x_{N1}w_1 & x_{N2}w_2 & \dots & x_{NN}w_K \end{bmatrix} \qquad (16)$$

Step 7. Final assessments and synthesis. The final alternative performance weights with respect to the overall goal are calculated by the summation of elements in the rows of the performance matrix (15) to obtain equation (17).

$$F_i = \sum_{j=1}^{K} x_{ij} w_j,\ i = 1,2,...,N \qquad (17)$$

To finally rank the alternatives, the prioritization of aggregated assessments is required. Since each F_i is a triangular fuzzy number, it is necessary to apply the method of ranking triangular fuzzy numbers. For the given triangular fuzzy number A = (a_1, a_2 ,a_3) the total integral value is defined as [11] (18):

$$I_T^{\lambda}(A) = \left[\lambda a_3 + a_2 + (1-\lambda) a_1 \right] \cdot 2^{-1},\ \lambda \in [0,1] \qquad (18)$$

λ represents an optimism index which expresses the decision maker's attitude towards risk. A larger value of λ indicates a higher degree of optimism. In practical

applications, values 0, 0.5 and 1 are used respectively to represent the pessimistic, moderate and optimistic views of the decision maker.

The final ranking of alternatives means adopting a certain level λ of optimism of the decision-maker, then applying equation (19) on fuzzy numbers equation (17), and finally ranking alternatives regarding values obtained for $I_T^{\lambda}(F)$, *i=1,2,...,N*. [9] The best alternative from the set is represented as:

$$f_{F_i} = \max\left(f_{F_i}\right),\ i = 1, 2, \ldots, A \tag{19}$$

3. APPLICATION OF FA' WOT MODEL IN ORGANIZATIONAL DESIGN OF THE CYBERSECURITY MANAGEMENT BODIES

Enterprises are moving their business processes towards digitization, mobility, big data analytics, web collaboration and cloud services. Most of them usually do not consider enterprise IT security strategy a mandatory factor and lack adequate cybersecurity organizational structure.

This, however, makes up for a poor organizational strategy that leads nowhere. Businesses should recognize enterprise cybersecurity as their priority. Personal data, digital intellectual property, enterprise cyber infrastructure and even business-critical apps can be compromised via network attacks, break-ins, inadvertent security lapses, vulnerable web services etc.

Designing a CSMS has a large influence on the creation, adaptation, existence and quality of the system operation. No organizational system within the cybersecurity support can operate independently of its management subsystem responsible for issuing commands for the desired "behavior" of the system, while the actual behavior can deviate from the desired. SWOT analysis is used to manage the total organization, the overall pattern of structural components and arrangement. Through the analysis of the internal and external factors, which affect organizational changes and organizational structuring, four different types of cybersecurity organizations in enterprises were obtained. Applying modified AHP method, evaluation of the suggested types was performed and the most affordable option of the organizational structure was chosen. The decision hierarchy of FA'WOT model is defined as follows:

1. Goal: to identify the best alternative organizational
2. Criteria (Level 1) and sub-criteria (Level 2):

S. Strengths

S_1: Simple structure

S_2: The minimum number of hierarchical levels

S_3: Functional grouping of working processes

S_4: Quick transfer of information

S_5: Avoidance of resources duplication within functions of the cybersecurity support

S_6: Simple coordination within the cybersecurity Support functioning

S_7: Possibility of preferment in career (career development)

S_8: The ability to track personnel development and motivation

S_9: Low probability of dismissal

W. Weaknesses

W_1: Low specialization toward work processes

W_2: Need for better coordination between the cybersecurity support functions

W_3: Poor communication between the cybersecurity support functions

W_4: Danger of conflict in defining priorities

W_5: Focusing on section (departmental) problems

W_6: Difficult co-ordination between the cybersecurity support functions when making plans

W_7: Development of managers (executives) specialized in specific areas

W_8: Close monitoring of organizational goals

W_9: The risk of accumulation of decisions at the top of the hierarchy

O. Opportunities

O_1: Effective in a stable environment

O_2: Strong management team

O_3: Training of existing and introduction of new personnel in the administrative structure of the cybersecurity support

O_4: Capability for organization of management processes cybersecurity bodies

O_5: Introduction of up-to-date informational technology into the process of the cybersecurity support management

O_6: Automated managing of cybersecurity support processes

T. Treats

T_1: Slow adaptation to changes in the environment

T_2: Weak innovative capabilities

T_3: Changing of positions of the expert personnel by the cybersecurity support functions

T_4: Introduction of "outsourcing" technology in some of the functions of cybersecurity support

T_5: Requirements for rapid adaptation and response to social changes

3. Types of the organizational structure of administrative bodies (Level 3):

Alternative 1. Represents an existing organization of cybersecurity management bodies in an enterprise.

Alternative 2. Represents a modification of the existing organization of cybersecurity management bodies in an enterprise. Application of the cybersecurity approach and cybersecurity organization upon a functional principle is the basis for development of II type. This type is based on the internal division of labor, specialization and differentiation of organizational units and holders of management. Grouping of individual functions, processes and activities was done by the following principles: the executive principle (grouping of individual processes executive personnel into a single function, which creates a functional organization), the property principle (grouping according to proprietors for whom a job is performed or who perform the functions, processes and activities), the rank principle (grouping according to priority and executive level), according to the phases (grouping according to phases of planning, implementation and control), by purpose principle (grouping according to organizing administrative processes feasibility and functions of a particular business in certain organizational units). Functional structure model is based on the functional division of labor, it is oriented towards the labor process, and based also on functional groupings of units and the optimization of employee numbers.

*Alternative 3.*Represents the organization of administrative bodies upon cybersecurity processes. The governing process (management) within an organization consists of five basic sub-processes or phases: planning, organizing, leadership, personnel management and controlling. All stages are interrelated and interdependent and make a continuous process of managing the cybersecurity support. These stages, or organizational units are attached to each other, connected and interrelated. After the process of planning, the process of organization continues, associated with the previous one by direct channels and direct feedback. The advantage of such type of organizing in support of administrative authority is the fact that specialized personnel is grouped by the same process or governing stage and they are oriented towards the realization of the process. The disadvantage is reflected in the requirement for better coordination of the entire work, preventing problems in one process causing problems in the whole business.

Alternative 4. Represents the organization of the administrative organs of cybersecurity by processes and by functions. In this type of the organizational structure, positive sides of functional organization and organizations designed upon managing processes are taken into consideration.

To determine relative importance of the evaluation criteria Strengths, Weaknesses, Opportunities and Treats, they were pairwise compared with respect to the goal by using the fuzzified scale given in Table 1 [7-10]. Linguistically expressed preferences among criteria have been used to create a judgment matrix A as given by (8):

$$A_{SWOT} = \begin{matrix} \\ S \\ W \\ O \\ T \end{matrix} \begin{matrix} \begin{matrix} S & W & O & T \end{matrix} \\ \begin{bmatrix} \tilde{1} & \tilde{3} & \tilde{3} & \tilde{2} \\ \tilde{3}^{-1} & \tilde{1} & \tilde{2} & \tilde{2} \\ \tilde{3}^{-1} & \tilde{2}^{-1} & \tilde{1} & \tilde{6} \\ \tilde{2}^{-1} & \tilde{2}^{-1} & \tilde{6}^{-1} & \tilde{1} \end{bmatrix} \end{matrix} \Rightarrow W_{c_2} = \begin{bmatrix} W_s \\ W_w \\ W_o \\ W_T \end{bmatrix} = \begin{bmatrix} (0.259, 0.370, 0.481) \\ (0.076, 0.096, 0.125) \\ (0.268, 0.384, 0.499) \\ (0.105, 0.151, 0.196) \end{bmatrix}$$

The weighting vector w of criteria matrix A_{SWOT} was determined by applying (9). Each entry of this vector is the sum of elements in the related row of matrix A_{SWOT}, divided by the sum of all its elements. For example:

$$W_s = \frac{\tilde{1} + \tilde{3} + \tilde{3} + \tilde{2}}{\tilde{1} + \tilde{3} + \tilde{3} + \tilde{2} + \tilde{3}^{-1} + \tilde{1} + \tilde{2}^{-1} + \tilde{2}^{-1} + \tilde{3}^{-1} + \tilde{2} + \tilde{1} + \tilde{6} + \tilde{2}^{-1} + \tilde{2} + \tilde{6}^{-1} + \tilde{1}} = (0.259, 0.370, 0.481)$$

$$W_{SWOT} = \begin{bmatrix} W_s \\ W_w \\ W_o \\ W_T \end{bmatrix} = \begin{bmatrix} (0.140, 0.200, 0.259) \\ (0.067, 0.096, 0.125) \\ (0.268, 0.384, 0.499) \\ (0.105, 0.151, 0.196) \end{bmatrix}$$

In the next step, through the use of fuzzy pairwise comparisons, the judgment matrices (10) for sub-criteria related to respective criteria were obtained. Related sub-criteria weighting vectors were calculated as defined by (9):

$$W_S = \begin{bmatrix} W_{s_1} \\ W_{s_2} \\ W_{s_3} \\ W_{s_4} \\ W_{s_5} \\ W_{s_6} \\ W_{s_7} \\ W_{s_8} \\ W_{s_9} \end{bmatrix} = \begin{bmatrix} (0.110, 0.157, 0.204) \\ (0.041, 0.059, 0.077) \\ (0.016, 0.023, 0.030) \\ (0.120, 0.171, 0.222) \\ (0.063, 0.090, 0.117) \\ (0.076, 0.108, 0.141) \\ (0.060, 0.085, 0.111) \\ (0.093, 0.133, 0.173) \\ (0.121, 0.173, 0.225) \end{bmatrix}$$

$$W_w = \begin{bmatrix} W_{w_1} \\ W_{w_2} \\ W_{w_3} \\ W_{w_4} \\ W_{w_5} \\ W_{w_6} \\ W_{w_7} \\ W_{w_8} \\ W_{w_9} \end{bmatrix} = \begin{bmatrix} (0.177, 0.252, 0.328) \\ (0.074, 0.106, 0.138) \\ (0.046, 0.065, 0.085) \\ (0.106, 0.151, 0.195) \\ (0.030, 0.043, 0.056) \\ (0.062, 0.088, 0.115) \\ (0.103, 0.147, 0.191) \\ (0.024, 0.034, 0.044) \\ (0.080, 0.144, 0.148) \end{bmatrix}$$

$$W_o = \begin{bmatrix} W_{o_1} \\ W_{o_2} \\ W_{o_3} \\ W_{o_4} \\ W_{o_5} \\ W_{o_6} \end{bmatrix} = \begin{bmatrix} (0.230, 0.328, 0.427) \\ (0.251, 0.359, 0.467) \\ (0.095, 0.135, 0.176) \\ (0.024, 0.034, 0.044) \\ (0.039, 0.055, 0.072) \\ (0.062, 0.088, 0.115) \end{bmatrix}$$

$$W_T = \begin{bmatrix} W_{T_1} \\ W_{T_2} \\ W_{T_3} \\ W_{T_4} \\ W_{T_5} \end{bmatrix} = \begin{bmatrix} (0.140, 0.200, 0.259) \\ (0.071, 0.101, 0.131) \\ (0.357, 0.510, 0.664) \\ (0.026, 0.038, 0.049) \\ (0.106, 0.151, 0.197) \end{bmatrix}$$

By fuzzy multiplication of the related sub-criteria weighting vectors and criteria weights, as given in (11), the aggregated weights of the sub-criteria were obtained with respect to the goal. For example:

$$W'_S = W_{s_i} \cdot W_s = \begin{bmatrix} W_s \cdot W_{s_1} \\ W_s \cdot W_{s_2} \\ W_s \cdot W_{s_3} \\ W_s \cdot W_{s_4} \\ W_s \cdot W_{s_5} \\ W_s \cdot W_{s_6} \\ W_s \cdot W_{s_7} \\ W_s \cdot W_{s_8} \\ W_s \cdot W_{s_9} \end{bmatrix} = \begin{bmatrix} (0.140, 0.200, 0.259) \cdot (0.110, 0.157, 0.204) \\ (0.140, 0.200, 0.259) \cdot (0.041, 0.059, 0.077) \\ (0.140, 0.200, 0.259) \cdot (0.016, 0.023, 0.030) \\ (0.140, 0.200, 0.259) \cdot (0.120, 0.171, 0.222) \\ (0.140, 0.200, 0.259) \cdot (0.063, 0.090, 0.117) \\ (0.140, 0.200, 0.259) \cdot (0.076, 0.108, 0.141) \\ (0.140, 0.200, 0.259) \cdot (0.060, 0.085, 0.111) \\ (0.140, 0.200, 0.259) \cdot (0.093, 0.133, 0.173) \\ (0.140, 0.200, 0.259) \cdot (0.121, 0.173, 0.225) \end{bmatrix}$$

$$F = \begin{matrix} A_1 & A_2 & A_3 & A_4 \end{matrix} \begin{bmatrix} (0.30, 0.32, 0.36) & (0.36, 0.32, 0.30) & (0.16, 0.19, 0.21) & (0.12, 0.16, 0.19) \\ (0.20, 0.21, 0.23) & (0.24, 0.26, 0.23) & (0.19, 0.21, 0.23) & (0.30, 0.33, 0.35) \\ (0.07, 0.08, 0.11) & (0.29, 0.31, 0.32) & (0.26, 0.27, 0.29) & (0.26, 0.27, 0.29) \\ (0.14, 0.14, 0.17) & (0.30, 0.31, 0.32) & (0.21, 0.23, 0.25) & (0.29, 0.31, 0.34) \end{bmatrix} \times \begin{bmatrix} 0.33 \\ 0.29 \\ 0.20 \\ 0.17 \end{bmatrix}$$

Table 2. Ranking of alternatives

Decision alternative	Index of optimism λ=0.0 (pessimistic)	λ=0.5 (moderate)	λ=1.0 (optimistic)	Final rank
Alternative 1	0.205	0.212	0.220	4
Alternative 2	0.285	0.295	0.305	1
Alternative 3	0.210	0.220	0.230	3
Alternative 4	0.245	0.255	0.265	2

The assessment of the alternatives has been performed using relations (13), (14) and (15). The final alternative performance weights, with respect to the overall goal, have been calculated by equation (17) as shown:

$$V = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \\ V_4 \end{bmatrix} = \begin{bmatrix} (0.20, 0.21, 0.23) \\ (0.28, 0.29, 0.32) \\ (0.20, 0.22, 0.24) \\ (0.22, 0.26, 0.27) \end{bmatrix}$$

For the typical values of λ that express the decision-maker's attitude toward risk, the final ranking of alternatives is obtained by applying equation (18). The normalized values presented in Table 2 show that Alternative 2 is the best. It is followed by Alternative 4, Alternative 3 and Alternative 1 respectively, regardless of the decision-maker's level of optimism.

By using the center of gravity method to defuzzify the *V* values given above, the final weights of alternatives obtained after normalization were: 0.213 (Alternative 1), 0.297 (Alternative 2), 0.220 (Alternative 3) and 0.253 (Alternative 4). Obviously, the final ranking is equal to the previous one.

4. DISCUSSION AND CONCLUSION

Organization is not a sum of mechanical parts, rather an "organic whole" with a purpose and mission. In the process of designing the organizational structure it is necessary, having defining the objectives and design criteria, to analyze the state of the organization.

In addition to organizations operating in an uncertain environment, there is a degree of uncertainty and imprecision of criteria used in the process of organizational design. Fuzzy multi-criteria approach developed in this paper allows the quantification of these criteria and selection of the best alternative out of the proposed organizational models. For the academic audience, we present effective and contemporary modeling using mathematical solution for application in the area of cybersecurity. The presented model enables the evaluation of the proposed options of organizational structure, regardless of the number of optimality criteria and sub-criteria. The model allows for the choice of best alternative from a set described ones using K optimality criteria and sub-criteria.

Application of the given model is shown on the example of designing the organizational structure of the management of the enterprise cybersecurity.

The complex environment, in which these management bodies act, does not tolerate organizational improvisation, rather requires a planned and methodological organizational approach.

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FACTORS OF A PERFECT STRATEGY FOR RELATIONSHIPS IN ORGANIZATION - EXAMPLE OF EMOTIONAL ECONOMY

Miodrag Radivojević[1],
Goran Biševac[2,] *

[1]Intelligence and Reconnaissance Directorate of the General Staff of the Serbian Army
[2]Military Geographical Institute,
Belgrade, Serbia

Abstract:
The success of an organization depends not only on economic parameters. Relationships in organization represent social interaction and imply emotional reactions and various other forms of interpersonal relationships and form a very complex social field. The paper deals with the notion and phenomenon of emotional economy as a factor in successful management of relationships in the organization. The aim of the paper is to point out the importance of the influence of spiritual and emotional intelligence in interpersonal relations, as well as to present possible strategies for their management. Spiritual intelligence provides personal security and optimal effectiveness, building functional relationships among people, understanding and accepting change and resolving conflicts. Emotional intelligence is considered a key to business success. It is assumed that emotional and spiritual intelligence has a very significant impact on the creation of the competitive advantage of the organization, and that they are responsible for creating added value and building an organization's intellectual capabilities.

Keywords:
Organization, Economy, Management, relationships, emotional intelligence.

1. INTRODUCTION

Always human intelligence has been a great subject of interest. Our intellectual or rational intelligence is the intelligence we use in everyday life to solve the problem. Later, psychologists began to make tests for measuring this intelligence, and these tests turned into a means of assigning people to various degrees of intelligence, known as IQ's intelligence coefficient. The higher IQ's intelligence coefficient was considered by people to be more eloquent and this was a factor in determining human abilities.

At the end of the 20th century, scientist Daniel Goleman showed research by many psychologists and neurologists that emotional intelligence "EQ" is very important in human life in building and strengthening relationships and managing relationships in organizations, and in giving meaning and effective application rational intelligence IQ [1].

At the very end of the 20th and the beginning of the 21st century, scientists discovered that there is a third type of intelligence that is the third

Correspondence:
Goran Biševac

e-mail:
sbakrac@yahoo.com

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Q, which is spiritual or spiritual intelligence "SQ". The full image of human intelligence is achieved by observing all three types of intelligence "Q", "EQ" and "SQ". Using spiritual or spiritual intelligence, we solve problems of value and meaning, it helps us to give a more meaningful and meaningful meaning to all life flows. Spiritual intelligence helps us to make effective use of "IQ" and "EQ", and "SQ" and this is the highest human intelligence stage for the time being.

There are scientists who claim that there are at least seven types of human intelligences, such as: spatial, musical, sports, emotional and rational [2], [3]. But other scientists argue that all these types of intelligence can be linked to one of the three neural systems in the brain, and hence can be classified into rational intelligence "IQ", emotional intelligence "EQ" and spiritual intelligence "SQ" [4]. Human intelligence has to be seen through these three contexts, because computers also have a visuku "IQ" because they know the rules and follow the procedures without error, and the animals have an "EQ" because they have a sense of the situation and know how to react [5]. However, none of them except the man asks for the meaning of all this, does not analyze the situation and does not ask if it can be any better [6].

The roots of human intelligence rest in our genetic code and in the entire evolutionary history of life on this planet. It is influenced by our everyday experience, our physical and mental health, the way of eating, the amount of physical exercise, the types of relationships we educate and many other factors [7]. However, neurologically speaking, everything concerning intelligence has been transmitted or controlled by the brain and its nerve sequences in the body.

2. APPLYING EMOTIONAL INTELLIGENCE AND THE BENEFITS IT BRINGS

Earlier, it was believed that when selecting candidates for admission to work positions in certain work organizations, care must be taken to ensure that applicants have as high IQ as well as a higher average during the studies. Even the limits have been set, for example, not receiving candinas from "IQ" below 150. However, this method of work has led to disastrous consequences for the work organization, since not all with the high "IQ" contributed to the organization, even became destructive . Practice has shown that at the present time, the most important thing is that the person has developed emotional intelligence "EQ" to become part of the collective, to fit into the collective and contribute to the organization. There are cases where employees with lesser knowledge and intellectual capacity surprised the quality of their work.

Nowadays, working organizations are managed by managers who need to keep this in mind when choosing a team of people to work with when they implement a relationship management and employee management strategy at their own company. The goal of each private work organization is to maximize profits, using all the potentials, knowledge and skills of employees, with the optimal use of time and means of work. In addition, every experienced and good manager knows that his goals in the organization will be achieved if his chosen team of people gives a personal example, human, moral virtue and quality. The manager will use the relationship management strategy, managing the skills of emotional intelligence: Self-awareness, self-control, adaptability, transparency, ensure that people maximally support themselves in their work, do their best so that the combined energy and work give the synergy necessary for the fulfillment of missions and the task of this organization, which is in most cases a profit. The use of an emotional economy and a relationship management strategy in an organization can be called an emotional economy. This example of emotional economy is applied in all democratic and economically developed countries of Western Europe and the United States.

Knowing emotional intelligence can contribute not only to a more humane approach to employees, but also to the new development of the concept of business, better results at work, a new understanding of leadership.

Emotional intelligence is not an ordinary kindness, constant smile and convalescence to the interlocutor. On the contrary, an emotionally intelligent man will often oppose wrong thinking and prejudice. EQ is not a free, uncontrolled manifestation of all of its emotions, but just the opposite. It means (successful) control of especially unhealthy emotions. Emotional intelligence strengthens and develops for a lifetime.

"EQ" emotional intelligence has been defined as "the ability to track and distinguish one's own and others' emotions and use that information as a guide for thinking and behavior" [8].

Domains of emotional intelligence and relevant characteristics:

Self – awareness [9]:

Emotional self-awareness: knowledge of one's own emotions and understanding of their actions.

Exact evaluation of oneself.

Self-indulgence: a reasonable feeling of one's own values and abilities.

Rule itself [9]:

Emotional self-control: restraining turbulent feelings and impulses.

Transparency: Expressing honesty, integrity and reliability.

Flexibility: flexible adaptation to new situations or overcoming obstacles.

The pursuit of success. The urge to achieve personal standards of excellence through training.

Initiative: willingness to act and take advantage of the opportunity.

Optimism: a Positive View of the Event.

Social consciousness:

Empathy: Feeling the emotions of other people, understanding their perspective and expressing interest in their care.

Awareness of the organization: understanding of electricity, decision-making channels and policies at the organizational level.

Intelligibility: understanding and meeting the needs of employees, clients or customers.

Relationship menagament [9]:

Inspiring leadership: leadership and motivation based on an appealing vision.

Impact: skillful use of persuasion tactics.

Improvement of other people: encouraging their ability through guidance based on feedback.

Change catalyst: initiating, managing and operating in a new direction.

Conflict management: solving disputes.

Creating links: cultivating and maintaining a network of relationships.

Team work and cooperation: working together and creating teams.

Self – awareness:

Understanding their own emotions, advantages and disadvantages, the value of the motive is self-awareness.

Self-conscious people are above all realistic (not too critical or not even self-confident) towards themselves. Accurate self-assessment helps us to understand our possibilities and limitations. In this way, constructive criticism can be accepted and feedback can be given. When they know exactly the strengths and weaknesses, the foundation of security in their own personality is given. A clear understanding of one's own emotions, intentions - the possibility of managing one's own personality.

For leaders it is essential to restrain (understand) negative emotions that create a negative atmosphere and most directly affect the work of employees. Simply put, a leader can not effectively manage someone's emotions if he does not manage his own first. Emotional control does not mean denial and neglect of emotions and their choking. Leaders who possess emotional control manage to control emotional emotions and make them useful. Transparency refers to the fact that leaders live in accordance with their values.

Social consciousness:

Social awareness as a component of intelligence encompasses empathy, awareness of organization and sensitivity.

Empathy, the ability to feel compassion with others is one of the important aspects of "EQ". Paying attention to the feelings of employees, and then making the right decisions while taking care of others' feelings.

Social awareness is a component of the EQ and involves more awareness of the organization and the susceptibility of the leaders. Leaders, as a rule, have sharpened social awareness and political wisdom.

Relationship menagament [9]:

Relationship management is another feature of EQ. Leaders perform inspiringly, offering a sense of common purpose - which in fact goes beyond everyday tasks[10]. They affect people convincingly and attractively. They are able to instill others into self-improvement, consecutively and give feedback which makes them perfect mentors. A team friendly work creates a friendly and collegial atmosphere.

The skillful "management" of the conflicts is in the leader's ability to hear both sides and understand the attitudes and emotions of the involved actors of the conflict.

3. EMOTIONAL ECONOMY

In large companies around the world, management knows that human potential is the most valuable part of their intellectual capital. They are aware that "people are, above all, emotional beings, and then only reasonable." So the Emotional Economy "is an important segment of achieving the competitive advantage of each organization.

"The success of an enterprise does not depend primarily on how managers and owners understand economic

principles or basic postulates of marketing, but also how much the owner is understood in the" emotional economy ". Each employer must understand how the development and goals of each employee are consistent with the goals of the organization, as well as to understand the correlation between each employee and the consumer.

Emotional economy as an asset that in today's business environment should provide greater employee commitment and greater loyalty to consumers, which will result in a better competitive position and greater profit, is followed by the Follow That Path by Curt Coffman and Gabriel Gonzalez Molina [11]. From the findings reached by the authors of the book, it is clear what the emotional economy is.

In the shortest, it is commitment to work, effective and efficient performance of the job using all its potentials. In this way, the added value of the company, as well as the relative capital, which also contains the elements of emotional intelligence of the employees, is created.

Coffman [11] considers that "the success of a company depends solely on how much the owner is understood in the" emotional economy ". Each employer must understand how the development and goals of each employee are in line with the goals of the organization, as well as to understand the correlation between each employee and consumer. "

"The Gallup Institute has compiled a performance system (Q12), which defines what individuals and businesses need to do to be successful and better than their competitors. This system of performance is the result of research of employee attitudes in relation to: employee fluctuation, productivity, employee satisfaction / dedication, security and profitability of the organization. Companies that manage to build a system that supports undetected twelve points as a result will have a better competitive position and, therefore, a greater profit.

"Q12 - the performance system includes the following 12 points:

Define the right results

Ensure the necessary funds

Select appropriate employees for the appropriate job

Focus on the strength of each employee

Care for employees

Identify the hidden talents of each employee and form teams based on that

Listen to employees, let them be heard

Help each employee understand the meaning of the mission

All employees together should provide quality to customers

Employees need each other to "keep their backs"

Employees like to know how advanced they are

Organizations learn through their employees."

For the successful implementation of the emotional economy, leaders, or managers, must be guided by the principles of the strategy of relationship management and emotional management. Like when the coach of a losing football team, hold a speech in the half-timing of his team, they return to their team after returning to the second half with a new idea of lead and win. What the coach used here, rather than managing the relationships and emotions of the soccer players, in this way ensured that they achieved their desired goal. The relationship management strategy implies 17 tactics that every leader must know and apply in his work:

- Be open and curious,
- Improve your natural style of communication,
- Avoid giving mixed signals in communication,
- Remember that small things can accomplish the goal (hit in the target),
- Welcome feedback,
- Build confidence,
- Implements an open door policy,
- It is only when you have a purpose for it (when you achieve a goal),
- Do not avoid inevitable,
- Recognize the feelings of others,
- Compliments of feelings or situations in which other persons are found,
- Show when you are worried,
- Do not just make decisions, explain them,
- Let your answer be direct and constructive,
- Synchronize your intent with your influence,
- When the negotiations fail, try to build relationships,
- Complete the difficult negotiations.

From all of the above it follows that the basic task of the company management would be to enable its employees to develop their potentials to the maximum and to use them at work. Leaders should be an emotional anchor in the organization and some kind of buckle in building the relational and human capital of the organization [11]. Coffman calls s In evolutionary contexts, Dickon's neurobiological work on language and

symbolic representation shows that we have literally used SQ to develop our human brains. SQ has provided us with the necessary "installations" to become what we are and provide us with the potential for further "reinstallation" - for development and transformation, for the further evolution of our human potential. We use SQ to be creative. We call upon him when we need flexibility, visionary ability, or creative ability. We also use SQ in dealing with existential problems - problems when we feel that something has happened to us somewhere in life, that we are caught in a trap of habit or neurosis from the past, or problems associated with disease and depression. SQ makes us aware of the fact that we have existential problems and allows us to solve them - or at least to reconcile with them. It gives us a deep sense of the meaning of life's struggle.

SQ is our compass "on the edge". The most challenging living existential problems begin beyond the expected and well-known, beyond the established rules, beyond the reach of the previous experience, far from what we know to come to an end. In the chaos theory, the "edge" is the boundary between order and chaos, between the comfortable cognitions, which we strive for and total loss. This is a place where we can best express our creativity. SQ, our deep, intuitive sense of meaning and value, is our guide on the edge. SQ is our conscience. (In Hebrew, the words that signify "conscience", "compass" and "hidden, inner truth of the soul" have the same root).

We can apply SQ so that we become spiritually more intelligible in terms of religion. SQ leads us to the very heart of things, to unity that lies behind the difference, to the potential beyond any current expression. SQ can bring us in touch with the sense and essential spirit behind all major religions. A person who possesses a high SQ can exercise any religion, but without narrow eyes, exclusiveness, constancy or prejudice. Likewise, someone who is distinguished by a high SQ can possess distinctive spiritual qualities, without being religious at all.

SQ allows us to integrate intrapersonally and interpersonally, to overcome the gap between ourselves and others. Danijel Goleman (DanielGoleman) wrote about intrapersonal emotions, to those who inhabit within the self and interpersonal emotions - emotions that we share with others or use them in relationships with other people. However, a mere EQ can not help us overcome this gap. We need SQ so that we can understand who we are and what certain things mean to us, as well as how they give the other people and their meaning a place in our own world.

SQ is used in order to more fully oppose to the developed sizes whose potential we carry in ourselves. Each of us forms a character through a combination of experience and vision, through the tension between what we are currently doing and the larger, better things we can do. On a pure ego level, we are focused on ourselves, selfish, materially ambitious, etc. But despite this, we possess transpersonal visions of goodness, beauty, perfection, generosity, sacrifice, etc. SQ helps us overcome our immediate egoities and get out of them towards those deeper layers of potential that lie hidden within us. It helps us to live lives at a deeper level of meaning.

4. CONCLUSIONS

Collective SQ is low in modern society. We live in a spiritually defective culture characterized by materialism, the principle of usefulness, narrow-minded egocentricity, lack of sense and lack of commitment. However, as individuals we can work on the rise of our personal SQ, moreover, further evolution of society depends on a sufficient number of individuals who will dedicate themselves to this goal. Generally speaking, we can increase our SQ by increasing the use of the tertiary process - our tendency to ask why, to seek for connections between things, to put the surface of the assumptions we create about the meaning behind inside the thing, to become more reflexive, to get a little out of ourselves , to take responsibility, to become more self-aware, to be more honest with ourselves, as well as to be more brave.

Through a more cultivated application of our spiritual intelligence, as well as through the personal sincerity and courage that such cultivation requires, we can reconnect ourselves with deeper sources and deeper meanings within ourselves, and this can be put into the service of objectives and processes that are much greater than us. In such a service we can find our psychic self-development. Our psychological self-development can rest in service to our own deep imagination.

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HYBRIDIZED PARTICLE SWARM OPTIMIZATION FOR CONSTRAINED PROBLEMS

Nebojša Bačanin Džakula*,
Ivana Štrumberger,
Eva Tuba,
Milan Tuba

Singidunum University,
Belgrade, Serbia

Abstract:
This paper presents hybridized implementation of the well-known particle swarm optimization algorithm that belongs to the family of swarm intelligence metaheuristics. The proposed approach was adapted for tackling constrained optimization problems. With the basic goals to enhance the converge of the algorithm and to improve the exploitation – exploration tradeoff, the mechanism that replaces exhausted solutions from the population with randomly generated solutions from the search domain was adopted from the artificial bee colony approach. Proposed metaheuristic was tested on standard constrained engineering benchmark, and comparative analysis with other state-of-the-art algorithms was conducted. Empirical results obtained from practical simulations proved that the hybridized particle swarm optimization for constrained problems is able to successfully tackle this type of NP hard challenges.

Keywords:
particle swarm optimization, NP hardness, constrained optimization, engineering problems, swarm intelligence.

1. INTRODUCTION

Since many real-world problems can be formulated as optimization tasks, optimization has been widely applied in the domains of computer science and mathematics. The hardness of particular problem depends on the types of mathematical relationships between decision variables, objective function and in same cases constraints.

Many real-life challenges can be categorized as NP hard problems. These problems can be be further divdied into two basic groups: discrete (combinatorial) and global optimization (conitnuous) problems. Global optimization tasks can be distinguished as unconstrained (bound constrained) and constrained.

In this paper, the nonlinear continious constrained optimization problems are particulary addressed, and they can be mathematically expressed as:

$$\min f(x), x = (x_1, x_2, x_3, \dots, x_n) \in R^n, \quad (1)$$

Correspondence:
Nebojša Bačanin Džakula

e-mail:
nbacanin@singidunum.ac.rs

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where $x \in F \subseteq S$. Symbol S denotes the search space, as n-dimensional hyper-rectangular space in R^n. The R^n is defined by lower and upper bounds of decision variables:

$$lb_i \leq x_i \leq ub_i,\ 1 \leq i \leq n \tag{2}$$

Finally, the feasible domain of the search space $F \subseteq S$ is determined with a set of m linear and nonlinear constrains that are formulated as following:

$$\begin{aligned} &g_j(x) \leq 0, for\ j = 1, \ldots q \\ &h_j(x) = 0, for\ j = q+1, \ldots, m, \end{aligned} \tag{3}$$

where q denotes the number of inequality constraints, while the number of equalities constrains is m-q.

The utilization of classic deterministic algorithms (algorithms that for the same set of input always generate the same output), or exhaustive search approaches for solving NP hard problems is not feasible since it would take too long time for algorithms to execute. In the case of such problems, it is better to employ some of the metaheuristic methods, that could not guarantee to obtain an optimal solution, but could provide satisfying solution within reasonable execution period.

In recent years, many metaheuristic algorithms have been devised for solving large variety of optimization problems from both areas, combinatorial and global. Usually, metaheuristics are population and iterative based approaches that work with a set of solutions that are being improved in each iteration of algorithm's execution by applying the search equation. When a new metaheuristic approach is developed, it is good practice to test it first on standard benchmark problems to evaluate its solutions' quality and robustness. Later, the metaheuristics can be adapted for solving various kinds of real-life optimization problems.

In this paper, we present our implementation of the well-known particle swarm optimization (PSO) metaheuristics that was adjusted for solving global constrained optimization tasks. The PSO approach belongs to the group of swarm intelligence metaheuristics. The solutions' quality and the performance of the proposed approach was validated against the well-known conastraned optimization benchmarks.

The rest of the paper is structured as follows. In Section I, we brifely present basic principles and literature review of swarm intelligence metaheuristics. The implementation of the hybridized PSO algorithm for constrained optimization is given in Section II. Experimental setup, empircal results and comparative analysis is given in Section III, while Section IV concludes this paper and provides guidelines for future work in this domain.

2. REVIEW OF SWARM INTELLIGENCE METAHEURISTICS

At the very general level, metaheuristics can be divided into two groups: those that are inspired by the nature, and those that are not inspired by the nature. Nature-inspired metaheuristics can further fall into one of two categories: evolutionary algorithms (EAs) and swarm intelligence. The EAs conduct the search by simulating the process of natural evolution by applying operators adopted from the nature, such are crossover, mutation and selection, The most well-known example of EA is genetic algorithm (GA) [1]. The GA was successfully applied to various kinds of optimization challenges [2], [3].

Swarm intelligence metaheuristics mimic collective behavior and social interactions between individuals in swarms, like groups of birds and fish, bees, fireflies, bats, ant, etc [4]. Every artificial agent (individual) in swarm intelligence algorithms is relatively unsophisticated and simple. However by established communication between such agents, a sofisticated system is developed that is directed towards achiving a particular goal.

Two essential mechanisms that guide the search process in swarm intelligent approaches are exploitation (intensification) and exploration (diversification). The intensification perform the local search process around the current solutions in the population, while the diversification conduct exploration of the still undiscovered domain of the search space. Since many benchmark and real-life optimization problems have many local and/or global optimums, exploration prevents the algorithm to be trapped in the local optimu,, while the exploitaiton enables fine search process around the current best solutions in the population.

Artificial bee colony (ABC) is one of the most prominent representative of swarm algorihtms. The ABC simulates behavior of honey bee swarms by utilizing three types of artificail agents: employees, scouts and onlookers. This metaheuristics has many successful implementations for many benchmark problems [5], as well as for practical challenges [6], [7]. Firefly algorithm (FA) is another widely applied representative of swarm algorithms, that was devised by Yang in 2008 [8], and later was improved [9]. Some of the FA's applications

include: constrained benchmark challenges [10], wireless sensor network localization [11] and portfolio optimization [12]. Many hybridized FA approaches can be also found in the literature survey [7], [13].

Fireworks algorithm (FWA), that emulates the process of fireworks' explosion, was firstly proposed by Tan and Zhu in 2010 for tackling global optimization challenges [14]. According to the literature survey, since its creation, this metaheuristic has eight versions that have been adopted and applied to different benchmark [15] and practical challenges, for example retinal image registration [16], constrained portfolio optimization [17], multilevel image thresholding [18], RFID network planning problem [19], capacitated p-median problem [20]. Another swarm intelligence metaheuristic, that models herds of elephants (elephant herding optimization – ECHO), emerged in 2015. EHO is known as good NP hard problems optimizer with many implementations in both domains, benchmark [21], and real-life challenges. Some of the EHO's implementations for the practical tasks include: support vector machine (SVM) [22], static drone placement problem [23] and localization of sensors with unknown location in wireless sensor networks (WSNs) topology [24].

Relatively new monarch butterfly optimization (MBO) has been recently proposed by Wang and Deb for global benchmark problems [25]. Despite of this fact, MBO already has adaptations for practical tasks [26] and multi-objective optimization problems [27]. Another representative of swarm intelligence algorithm, moth serach (MS), that was also proposed by Wang [28], qualifies as the state-of-the-art metaheuristic. Besides implementations for the benchmark problems [29], [30], many MS's adaptations for the real-world problems can be found in the literature survey [31], [32].

Besides all above mentioned, other swarm intelligence approaches that are worth of mentioning encompass: seeker optimization algorithm (SOA) [33], cuckoo search (CS) [34], [35], [36], bran storm optimization (BSO) [37], [38], bat algortithm (BA) [39], [40], and state-of-the-art approach for cobinatorial optimization, ant colony optimization (ACO) [41].

3. PARTICLE SWARM OPTIMIZATION FOR CONSTRAINED PROBLEMS

Particle swarm optimization (PSO) is well-known swarm intelligence approach devised in 1995 by Kennedy and Eberhart [42], [43]. The PSO proved to be robust and state-of-the-art metaheuristics with many implementations and adaptations [44]. In this Section of the paper we present our adaptations of this outstanding optimizer adapted for tackling constrained optimization problems.

In the basic PSO implementation, potential problem solution (individual in the population) within the boundaries of the search space domain is represented as particle. Each solution i in the D-dimensional search space is defined by its position and velocity, denoted as $x_i=(x_{i1},x_{i2},x_{i3},\ldots,x_{iD})$ and $v_i=(v_{i1},v_{i2},v_{i3},\ldots,v_{iD})$, respectively.

At the beginning of algorithm's execution, in the initialization phase, all solutions in the population are generated randomly within the lower and upper boundaries of the search space (see Eqs. (1)-(2)). After random initialization, in each iteration of algorithm's execution, the position and velocity of each solution are updated using the following expressions [43]:

$$v_i(t+1) = wv_i(t) + c_1 r_1\left(p_i - x_i(t)\right) + c_2 r_2(p_g - x_i(t)) \tag{4}$$

$$x_i(t+1) = x_i(t) + v_i(t+1), \tag{5}$$

where the ω denotes the inertia weight that is utilized for the purpose of controlling the influence of the old velocity to the new one, c_1 and c_2 control constants that are used for determining the weights of p_g and p_i. Previously best position of the i-th individual in the population is denoted as p_i, while the p_g represents the best previous position of solutions in the current iteration. Finally, r_1 and r_2 are pseudo-random numbers uniformly generated in the range [0,1], t is the current iteration, and $t+1$ is the next iteration.

By utilizing presented equations (Eq. (4) and Eq. (5)) the exploitation and exploration process of the PSO metaheuristics is being performed. By adjusting the values of c_1 and c_2 control parameters, the balance (trade-off) between the intensification and diversification is also being adjusted. If the values of c_2 and c_2 parameters are too high, this balance is shifted towards exploitation. Otherwise, if the values of c_2 and c_2 parameters are too low, the trade-off favours the process of exploration.

According to prevously conducted studies [12], [13], [33], in the first iterations of the algorithm's execution, the exploration should be more intensive, due to the assumption that the search process has not yet converged to the optimum domain of the search space. However, in the later iterations, with the basic assumption that the

promising part of the search domain is found, the power of intensification should be enhanced.

For the sake of better controlling the balance between exploitation and exploration, in our PSO implementation, we introduced the *limit* parameter from the ABC metaheuristic. The basic idea behind this approach can be summarized into one sentence: each solution in the population that can not be enahnced in a predefined number of iterations is being discarded from the population and replaced with the pseudo-random solution generated within the lower and upper boundaries of the search domain. Every time when a particular solution could not be improved, the value of its *limit* parameter is incremented. When a value of the *limit* parameter reaches the threshold value (*tvalue*), this solution is discarded from the population.

One of the greatest challenges in the domain of constrained optimization is how to handle constraints. Equality constraints could pose serious problem due to the fact that they could significantly shrink the feasible part of the search space that becomes very small compared to the entire search space. In our PSO implementation, we replaced the equality constraints by inequality by using small violation limit $\varepsilon > 0$ [45]:

$$|h(x)| - \varepsilon \leq 0 \tag{6}$$

Feasibility of the solutions depends on the value of violation limit ε. If this value is too low, the search process may not find feasible part of the search space. Otherwise, if the chosen value for the ε is too high, obtained results may be far from the feasible space. One of the best approaches is to adapt dynamic violation limit approach, by starting with the large value of violation limit in early iterations, and then to gradually decrease its value during the course of algorithm's execution.

In our PSO implementation for this purpose we used the following expression [13], [33]:

$$\varepsilon(t+1) = \frac{\varepsilon(t)}{dec}, \tag{7}$$

where t and $t+1$ denote the current iteration and next iterations, respectively, and $dec>1$ represents the decreasing coefficient in each iteration.

In our implementation we perform the selection process between old and new solution, after utilization of the search equations (Eq. (4) and Eq. (5)), by employing Deb's rules [46], [47]. In this way, we make sure that the feasible solutions are favoured over infeasible solutions, and also that if both solutions, old and new, are infeasible, we make sure that the infeasible solution that is closer to the feasible part of the search region is favoured over other infeasible solution, that is distant from the feasible space.

By introducing all described modifications in the basic PSO version, we devised hybridized constrained PSO (HCPSO) metaheuristic. All execution steps of the HCPSO are summarized in the pseudo-code given below.

1. Initialize pseudo-random population
2. Evaluate population
3. Set the violation limit to 1
4. *iter* = 1
5. **repeat**
6. For every solution in the population, generate new solution by using Eq. (4) and Eq. (5)
7. Apply selection between old and new solution based on the Deb's rules [46], [47]
8. For all solutions that can not be improved, increment the value of the *limit* parameter
9. Replace all solutions from the population whose *limit* parameter value reach the *tvalue*. with randomly generated solutions
10. Memorize the best solution obtained so far
11. If the condition is met, dynamically adjust the value by using Eq. (7)
12. *iter* = *iter* +1
13. **until** *iter* = *MITER*
14. Output the best solution in the population

In the presented pseudo-code, *MITER* denotes the maximum iteration number in one algorithm's execution (run).

4. PARAMETER SETUP, EMPIRICAL RESULTS AND COMPARATIVE ANALYSIS

In this section of the paper we first show one of the well-known constrained engineering benchmarks that was used for validation purposes of our proposed approach. Then we show HCPSO control parameters adjustments, and finally we present empirical results along with comparative analysis with other state-of-the-art metaheuristics tested on the same problem.

Speed reducer design problem

In order to prove robustness, convergence speed and solution's quality of the HCPSO metaheuristic, we utilized speed reducer design problem that was firstly introduced by Golinski [48]. The basic objective of this problem is to minimize the weights of the speed reducer. Visual representation of the speed reducer is given in Fig. 1.

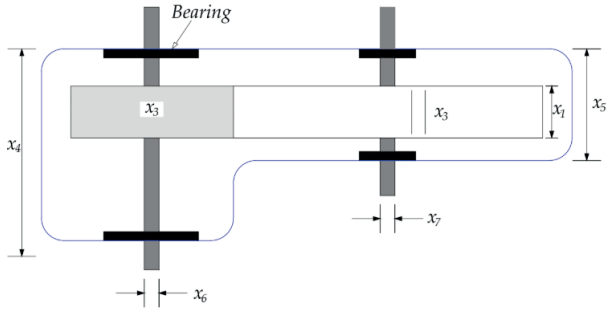


Fig. 1. Example of a figure caption. *(figure caption)*

The speed reducer problem includes seven design variables: face width (x_1), teeth module (x_2), pinion teeth number (x_3), shaft between the bearings (x_4), first shaft length (x_5), first shaft diameter (x_6) and the second shaft diameter (x_7). Moreover, the speed reducer problem incorporates eleven inequality constraints.

Mathematical formulation of the speed reducer problem is given in Eqs. (8) – (20).

$$min\, W(x) = 0.7854x_1x_2^2(3.3333x_3^2 + 14.9334x_3 - 43.0934) - 1.508x_1(x_6^2x_7^2) + 7.4777(x_6^3x_7^3) + 0.7854(x_4x_6^2 + x_5x_7^2) \quad (8)$$

Subject to:

$$g_1(x) = \frac{27}{x_1x_2^2x_3} - 1 \le 0 \quad (9)$$

$$g_2(x) = \frac{397.5}{x_1x_2^2x_3^2} - 1 \le 0 \quad (10)$$

$$g_3(x) = \frac{1.93x_4^3}{x_2x_3x_6^4} - 1 \le 0 \quad (11)$$

$$g_4(x) = \frac{1.93x_4^3}{x_2x_3x_7^4} - 1 \le 0 \quad (12)$$

$$g_5(x) = \frac{1}{110x_6^3}\sqrt{\left(\frac{754x_4}{x_2x_3}\right)^2 + 16.9 \cdot 10^6} - 1 \le 0 \quad (13)$$

$$g_6(x) = \frac{1}{85x_7^3}\sqrt{\left(\frac{754x_5}{x_2x_3}\right)^2 + 157.5 \cdot 10^6} - 1 \le 0 \quad (14)$$

$$g_7(x) = \frac{x_2x_3}{40} - 1 \le 0 \quad (15)$$

$$g_8(x) = \frac{5x_2}{x_3} - 1 \le 0 \quad (16)$$

$$g_9(x) = \frac{x_1}{12x_2} - 1 \le 0 \quad (17)$$

$$g_{10}(x) = \frac{(1.5x_6+1.9)}{x_4} - 1 \le 0 \quad (18)$$

$$g_{11}(x) = \frac{(1.1x_7+1.9)}{x_5} - 1 \le 0 \quad (19)$$

with parameter's bounds:

$$2.6 \le x_1 \le 3.6, 0.7 \le x_2 \le 0.8, 17 \le x_3 \le 28$$
$$7.3 \le x_4 \le 8.3, 7.8 \le x_5 \le 8.3, 2.9 \le x_3 \le 3.9 \quad (20)$$
$$5 \le x_7 \le 5.5$$

HCPSO Control parameters setup

We adjusted the global HCPSO control parameters as follows: number of solutions in the population (*N*) was set to 40, and *MITER* was set to the value of 750. These settings yield to the total number of 30,000 objective function evaluations in one algorithm's run (40 750 = 30,000).

The HCPSO local control parameters c_1 and c_2 were both set to the value of 2, while the inertia weight () was adjusted to 0.7. For setting the threshold value (*tvalue*) to 19, by using the following equation:

$$tvalue = round(\frac{MITER}{N}) \quad (21)$$

As already stated in the Section II, at the beginning of the algorithm's execution we set to 1, whose value was gradually decreasing during the algorithm's execution according to Eq. (7). The value of the *dec* was set to 1.002, while the threshold for the was adjusted to 0.0001.

Empirical results and comparative analysis

Comparative analysis was performed between our proposed approach HCPSO and society and civilization (SCA) metaheuristic, hybridized artificial immune system with clearing procedure (AIS-GA^{c}), ABC and BA metaheuristics. Results of other approaches for the purpose of comparative analysis were taken from [49].

Results of conducted comparative analysis are presented in the Table I. The notation "V" used for some results indicate that such results are not feasible. From the presented comparative analysis, it is clear that HCPSO obtains the best value for objective function (w). Results reported for the BA metaheuristic are slightly better, but violate g_5 and g_6 constrains, and such are infeasible.

It also should be noted that the SCA and AIS-GA^{S} were tested with 54,456 and 36,000 function evaluations [50], which is significantly more than 30,000 function evaluation that were utilized in tests conducted with HCPSO metaheuristic. The ABC approach was also tested with 30,000 objective function evaluations, while the BA metaheuristic utilized only 15,000 evaluations [50]. However, the results reported for the BA approach are not feasible and cannot be taken into consideration.

Table 1. Simulation Results And Comparative Analysis

	Algorithms				
	SCA	*AIS-GA^{C}*	*ABC*	*BA^{V}*	*HCPSO*
x_1	3.50000681	3.5	3.499999	3.5	3.50000001
x_2	0.70000001	0.7	0.7	0.7	0.7
x_3	17	17	17	17	17
x_4	7.32760205	7.3000035	7.3	7.30001	7.30000012
x_5	7.71532175	7.7153225	7.8	7.71532	7.71532019
x_6	3.35026702	3.3502147	3.350215	3.35021	3.3502145
x_7	5.28665450	5.2866545	5.287800	5.28665	5.28665437
g_1	−0.073917	−0.07391524	−0.073915	−0.074	−0.07391518
g_2	−0.198000	−0.19799852	−0.197999	−0.198	−0.19799853
g_3	−0.493501	−0.49917156	−0.499172	−0.499	−0.49917226
g_4	−0.904644	−0.90464383	−0.901555	−0.905	−0.9046439
g_5	−6.362E−07	−2.451E−08	−2.990E−07	4.195E−06^{v}	−3.013E−08
g_6	−1.954E−08	−1.938E−08	−6.335E−04	2.534E−05^{v}	−2.754E−09
g_7	−0.702500	−0.7025	−0.7025	−0.7025	−0.7025
g_8	−1.931E−06	0	2.857E−07	0	−9.431E−09
g_9	−0.583333	−0.5833333	−0.583333	−0.583	−0.58333333
g_{10}	−0.054889	−0.05132616	−0.051326	−0.051	−0.05132576
g_{11}	−2.333E−07	−3.305E−07	−0.010695	−6.481E−07	−4.315E−08
w	2,994.7442	2,994.4712	2,997.0584	2,994.4671	**2,994.470123**

5. CONCLUSION

In this paper we presented implementation of the hybridized particle swarm optimization for constrained problems. In order to enhance the convergence, and to improve the balance between intensification and diversification, we incorporated the *limit* control parameter from the well-known artificial bee colony metaheuristic. The proposed approach was named hybridized constrained particle swarm optimization (HCPSO).

Proposed metaheuristic was tested on standard constrained engineering optimization benchmark – speed reducer design problem. According to the results of comparative analysis with other state-of-the-art optimizers that were tested for the same problem instance, and under the equivalent experimental conditions it can be concluded that the proposed HCPSO represents promising approach for tackling these types of NP hard challenges.

Since many real-world optimization tasks belong to this group of problems, the HCPSO will be adapted for other problems as part of the future research.

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THE IMPACT OF ROAD CHARACTERISTICS ASSESSMENT ON THE TRAFFIC ACCIDENTS OCCURRENCE

Marjana Čubranić-Dobrodolac[1,*],
Tatiana Molková[2],
Libor Švadlenka[2]

[1]Faculty of Transport and Traffic Engineering,
University of Belgrade,
Belgrade, Serbia
[2]Faculty of Transport Engineering,
University of Pardubice,
Pardubice, Czech Republic

Abstract:
This paper proposes a model for assessment of driver's propensity toward traffic accidents based on the implementation of fuzzy logic. The proposed Fuzzy inference system is based on three input variables and one output. Input variables are: The assessment of dangerous places on the observed road section (nine dangerous spots are selected; however, the scores from these nine spots are sublimated in one variable), Assessment of road characteristics (seven road characteristics are chosen; however, the scores from these seven spots are sublimated in one variable) and Frequency (Input variable Frequency is based on the criterion how many times a week or a month the examinee drives on the observed road section). Output variable is The number of accidents that a driver had experienced. The model is tested on the sample of 305 drivers and most of them are professional drivers. The results are perceived through the cumulative error that fuzzy inference system makes in description of empirical data.

Keywords:
traffic accidents, road safety, dangerous spots assessment, road characteristics assessment, fuzzy systems.

1. INTRODUCTION

The vulnerability of people in traffic accidents is one of the biggest threat of nowadays. According to the World Health Organization [1], around 3700 people die on the roads every day. In addition to human losses, traffic accidents also cause significant economic costs. Based on various reports, these costs are in range from 1 to 2% of some country's Gross Domestic Product – GDP.

Some general causes of traffic accidents relate to the following: driver, i.e. human factor, vehicle and road [2,3]. According to the police reports in the Republic of Serbia, the most common circumstances that lead to the occurrence of accidents are: unadjusted speed, wrong assessment of the traffic situation and the performance of improper actions in traffic, as well as the psycho-physical condition of the driver, for example, driving under the influence of alcohol [4].

Correspondence:
Marjana Čubranić-Dobrodolac

e-mail:
marjana@sf.bg.ac.rs

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The previous stated indicate the importance of studying the nature of risk behavior of drivers in order to take appropriate measures to increase traffic safety. However, it is also important to analyze the factor of road, and particularly the interaction of driver-road factor. This is the reason why the subject of interest in this paper is the question how the road characteristics assessed by a driver impact the propensity toward traffic accidents. For the purpose of this phenomenon quantification, a model proposed in this paper is based on the implementation of fuzzy logic [5]. The model is tested on the sample of 305 drivers and most of them are professional drivers.

2. MODEL DEVELOPMENT – USED VARIABLES

The model proposed in this paper is based on the implementation of fuzzy logic. Fuzzy inference system is based on three input variables and one output. Input variables are: The assessment of dangerous places on the observed road section, Assessment of road characteristics and Frequency of driving on the road section. Output variable is The number of accidents that a driver had experienced.

The first variable x_1 named *Dangerous spots* is formed based on assessment of nine dangerous places on the considered road section which are previously noticed by the authors. These dangerous places are determined based on the official statistic about the most frequent location of traffic accidents in the past.

The chosen road section is in the Republic of Serbia, road category IB, number 22, which is colloquially known as „Ibarska magistrala". Each of 305 examinees from the sample gave scores about the following nine dangerous spots: Žarkovo, Orlovača, Ripanj, Šiljakovac, Stepojevac, Šopić, Lazarevac roundabout and Ćelije. The final value of the first input variable is a mean of all nine scores. The scores are an assessment given by a driver about to what extent are the considered dangerous spots really dangerous.

Input variable *Dangerous spots* refers to the sum of estimates of nine hazardous sites that could be rated by a score of 1 to 10, which means that the domain of this variable is from 9 to 90. It can be displayed using the 5 fuzzy sets and their membership functions (Fig. 1): VNPR – very low assessment of risk, NPR – low assessment of risk, SPR – medium assessment of risk, VPR – high assessment of risk, VVPR – very high assessment of risk.

As can be seen from Fig. 1, the fuzzy sets that describe the input variable *Dangerous spots* do not cover the same intervals, as a result of the fact that these fuzzy sets are defined based on the empirical data of 305 respondents. Although the minimum value for the assessment of nine points is 9, the observed sample showed that the minimum value was 35. Based on this, it can be concluded that in the average driver population, the lesser values are rarely met and therefore, a relatively large interval for potential values of risk assessment remains uncovered. Accordingly, the fuzzy set VNPR has the largest interval compared to the remaining 4 fuzzy sets.

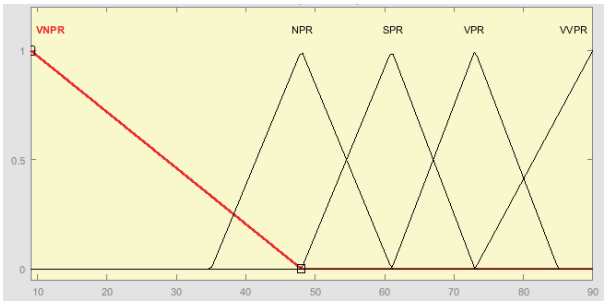


Figure 1. Input variable Dangerous spots

On the other hand, the mean value of the assessment of the hazardous locations of all respondents who participated in the study was 60.91; on the basis of which the value of 61 was taken as part of fuzzy set SPR with the value of membership function equal to 1.

The second input variable x_2 named *Road characteristics* contains an evaluation of seven characteristics of the observed road section. These are: The shape of the route and general perspective, roadway condition, state of horizontal signaling, state of vertical signaling, condition of the protective fence, sideroad part - drainage channels, etc, and traffic safety on connecting roads.

The input variable *Road characteristics* refers to the sum of the estimates of seven road characteristics that could be estimated from 1 to 10, which means that the domain of this variable is from 7 to 70. It can be displayed using the 5 fuzzy sets and their membership functions, as shown in Fig. 2: VNPK - very low assessment of road characteristics, NPK - low assessment of road characteristics, SPK - medium assessment of road characteristics, VPK - high assessment of road characteristics, VVPK - very high assessment of road characteristics.

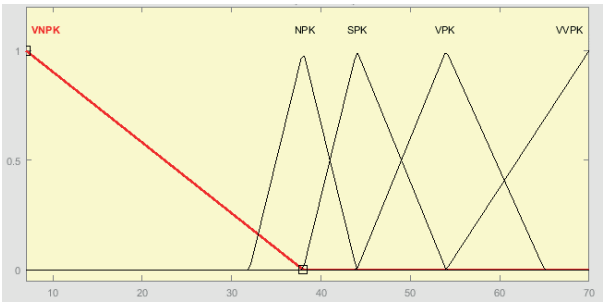


Figure 2. Input variable Road characteristics

It can be noticed that the fuzzy sets that describe the input variable *Road characteristics* do not cover the same intervals. Empirical data showed that the sum of grades ranges from 32 to 65. The mean value of the assessment of all respondents who participated in the study was 43.83; on the basis of which the value of 44 was taken as the value of the fuzzy set SPK with the highest degree equal to 1.

The third input variable x_3 named *Frequency of driving* refers to the characteristic of how often the driver drives at the observed road section. The following marks are introduced: 1 – every day, 2 – drives 3-4 times a week, 3 – drives 2 times a week, 4 – drives once a week, 5 – drives 2-3 times a month, 6 – drives once a month and 7 - drives once in a couple of months. The mentioned values are desribed by the seven fuzzy sets as follows: VVU - very high frequency, VU - high frequency, SVU - medium high frequency, SU - medium frequency, SNU - medium low frequency, NU - low frequency and VNU - very low frequency.

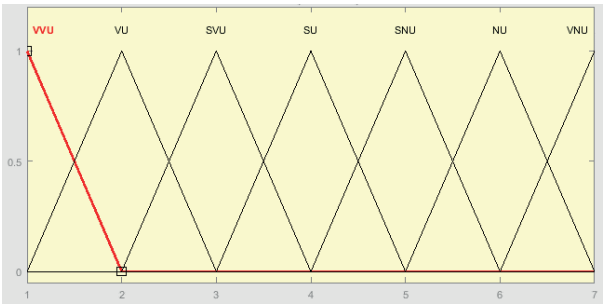


Figure 3. Input variable Frequency of driving

The output variable *y* named *Accidents* relates to the number of traffic accidents that respondents had experienced. In the sample, the examinees reported the number of accidents from 0 to 8; however, drivers who participated in more than 5 accidents are relatively rare. Therefore, the output variable *y* is defined as shown in Fig. 4. The following fuzzy sets are introduced: VMBN – very small number of accidents, MBN – small number of accidents, SMBN – moderately small number of accidents, SBN – medium number of accidents, SVBN – moderately high number of accidents, VBN – high number of accidents, VVBN – very high number of accidents.

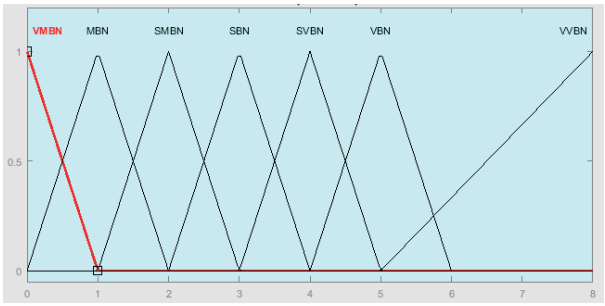


Figure 4. Output variable Accidents

3. MODEL DEVELOPMENT – FORMING FUZZY RULES BASED ON EMPIRICAL DATA

The fuzzy rule base is essential for the performance of fuzzy inference system. In this paper we use well-known approach for defining fuzzy rules proposed by Wang and Mendel [6].

The Wang-Mendel method consists of five steps. Step 1 divides the input and output spaces of the given numerical data into fuzzy regions. In this paper, the implementation of Step 1 is illustrated in the section I. For each of the used variables, the domain interval is determined, i.e. the interval of the possible values of variables. Each domain interval is divided into 2N+1 regions, as shown in Fig. 1 to 4.

Step 2 generates fuzzy rules from the collected data. The data set is structured as shown in Table I, where letter *i* represents one of 305 respondents from the sample.

Table 1. Data set of input and output values

Examinee	$x_1^{(i)}$	$x_2^{(i)}$	$x_3^{(i)}$	$y^{(i)}$
1	82	39	1	8
2	55	44	1	0
3	52	46	1	0
4	59	47	1	0
305	64	49	3	3

First, one data pair is used for construction of one fuzzy rule. For example, the degrees of a given pair ($x_1^{(i)}$, $x_2^{(i)}$, $x_3^{(i)}$; $y^{(i)}$) should be determined in different regions. Then, this data pair should be assigned to the regions with maximum degree. Finally, one fuzzy rule from one pair of desired input-output data is obtained. IF part is composed of the names of regions with maximum degree for input variables and THEN part from the name of region with maximum degree for output variables. By this, we obtained 305 fuzzy rules. However, there are some rules that are the same. After excluding the same fuzzy rules, there are 131 of them left.

In Step 3, a problem of conflicting rules should be solved. These are the rules that have the same IF part, but a different THEN part. For this purpose, each of the formed rules should be assigned a degree, defined by the Eq. (1) for the case when a rule is defined as following: "IF x_1 is A and x_2 is B, THEN y is C".

$$D(Rule) = \mu_A(x_1) * \mu_B(x_2) * \mu_A(y) \quad (1)$$

where $D(Rule)$ is a degree of a rule, $\mu_A(x_1)$ is a value of membership function of the region A when input value is x_1, $\mu_B(x_2)$ is a value of membership function of the region B when input value is x_2, and $\mu_A(y)$ is a value of membership function of the region C when output value is y. In a conflict group, only the rule that has maximum degree should be accepted. By implementing the proposed procedure, in our case, from 131 different rules, there are 64 non-conflict fuzzy rules obtained from the collected data.

Step 4 makes a combined fuzzy rule base which consists of rules obtained from empirical data and linguistic rules of human expert. In this case, the complete fuzzy rules base consists of 175 fuzzy rules. Finally, Step 5 determines a mapping from input to output space using a defuzzification procedure.

4. RESULTS AND DISCUSSION

Finally, the defined fuzzy inference system should be tested. This is performed based on Eq. 2. Cumulative deviation (*CD*), as a measure that describes how good the fuzzy inference system describes empirical data, is calculated as an absolute value of difference between the number of accidents which drivers from the sample experienced and corresponding result of fuzzy inference system based on the same input values for the particular driver. The result of fuzzy inference system for an examinee number *i* in the Eq. (2) is marked as *Propensity(i)*.

$$CD = \sum_{i=1}^{305} \left| y^{(i)} - Propensity\,(i) \right| \quad (2)$$

where *CD* is Cumulative deviation, $y^{(i)}$ is the number of accidents which drivers from the sample experienced and *Propensity(i)* is the result of fuzzy inference system.

After all the calculations, the final result is CD=844.945. To get a conclusion about the quality of this result, it is necessary to perform further research about causes of traffic accidents and to test new fuzzy inference systems with new variables.

Table 2. Testing different shapes of membership functions

Fuzzy inference system (input membership function – output function)	***CD***
I (*trimf; trimf; trimf – trimf*)	844.945
II (*trapmf; trapmf; trapmf – trimf*)	853.037
III (*trapmf; trapmf; trapmf – trapmf*)	856.085
IV (*gaussmf; gaussmf; gaussmf – trimf*)	835.211
V (*gaussmf; gaussmf; gaussmf – gaussmf*)	833.732
VI (*gauss2mf ; gauss2mf; gauss2mf – trimf*)	854.587
VII (*gauss2mf; gauss2mf; gauss2mf – gauss2mf*)	856.714
VIII (*gbellmf; gbellmf; gbellmf – trimf*)	848.843
IX (*gbellmf; gbellmf; gbellmf – gbellmf*)	851.726
X ((*zmf, dsigmf, sigmf); (zmf, dsigmf, sigmf); (zmf, dsigmf, sigmf) – trimf*)	829.578
XI ((*zmf, dsigmf, sigmf); (zmf, dsigmf, sigmf); (zmf, dsigmf, sigmf) – (zmf, dsigmf, sigmf)*)	828.415

XII ((*zmf, psigmf, sigmf*); (*zmf, psigmf, sigmf*); (*zmf, psigmf, sigmf*) – *trimf*)	829.293
XIII ((*zmf, psigmf, sigmf*); (*zmf, psigmf, sigmf*); (*zmf, psigmf, sigmf*) – (*zmf, psigmf, sigmf*))	828.163
XIV ((*zmf, pimf, smf*); (*zmf, pimf, smf*); (*zmf, pimf, smf*) – *trimf*)	865.620
XV ((*zmf, pimf, smf*); (*zmf, pimf, smf*); (*zmf, pimf, smf*) – (*zmf, pimf, smf*))	873.090
XVI (*trimf*; (*zmf, psigmf, sigmf*); (*zmf, psigmf, sigmf*) – *trimf*)	827.565
XVII (*trimf*; (*zmf, psigmf, sigmf*); (*zmf, psigmf, sigmf*) – (*zmf, psigmf, sigmf*))	826.807

Besides, it is possible to optimize the results of the current fuzzy inference system. This should be examined by changing fuzzy rules, intervals and shapes of membership functions, modifying the method of defuzzification. In this paper, we test the impact of changing the shape of membership functions and other testing may be seen as a direction for further research.

The various membership functions tested in this research are shown in Table II. The first is triangular membership function, and it has the function name *trimf*. The trapezoidal membership function is named *trapmf*.

Two membership functions are built on the Gaussian distribution curve: a simple Gaussian curve and a two-sided composite of two different Gaussian curves. Their names are *gaussmf* and *gauss2mf*.

The generalized bell membership function is specified by three parameters and has the function name *gbellmf*. The next is sigmoidal membership function, which is either open left or right. Asymmetric and closed membership functions can be synthesized using two sigmoidal functions, so in addition to the basic *sigmf*, there is a difference between two sigmoidal functions, *dsigmf*, and the product of two sigmoidal functions *psigmf*.

Polynomial based curves that make three related membership functions are the Z, S, and Pi curves, all named because of their shape. The function *zmf* is the asymmetrical polynomial curve open to the left, *smf* is the mirror-image function that opens to the right, and *pimf* is zero on both extremes with a rise in the middle.

The results of testing various shapes of membership functions are shown in Fig. 5. As it can be noticed, the best result is achieved by the fuzzy inference system No. XVII. The results of this system are compared with the empirical data which is illustrated in Figure 6. By analyzing the obtained results, an assumption is that there is a space for improvement of the proposed model by introducing new variables that impact the occurrence of traffic accidents.

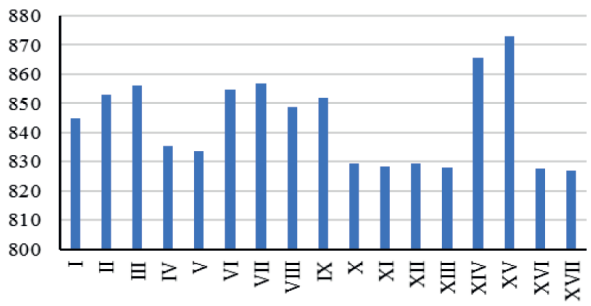


Figure 5. Comparison of various fuzzy inference systems

A possible explanation about the fact that the fuzzy inference system No. XVII does not fit "so well" to the empirical data may be found in the fact that the causes of traffic accidents are very heterogeneous. For example, the personality traits may have a significant role [7]. Therefore, to explain the considered phenomenon more precise, further research is needed.

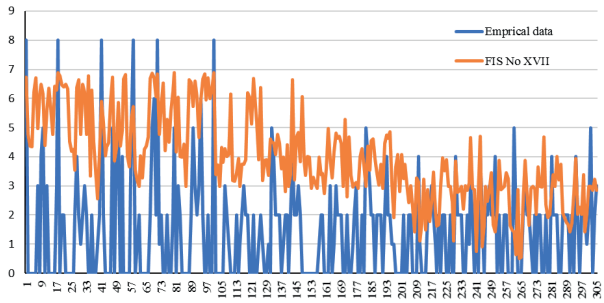


Figure 6. Comparison of empirical data and results of FIS No. XVII

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OPTIMIZATION OF DIGITAL MARKETING PROCESSES THROUGH MODELING OF LEAD-SCORING

Aleksandar Đorđević

Singidunum University,
Belgrade, Serbia

Abstract:

The primary purpose of this paper is to explore and identify the possibilities for optimizing of digital marketing activities through establishing value-systems reflected in lead-scoring models. Methodologically, the paper was based on the conclusions of quantitative and qualitative research, largely through drawing conclusions through secondary research, but also through primary research based on experimental, empiric cases of using digital marketing software tools such as the *ClickDimension* - corporate CRM tool. The empiric part of the primary research was enabled through the author's practical experience as a marketing executive in an IT industry-leading Serbian and regional system-integrator company. Conclusions of this paper can positively influence practical application of marketing, namely CRM tools through which organizations can model their value-systems reflected in lead scoring, in order to best optimize their digital marketing efforts in an optimal utilization of their resources. Although this particular paper focuses on the use of a particular software tools, the methodology translates to other similar consumer-relationship-management tools used in practice as well, making its potential application broader and more relevant to marketing professionals and academic community.

Keywords:

business optimization, lead-scoring, modeling, campaign management, marketing management.

1. INTRODUCTION

It used to be considered as traditional that the marketing departments, in some medium and most large-sized companies, are the go-to address that uses certain analytics in order to better understand and predict customer behavior that leads towards their purchasing preferences. This approach, natively channeled through the activities of marketing departments, have given the companies an opportunity to gravitate towards the more frequent and more focused, highly targeted marketing campaigns rather than the bulk marketing campaigns.

With the recent technology development many processes - including the collection of relevant consumer information and models of their likely purchasing behavior - have been heavily automated. This has led to companies' reliance on the evolving modeling and optimization through

Correspondence:
Aleksandar Đorđević

e-mail:
adjordjevic@singidunum.ac.rs

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some key-process automation. Such a positive evolution has allowed companies to carry out marketing analytics beyond marketing departments only, and empower their cross-functional teams which, by design, have a better position to feed into the company's value system to sibsutitude some of the traditionally marketing led analytics in order to optimize entire business functions.

Although such shared marketing analytics is more pronounced in a B2B oriented model, for the sole reason that B2B markets are typically smaller in size and consequentially easier to comprehend and oversee, the automation of the mentioned processes would also be possible for application a B2C marketing, given the assumption that there would be a reasonably smaller number of targeted markets that share similar key characteristics.

Additionally, the amount and type of data collected by the content that users consensually leave behind themselves throughout use of social media, has changed the strategies of traditional marketing, providing an opportunity to address marketing from a new perspective [1].

2. REVIEW OF THE MARKETING-LED PROCESS AUTOMATION

The hereby presented core problem is in the fact that many of the inbound marketing-related problems find their organizational bottlenecks in the activities restrained by:

- the lack of relevant data,
- appropriate resources that would enable the position to process the mentioned data into a meaningful information,
- the lack of means to replicate the repetitive processes through a model of automated actions that need little to virtually no attention throughout the process, and
- the lack of know-how in managing the automation software streamlined towards general business optimization.

In author's professional experience, particularly in the IT industry, there is an apparent lack of focus on promotion activities towards the end-users targeted advertising. These last mile advertising challenges have been identified as a tangent problem in attracting and maintaining a segment of profitable consumers, and on the other hand to determine those factors that undermine this objective [2].

Strangely enough though, it is quite curious that many small companies globally are held below the bottom in the competing world regarding earning of profits compared with multinational companies mainly because of not employing modern techniques that digital marketing allows for. Consequently, these leads underline the need for a deeper study be undertaken to identify and highlight the probable benefits, attached deficiencies and managing options for the potential disadvantages of digital so that all-sized business, especially the small ones, could join the economic and business competition with the rapidly growing companies [3].

Just like automation software can pretty much circumvent a key business aspect such as warehousing, marketing process automation could potentially optimize company's resources in order to drive most efficiency out of company's resources. A good example of a business model that used model of heavy marketing-processes optimization, in order to optimize the business holistically is known as "*dropshipping*". *Dropshipping* is a method of selling products in which the seller does not necessarily physically store them. This method usually generates more profit per unit sold due to the cost savings that occurs when retailers outsource the warehousing and distribution process [4].

Therefore, the core problem that exist is not if and who within the organization would be in best position to optimize the chosen CRM to best feed the marketing, cross-functional team leaders and members, or management with intel and inputs for future decision making in order to maximize business optimization.

The core problem that this research focuses on is the fact that any model of lead-scoring – and some sort of lead-scoring is necessary in order to be able to quantifiably set the KPIs – is a challenge that many of the business will find themselves in.

Optimization of Marketing Processes With Use of Social Networks That Feed Data to CRM

The first glance at one of the commonly accepted definitions of what CRM portraits, is that "CRM is a comprehensive and marketing strategy; that integrates technology, process and all business activities around the customer" [5], showcases the comprehensiveness of the scope of customer relations.

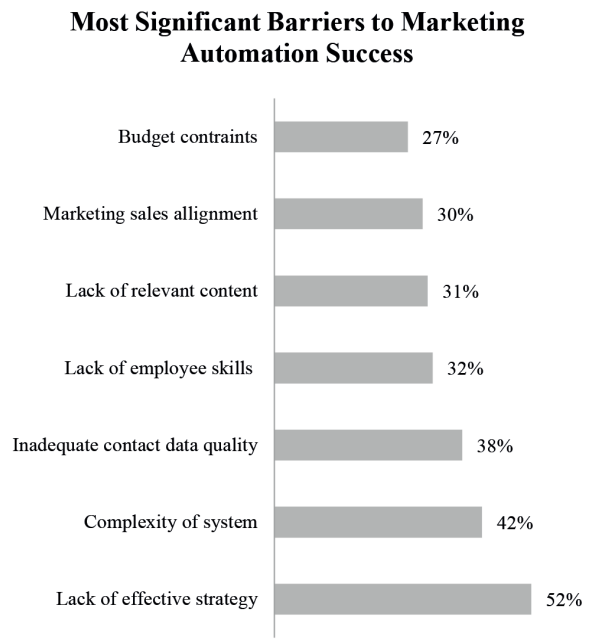
As Chi-Shen rightfully points out, transactional content defines four types of purposes for which people use social networks to communicate:

1. exchange of affect,
2. exchange of influence or power,
3. exchange of information, and
4. exchange of goods and services [6].

A social network may have the characteristics of internal and/or external linkages, and people may not be equally important in the social network nodes in terms of the role they play [7].

As proscribed by Cox the inbound marketing manager faces the biggest obstacles in overcoming the process automation rely heavily on the lack of effective strategic guidance, fairly closely followed by the complexity of the system [8]:

Table 1. *Perceived barriers in marketing process automation*



3. PRACTICAL APPLICATION OF A LEAD-SCORING MODEL APPLIED TO A MARKETING CAMPAIGN

It is safe to assume that the common denominator for most strategies, regardless of the industry at stake, would rely on utilizing available resources in a manner that is not easily or quickly replicable by the relevant competitors. Instead of the classic strategies approach which insisted that the organization responds to changes in the environment, through the strategy of "shaping" the organization seeks to shape the business environment in its favor, the shaping strategy is particularly applicable in varying industries, such as digital marketing, IT industry, fashion and other areas.

Contrary to the above, the classic strategies have greater success in traditional industries, such as automotive, oil, mining and other less volatile sectors [9]. Yet, the IT industry is one of the leaders of shaping the business in a automated manner, where the business organization tends to lean onto the software to do (at least) most of the repetitive tasks. One of the first dominoes in this structure is, however, the value system of an organization that needs to be shaped thoroughly.

This value system will later be reflected throughout all of the processes – especially the ones aimed at to be automated – and all of the systems outputs. Therefore, the question of how does an organization model the lead-scoring, in order for marketing activities to fulfill its key role (in many B2B organizations this role is to feed the presales or the sales teams)?

It is a well-established practice that marketing department defines the values for lead-scoring modeling, based on the:

1. business intuition and information from the presales and sales teams,
2. current market conditions,
3. type of the campaign aimed at targeting a specific group.

Some of the good experiences with lead scoring, reflected some common values and were drawn from:

- marketing's experience about the effectiveness of particular channels that has led to actual conversions
- the aspects that express a deeper involvement should naturally be scored higher in the model
- cross-functional teams consisting of both sales and marketing employees should give inputs through several iterations of campaign management, especially in the retargeting stages of the campaign

It is critical that the CRM is fed not only from the digital sources, but also from the offline points of interaction with the leads, especially considering that the modeled lead-scoring is supposed on bettering organizational processes for developing valuable and timely content to meet customer needs and for integrating content marketing whit B2B selling processes [10].

Process automation through use of a particular software

In an empirical research, observing an actual experiment carried out by the marketing team of the largest Serbian IT system integrator company, through the use of a proprietary commercial software *ClickDimensions*

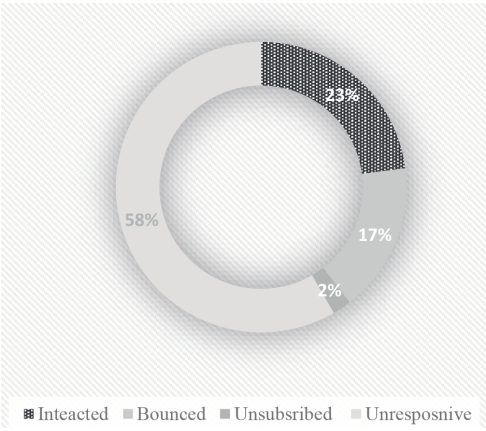
(of the so-named company), the results came out quite interesting. The experiment itself was aimed at a select number of B2B leads, namely representatives of financial institutions that some contact was already established with and that would be qualified as early-warm leads by the company's sales department.

The benefits of automated CRM solution are numerous, starting from the better time management to a more accessible qualified workforce to set, monitor and maintain the system is not obliged by formal education, as expressed in the underwhelming offering of specialize formal education in this filed globally [11].

Additionally, the connection between the employee engagement and self-regulated learning seems to be strong, which is obviously beneficial to the companies deploying a CRM solution [12]. A CRM solution such as the *ClickDimension* lands onto the architecture of MS Dynamics, understanding that an organization would use a single ERP platform to manage its resources across its different business functions.

One of the campaign flow's steps was as an automated email to the targeted group that would lead to a topic-specific blog post, which would contain a fairly simple fill-in for to opt in for further information on the topic. This step of the flow is a usual engagement of a direct, targeted communication channel that intends to establish direct communication to a member of a particular targeted group. Email itself is known to be a primarily one-way channel in marketing communication, so in order to make it a return-channel that could provide some behavioral inputs for the analytics, the email itself had a strong call-to-action.

Below are some of the outcomes of the automated email campaign carried out as a flow-step in a particular campaign for a software solution for financial institution, as a pre-sales support campaign.



Graph 1. Conversion results of an automated email campaign

Interestingly, through the warm-leads automated email campaign, which is not known as the most effective conversion-focused channels in the digital marketing tools, we can see that the conversion rate was actually extremely high at 23% of the total number of responses.

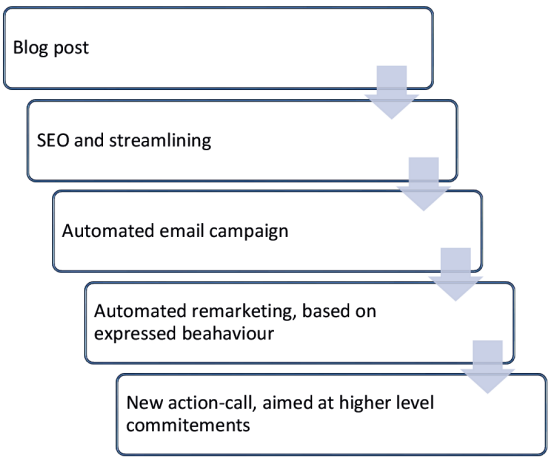
Some alternative methods, such as social media targeting and retargeting would have a far less effective outcomes, with reasonably good conversions ranging from 3-5% of total outreach.

Lead scoring modeling based on iterative campaign management

Although the modeling for particular lead-scoring would vary from one market situation to another, the underlining idea is that a model that would reflect organizational values and long-term goals is applicable as foundation to the later-evolving, situation-specific models that would come out of CRM's lead scoring [13].

Obviously the core architecture of a marketing campaign depends on the contextual market conditions, inclusive of the given product characteristics, targeted audience's preferences, competitor's recourses, planned level of marketing investments, and many other contributing factors.

The experience of establishing a lead-scoring model from a particular campaign, a conclusion has been made that he following campaign flow gave results better than anticipated:



Graph 2. A particular digital campaign flow

The first step of the campaign was to produce the initial content, a blog post, that was aimed at providing some valuable information to the targeted readers and at the same time serve the campaign as the early traffic driver. The attributed score for the lead-scoring at this first step of the flow was at about 20%, as the selection metric was fairly wide.

A proven way to begin assessing the digital marketing opportunities would start with SEO as a service. SEO has a dominant role in the digital promotion strategy, since it influences the positioning of digital channels available to an organization such as: web sites, blogs, social network accounts, etc. So, web pages can be optimized to become "the most attractive" for the search engines in order to be first displayed when searches are performed using browsers [14]. The attributed score for the lead-scoring at this first step of the flow was much higher – at 35%.

If the blog content and platform and the SEO criterion turned out to be success, the later stages of the campaign can afford the lower lead scoring as the quality of the lead-pool should have been heavily refined by now. In other words, the new, retargeted leads are now much more likely to lead to conversions. Therefore, the remaining 45 points are distributed as of 15-25-5, respectively.

4. CONCLUSIONS

The author of this paper does by any means advocate that the processes automation should in a way substitute for the existence of marketing teams; furthermore, the main argument is that the marketing-native teams should devote their time to the more critical processes that required their expertise, rather than focusing on highly repetitive routine-based tasks.

Establishing modeled lead-scoring through configuring the CRM's tools could likely lead to the overall business optimization. The benefits of establishing a good model are apparent in the facts that it requires only informal/practical education, relies on organization-wide knowledge of processes and information rather than the marketing-specific expertise, and is fairly easily quantifiable and measurable – nearly in real-time.

These conclusions drawn from the paper analyses direct towards a modeled solution that that would be highly applicable in companies that already have in use a CRM such as Microsoft Dynamics, Oracle BI or some other similar solution. however, the author assumes that the proposed methodology could possibly be applicable to other brand's CRM solutions as well, given some necessary adjustments.

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MODELING PHYSICAL CHARACTERISTICS OF MOSFETS WITH GENERALIZED LOGISTIC FUNCTIONS

Tijana Kevkić[1, *],
Vladica Stojanović[1, 2],
Dušan Joksimović[2]

[1]University of Priština - Kosovska Mitrovica,
Faculty of Sciences
[2]University of Criminal Investigation and
Police Studies,
Belgrade, Serbia

Abstract:
The improved surface potential and charge based MOSFET models have been developed in this work. Compared to the corresponding compact models, the improvement consists in implementation of generalized logistic (GL) functions of the second type in fitting of two important smoothing factors. New GL functional forms of these factors enable the control of continuality of the surface potential (SP), inversion charge density (ICD) and drain current in entire useful region of MOSFET operation. Beside the successful following of the changes in specific technology characteristics of MOSFET devices, the GL smoothing factors also provide continuous and various transitions of the SP and ICD between weak and strong inversion region. Satisfactory matches of the simulated SP, ICD and drain current values with numerical data indicate on suitability of introducing GL functions in MOSFET modeling.

Keywords:
MOSFET modeling, Generalized Logistic functions, Surface potential, Inversion charge density, Parameters estimation.

1. INTRODUCTION

Since the early 60-70s, Metal-Oxide Semiconductor Field Effect Transistor (MOSFET) has been widely used as a switch to amplify the electronic signal. That device rapidly has become the heart of the digital circuit, microprocessor and memory circuit industry. During the time dimensions of MOSFETs have been decreased, their performances improved, and the fabrication process has experienced a great decrease in cost. Nowadays, the integrated circuit comprises million numbers of MOSFETs due to their small sizes. Since the efficiency in the design of the circuits depends very much on the accuracy and simplicity of the analytical transistor models involved in the circuit simulation, the models should accurately predicted drain current and its derivatives as functions of the applied voltages. Furthermore, they should be as simple as possible in order to limit circuit simulation time.

The most of attempts for developing so-called compact MOSFET model led to a regional approach which uses different sets of equations for different operation regions [1]. The continuity of the current and its derivatives with respect to bias at the transition points is achieving by

Correspondence:
Tijana Kevkić

e-mail:
tijana.kevkic@pr.ac.rs

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appropriate smoothing functions which contain the empirical parameters without the physical meaning. That is why the regional approach imprecisely describes the drain current in the transition region, called the moderate inversion, between subtreshold and strong inversion region. However, the moderate inversion region has become a dominant fraction in the overall operation bias of scaled MOSFET devices as the supply voltages are scaled down [2].

In recent years the considerable attention has been drawn on development of the charge sheet MOSFET models based on surface potential formulations (henceforth referred to as SPBMs) [3]. Meantime, there were efforts for obtaining a simple and explicit inversion charge density (ICD) expression valid for all regions of operation. In that way, the charge-based MOSFET models have been developed [4]. Both of these models give accurate and continual descriptions of current and its derivatives in whole useful range of MOSFET operation. However, the both of them are based on an implicit relation between the surface potential and the terminal voltages, which can be solved only iteratively resulting in long computation times.

In order to overcome this problem, an explicit approximate relation for the surface potential as a function of terminal voltages has been proposed [5]. Inside that approximate relation there is a pure empirical fitting parameter ε which controls the continuity and smoothness of the surface potential transition between weak and strong inversion region. In view of this, the accuracy of the mentioned approximation is just about 2-3mV [6] which does not allow an accurate reproduction of derivatives of current and charges in moderate inversion region. On the other side, an interpolating function connecting the expressions for ICD in weak and strong inversion region has been introduced in [7]. That function gets an exponential form in weak inversion and a linear form in strong inversion, but continual ICD transition across the moderate inversion region is reaching thanks to an empirical smoothing factor *K*.

Here, the basic explicit SPB model [4] as well as the interpolated ICD model [7] have been modified and improved. The modification was achieved by replacing the pure empirical parameters with so-called Generalized Logistic (GL) fitting functions. The improvement consists in precisely determining the fitting functions for various technological characteristics of the MOSFET devices. Another advantage is possibility of control of the smoothness and speed of the transitions of SP and ICD from the depletion region to the strong inversion region. The simulated values of the surface potential, inversion charge density as well as drain current match almost exactly with corresponding numerical data for a wide range of substrate doping and oxide thickness of MOSFET devices which belong to different technology generations.

2. THE BASIC EXPLICIT SP AND ICD MODELS

An ideal n-channel MOSFET with gate oxide thickness t_{ox} and acceptor concentration N_A in substrate will be considered. Application of positive voltage on the gate electrode attracts mobile electrons from the source to the channel, and applying a positive drain voltage gives rise to drain current. The gradual channel and charge sheet approximations are assumed and give following implicit relation between the electrostatic surface potential ψ_s and terminal voltage V_G [1,2]:

$$V_G - V_{FB} - \psi_s = \gamma \cdot \sqrt{\psi_s + u_T \cdot \exp\left(\frac{\psi_s - 2\varphi_F - V_{ch}}{u_T}\right)}. \quad (1)$$

Here, V_{FB} and u_T are flat band and thermal voltage respectively; Φ_F and V_{ch} are bulk and channel potentials; $\gamma = \sqrt{2q\varepsilon_{Si}N_A}/C_{ox}$ is the body effect coefficient, where $C_{ox} = \varepsilon_{ox}/t_{ox}$ is the gate oxide capacitance per unit area.

On the other hand, according to Gauss theorem at the oxide – semiconductor interface the inversion charge density Q'_I can also be related to the applied gate bias [7]:

$$Q'_I = -\gamma \cdot C_{ox} \cdot \left(\sqrt{\psi_s + u_T \exp\left(\frac{\psi_s - 2\varphi_F - V_{ch}}{u_T}\right)} - \sqrt{\psi_s}\right). \quad (2)$$

In that way, the values of Q'_I, regarding to the gate voltage V_G, depend also on implicit Eq. (1) which, as it is already said, can be only numerically solved. For that purpose, i.e. for understanding the behavior of the ψ_s as a function of V_G and V_{ch} the analytical solution of Eq. (1) is necessary. An attempt for finding the explicit approximate solution for ψ_s has been made in following form [4]:

$$\psi_s^*(V_G) = f + u_T \ln\left[\frac{1}{\gamma^2 u_T}\left(V_G - V_{FB} - f - \frac{\psi_{s_{wi}} - f}{\sqrt{1+\left(\frac{\psi_{s_{wi}} - f}{4u_T}\right)^2}}\right) - \frac{f}{u_T} + 1\right]. \quad (3)$$

Here, $\psi_{s_{wi}}$ is the surface potential in the weak inversion region (for $\psi_s < 2\varphi_F + V_{ch}$), approximately written as [4]:

$$\psi_{s_{ei}}(V_G) = \left(-\frac{\gamma}{2} + \sqrt{V_G - V_{FB} + \frac{\gamma^2}{4}}\right)^2. \quad (4)$$

Additionally, in Eq. (3), by f is labeled the empirical function which value must smoothly changes from $\psi_{s_{wi}}$ to $2\varphi_F + V_{ch}$, and is given by [4]:

$$f(\psi_{s_{ei}}, \varepsilon) = \frac{2\varphi_F + V_{ch} + \psi_{s_{ei}}}{2} - \frac{1}{2}\sqrt{(\psi_{s_{ei}} - 2\varphi_F - V_{ch})^2 + 4\varepsilon^2}, \quad (5)$$

Here, the smoothing factor ε is introduced in order to achieve the smooth transition of the function f from weak inversion region to the onset of the strong inversion region. The value of ε has been firstly fixed at a convenient value of 0.02V [4].

Comparison of ψ_s^* values obtained from Eq. (3) with numerical solution of Eq. (1) shown certain disagreements, particularly deep in the weak inversion region and in the depletion region. The cause of this disagreement is that f differs significantly from $\psi_{s_{wi}}$ because f still remains the function of V_{ch} in the weak inversion region. For avoiding the observed difference the value of ε should be reduced in the subthreshold region. Yet, simple annulment the value of ε can make the transition of the function f abrupt at the threshold voltage V_T jeopardizing the smoothness of the behavior both of f and ψ_s^* as functions of effective voltage $V_E = V_G - V_T$. The better way is replacement of the constant value of parameter ε by a function which varies from a value close to zero in the depletion region, to a value close to 0.02V as the threshold voltage V_T is approached. Having that in mind, in [5] is proposed following form for factor ε as the function of effective bias V_E:

$$\varepsilon_m(V_E) = 0.01\left(1 + \frac{V_E + 8u_T}{\sqrt{(V_E + 8u_T)^2 + 0.02}}\right). \quad (6)$$

Values of ψ_s^* obtained from Eq. (2) with ε_m, show better match with the numerical results of the implicit Eq. (1) than with constant value of 0.02V, as proposed in [4].

On the other hand, the single expression for the inversion charge density in whole inversion region is given by interpolation function [7]:

$$Q'_{inv} = -K \cdot C_{ox} \cdot u_T \cdot \ln\left[1 + \exp\left(\frac{V_E}{u_T}\right)\right]. \quad (7)$$

Here, K is the smoothing factor which insures a continuous transition of the ICD between weak and strong inversion region and takes value from 0 to n. For that smoothing factor as function of the effective voltage $V_E = V_G - V_T$ is proposed the following relation [5]:

$$K_m(V_E) = n + \frac{1}{2}\left(-1 + \frac{V_E}{\sqrt{V_E^2 + \delta^2}}\right), \quad (8)$$

where δ is an empirical parameter which takes values between 0.2V and 0.8V.

However, several simulations have shown that the SP and ICD values obtained from Eq. (8) with the smoothing factor K_m deviate significantly from those obtained from the implicit charge sheet (CS) solution, particularly in the weak inversion region [8]. The cause of the deviation comes from a purely empirical nature of the factor K_m, i.e. from neglecting of the fact that manner and speed of K (and consequently ICD) transition are sensitive to changes in technological and physical characteristics of the MOSFET devices [9, 10].

3. GL-MODIFICATION OF FACTORS ε AND K

In past few decades the MOSFET devices have continued to scale as predicted by Moore's Law. In order to keep the various short-channel effects under check in the scaled MOSFETs, the substrate doping is continually increased, while the oxide thickness keeps on reducing.

These changes of specific technological characteristics are not taken into account in purely empirical function ε_m, given by Eq. (6). That is why several simulations have shown that values of ψ_s^* with ε_m deviate significantly from results of implicit SPB model in case of scaled MOSFET devices.

The simulations also show that way as well as speed of the transition of parameter ε from 0 to 0.02 are sensitive to changes in technology devices characteristics [11]. More precisely the transition of the function f, and consequently of ψ_s^* between weak and strong inversion, is dependent on dimension size and other technology characteristics of devices. Due to these dependencies, here we suggest new the *Generalized Logistic (GL)* functional form for ε:

$$\varepsilon_{GL}(V_E) = 0.02\left[1 + b\exp\left(-aV_E / u_T\right)\right]^{-1/\nu}, \tag{9}$$

where a, $b > 0$ and $\nu > 1$ are the model's parameters. The functional dependencies $\varepsilon_{GL}(V_E)$ provides various and, at the same time, smooth transition of ε_{GL} from a value close to zero in the weak inversion region, when $V_E < 0$ holds, to its supreme 0.02, when $V_E \geq 0$.

Similarly, the pure empirical nature of smoothing factor K_m given by Eq.(8) leads to deviations of values of ICD obtained from interpolated relation (7) in comparison to results of implicit charge based model. These deviations can be avoided by using following factor [12]:

$$K_{GL}(V_E) = (n-1) + I_{GL}(V_E), \tag{10}$$

with *Generalized Logistic function* of the second type:

$$I_{GL}(V_E) = 1 - \left[1 + b\exp\left(aV_E / u_T\right)\right]^{-1/\nu}. \tag{11}$$

A procedure for obtaining the GL-fit factors ε_{GL} and K_{GL}, accordingly to given MOSFET's technological characteristics, is based on estimation of the unknown parameters a, $b > 0$. For that purpose, we introduce the so-called Logit-function $y = L(x) = ax \pm \ln b$, where $x = V_E / u_T$. In the case of factor ε_{GL}, we have, according to Eq. (9), $y = \varepsilon_{GL}^{\nu} / 0.02^{\nu} - \varepsilon_{GL}^{\nu}$, while for the smoothing factor K_{GL}, Eqs. (10) and (11) imply $y = \ln\left[\left(n - K_{GL}\right)^{-\nu} - 1\right]$.

Obviously, $L(x)$ is the linear function on x, and the GL-fit parameters a, $b > 0$ can be estimated according to the well-known last squares approximate method [13]. In our case, the estimation procedure is based on the following algorithm:

Step 1. For given values of the gate voltage $V_G^{(1)}, \ldots, V_G^{(N)}$, solve numerically Eq. (1) with respect ψ_s, i.e. compute the values $\psi_s^{(1)}, \ldots, \psi_s^{(N)}$ such that for each $k = 1,..,N$ hold:

$$V_G^{(k)} - V_{FB} - \psi_s^{(k)} = \gamma\sqrt{\psi_s^{(k)} + u_T \exp\left(\frac{\psi_s^{(k)} - 2\varphi_F - V_{ch}}{u_T}\right)}.$$

Step 2. Find the values $f_1, \ldots, f_N$ as the solutions of equations $\psi_s^{(k)} = \psi_s^*(V_G^{(k)})$, $k = 1,..,N$. According to them and Eqs. (2)-(5), for each $k = 1,..,N$ compute the values:

$$\varepsilon_k = \frac{1}{2}\sqrt{\left|\left(2f_k - 2\varphi_F - V_{ch} - \psi_{s_{wi}}^{(k)}\right)^2 - \left(\psi_{s_{wi}}^{(k)} - 2\varphi_F - V_{ch}\right)^2\right|}$$

$$\left|Q_I^{(k)}\right| = \gamma \cdot C_{ox} \cdot \left(\sqrt{\psi_s^{(k)} + u_T \exp\left(\frac{\psi_s^{(k)} - 2\varphi_F - V_{ch}}{u_T}\right)} - \sqrt{\psi_s^{(k)}}\right)$$

$$K_{ref}^{(k)} = \left|Q_I^{(k)}\right| \cdot \left[C_{ox} \cdot u_T \cdot \ln\left[1 + \exp\left(\frac{V_E^{(k)}}{u_T}\right)\right]\right]^{-1},$$

where $V_E^{(k)} = V_G^{(k)} - V_T$.

Step 3. Determine the parameter $\nu > 0$ which satisfies the linear growth condition in Logit-function $y = L(x)$.

Step 4. Minimize, with respect to a, $b > 0$, the objective functions:

$$F_1(a,b) = \sum_{k=1}^{N}\left[L(V_E^{(k)}/u_T) - \ln\frac{\varepsilon_k^{\nu}}{0.02^{\nu} - \varepsilon_k^{\nu}}\right]^2$$

$$F_2(a,b) = \sum_{k=1}^{N}\left[L(V_E^{(k)}/u_T) - \ln\left(\left(n - K_{ref}^{(k)}\right)^{-\nu} - 1\right)\right]^2.$$

Step 5. For estimated values of a, $b > 0$ form the GL-fit factors ε_{GL} and K_{GL}, as they are given in Eqs. (9)-(11).

Note that minimization of the functions $F_1(a,b)$ and $F_2(a,b)$ in the last step of algorithm is usually performed by solving the coupled set of equations $\partial F(a,b)/\partial a = \partial F(a,b)/\partial b = 0$. Hence, the estimates of GL-fit parameters can be calculated in the simple way.

4. VALIDATION RESULTS OF GL-FITTING

The GL-fit modifications of factors ε_{GL} and K_{GL} versus the effective voltage V_E, obtained by developed algorithm, are shown in Fig 1. for two MOSFET transistors with different devices parameters. They are compared to the real-based, reference values, obtained in the first

two steps of algorithm. As gate voltage, the series of $N = 30$ equidistant values $V_G^{(1)},\ldots,V_G^{(N)}$ symmetrical placed around the threshold voltage V_T have been taken. After that, the whole algorithm procedure has been implemented in the software package MATHEMATICA 11.0.

The both GL-fit factors, shown by solid lines in left diagrams of Fig. 1, match more closely with the reference values (labeled by dots) in comparison to the factors suggested in Eqs. (6) and (8) (labeled by dashed lines). Moreover, the increase of the number of reference data N leads to higher accuracy of the least squares approximation. This fact also confirm the linear Logit-functions $L(x)$ of the GL-fit models, given by Eqs. (9) and (11). In right diagrams of Fig. 1, the graphs of Logit-functions, for the both GL-factors ε_{GL} and K_{GL} are presented, where the values of growth parameters are $\nu = 4$ and $\nu = 10$, respectively. Additionally, the coefficient of determination R^2, as one of the typical relative measure of quality fitting, has been computed. Let us point out that in the both cases of GL-fitting, the R^2-values are higher than 99%. This also indicates the high-level performance of thus obtained GL-fit factors.

Additionally, the mean values of some typical error functions for factors ε_m and K_m, obtained by using Eqs.(6) and (8), as well as GL-fit factors ε_{GL} and K_{GL} are shown in Tables 1 and 2. All the errors have been computed for two considered MOSFET transistors, and also separately for weak and strong inversion region. The first two rows of the both Tables show the average values of *the Absolute Error* (*AE*) representing the absolute value of the difference between fitted and reference values of the parameters ε and K, as well as between the corresponding approximations of the surface potential and the inversion charge density, obtained from Eqs. (1) and (2). The next two rows contain the average values of *Fractional Error* (*FE*), as the percentage values of the ratio of *AE* and the reference values. Finally, the last two rows show average values of *the Squared Error* (*SE*), which is typical statistics error used in approximation theory.

As it can be seen from Tables 1 and 2, all the estimated errors are significantly smaller in the case of GL-fit factors ε_{GL} and K_{GL}. The particularly improvement in the case of ε-fitting is pronounced in the weak inversion region where, for instance, the fractional error for ε_{GL} is only 1.24%, what is about 25 times smaller than corresponding *FE* value obtained by factor ε_m. Further, the values of *FE* for the GL-fit factor K_{GL} is only 0.46% and 0.71% in weak and strong inversion region, respectively. That is exactly 187, i.e. 83 times lesser than corresponding *FE* values obtained by fitting with the factor K_m.

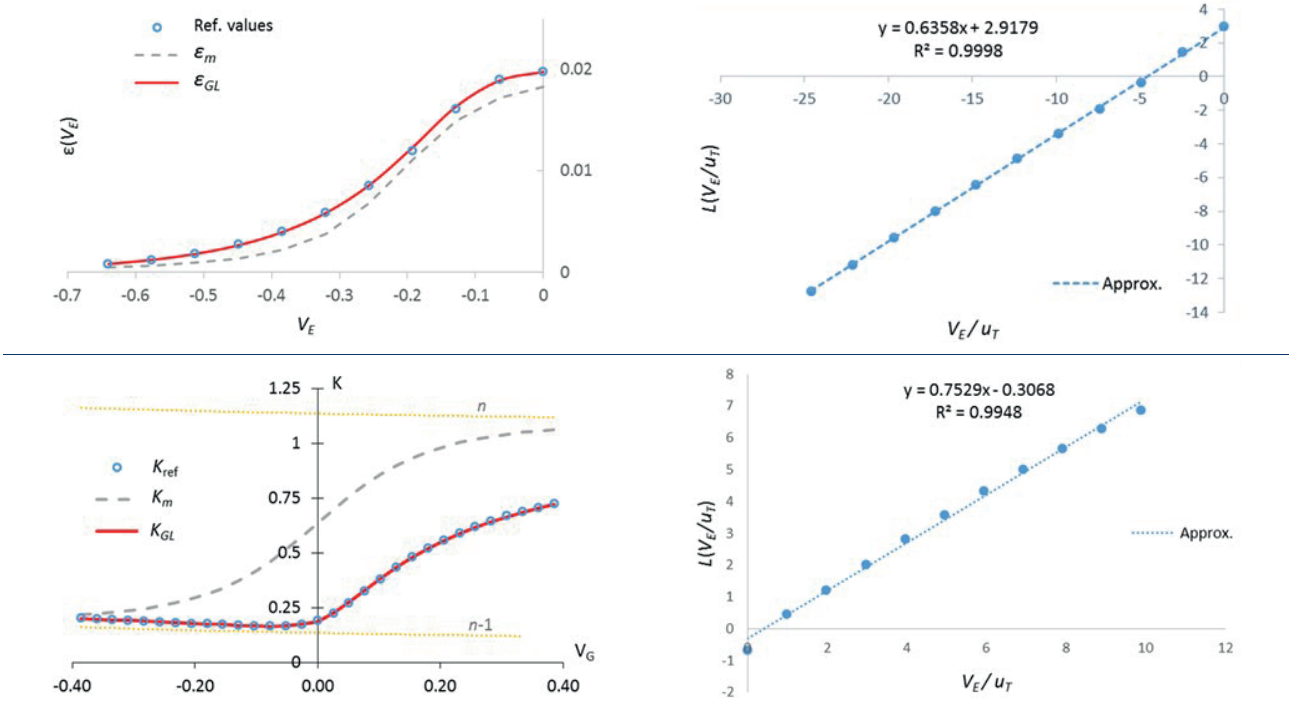


Fig. 1. Left diagrams: Estimated values of ε and K smoothing factors vs. effective voltage V_E. Right diagrams: Last squares approximation of Logit-functions vs. V_E/u_T. Device parameters are: t_{ox} = 1nm, $N_A = 10^{19}$cm^{-3}, V_{FB} = -1V, V_{ch} = 0.01V, V_T = 0.64V (diagrams above) and t_{ox} = 2.3nm, $N_A = 5\times10^{17}$cm^{-3}, V_{FB} = -0.8V, V_{ch} = 0V, V_T = 0.386V (diagrams below).

Table 1. Estimated errors obtained by the fitting of factor ε. Device parameters are: t_{ox} = 1nm, $N_A = 10^{19}$cm^{-3}, V_{FB} = -1V, V_{ch} = 0.01V, V_T = 0.64V.

Errors	Regions	ε-fitting		SP approximation	
		ε_m	ε_{GL}	ε_m	ε_{GL}
AE	Weak inversion	1.26E-03	1.04E-04	2.41E-04	8.26E-05
	Strong inversion	1.65E-03	140E-03	2.78E-03	2.67E-03
FE (%)	Weak inversion	30.81	1.24	2.43E-02	8.15E-03
	Strong inversion	7.56	6.35	2.58E-01	2.48E-01
SE	Weak inversion	1.38E-03	1.60E-04	5.45E-04	2.14E-04
	Strong inversion	1.89E-03	1.71E-03	4.70E-03	4.50E-06

Table 2. Estimated errors obtained by the fitting of factor K. Device parameters are: t_{ox} = 2.3nm, $N_A = 10^{18}$cm^{-3}, V_{FB} = -0.8V, V_{ch} = 0V, V_T = 0.386V.

Errors	Regions	K-fitting		ICD approximation	
		K_m	K_{GL}	K_m	K_{GL}
AE	Weak inversion	1.49E-01	8.01E-04	5.49E-06	1.14E-08
	Strong inversion	3.30E-01	4.66E-03	1.61E-03	3.33E-05
FE	Weak inversion	85.93	0.46	85.93	0.46
	Strong inversion	58.93	0.71	58.93	0.71
SE	Weak inversion	1.91E-01	1.02E-03	1.41E-05	2.25E-08
	Strong inversion	3.42E-01	5.58E-03	1.73E-03	4.99E-05

The ICD values as the function of gate voltage V_G, implemented in a Verilog A compact model code and simulated in QucsStudio simulator, are plotted in logarithmic and linear scales, in left diagram of Fig. 2. The reference values obtained from the implicit charge sheet Eqs. (1) and (2) by using the Newton–Raphson algorithm [14] are labeled by dots. These values are also compared with the values obtained by the interpolation function in Eq. (7), for the both of smoothing factors K_m and K_{GL}. Obviously, implementation of the GL-fit factor K_{GL} in Eq. (7) leads to the better and more accurate predictions of the ICD behavior in the both of inversion regions.

One more advantage of introducing the GL-fit factors can be observed in approximating of the drain current (*Id*). Under the assumption that velocity of charge carriers along the channel is constant, the drain current can be written as [15]:

$$I_d = -\mu \cdot Q'_I \cdot \frac{W}{L} \cdot V_{DS} \cdot \tag{12}$$

Here, μ is the mobility of the carriers, W is the gate width, L is the gate length, and V_{DS} is the drain–source voltage. The reference values of the linear current-versus-voltage characteristics, obtained from Eq. (12) with μ = 400 cm2/Vs, W = 45nm and L = 22nm, are shown in the right diagram of Fig. 2 (labeled by dots). On the other hand, the approximate values of the drain current, computed by replacing Q'_I with Q'_{inv} and by inputting the GL-fit smoothing factor K_{GL}, are also shown by lines in the same figure. These output characteristics confirm again the validity and reasonability of introducing the GL functional form for the smoothing factor K into the interpolated relation (7)

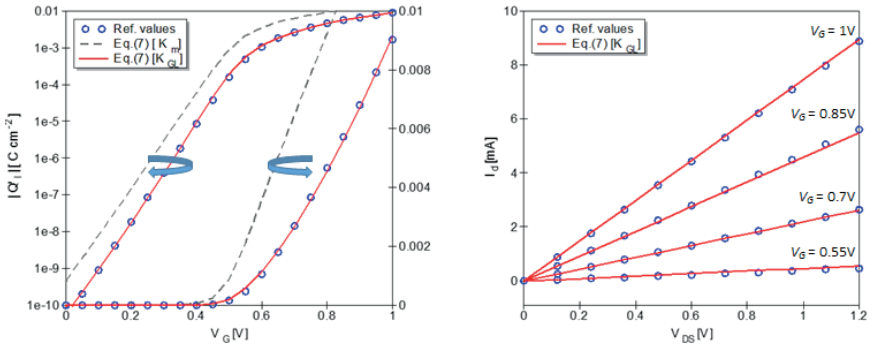


Fig. 2. Diagram left: Various types of ICD approximations versus gate voltage V_G. Diagram right: Drain current I_d versus drain-source voltage V_{DS} for various values ofg V_G. Device parameters are: t_{ox} = 1.2nm, $N_A = 5\times10^{19}$cm^{-3}, V_{FB} = -1V, V_{ch} = 0V, V_T = 0.5002V.

5. DISCUSSION

The rapid development in semiconductor technology over the past few decades have led to a dramatic increase in interest in device modeling. The need to understand the detailed operation of compound semiconductor devices has meant that device modeling now plays a crucial role in modern technology. Moreover, the modeling also allows new device structures to be rigorously investigated prior to fabrication. Two semiconductor industry standard compact models, i.e. charge and potential based are improved here by introducing the Generalized Logistic functions instead some empirical smoothing factors. These functions provide completely control of smoothness, speed as well as manner of transitions both of surface potential and inversion charge density in interface regions. The values for SP, ICD and the drain current have been compared with numerical results of implicit charge sheet model extensively. The good agreement obtained for MOSFET transistors with different technology parameters justifies the implementation of the GL functions in SPBM and charge-based MOSFET model. Furthermore, the proposed GL approaches can be also extended to the case of scaled MOSFET devices which show significant quantum mechanical behavior [16].

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OPTIMIZACIJA ISKORIŠĆENJA TOVARNOG PROSTORA FORMIRANJEM GEOMETRIJSKOG MODELA PLANA PAKOVANJA POŠILJAKA

Dragan Lazarević*,
Momčilo Dobrodolac,
Maja Petrović

Saobraćajni fakultet,
Univerzitet u Beogradu,
Beograd, Srbija

Rezime:

U radu se predlaže koncept za unapređenje nivoa efikasnosti iskorišćenja tovarnog prostora transportnih sredstava u okviru sistema za distribuciju robe i pošiljaka. Ovaj koncept se zasniva na rešavanju problema trodimenzionalnog pakovanja (*3D Bin Packing Problem*). Predstavljen je primer iz realnog sistema poštanske kompanije u Srbiji, kao jednog od najvećih logističkih i distributivnih sistema u regionu. Definisani problem, dobija dodatno na važnosti usled pojave velikog broja nestandardnih pošiljaka (paketa) u sistemima za njihovu preradu i transport. Značajan uticaj na povećanje broja pošiljaka ima ekspanzija e-trgovine. Rešenje ovog problema je predstavljeno geometrijskim modelom plana pakovanja robe i pošiljaka, a u skladu sa njihovim karakteristikama i kapacitetom tovarnog prostora transportnog sredstva.

Ključne reči:

Trodimenzionalno pakovanje, pošiljke, tovarni prostor, transportno sredstvo, geometrijski model.

1. UVOD

U savremenom čovekovom okruženju, prisutni su različiti sistemi, koji svakom pojedincu, kroz uslužne delatnosti, pružaju mogućnost da realizuje svoje poslovne i privatne potrebe. Uslužna delatnost, posmatrajući od poslednje decenije prethodnog veka, jeste jedan od sektora sa izraženo visokim stepenom razvoja. Ako posmatramo razvijene zemlje, u uslužnom sektoru radi preko 70% od ukupnog broja zaposlenih [1]. Proizvodnja bez plasmana nema značajnu svrsishodnost i zato je neophodno istaći važnost transporta proizvoda. Transportne aktivnosti se realizuju kroz odgovarajuće sisteme distribucije, koji mogu biti različitog obima i nivoa složenosti. U slučaju distribucije robe široke potrošnje, sistemi distribucije nude pojedinačnu ili kompletnu uslugu, koja može obuhvatati uvoz i carinjenje robe, skladištenje, marketinške usluge, prodaju i dostavu. U skladu sa savremenim tendencijama održivog razvoja, prisutna je globalna svest i težnja za unapređenjem ekonomske, društvene i ekološke dimenzije svakog poslovnog sistema [2], što zahteva sprovođenje kontinualnih analiza i odgovarajućih aktivnosti unapređenja.

Odgovorno lice:
Dragan Lazarević

e-pošta:
d.lazarevic@sf.bg.ac.rs

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U okviru ovog rada, analiziran je proces transporta ekspres pošiljaka u poštanskoj kompaniji, koja predstavlja jedan od najvećih logističkih i distributivnih sistema u Srbiji i regionu. Identifikovani su određeni problemi i izazovi, koji su nastali pre svega pojavom velikog broja nestandardnih pošiljaka u sistemu. Jedan od osnovnih razloga ovog trenda jeste ekspanzija lanaca e-trgovine i učešće poštanskih kompanija u istim, pre svega u segmentu dostave kupljene robe. Jedan od izdvojenih problema, odnosi se na efikasnost iskorišćenja tovarnog prostora transportnih sredstava usled nemogućnosti potpuno kompaktnog pakovanja nestandardnih pošiljaka. Konsekvence inicirane ovim problemom, odnose se pre svega na pojavu slučaja da se sve pošiljke na stanju, za posmatranu liniju prevoza, ne mogu spakovati u predviđeni tovarni prostor. To može dovesti do kašnjenja pri prenosu pošiljaka (čekanje na narednu liniju po redu prevoza), odnosno do potrebe za angažovanjem dodatnih resursa (transportno sredstvo i kurir) čime se uvećavaju troškovi. Sve ovo doprinosi formiranju negativnog uticaja na održivi razvoj poštanske usluge.

U cilju optimizacije iskorišćenja tovarnog prostora pri prenosu pošiljaka, predlaže se uvođenje i primena koncepta rešavanja problema pakovanja (*3D Bin Packing Problem),* na osnovu koga se formira geometrijski model plana pakovanja u skladu sa odgovarajućim ograničenjima. Prikazani su rezultati primene koncepta na primeru iz realnog sistema, pri čemu je za rešavanje zadatka trodimenzionalnog pakovanja, korišćen specijalizovani softver *EasyCargo*.

2. KONCEPT PROBLEMA PAKOVANJA

Problem pakovanja se u literaturi najčešće sreće kao *3D Bin Packing Problem,* odnosno kao problem trodimenzionalnog pakovanja. Međutim, ovom konceptu su prethodili pristupi za rešavanje problema u jednoj odnosno dve dimenzije.

Jednodimenzionalni i dvodimenzionalni problemi pakovanja

Jednodimenzionalno pakovanje podrazumeva zadatak, gde je određenu robu, predmete ili pakete potrebno smestiti u odgovarajuće tovarne (teretne) prostore, tako da njihovo iskorišćenje bude na visokom nivou, pri čemu se vodi računa o samo jednom ograničenju – dimenziji (npr. nosivost transportnog sredstva) [3].

Dvodimenzionalni problem pakovanja (*2D Bin Packing Problem*) jeste unapređenje jednodimenzionalnog problema u pogledu ograničenja, koja se pri pakovanju uzimaju u obzir. Naime, kod ovog zadatka, posmatraju se dva ograničenja – dimenzije (npr. dužina i širina paketa). Jedan od prvih zadataka iz ove oblasti, koji se može pronaći u literaturi, jeste pakovanje (postavljanje) što većeg broja manjih pravougaonika određenih dimenzija (bez preklapanja), na površinu jednog većeg pravougaonika [4].

Trodimenzionalni problem pakovanja - 3D Bin Packing Problem

Za trodimenzionalni zadatak pakovanja, se može reći da predstavlja specijalan slučaj, odnosno sintezu prethodno definisanih problema, u kome se u obzir uzimaju bar tri ograničenja - dimenzije [5]. Rešenje ovog zadatka podrazumeva formiranje geometrijskog modela plana pakovanja u okviru definisanog tovarnog prostora, kontejnera, na paleti i sl.

Opšti matematički model podrazumeva zadatak pakovanja paketa određenih dimenzija u tovarni prostor definisane strukture i kapaciteta, pri čemu je osnovni cilj njegovo maksimalno iskorišćenje, odnosno kompaktno pakovanje i smanjenje prostora između paketa [6].

3D Bin Packing Problem se često povezuje sa utovarom robe i paleta u tovarni prostor transportnog sredstva ili u kontejner, ali i na brojne druge modifikacije, kao što je pakovanje robe na palete. Među prvim radovima u ovoj oblasti je rešenje koje je predstavio Wright 1974. godine, a odnosilo se na formiranje najpogodnije konfiguracije za utovar paleta u tovarni prostor [7]. Zadatku *3D* pakovanja, mogu se dodati različita ograničenja i specifičnosti, poput rotacije paketa (da/ne), definisanja njihovog prioriteta pri pakovanju, analize stabilnosti i sl. [8, 9, 10]. *3D Bin Packing Problem* je delimično, kao koncept, analiziran od strane Lin-a i saradnika (2016) u oblasti dostave paketskih pošiljaka. U okviru pomenute studije, cilj je bio primeniti koncept *3D* pakovanja i pri tome eliminisati dodatni pretovar paketa nakon svake izvršene dostave [11].

Do danas je razvijen značajan broj algoritama za rešavanje zadataka *2D* i *3D* pakovanja [12, 13, 14, 15, 16, 17]. Neki od njih su primenu našli i u odgovarajućim specijalizovanim softverima.

3. PREDLOG KONCEPTA ZA REŠAVANJE 3D BIN PACKING PROBLEM-A PRI PRENOSU EKSPRES POŠILJAKA

Značaj rešavanja problema trodimenzionalnog pakovanja pri prenosu ekspres pošiljaka, polazi od činjenice da se u sistemima za prenos pojavljuje sve veći broj pošiljaka nestandardnih dimenzija. Izvor ovih pošiljaka su pre svega lanci e-trgovine. Naime, kako bi unapredile svoju poziciju na tržištu i pridobile veći broj korisnika, a sve u cilju uvećanja profita, poštanske kompanije su prinuđene da uzmu učešće u lancima e-trgovine, a samim tim i da prihvataju na prenos sve veći broj nestandardnih pošiljaka. Nestandardne pošiljke su sve one pošiljke koje svojim dimenzijama i ostalim karakteristikama ne odgovaraju propisanim standardima. Automatizovani sistemi u poštanskim kompanijama su prilagođeni za rad sa standardnim pošiljkama, što dalje implicira na nemogućnost automatizovane prerade nestandardnih pošiljaka. Iz tog razloga se ove pošiljke uglavnom prerađuju manuelno.

Značajni problemi se javljaju prilikom pakovanja nestandardnih pošiljaka u tovarni prostor transportnog sredstva. Ove pošiljke se ne mogu upakovati u standardnu ambalažu za prenos ekspres pošiljaka, tako da se u transpotno sredstvo pakuju u sopstvenoj ambalaži (ako je poseduju). Navedeno utiče na nemogućnost potpuno kompaktnog pakovanja i na smanjenje nivoa iskorišćenja tovarnog prostora, što indirektno može izazvati brojne probleme. Dešava se da usled nedostatka mesta u tovarnom prostoru nije moguće utovariti sve pošiljke, predviđene definisanim redom prevoza, a u skladu sa vremenskim rokovima uručenja. U navedenom slučaju su moguća dva scenarija: transport pošiljaka linijama sa kasnijim polascima (može izazvati kašnjenje pošiljaka na uručenje); angažovanje dodatnih resursa (transportno sredstvo i kurir) kako bi se transport preostalih pošiljaka realizovao po unapred definisanom redu prevoza. Kod drugog scenarija, pojavljuju se dodatni troškovi, koji se ne mogu nadoknaditi kroz cenu usluge, dok je usled angažovanja dodatnog transportnog sredstva evidentan i negativan uticaj na životnu sredinu.

Nestandardne pošiljke su podložne oštećenju, kako pri pretovarnim manipulacijama, tako i u okviru procesa transporta. Naime, nemogućnost kompaktnog pakovanja ostavlja veći prostor između pošiljaka, što uvećava verovatnoću da tokom transporta dođe do njihovog pomeranja, klizanja i nagnječenja. Kako je naglašeno, u sistemima poštanskih kompanija, pojavljuje se sve veći broj različitih pošiljaka, odnosno robe različitih karakteristika, osetljivosti i vrednosti, što dodatno doprinosi značaju navedenog problema.

Rastući trend e-trgovine će i u budućnosti uticati na pojavu sve većeg broja nestandardnih pošiljaka u sistemima poštanskih kompanija. U skladu sa tim i navedenim problemima, potrebno je na odgovarajuće načine unaprediti njihove poslovne procese, kako bi se eliminisale negativne posledice. Analiza izdvojenog problema pakovanja pošiljaka, ukazala je na potrebu primene odgovarajućeg pristupa, koji bi omogućio njihovo kompaktno pakovanje, odnosno unapredio efikasnost iskorišćenja tovarnog prostora.

Predlaže se primena koncepta rešavanja *3D bin packing problem*-a. Podrazumeva kreiranje geometrijskog modela, odnosno plana na osnovu koga treba realizovati pakovanje, a u zavisnosti od definisanih karakteristika tovarnog prostora i pošiljaka. Benefiti primene ovog pristupa proističu iz samog unapređenja efikasnosti iskorišćenja tovarnog prostora, a odnose se pre svega na eliminisanje vremenskih kašnjenja, unapređenje bezbednosti pošiljaka i smanjenje broja potrebnih transportnih sredstava (smanjenje troškova i negativnog uticaja na životnu sredinu).

Predlog realizacije koncepta 3D bin packing problem-a

Realizacija koncepta rešavanja *3D bin packing problem*-a u okviru sistema za prenos ekspres pošiljaka se može prikazati narednim koracima:

- 1. korak: Prikupljanje informacija o fizičkim karakteristikama pošiljaka (dužina, širina, visina i masa);
- 2. korak: Definisanje tovarnog prostora, odnosno transportnog sredstva;
- 3. korak: Primena softvera za rešavanje *3D bin packing problem*-a;
- 4. korak: Analiza dobijenog rešenja;
- 5. korak: Pakovanje pošiljaka u skladu sa definisanim geometrijskim modelom plana pakovanja.

U prvom koraku se u skladu sa odgovarajućim pristupom za svaku pošiljku određuju osnovne karakteristike: dužina, širina, visina i masa. Standardan pristup za određivanje ovih karakteristika, podrazumeva manuelno merenje, koje bi u skladu sa brojem pošiljaka oduzelo značajno vreme, pa bi i sam koncept bio neracionalan za primenu. Masa pošiljaka se i u dosadašnjem načinu prenosa uzimala u obzir, a primena preciznih elektronskih vaga doprinosi da se ova karakteristika može efikasno i jednostavno odrediti.

Kada je reč o određivanju ostalih potrebnih karakteristika (dužina, širina i visina), mogu se koristiti

savremeni pristupi, koji su nastali kao rezultat razvoja novih tehnologija. Na prvom mestu, predlaže se upotreba *3D* skenera ili kombinovana primena odgovarajućih senzora i koncepta *Internet of Things (IoT)*.

U drugom koraku se definiše tovarni prostor predviđenog transportnog sredstva, u zavisnosti od nivoa u sistemu na kome se transport realizuje. Treći korak u rešavanju ovog problema (*3D bin packing problem*) obuhvata primenu odgovarajućeg softvera, u skladu sa ulaznim podacima koji su rezultat prva dva koraka. Izlaz iz softvera, odnosno rešenje, predstavljeno je geometrijskim modelom plana najpogodijeg načina pakovanja u skladu sa zadatim ograničenjima. U četvrtom koraku se dobijeno rešenje dodatno analizira i eventualno uvode određene korekcije. Peti korak podrazumeva fizičku realizaciju pakovanja na osnovu definisanog geometrijskog modela plana pakovanja.

U nastavku će biti prikazano rešavanje problema pakovanja ekspres pošiljaka, na primeru iz jednog realnog sistema poštanske kompanije u Srbiji.

4. REŠAVANJE 3D BIN PACKING PROBLEM-A NA PRIMERU IZ REALNOG SISTEMA ZA PRENOS EKSPRES POŠILJAKA

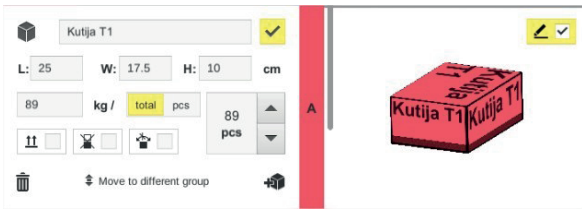
Analizirani zadatak pakovanja se odnosio na primer iz realnog sistema poštanske kompanije. Pošiljke, prikupljene sa određenih rejona, trebalo je transportovati u preradni centar. Pri utovaru u transportno sredstvo, određeni broj pošiljaka (oko 15% od ukupne količine) nije mogao da stane u predviđeni tovarni prostor. Kako je već naglašeno, u ovoj situacije se čeka naredni polazak na istoj liniji prevoza, odnosno angažuju se dodatni resursi, kako bi se transport odmah realizovao, što dovodi do opisanih negativnih posledica. Primenom predloženog koncepta, moguće je: kreirati geometrijski model plana pakovanja, na osnovu koga će sve pošiljke biti spakovane; ukazati na nemogućnost utovara svih pošiljaka u definisani tovarni prostor. Rezultati koji se odnose na drugi slučaj, mogu poslužiti kao inicijator promena u organizaciji transporta (angažovanje transportnog sredstva sa većim kapacitetom tovarnog prostora, raspodela pošiljaka na dva ili više transportnih sredstava). Rešavanje zadatka je realizovano u skladu sa predloženim koracima, a kao softverska podrška korišćen je *EasyCargo* softver.

Prvi korak podrazumeva prikupljanje informacija o fizičkim karakteristikama pošiljaka. Kako koncept nije implementiran u posmatranoj kompaniji (ne postoji sistem za prikupljanje svih neophodnih informacija), za posmatrani slučaj nije bilo moguće potpuno precizno odrediti potrebne karakteristike, jer se o njima u standardnom poslovnom procesu ne vodi takva evidencija. U Tabeli 1, prikazani su zahtevi, odnosno broj i karakteristike pošiljaka koje je trebalo upakovati u tovarni prostor određenog transportnog sredstva. Precizne informacije o karakteristikama su uzete u obzir kod standardnih pošiljaka (dimenzije ambalaže), dok su karakteristike preostalih – nestandardnih pošiljaka definisane u saradnji sa zaposlenima u kompaniji, koji su u posmatranom slučaju, radili na poslovima pretovara i usmeravanja pošiljaka. Dužina punih vreća je iznosila oko 100cm, dok je prečnik iznosio približno 70cm. Tačne informacije o masi pošiljaka, nisu bile dostupne, ali je ukupna masa po proceni zaposlenih bila u granicama nosivosti predviđenog transportnog sredstva. Iz tog razloga, pošiljkama su dodeljene proizvoljne vrednosti mase.

Na Slici 1, prikazan je segment za kreiranje pošiljaka (paketa) u softveru *EasyCargo*. Jedna od mogućnosti koju većina softvera iz ove oblasti poseduje, jeste povezivanje sa odgovarajućim tabelama iz softvera *Excel*, što u velikoj meri može doprineti efikasnosti primene koncepta. Ova opcija je naročito od značaja ukoliko se informacije o karakteristikama dobijenim sa *3D* skenera i precizne vage, po automatizmu skladište u odgovarajuću *Excel* tabelu.

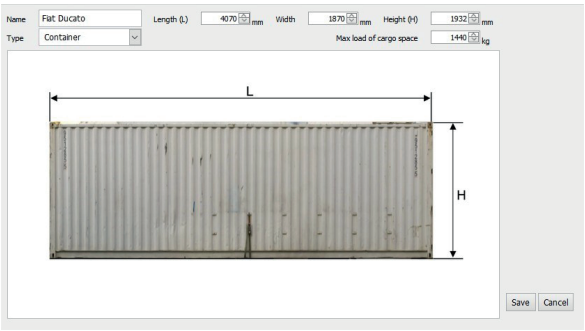
Tabela 1. Karakteristike zahteva

Tip ambalaže	**Dimenzije (DxŠxV) [mm]**	**Količina**
Kartonske kutije T1	(250x175x100)	89
Kartonske kutije T2	(350x250x120)	95
Kutije za ukrupnjavanje	(550x500x400)	37
Vreće		7
Pošiljke van standardne ambalaže		92



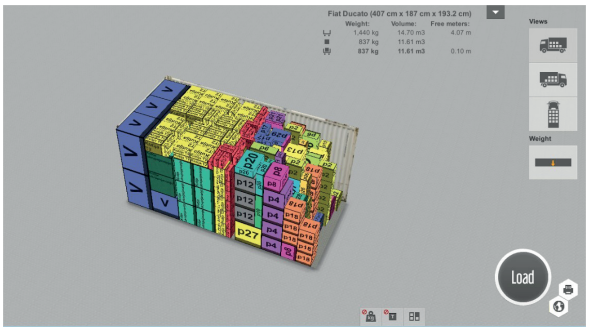
Slika 1. Kreiranje pošiljke (paketa) u softveru EasyCargo

U drugom koraku se definiše tovarni prostor u koji treba spakovati pošiljke. U analiziranom slučaju, korišćeno je vozilo *FIAT Ducato,* nosivosti 1440kg, sa sledećim dimenzijama tovarnog prostora: dužina - 4070mm; širina - 1870mm; visina - 1932mm. Na Slici 2, prikazan je modul za definisanje tovarnog prostora.

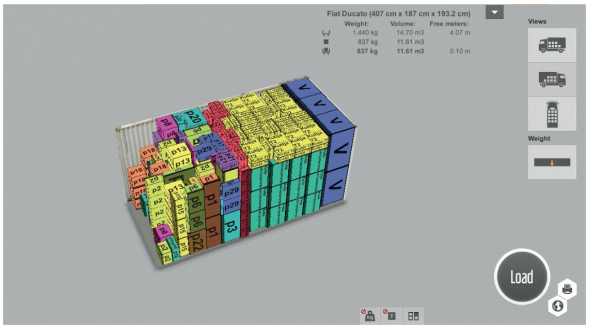


Slika 2. Definisanje tovarnog prostora

U trećem koraku se primenom softvera rešava *3D Bin Packing Problem*, odnosno kreira geometrijski model plana pakovanja. U konkretnom slučaju, dobijeno je rešenje po kome je sve pošiljke na stanju moguće upakovati u definisani tovarni prostor, za razliku od realnosti gde je van tovarnog prostora ostalo oko 15% od ukupne količine pošiljaka. Iskorišćenje tovarnog prostora rešenja, prikazano kroz procenat zauzetosti iznosi oko 79%. Pošiljke sa naznakom za posebno rukovanje, pre svega lomljive, koje se nalaze van ambalaže za ukrupnjavanje, su od strane korisnika softvera smeštene u plan pakovanja, kako bi se povećao nivo njihove bezbednosti. Na slikama (Slika 3 – Slika 5) dat je geometrijski prikaz modela plana pakovanja u različitim pogledima, kao grafički izlaz softvera.

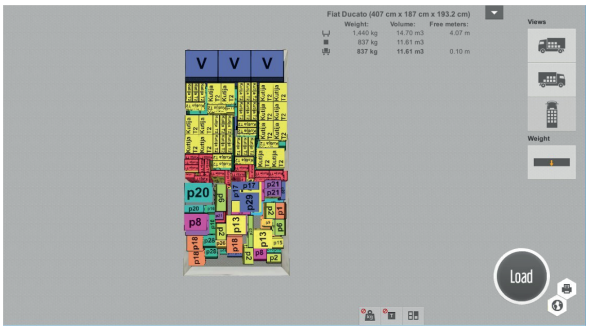


Slika 3. Geometrijski model plana pakovanja (perspektivni prikaz 1)



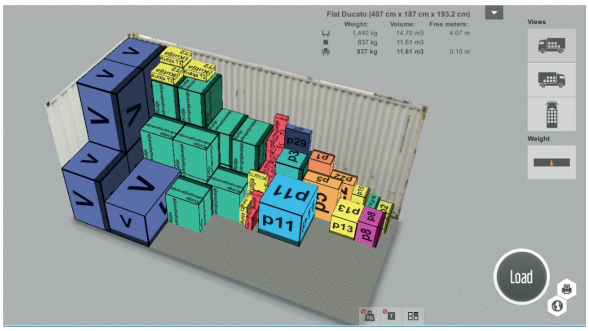
Slika 4. Geometrijski model plana pakovanja (perspektivni prikaz 2)

Rešenje dobijeno ovim putem se može razložiti, kako bi se izdvojio detaljniji vizuelni plan. Nivo razlaganja zavisi od strukture pošiljaka, odnosno od nivoa preglednosti pozicije pošiljaka u tovarnom prostoru.

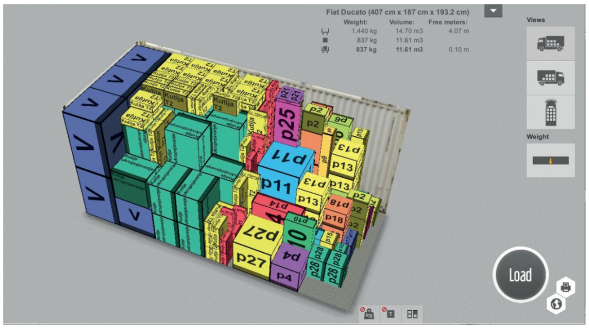


Slika 5. Geometrijski model plana pakovanja (perspektivni prikaz 3)

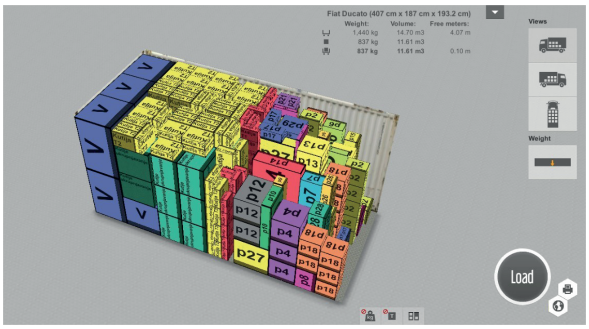
Na narednim slikama (Slika 6 – Slika 9) je prikazan plan pakovanja sa proizvoljnim nivoom razlaganja.



Slika 6. Razloženi geometrijski model plana pakovanja – nivo 1



Slika 7. Razloženi geometrijski model plana pakovanja – nivo 2



Slika 8. Razloženi geometrijski model plana pakovanja – nivo 3

Broj nivoa razlaganja zavisi od strukture geometrijskog modela plana pakovanja. Teoretski, nivoa može biti onoliko koliko ima pošiljaka za pakovanje (utovar). Poslednji nivo, predstavlja potpuni plan pakovanja, koji je prikazan u radu kao dobijeno konačno rešenje.

Analiza rešenja podrazumeva proveru da li se sve pošiljke nalaze u planu pakovanja, kao i pozicije pošiljaka sa posebno naznačenim rukovanjem i osetljivim sadržajem. Softver pruža mogućnost manuelne korekcije pozicije pošiljaka, ukoliko se za to ukaže potreba, kao i generisanje izveštaja o njihovom statusu. Na osnovu rešenja i kreiranog geometrijskog modela plana pakovanja, analizira se kojim transportnim sredstvom je najpogodnije realizovati transport. U slučaju niskog nivoa iskorišćenja tovarnog prostora, potrebno je razmatrati korišćenje transportnog sredstva sa manjim kapacitetom. U suprotnom slučaju, kada je kapacitet tovarnog prostora nedovoljan za utovar svih pošiljaka, rešava se zadatak izbora koncepta transporta – jedno veće transportno sredstvo ili 2 ili više manjih. Izbor drugog koncepta, podrazumeva rešavanje dodatnog zadatka, koji se odnosi na raspodelu pošiljaka između transportnih sredstava. U konkretnom primeru nije bilo značajnih korekcija, a one koje su izvršene, deo su prikazanog konačnog rešenja geometrijskog modela plana pakovanja.

5. ZAKLJUČAK

U sistemima distribucije različitih pošiljaka i robe, kao što su poštanske kompanije, izražen je porast broja nestandardnih pošiljaka. Razlog tome jeste, pre svega, njihovo učešće u lancima e-trgovine u segmentu dostave kupljene robe.

Nestandardne pošiljke izazivaju različite konsekvence u procesu prerade i transporta, koje negativno utiču na efikasnost realizacije čitavog poslovnog procesa prenosa. Analizom aktivnosti koje prethode procesu transporta, zaključeno je da nivo iskorišćenja tovarnog prostora transportnih sredstava, ima značajan uticaj na definisani pokazatelj efikasnosti. Kako broj nestandardnih pošiljaka u sistemu raste, smanjuje se mogućnost kompaktnog pakovanja pošiljaka, koje bi obezbedilo visok nivo iskorišćenja tovarnog prostora, a istovremeno imalo i pozitivan uticaj na bezbednost pošiljaka (kompaktno pakovanje umanjuje verovatnoću oštećenja pošiljaka).

U radu se predlaže primena koncepta rešavanja *3D bin packing problem*-a. Podrazumeva formiranje geometrijskog modela plana pakovanja pošiljaka, a u skladu sa njihovim karakteristikama i definisanim tovarnim prostorom transportnog sredstva. Kroz primenu koncepta, može se generisati rešenje za kompaktno pakovanje pošiljaka sa visokim nivoom iskorišćenja tovarnog prostora ili ukazati na nedovoljan kapacitet tovarnog prostora anliziranog transportnog sredstva. U radu su prikazani rezultati uspešne primene koncepta na primeru iz realnog sistema poštanske kompanije, pri čemu je korišćen specijalizovani softver *EasyCargo*.

Ekspanzija e-trgovine će u budućnosti usloviti pojavu još većeg broja nestandardnih pošiljaka, što značajno naglašava važnost rešavanja ove vrste problema.

ZAHVALNOST

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PRIMENA LAMBDA FAZI MERE I ŠEPLIJEVE VREDNOSTI NA PROCENE PERFORMANSI ROBE U SKLADIŠTIMA

Endre Pap,
Ana Blagojević*

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Klasična teorija mere se bavi proučavanjem skupovnih funkcija koje praznom skupu dodeljuju nulu i imaju osobinu aditivnosti. Takve skupovne funkcije se nazivaju merama. Uprkos širokoj primeni u različitim oblastima kako matematike tako i u rešavanju praktičnih problema, njihova primena zbog same osobine adtitivnosti je ograničena. Stoga se razvila teorija fazi mere u kojoj se polazi od skupovne funkcije koja pored osobine da je na praznom skupu nula, ima osobinu monotonosti, dok u opštem slučaju ne mora da bude aditivna. Ovakve skupovne funkcije predstavljaju uopštenje mere i nazivaju se monotone skupovne funkcije ili fazi mere. Određivanje fazi mere je kompleksan proces zbog eksponencijalnog broja podskupova nad kojima se mera procenjuje. Da bi smanjili složenost izračunavanja koristi se specijalna vrsta fazi mere pod nazivom λ -fazi mera. U ovom radu opisan je problem određivanja parametra λ , λ -fazi mere i Šeplijeve vrednosti pri proceni performansi robe u skladištima.

Ključne reči:

λ -fazi mera, višekriterijumsko odlučivanje, indeks važnosti, Šeplijeva vrednost.

1. UVOD

Višekriterijumsko odlučivanje (Multiple criteria decision making, MCDM) odnosi se na problem izbora alternativa vezanih za više kriterijuma, videti [1]. Od 50-tih godina prošlog veka pa do danas razvio se veliki broj MCDM metoda koje se međusobno razlikuju u pogledu zahtevanog kvaliteta i kvantiteteta informacija, korišćene metodologije i matematičkih osobina koje treba da potvrde. Vince je u [1] sažeto podelio MCDM u tri grupe: teorija korisnosti na bazi višestrukih atributa, metode rangiranja i interaktivne metode. Carlsson i Fuller navode da postoje različite vrste MCDM metoda, videti [2]:

1. Metode rangiranja
2. Metode bazirane na teoriji korisnosti i vrednosti
3. Programiranje sa višestrukim ciljevma
4. Metode bazirane na grupnom odlučivanju i pregovaranju

Odgovorno lice:
Ana Blagojević

e-pošta:
asimicevic@singidunum.ac.rs

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Većina MCDM metoda bavi se diskretnim alternativama, koje su opisane nizom kriterijuma. Informacije mogu da budu precizno utvrđene ili fazi utvrđene, u intervalima. Jedan od problema koji se javlja pri rešavanju MCDM-a, je izbor agregacione procedure za rešavanje problema odlučivanja. U kontekstu višekriterijumskog odlučivanja, odluke se često donose na bazi nepreciznih, nesigurnih, i nekompletnih informacija koje dolaze od nekoliko manje ili više pouzdanih izvora. Teorija verovatnoće je razvijena zbog neizvesnosti ili nedostatka znanja o mogućim stanjima alternativa. Evidenciona racionalna teorija, koja predstavlja nastavak teorije verovatnoće, je čuvena alatka za odlučivanje usled neizvesnosti, videti [3]. Međutim, neizvesnost je neprecizna i neizvesna u mnogim situacijama i ne može se modelirati verovatnoćom. Da bi se ova vrsta neizvesnosti prevazišla predložena je teorija fazi skupova. Akcije su jedan od najvećih problema maloprodajnih lanaca, jer direktno dovode do gubitka prodaje, smanjenja profita i potencijalnog gubitka kupaca. U ovom radu korišćena je λ -fazi mera i Šeplijeva vrednosti da bi se odredio odnos između različitih atributa jedinice za vođenje zaliha i performansi maloprodajnih zaliha.

2. LAMBDA FAZI MERA I ŠEPLIJEVA VREDNOST

Kao efikasna alatka za merenje interakcije između elemenata, fazi mera se definiše na sledeći način:

Definicija 1: Neka je $X=\{x_1,x_2,...,x_n\}$ fiksni skup. $P(X)$ je skup svih podskupova skupa X. Fazi mera na X je skupovna funkcija $\mu: P(X)\to[0,1]$, koja ispunjava sledeće uslove, videti [4],[5]:

1. $\mu(\varnothing)=0$, $\mu(X)=1$

2. Ako $A,B\in P(X)$ i $A\subseteq B$, tada važi $\mu(A)<\mu(B)$

Da bi utvrdili tavu fazi meru, mora se naći ukupno 2^n-2 brojeva nad kojima se mera procenjuje, jer u skladu sa gore navedenom definicijom vrednosti $\mu(\varnothing)$ i $\mu(X)$, su uvek jednake nuli tj. jedinici. Očigledno je da je ovakav proces procenjivanja prilično složen. Da bi smanjili složenost izračunavanja, predložena je λ -fazi mera g koja se ponaša kao specijalna vrsta fazi mere, videti [6], [7], [8].

Definicija 2: Neka je $X=\{x_1,x_2,...,x_n\}$ fiksni skup. Fazi mera g na X naziva se λ -fazi fazi mera, ako zadovoljava sledeće uslove:

$$g(A\cup B)=g(A)+g(B)+\lambda g(A)g(B)$$

Gde je, $\lambda\in(-1,\infty)$ za svako $\forall A,B\in P(X)$ i $A\cap B=\varnothing$.

Teorema 1. Ako je X konačan skup $\bigcup_{i=1}^{n}x_i=X$, λ -fazi mera g zadovoljava sledeću jednačinu:

$$g\left(\bigcup_{i=1}^{n}x_i\right)= \\ =\begin{cases}\frac{1}{\lambda}\left(\prod_{i=1}^{n}\left[1+\lambda g(x_i)\right]-1\right), za\ __\ \lambda\neq 0\\ \sum_{i=1}^{n}g(x_i), za\ ___\ \lambda=0\end{cases} \quad (1)$$

gde je $x_i\cap x_j=\varnothing$, za svako $i,j=1,...,n$ i $i\neq j$.

$g(x_i)$ za podskup sa jednim elementom x_i naziva se fazi gustina, označena kao $g_i=g(x_i)$, što predstavlja subjektivnu težinu kriterijuma c_i u MCDM. Za interaktivan kriterijum generalno važi da je $\sum_{i=1}^{n}g(x_i)\neq 1$.

Specjalno za svaki podskup $A\in P(X)$ imamo da važi:

$$g(A)=\begin{cases}\frac{1}{\lambda}\left(\prod_{i\in A}\left[1+\lambda g(i)\right]-1\right), za\ __\ \lambda\neq 0\\ \sum_{i\in A}g(i), za\ ___\ \lambda=0\end{cases} \quad (2)$$

Vrednost λ može se jedinstveno utvrditi pomoću prethodne jednačine. Za $g(X)=1$ jednačina se svodi na:

$$\lambda+1=\prod_{i=1}^{n}(1+\lambda g_i). \quad (3)$$

Teorema 2.

1. $\lambda>0$ kada je $\sum_{i=1}^{n}g(\{x_i\})<g(X)$

2. $\lambda=0$ kada je $\sum_{i=1}^{n}g(\{x_i\})=g(X)$

3. $-\frac{1}{g(X)}<\lambda<0$ kada je $\sum_{i=1}^{n}g(\{x_i\})>g(X)$

Bazirano na skupu aksioma, Šepli je predložio definiciju koeficijenta važnosti, koji se naziva Šeplijeva vrednost $\varphi_i(\mu, X)$ (kraće zapisano sa $\varphi_i(\mu)$), i definisao ga je na sledeći način, videti [9]:

$$\varphi_i(\mu, X) = \\ = \sum_{T \subseteq X|i} \frac{(n-t-1)!t!}{n!}\left[\mu(T \cup i) - \mu(T)\right] \quad (4)$$

gde n, t označavaju kardinalnost skupova X, T redom.

Na bazi prethodne jednačine mi znamo da je Šeplijeva vrednost očekivana vrednost ukupnog marginalnog doprinosa između elementa i i bilo koje koalicije $T \subseteq X|i$. Na osnovu definicije fazi mere, lako je uvideti da za svako i, važi da je $\varphi_i(\mu) \geq 0$ i $\sum_{i=1}^{n} \varphi_i(\mu) = 1$, što znači da je $\{\varphi_i(\mu)\}_{i \in X}$, težinski vektor, koji se naziva Šeplijev težinski vektor.

Kada je mera μ aditivna, imamo da je $\varphi_i(\mu) = \mu(i)$, što pokazuje da nema interakcije između elementa i i bilo koje koalicije $T \subseteq X|i$. U ovom slučaju Šeplijev težinski vektor se svodi na tradicionalan težinski vektor $\omega = (\omega_1, \omega_2, ..., \omega_n)^T$, gde je $\omega_i = \mu(i)$.

Kada μ nije aditivna, ako je $\varphi_i(\mu) > \mu(i)$, onda postoji komplementarna interakcija između elementa i i bilo koje koalicije $T \subseteq X|i$. Ako je $\varphi_i(\mu) < \mu(i)$, onda postoji redudantna interakcija između elementa i i bilo koje koalicije $T \subseteq X|i$. Stoga, Šeplijeva težina ne samo da pruža meru važnosti kriterijuma, već takođe odražava njihove interaktivne karakteristike.

Kombinovanjem sa definicijom λ-fazi mere g i Šeplijeve vrednosti, lako je izračunati indeks važnosti $\varphi_i(g)$, za kriterium i koji se izražava sledećom jednačinom:

$$\varphi_i(g) = \\ = \sum_{T \subseteq X|i} \frac{(n-t-1)!t!}{n!} g(i) \prod_{j \in T}\left(1 + \lambda g(j)\right) \quad (5)$$

Sledeći primer prikazuje određivanje parametra λ i fazi mere. Podaci su preuzeti iz Tabele 4, videti [10], s tim što su vrednosti podeljene sa 2. U tabeli su prikazani sledeći podaci: prosečna prodaja, prosečna cena, nedostatak zaliha u centralnom magacinu, da li je proizvod na promociji ili ne, da li se automatski poručuje, kao i verovatnoća da proizvoda nema na stanju. Kako su prva dva podatka kontinualna, u ovom radu oni su upoređeni, tako što su izračunate Šeplijeve vrednosti za obe varijable.

Table 4 Descriptive statistics of the variables for the manufacturer risk category

Variable	Obs.	Mean	Std dev.	Min.	Max.
avg_sales	1563855	0.4971689	0.9021178	0	14.91257
avg_price	1563855	1.4928780	0.8573341	0.486092	3.970331
st_out_dc	1563855	0.1577934	0.3645473	0	1
promotion	1563855	0.1633783	0.3697106	0	1
auto_ordr	1563855	0.3574065	0.4792361	0	1
stock_out	1563855	0.0341950	0.1817298	0	1

3. PROCENA PERFORMANSI ROBE U SKLADIŠTIMA

Radi lakšeg izračunavanja skup promenljivih iz tabele 4. označavamo sa X i savkoj promenljivoj dodeljujemo redom oznake a, b, c, d, e, f.

$$X = \{a, b, c, d, e, f\}, \mu(X) = 1,$$

$$\mu(\{a\}) = 0.24859,\ \mu(\{b\}) = 0.74644,$$

$$\mu(\{c\}) = 0.07889,\ \mu(\{d\}) = 0.08169,$$

$$\mu(\{e\}) = 0.17870,\ \mu(\{f\}) = 0.01709.$$

Sada koristimo formulu (3) da izračunamo parametar λ. Kako je $\sum_{i=1}^{6} \mu(\{x_i\}) > \mu(X)$, očekujemo, na osnovu Teoreme 2., da važi $-1 < \lambda < 0$. Dobijamo sledeću jednačinu:

$$(1 + \lambda \cdot 0,24859) \cdot (1 + \lambda \cdot 0,74644) \cdot (1 + \lambda \cdot 0,07889) \cdot \\ \cdot (1 + \lambda \cdot 0,08169) \cdot (1 + \lambda \cdot 0,17870) \cdot (1 + \lambda \cdot 0,01709) = \lambda + 1$$

Koja se nakon transformisanja svodi na jednačinu petog stepena:

$$\lambda^5 \cdot 0.000004 + \lambda^4 \cdot 0.00034 + \lambda^3 \cdot 0.00935 + \\ + \lambda^2 \cdot 0.10859 + \lambda \cdot 0.58109 + 0.3514 = 0$$

Metodom polovljenja nalazimo približno rešenje prethodne jednačine sa greškom koja je manja od 10^{-2}. Broj koraka nalazimo iz uslova:

$$\frac{b-a}{2^n} \leq 10^{-2} \Leftrightarrow n \geq 7$$

Primenjujući metod polovljenja dobijamo niz aproksimacija tako što nalazimo sredinu intervala:

$$x_1 = \frac{a+b}{2} = \frac{-1+0}{2} = -0.5$$

a zatim, pomoću znaka funkcije ($f(x_1) > 0$) proveravamo u kojoj polovini intervala se nalazi koren jednačine. Isti metod se ponavlja na toj polovini intervala, sa novim a i b. Ponovo tražimo sredinu intervala i metod ponavljamo 7 puta. Sve vrednosti su date u tabeli:

n	a	b	x_n	$f(x_n)$
1	-1	0	-0.5	0.086
2	-1	-0.5	-0.75	-0.0271
3	-0.75	-0.5	-0.625	0.0284
4	-0.75	-0.625	-0.6875	-0.0084
5	-0.6875	-0.625	-0.65625	0.0142
6	-0.6875	-0.65625	-0.671875	0.0076
7	-0.6875	-0.671875	**-0.6796875**	

Vrednost $\lambda = -0.6796875$ je traženo približno rešenje polazne jednačine.Sada na osnovu formule (1) izračunavamo preostale mere svih podskupova skupa X. Rezultati su prikazani u sledećoj tabeli:

$$\mu\{a\} = 0.24859$$
$$\mu\{a,b\} = 0.868909$$
$$\mu\{a,b,c\} = 0.901208$$
$$\mu\{a,b,c,d\} = 0.932859$$
$$\mu\{a,b,c,d,e\} = 0.998254$$
$$\mu\{a,b,c,d,e,f\} = 1.00375$$
$$\mu\{a,b,c,d,f\} = 0.939113$$
$$\mu\{a,b,c,e\} = 0.970447$$
$$\mu\{a,b,c,e,f\} = 0.976264$$
$$\mu\{a,b,c,f\} = 0.907829$$
$$\mu\{a,b,d\} = 0.902354$$
$$\mu\{a,b,d,e\} = 0.971454$$
$$\mu\{a,b,d,e,f\} = 0.97726$$
$$\mu\{a,b,d,f\} = 0.908962$$
$$\mu\{a,b,e\} = 0.942071$$
$$\mu\{a,b,e,f\} = 0.948218$$
$$\mu\{a,b,f\} = 0.875906$$
$$\mu\{a,c\} = 0.31415$$
$$\mu\{a,c,d\} = 0.378398$$
$$\mu\{a,c,d,e\} = 0.511137$$
$$\mu\{a,c,d,e,f\} = 0.52229$$
$$\mu\{a,c,d,f\} = 0.391092$$
$$\mu\{a,c,e\} = 0.454694$$
$$\mu\{a,c,e,f\} = 0.466502$$
$$\mu\{a,c,f\} = 0.327591$$
$$\mu\{a,d\} = 0.316477$$
$$\mu\{a,d,e\} = 0.456738$$
$$\mu\{a,d,e,f\} = 0.468523$$
$$\mu\{a,d,f\} = 0.329891$$
$$\mu\{a,e\} = 0.397096$$
$$\mu\{a,e,f\} = 0.409574$$
$$\mu\{a,f\} = 0.262792$$

$$\mu\{b\} = 0.74644$$
$$\mu\{b,c\} = 0.785305$$
$$\mu\{b,c,d\} = 0.823392$$
$$\mu\{b,c,d,e\} = 0.902083$$
$$\mu\{b,c,d,e,f\} = 0.908695$$
$$\mu\{b,c,d,f\} = 0.830918$$
$$\mu\{b,c,e\} = 0.868622$$
$$\mu\{b,c,e,f\} = 0.875622$$
$$\mu\{b,c,f\} = 0.793273$$
$$\mu\{b,d\} = 0.786685$$
$$\mu\{b,d,e\} = 0.869834$$
$$\mu\{b,d,e,f\} = 0.87682$$
$$\mu\{b,d,f\} = 0.794637$$
$$\mu\{b,e\} = 0.834477$$
$$\mu\{b,e,f\} = 0.841874$$
$$\mu\{b,f\} = 0.754859$$
$$\mu\{c\} = 0.07889$$
$$\mu\{c,d\} = 0.1562$$
$$\mu\{c,d,e\} = 0.315928$$
$$\mu\{c,d,e,f\} = 0.329348$$
$$\mu\{c,d,f\} = 0.171475$$
$$\mu\{c,e\} = 0.248008$$
$$\mu\{c,e,f\} = 0.262217$$
$$\mu\{c,f\} = 0.0950636$$
$$\mu\{d\} = 0.08169$$
$$\mu\{d,e\} = 0.250468$$
$$\mu\{d,e,f\} = 0.264649$$
$$\mu\{d,f\} = 0.0978311$$
$$\mu\{e\} = 0.1787$$
$$\mu\{e,f\} = 0.193714$$
$$\mu\{f\} = 0.01709$$

Na osnovu formule (4) izračunavamo Šeplijevu vrednost $\varphi_a(\mu, X) = 0.1244983$, koja predstavlja koeficijent važnosti varijable a , kao i Šeplijevu vrednost $\varphi_b(\mu, X) = 0.4826678$ koja predstavlja koeficijent važnosti varijable b.

4. ZAKLJUČAK

U ovom radu opisan je problem određivanja parametra λ , λ -fazi mere, kao i Šeplijeve vrednosti, na primeru procene robe u skladištima. Zaključeno je da je Šeplijeva vrednost za prosečnu cene veća od Šeplijeve vrednosti za prosečnu prodaju. Na taj način Šeplijeva težina ne samo da pruža meru važnosti kriterijuma, već dolaze do izražaja interaktivne karakteristike datih kriterijuma.

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INFORMATION TECHNOLOGY IN EDUCATION & DIGITAL TRANSFORMATION, CULTURE AND CREATIVE INDUSTRIES

HISTORICAL DEVELOPMENT OF COMPUTER-AIDED DESIGN (CAD) AND ITS APPLICATION IN EDUCATION AT FACULTY OF MECHANICAL ENGINEERING IN BELGRADE

Ivana Cvetković[1,*],
Branislav Popkonstantinović[1],
Dragan Cvetković[2],
Miša Stojićević[1],
Rodoljub Milićević[1]

[1]Faculty of Mechanical Engineering,
University of Belgrade,
Belgrade, Serbia
[2]Singidunum University,
Belgrade, Serbia

Abstract:
Since its appearance in the middle of 20th century, Computer–Aided Design (CAD) has been constantly developing. The man who is considered to be the father of CAD and pioneer of computer graphics is Ivan Sutherland, American electrical engineer and computer scientist. Nowadays, it is almost impossible to imagine the industry without programs for modeling, drawing, simulation. They simplified the process of production and at the same time, shortened the time needed to display the final product. The first part of this paper deals with the evolution of computer graphics and its application in general. The second part of the paper is dedicated to the application of SolidWorks, as a CAD program, in education at the Faculty of Mechanical Engineering in Belgrade.

Keywords:
Computer–Aided Design, Education, Mechanical Engineering, SolidWorks, Ivan Sutherland.

1. DEVELOPMENT OF COMPUTER – AIDED DESIGN (CAD)

The first commercial numerical control software package named PRONTO (Programme for Numerical Tooling Operations) was written in 1957 by Dr. Patrick J. Hanratty, an American computer scientist, who worked for General Electric at that time [1, 2, 3].

Although Hanratty was the first one who started working on the idea of computer graphics for design, the father of CAD is usually considered Dr. Ivan Sutherland (born in 1938). After high school, Sutherland enrolled Carnegie Institute of Technology (now Carnegie Mellon University) willing to study Electrical Engineering. Later on he moved to the University of California (Caltech), where he did his Master's Degree in Electrical Engineering. Eventually, he entered MIT where he started his PhD studies under the supervision of Claude Shannon (1916 – 2001), the inventor of information theory. Information theory studies the quantification, storage and communication of information and its discovery had a deep impact on the development of Internet, invention of compact disc, the success of the Voyager program (American scientific program made for study of outer Solar System) [1, 3].

Correspondence:
Ivana Cvetković

e-mail:
ivanacvetkovic1992@gmail.com

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The title of Sutherland's doctoral dissertation was "Sketchpad: A Man–Machine Graphical Communication System" and it was written in 1963. For his work, Sutherland received the Turing Award in 1988 and Kyoto Prize in 2012. Sketchpad was the first program that contained a graphical user interface (GUI). By using a light pen, users were able to draw directly on the CRT (cathode-ray tube) screen and that was the first time that engineering drawings could be drawn directly on a computer display. Sketchpad was developed and run on the TX–2 (computer built by Wesley Clark), one of the first programmable computers, within the MIT's Lincoln Laboratory. The light pen that was used for Sketchpad, was actually invented for the SAGE (Semiautomatic Ground Environment) air defense project. Commercial use of CAD programs started in 1970s [1, 3].

In 1977 Avions Marcel Dessault started the development of a 3D CAD program called CATI. The company was the property of Marcel Bloch (after World War II he changed his name to Marcel Dessault), who dedicated his life to aircraft manufacturing. In 1981, Avions Marcel Dessault created Dassault Systèmes in order to develop and market 3D CAD software CATIA V1 (first commercial version of CATI) [1, 3, 4].

Over the years, CATIA started getting noticed in other sectors outside of aeronautical design, notably in the automotive industry, machinery, shipbuilding [4]. In 1997 Dassault Systèmes acquired SolidWorks Corporation (which was founded in 1993 by John Hirschtick).

Software package SolidWorks is a solid modeling CAD/CAE program that runs on Microsoft Windows and it is learned at the Faculty of Mechanical Engineering in Belgrade.

2. AESTHETICS OF PRODUCT AS A COURSE AT FACULTY OF MECHANICAL ENGINEERING

Course called Aesthetics of Product belongs to Master Academic Studies at Faculty of Mechanical Engineering in Belgrade and it is mandatory for students of Department for Theory of Mechanisms and Machines. It covers principles of aesthetics in the process of product design, geometric harmony laws and advanced modeling in software package SolidWorks. As it is previously mentioned, SolidWorks is a CAD program that runs on Microsoft Windows and it is produced by a company named Dassault Systèmes.

Basics of modeling and drawing in SolidWorks is taught on the first year of Bachelor Academic Studies through the mandatory course named Engineering Graphics. This software package is elected due to its user–friendly interface. Throughout the years it has been proved that SolidWorks is the best choice for beginners. In order to improve their knowledge in the field of modeling, students are allowed to choose some courses dedicated to advance modeling later on.

The biggest part of the course Aesthetics of Product is dedicated to the SolidWorks feature called Surfaces. Surface body is a general term that describes connected zero–thickness geometries such as single surfaces, knit surfaces, trimmed and filleted surfaces [5]. This SolidWorks feature allows students to create different shapes easier than using regular features.

This software package enables students to define the shape of models in such way that models are more artistic [6]. It includes organic forms, complex geometry with complete control of their parameters. By using simulation tools, students can generate photorealistic images. As it is written before, SolidWorks has user-friendly and intuitive interface that allows its users to learn quickly all necessary commands so they can start creating their own items.

Considering the fact that all CAD programs are based on principles of Descriptive Geometry, students should learn its fundamentals firstly. In the first semester of the first year of bachelor studies, freshmen attend the mandatory course called Constructive Geometry and Graphics, where they acquire information about the basics of Descriptive Geometry. Their knowledge obtained during the previously mentioned course is applicable in every field of engineering, especially in the field of modeling.

The pyramid on a plane, conical sections, section of a cone and a plane and hyperboloid of one sheer that had been drawn manually during the course named Constructive Geometry and Graphics, afterwards are done in SolidWorks and shown in Figures 1, 2, 3 and 4.

Some items made by Surface feature, such as helmet, teapot, candlestick and bottle are shown in Figures 5, 6, 7 and 8.

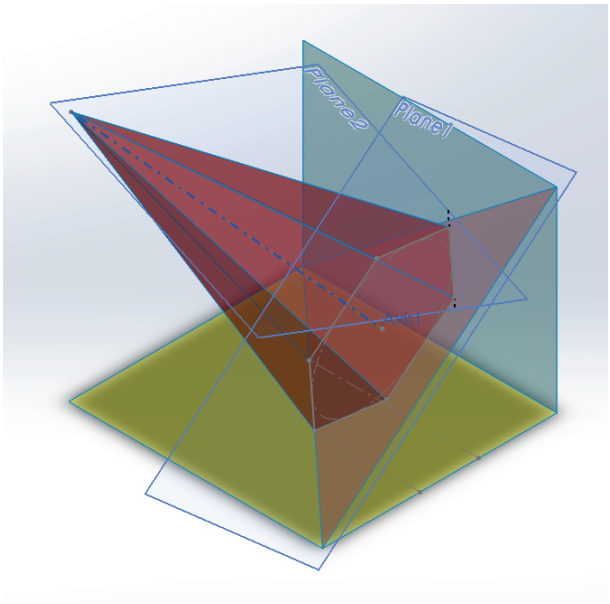


Fig. 1. Pyramid on a plane

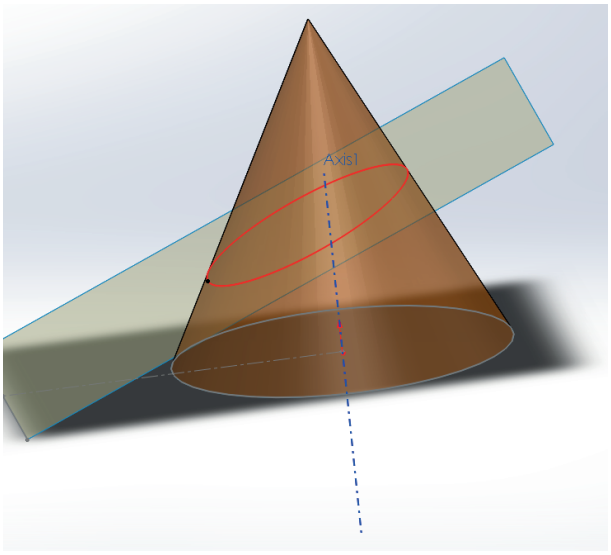


Fig. 3. Section of a cone and a plane

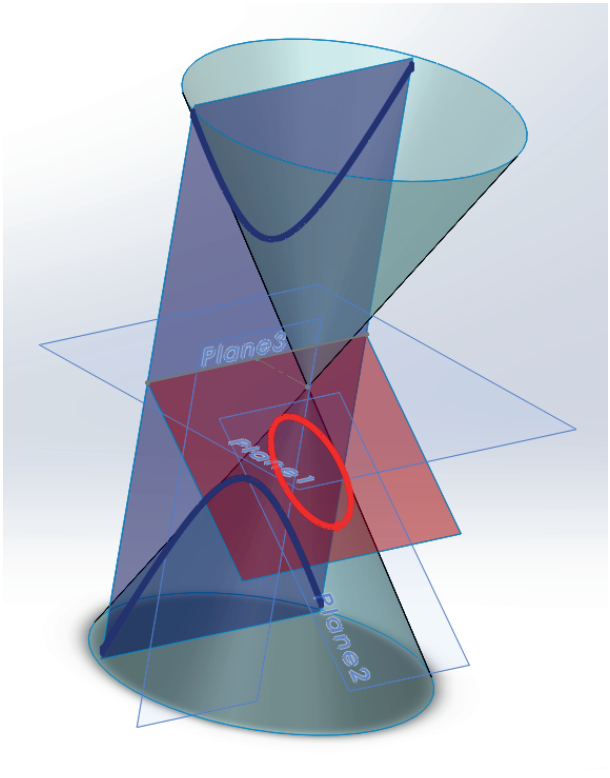


Fig. 2. Conical sections

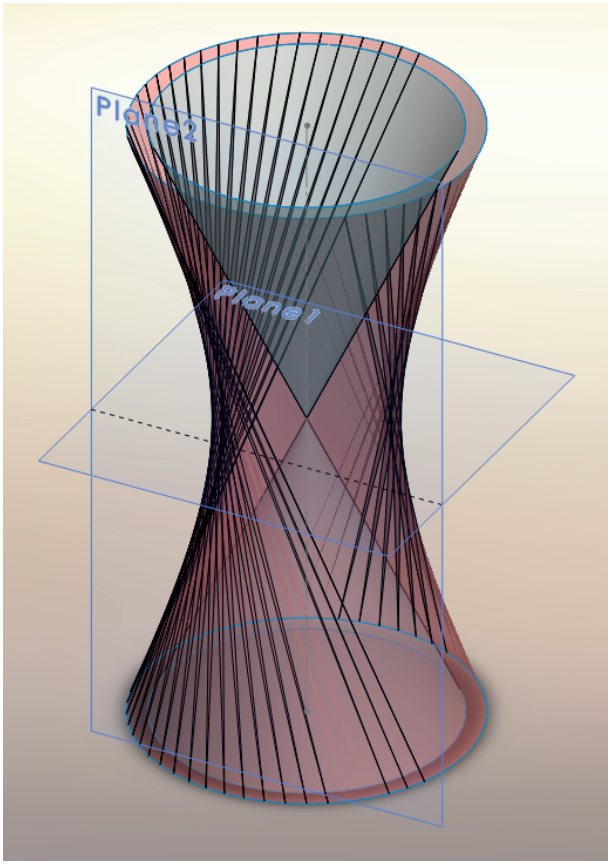


Fig. 4. Hyperboloid of one sheet

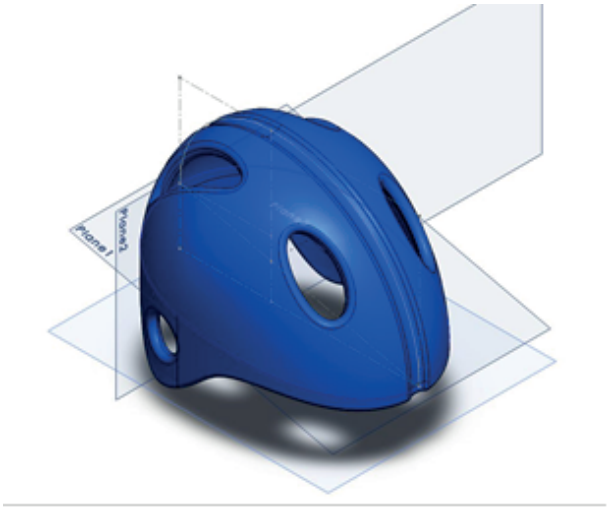


Fig. 5. Helmet

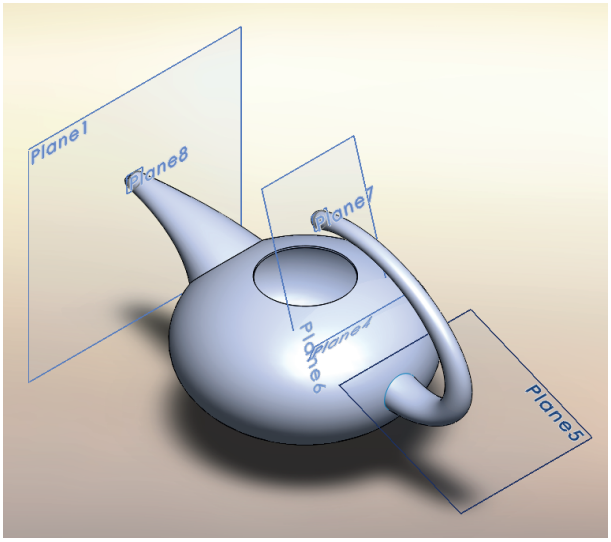


Fig. 6. Teapot

Astronomical clock that has been made by combining modeling, knowledge in the field of mechanics and Simulation tool in Solidworks is shown in Figure 9.

Thomas Earnshaw's chronometer detent escapement mechanism is shown in Figure 10. It represents marine chronometer that was simplified and modified by Thomas Earnshaw, English renowned watchmaker, in order to make it available to the public.

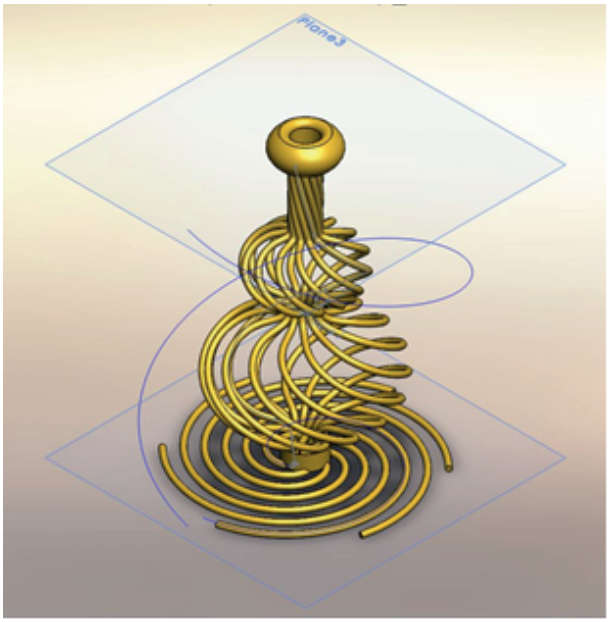


Fig. 7. Candlestick

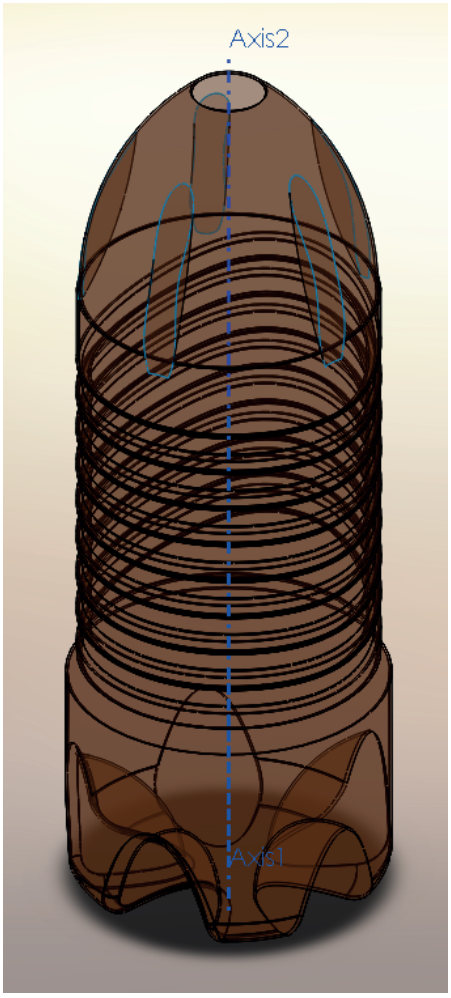


Fig. 8. Bottle

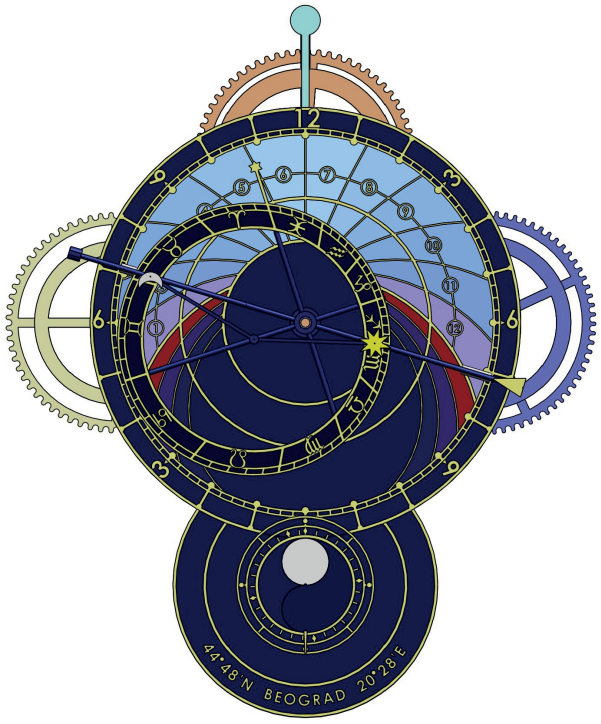


Fig. 9. Astronomical clock

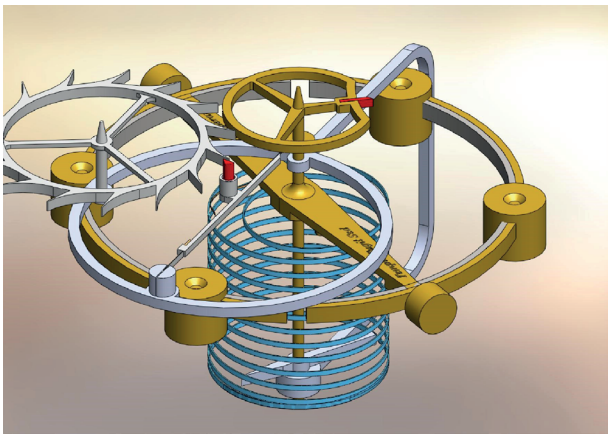


Fig. 10. Thomas Earnshaw's Chronometer
Detent Escapement Mechanism

3. CONCLUSION

Aesthetics of Product represents the course which enables students to apply their previously acquired skills on modeling of desired item. Since the students have gone through the mandatory courses named Constructive Geometry and Graphics and Engineering Graphics and dealt with the basics of Descriptive Geometry, they are able to continue with advanced modeling. Considering the fact that the subject of this paper was the usage of CAD programs in education, universal principles of Aesthetics are completely neglected, but that does not mean that they are not important. On the contrary, they are crucial for every future engineer who wants to comprehend demands given by product designers. Through theoretical and practical exercises, students are provided by knowledge that can help them create a product in SolidWorks and implement learned design principles into their future work.

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THE IMPORTANCE OF APPLIANCE COIN & FUND IN TEACHING

Lidija Barjaktarović[1, *],
Biljana Lazarević[2],
Veljko Davidović[2]

[1]Singidunum University,
Belgrade, Serbia
[2]Casa Forte d.o.o.,
Belgrade, Serbia

Abstract:

The subject of the article is presentation and the emphasis on the importance of appliance of educational business simulation Coin & Fund in teaching process. The aim of the article is to stress which important lessons students get by usage of Coin & Fund during the Bachelor degree studies in the field of applied economics.

Coin & Fund is developed in Republic of Serbia as result of partnership co-operation between Singidunum University and Casa Forte Belgrade. Coin & Fund is designed and implemented as educational tool which helps different users (students) to understand how their decisions, as managers of virtual companies, have impact on overall company's business through basic financial reports, i.e., chosen profitability ratios.

Keywords:

Educational simulator, Coin & Fund, decisions, ratio numbers, risks.

1. INTRODUCTION

According to Shannon simulation is "the process of designing model of real system and execution of experiments together with it in order to understand system's behaviour or evolution of different strategies (within determined boundaries or within defined criteria)". [1]. Furthermore, it can be said that business simulation represents activities which describe real states from the outside worlds, but in protected and controlled environment, in order to become familiar with particular business process and final results. [1,2]

Establishment and appliance of simulations allow students, researches and business people deeper and more complete insight in business processes and adequate tool for qualitative analysis. [3,4] Learning based on simulations is especially effective in developing decision making skills. During usage of simulation students get specific knowledge for defined discipline which they can implement further in professional environment. Moreover, simulations help students to learn more than defined discipline required, because it involves organization and interaction with other discipline, people and entities. Finally, simulations have special value in integrating different teaching goals, through connecting various principles or general knowledge with practical skills. This

Correspondence:
Lidija Barjaktarović

e-mail:
lbarjaktarovic@singidunum.ac.rs

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comprehensiveness of simulation makes it as very powerful pedagogical tool for integrated or final courses. [3,4,5]

The subject of the article is presentation and the emphasis on the importance of appliance of educational business simulation Coin & Fund in teaching process. The article is intended to all individuals who are keen on further professional development. The aim of the article is to stress which important lessons students get by usage of Coin & Fund during the Bachelor degree studies in the field of applied economics.

On regional market are present following simulators: Holcim's Ecoism (Economic Business Simulator), Mercuri International (Sweden Investment Company), H.art Development centre (consultant in human resources management, leadership, training, etc.) SimTeam On-line Business simulation /outsource/ and EDUardo On-line Business simulation for individual work /outsource/, Rockwell Automation's Arena Basic, Palisade's @Risk, „Virtuelna burza" Academia of Zagreb Stock Exchange, etc. [6, 7, 8, 9, 10, 11, 12, 13]

Coin & Fund is different from other educational business simulators because: 1) it is developed in Republic of Serbia, as result of partnership Singidunum University and Casa Forte Belgrade; 2) it is applied in teaching process from the first until the end of fourth year of academic bachelor degree studies on the Faculty of Business in Belgrade; it is applied on exercise classes of different professional courses in accordance with accredited curriculum; it allows students to have continuous progress in acquiring new knowledge and skills, i.e. they are trained to make appropriate business decisions. 3) Students are actively involved in every phase of educational simulation development. 4) Simulation results/outcomes depend on concrete choice of decision maker/s (other simulation solutions are based on predefined options). 5) Simulation represents functioning of the market, because demand and supply of Coin & Fund are determined by decisions of other players - virtual companies which are at the same time in the game (i.e. quantities of goods are limited). 6) In the practice companies of all size can use Coin & Fund; especially it is convenient for entrepreneurs (competitive simulations are aimed to employees in big companies and banks). It is important to emphasize that Coin & Fund can be used for solving of particular problems of any company, because starting point for any entity is the official or periodical financial reports. Representatives of Casa Forte wished to implement their experience in practice on improvement of business processes in companies related to the development of educational business simulator Coin & Fund. They noticed that within: 1) small and medium sized companies, that decision makers are not aware of influence of their decisions on business result, 2) bigger companies that team members don't show interest for activities of other organizational parts in order to achieve better result of organizational part where they work in. On the other hand, representatives of academic community: 1) had opportunity to improve their knowledge related to different international business schools, where educative simulators are integral part of teaching process, and they were very interested to implement own academic and practical knowledge in development of Coin & Fund. 2) They are committed to develop skilfully employees and entrepreneur from student days.

Coin & Fund is developed in Republic of Serbia as result of partnership cooperation between Singidunum University and Casa Forte Belgrade. Coin & Fund is designed and implemented as educational tool which helps different users (students) to understand how their decisions, as managers of virtual companies, have impact on total company's business through basic financial reports, i.e., chosen profitability ratios. Students have on disposal heritage in the amount of EUR 100,000 in cash, which they have to manage in the following period. Cash can be used for the trade with commodities or securities or foreign-exchange, i.e. depositing with banks or applying for the appropriate loan.

In addition to Introduction and Conclusion, the work is structured as follows. In the first chapter general characteristics of Coin & Fund will be presented. In the second chapter, simulation of the program Coin & Fund will be presented. In the third chapter focus will be on company's management of ratio numbers. In the fourth chapter will be identified business risks with which students will be met. In the fifth and sixth chapter students' activities, impressions and learned lessons by applying Coin & Fund will be presented.

2. GENERAL CHARACTERISTICS OF EDUCATIVE BUSINESS SIMULATOR COIN & FUND

Coin & Fund is a client-server application intended to be accessed via internet browser /such as Internet Explorer or Google Chrome/ as to achieve flexibility and impose determined configuration standards. The server is in a remote location or cloud, and working in operating system Linux. Server-side application is implemented in accordance with the requirement of Coin & Fund.

Additional functionalities of the application are:

- Auto save – allows storage of previous simulation's results (all movements and accompanied financial reports), and possibility to stop and continue usage of application in any moment.
- Delivery of financial documents (balance sheet, invoice, etc.) in accordance with defined law frame.
- Administrator console through which there is an insight into the business of all enterprises, statistics, simulation results, etc.
- Overall security of Coin & Fund against cyber-attacks.

3. THE COURSE OF THE EDUCATIONAL BUSINESS SIMULATION COIN & FUND

When all users (students) choose and configure their virtual company, the simulation starts. Everyone has the opportunity to make its decisions without consulting with colleagues (or teammates) or negotiating with its associates on the optimal solution for each problem.

To make the game adaptable to different situations, two different time flows in the simulation were implemented:

- Real-time runs at real speed, that is, the current simulation time is the same as in the real world.
- Accelerated - the program simulates a certain amount of time at the end of the move.

This quantity can be manually selected before the simulation starts. In this way, the game will take the same length in real time, while the simulated time will be able to vary in order to adapt to the situation.

Performance indicators (ratios numbers) are visible on the screen, with the possibility that the user has a detailed insight at any time and monitors their dynamics (for example, using graphics) by comparing the initial state with the indicators obtained after the decision.

Decisions that every user can bring to their company are a key part of the simulation, and are related to:

- Financial assets - term deposits with the bank, use of bank loans in the amount corresponding to the creditworthiness of the company, conversion of funds into different foreign currencies and sale of shares on the Belgrade Stock Exchange.
- Physical assets - buying and selling up to three different types of goods and sales through a warehouse (leased or owned).

Customer (student) can be connected with server on the basis of entering appropriate internet address and following instructions on the screen.

Coin & Fund consists of 5 modules. These are: financial reports, stock exchange, exchange office, bank and trade. In each module, student can see the company's financial standing through profitability (ROE - Return on Equity, ROA - Return on Assets, EBIT - Earnings before Interest and Taxes) and Altman Z-score model (reveals the risks of running a company's bankruptcy).

The Financial statements module includes balance sheet, income statement and statement of cash flows. The result of the implemented business decisions is recorded directly through the appropriate financial report.

The Stock exchange module is directly linked to the Belgrade Stock Exchange (BELEX) website, and enables the purchase and sale of shares at real prices.

The Exchange office module allows student to trade in selected foreign currencies. The currency exchange rate corresponds to the real values on the domestic financial market.

Module Bank enables short-term deposit or lending of funds, at fixed or variable interest rates, in selected convertible currencies. The basic interest rate on the loan is calculated using the Altman Z-score model, taking into account the value of the loan requested. When considering the borrowing option, a student may, for the purpose of making a decision, receive a Bank Credit Offer. In the case of deposit money, it is necessary for a student to enter into the simulation the appropriate combination of currency, term and chosen commercial bank, in order to receive a proper banks' offer. The interest rates are realistic and correspond to the offers of all banks operating in the Republic of Serbia.

The Trade module includes certain types of goods, which must be kept in the warehouse of adequate capacity and with the appropriate number of employees employed. Thus, the decisions that precede the trade in goods are related to the purchase or lease of the warehouse space, and depending on the size of the capability, the engagement of the appropriate number of employees, which can be either full-time employed or outsourced. Prices, discounts and terms of payment depend on the type and quantity of goods. Also, in the case of sales, stocks can be sold in the country or abroad, with the desired margin, rebate and discount on quantity.

4. THE MANAGEMENT OF VIRTUAL ENTERPRISES' RESOURCES HAS BEEN DRIVEN BY NUMBER RATIOS

Ratio numbers show key performance of the company. Ratio numbers are used primarily to assess the company's ability to service debt obligations, primarily to creditors, i.e. banks. Ratio analysis is also a practical means of control in the process of managing the company's financial system. [14,15] Important lessons for students are that ratio numbers have their practical value only if they are properly interpreted, and that external stakeholders consider the business of the company through the financial performance of the company.

Profitability ratios indicate the earning capacity of an enterprise. The main goal of the company's business, in our terms, is to maximize profit [15]. Thus, this group of indicators (ROA, ROE, and EBIT) is given a primacy.

Altman's synthetic indicator of financial uncertainty known as the ZETA analysis model or Z - score model is a synthetic indicator of financial uncertainty. It reveals the risks of bankruptcy occurrence of the company, by means of accounts indicating solvency, liquidity, profitability and efficiency. [14,15]

Its basic purpose is to evaluate the company's credit risk as applicant with commercial bank. A score obtained in the form of a single digit indicates the degree of risk for the bank when granting a loan to the particular company. Banks have pre-formulated upper and lower creditworthiness thresholds of the company. If the Z score is above the upper threshold, the credit risk is acceptable for the bank. If this figure is below the lower threshold, credit risk is unacceptable for the bank. If the Z - Score is between the upper and lower thresholds, banks need to evaluate on the basis of additional documentation and experience whether they can accept such a credit risk. [14] An important lesson for students is that the loan price is not the same for all credit beneficiaries, and that bank's accepted risk is directly reflected in the interest rate.

5. RISKS WHICH STUDENTS CONSIDER WHEN USING COIN & FUND

Business risk is certainly the first [4], considering the fact that the decisions in which funds will be invested, will affect achieved earnings. There is always a dilemma whether to invest in transactions that are known, or should accept the unknown and go further.

Financial risks are a special sub-category of business risk [4]. Students face the full range of financial risks, starting from market (especially foreign exchange, interest rate, price and competition), through credit and exposure risk, to liquidity risk and capital management.

Market risks [16] are present in each area of decision making in an educational business simulation, whether and when students are traded in goods, securities or foreign exchange, or which payment instruments are the most acceptable for execution of a specific business transaction. The risk of competition [16] is observed in the quantity of present goods in the market, which depends on the number of (virtual) companies at the moment of using the educational business simulation of Coin & Fund.

Credit risk [16] appears at the moment when a decision is made to grant a deferred payment to a particular buyer. This further exposes the examination of exposure to one entity on the basis of all non-collected receivables.

Capital is the basic determinant for risk management in an enterprise's business, and the essence is that it grows over time, that is, profit grows from year to year [16]. As stated, the initial amount of capital is EUR 100,000 and should be increased by making decisions that will ensure optimum profitability indicators.

Finally, the liquidity risk [16] is present at every moment of decision-making. It is not enough just to settle the obligation on time, but also in full amount.

6. ACTIVE PARTICIPATION OF STUDENTS IN ALL COIN & FUND PHASES OF DEVELOPMENT AND TESTING

Having in mind that this tool has been developing in stages, it is prescribed that students have been involved in testing and give suggestions for further improvement of simulator.

Students had a lot of constructive suggestions for further tool development. For example: define the selection options, so that instead of numbers, the letters will be written. The proposal was to introduce option of cancellation of renting or selling a warehouse at any time. Then, the suggestion was to allow the free movement of sales prices of goods in stock. Also, the proposal was that the precise prediction was made from what moment the purchase of goods from the supplier could go to the deferred payment. It is interesting that the tests of educational business simulations resulted in the development of an appropriate user guide for all interested Coin & Fund users.

Student impressions at all stages of development and testing of Coin & Fund have been very positive. Special attention is given to the holistic approach to the perception of virtual business operations and the team work of colleagues in the group.

7. WHAT ARE STUDENTS INTEND TO LEARN BY MAKING DECISIONS IN THE BUSINESS OF VIRTUAL ENTERPRISE?

The results of implemented decisions help students in perceiving which courses could help them gaining additional knowledge, no matter what field they belong to financial markets, risk management, banking, trade or business finance.

The logic of applying the appropriate exchange rate for the purchase or sale of foreign currency is the first challenge they face. Then, trading in shares represents an unknown if the logic of the securities itself and the corresponding financial market is not understood. The present dilemma is whether to own or rent a warehouse space. Furthermore, the interpretation of ratios numbers is very important for all business ventures. What are all relevant elements to placing or borrowing money from the bank? ... Etc.

It is also important to learn to communicate with colleagues from other study programs, or to precisely define their requirements. In the Coin & Fund testing, there are students from two different study programs – business economics and information technology (IT). The result of successful communication is that IT students understood the financial logic, especially in the following areas: 1) companies have receivables from the customers, and obligations toward suppliers; 2) when selling foreign currency to a commercial bank, the purchase (lower) price is used, and that when buying a foreign currency, the commercial bank applies the selling (higher) rate.

Finally, we can conclude that Coin & Fund enables teaching students about correct and analytical perception of business decisions, making them better colleagues, employees and entrepreneurs because it simulates the business of the entire company. The educational business simulation of Coin & Fund helps students combine theoretical and practical knowledge. Furthermore, usage of Coin & Fund is preparing them to get job more easily tomorrow or start their own business. Finally, appliance of Coin & Fund helps students to gain soft skills such as teamwork and peer education.

8. CONCLUSION

The educational business simulation Coin & Fund is aimed at helping students to combine theoretical and practical knowledge. It can be concluded that Coin & Fund can teach students about the correct and analytical perception of business decisions, making them better for colleagues, employees and entrepreneurs because it simulates the business of the entire company. Furthermore, it has a capacity to prepare them to get job more easily tomorrow or start their own business. Finally, it can help them to gain the skills of teamwork and peer education.

It is important that students understand from which courses they should get additional knowledge, whether they are financial markets, risk management, banking, trade, business finance, or the development of the so-called soft skills, such as communication, teamwork, peer education, and so on.

The future research will focus on monitoring student results from the moment of enrolment at the Faculty of Business in Belgrade until the graduation of a graduate economist, in order to determine how successful they were in getting and applying knowledge in usage of Coin & Fund.

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MODERN INFORMATION TECHNOLOGIES IN HIGHER EDUCATION: WHAT MIGHT THE ROLE OF A TEACHER LOOK LIKE IN A MODERN UNIVERSITY?

Suleimenova K.[1,*],
Suleimenov I.[2],
Egemberdyeva Z.[3]

[1]University of Birmingham,
Birmingham, UK
[2]Almaty University of energy and communications,
Almaty, Kazakhstan
[3]Institute of information and computing technologies,
Almaty, Kazakhstan

Abstract:
A comparison is offered between the nature of the educational process in modern universities and classical universities that existed in the XIX and XX centuries. It is shown that the decline in the quality of education in modern universities is largely due to the significantly increased workload (more than 10 times) over the past hundred years, , which greatly complicates the conduct of research by full-time teachers and actually cancels the principles of Humboldt. It is clear that modern information technologies allow a return to the implementation of Humboldt's principles at a qualitatively new level. This can be provided by transition to the organization of educational process in "autocatalytic" mode when the information resources providing educational process are maintained by professional, non-academic staff. In this case, the role of the professorship is refocused on the performance of curatorial functions.

Keywords:
University science, quality of higher education, information technologies, teaching staff, modernization of higher education.

1. INTRODUCTION

The key to the question in the title of this article is not as obvious as it may seem at first, especially if we consider teaching on graduate programmes, particularly those associated with the most rapidly developing areas of science and technology (information and telecommunication technologies, nanotechnology, etc.).

This can be proved by comparing the situation that took place at the turn of the XIX and XX centuries and now.

The turn of XIX and XX can indeed be chosen as a reference point, since it was at this time that the modern era can truly be said to have blossomed [1]. In addition, in this historical period the transition to mass higher education begins, accompanied by a pronounced professionalization of science [1].

Correspondence:
Suleimenova K.

e-mail:
k.suleymenova@bham.ac.uk

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2. BASIC FUNCTIONS OF THE TEACHER AND HUMBOLDT'S PRINCIPLES

If we approach from the standpoint of information theory, in the period under consideration the basic functions of a University teacher (as a teacher) should be defined as follows:

- selection of the most useful information for learning from current scientific literature;
- systematization of information relating to a particular specialism;
- transformation of this information into a convenient form for students to learn;
- overseeing the actual learning process (classroom, exams, etc.).

It should be underlined that in the classical university model, the educational process was only one of the functions of the "teacher" and, indeed, many prominent academics have prioritized their research without detracting from their standard of teaching or student interaction.

Evidence of this is both well-known historical facts [1] and the famous principles of Wilhelm von Humboldt, who managed to convince the Russian king of the need to create a new University model (1808).

The fundamental principles proposed by Humboldt as the basis of a new type of University are *academic freedom and the unity of research and teaching/learning* [1-3].

At Humboldt University the core of the educational process was based not on the principle of transmitting the unchanged essence of accepted academic wisdom. According to Humboldt, a true specialist cannot be trained solely through transmitting a set of certain established truths; this can only be done by involving the student in scientific processes. That is, not an offering ofcertain truths, but only engagement in research processes allows students to learn science.

Science classes become the most important component of the educational process [1-3], and this statement applies to both students and teachers. The student acquires and consolidates knowledge directly in the process of scientific research, which is carried out by them in conjunction with the supervisor. Teachers, conducting research continue to learn themselves and by learning, they teach others. Simplifying, the principles of Humboldt claim, that the University teacher should be learning throughout their life. The prerequisite for this is academic freedom-it is assumed that a specialist in a particular field knows better than others what to do in order to best carry out research in a particular field of science.

Humboldt's principles were put into practice in the vast majority of the world's leading universities in the XIX century, in an era when the political elites of European countries not only clearly understood the importance of the development of science and technology, but were also closely associated with the scientific community [1]. These principles have proven to be the best. In particular, it is the combination of academic freedoms with the scientific activities of teachers that made it possible to create numerous University textbooks, which left a mark in the history of science and pedagogy.

3. THE TEACHER AND THE CONTENT OF HIGHER EDUCATION

As history shows, a good University textbook can be created only by an active scientist, fully immersed in the appropriate information environment, or rather the person for whom science is not a craft, but the meaning of life, the only acceptable form of existence for them in this world.

This returns us to the above list of functions of the University teacher (lecturer). Each of the items on this list corresponds to the specific stages of the birth of a University textbook worthy of the name. It is obvious that in the conditions of rapid development of science (as was the case throughout the XIX century), the University textbook should combine novelty and fundamentality, to present new provisions in close connection with the basic results accumulated in the relevant field of knowledge.

Somewhat simplifying, we can distinguish the following stages of the birth of a University textbook:

- the appearance of the primary scientific material reflected in the original scientific papers published in scientific periods;
- primary systematization of the available scientific material in literature review articles;
- systematization of the material in monographic publications with parallel development during lectures;
- consolidation of information that has stood the test of time in University textbooks.

This scheme for many years remained not just an ideal, but was considered as the only acceptable practice. It is appropriate to emphasize once again that

academic freedom was the necessary condition for its implementation in practice; throughout the XIX century, such freedoms were not only a declaration, they were embodied in reality.

Indeed, the realization of academic freedom requires appropriate conditions, which were in place during this period of time. As noted in [4], at the beginning of XIX the volume of academic workload in the University Charter was not defined at all. An indication of what it could be, is given by the Charter of the Pedagogical Institute (St. Petersburg), in which professors read, depending on the disciplines taught, lectures on 3-4 astronomical hours a week.

In the cited work [4] it is also noted that during the reign of Nicholas I, University freedoms were limited, and the duties of the teaching staff, on the contrary, increased. Article 86 of the new University Statute of 1835 reads: "the Professor is obliged to teach his subject at least 8 hours a week" [5], CIT. on [4].

During the period of professionalization of science and the transition to mass higher education, the situation has changed. Thus, according to the standard regulations on the procedure for planning the teaching load of the teaching staff, approved by the orders of the ministry of higher education of the USSR No. 520 of 17.07.87, the actual teaching load of the teacher had to be from 450 to 1000 hours per year, including at least 150 hours of classroom (for professors and associate professors). Currently, the situation is only getting worse: for example, in Kazakhstan, the typical academic load of the teaching staff for the academic year is 23 credits for natural and technical areas and 25 credits for social sciences.

Academic freedom continues to be discussed now; in any case, the relevant debates are recorded in the documents of many Kazakh universities.

However, even if such freedom is available in theory, teachers cannot use them in practice, because in addition to the immeasurably increased (compared to the late XIX and early XX centuries) workload, teachers are forced to spend considerable time on drafting bureaucratic papers and meetingsetc.

This could not affect, among other things, the quality of teaching materials and teaching aids. The vast majority of them, compiled by teachers on duty, does not stand up to any criticism; it is an untalented compilation of information from open sources, the content of which is often selected randomly, only on the basis of compliance with formal requirements. In fact, the vast majority of teachers use the same methods that students use when writing essays in their textbooks. It is not surprising that both have long turned to profanity, especially if we talk about the most rapidly developing areas of knowledge (information and telecommunication technologies, for example).

It is not surprising that many teaching materials on the content and quality are no different from student papers, and this fact is a very clear illustration of the transformation of the functions that University teachers currently perform.

In a certain sense (especially if we talk about information and telecommunication technologies) teachers and students of post–Soviet universities were in the same position - and those, and others draw information from the same open sources (often different internet resources), only one retells this information in lectures, and others – in exams.

It is obvious that the teacher, overloaded with bureaucratic nonsense and current classes, will not be able to understand the material contained in open sources any more deeply than the student. As the current practice shows, very often the reverse situation occurs. This becomes especially evident in relation to the field of telecommunications (undergraduates who actually work in the units of Kaztelecom often openly laugh at the absurdities that are voiced at lectures by teachers familiar with the latest telecommunications equipment only on the poor internet resources, composed by the same poor fellows as themselves).

Generalizing, it can be argued that in modern conditions *de facto* there is a certain competition between teachers and students (or rather, those who really seek to acquire knowledge). The sources of information are the same for the vast majority of teachers and students., As such, the scheme of writing textbooks and preparing lectures, described above, no longer works (including objective reasons related to the rapid obsolescence of information, especially technical nature).

Therefore, except for some nuances, "the game is on an equal footing". Theoretically, on the side of the teacher such factors as experience and immersion in the appropriate communication (professional) environment should provide an advantage. Indeed, the most effective way to obtain information on the specialism is direct communication with colleagues (at conferences, in private conversations, etc.). Due to immersion in the professional environment, the teacher (even being a full-time scientist only in part) has the opportunity to form judgments and opinions at an expert professional level without wasting time.

This factor continues to operate in European universities (which, apparently, explains the relatively high quality of European education that still exists). However, in relation to post-Soviet universities, it can be stated with certainty that the factor of immersion in the professional environment has ceased to operate.

Visiting an international conference by a teacher of post-Soviet universities is an event. In any University there are only a small number of teachers who regularly communicate with foreign colleagues. In such countries as Kazakhstan, there is also a factor of low communication connectivity of the professional environment: very often, even within the same Department, teachers do not discuss scientific issues, as they write works in completely different directions. All have long been accustomed to the fact that at meetings of graduate departments of post-Soviet universities often discuss any issues other than the actual scientific. In the vast majority of Kazakh universities, the rarest event is the discussion of scientific issues at scientific councils, etc.

4. THE TEACHER AND THE COMPETENCE OF BACHELOR DEGREES AND MASTERS

As a result, the only advantage of the teacher of the Kazakh University relatively to the student (if we talk about the assimilation of new information from open sources) is their experience. However, in modern conditions this advantage is questionable, as many University teachers (especially under the age of 35 years) acquire less experience of scientific activity, and more experience of drawing up bureaucratic papers.

This state of affairs can be illustrated by simple formulas. The teacher retains an advantage over the student, if the product of the time they spend on the assimilation of new material, the speed of its assimilation exceeds the same figure for the student:

$$\nu_1(T_1-\tau_1-\tau_2)>\nu_2(T_2-\tau_3) \quad (1)$$

where ν_1 and ν_2 are the speeds of learning new information by teacher and student, respectively; T_1 and T_2, the time of their activity; τ_1 and τ_2 - time teacher is engaged in non-academic work and the learning process, respectively; τ_3 - unproductive (from the standpoint of learning) time of the student.

For post-Soviet (specifically, for Kazakhstany) universities, we can also write the following expression for the indicator ν_1, which *de facto* reflects the experience gained by the teacher

$$\nu_1 = k\int_0^t (T_1-\tau_1(t_1)-\tau_2(t_1))dt_1 \quad (2)$$

The record takes into account that over time, the teacher's time spent on bureaucratic activities may decrease. However, for teachers under the age of 35-40 years, which in the near future will play a main role in Kazakhstan's higher education (due to the natural loss of personnel trained during the existence of the USSR), this factor is unlikely to matter. Therefore, we can rewrite thus:

$$k(T_1-\tau_1-\tau_2)^2\tau_0>\nu_2(T_2-\tau_3) \quad (3)$$

where τ_0 - duration of experience (teaching experience).

The indicator ν_2 obviously has a significant spread, but this does not change the conclusion that can be made directly on the basis of the formula (3). There is a critical value of the indicator $(\tau_1+\tau_2)_{kr}$, above which the teacher will absorb information much less effectively than the student. Moreover, this critical threshold should be determined, focusing on the part of students who are most motivated to study, i.e. the maximum value of ν_2 and the minimum value of τ_3.

It is the most motivated students who *de facto* form an opinion about the teacher in the study group; if such students explain to fellow students that the teacher is talking nonsense, the whole group will stop engaging. According to bureaucratic papers, everything will look as it should, but in fact, such a course of lectures will turn into profanity, which, alas, is often the case in practice.

It is obvious that as the volume of bureaucratic papers compiled by teachers increases (which is the case in practice), sooner or later conditions will be created when the critical value $(\tau_1+\tau_2)_{kr}$ will be achieved. Of course, it is difficult to specify the specific numerical values of the indicators appearing in the above equations (the formulas are given only for illustration), however, there is every reason to believe that in modern conditions the following already takes place:

$$(\tau_1+\tau_2)>(\tau_1+\tau_2)_{kr} \quad (4)$$

This is corroborated by the analysis of methodological materials compiled by teachers of Kazakh universities. As noted above, many of them are inferior in quality and depth of coverage relatively to students' abstracts available on the free market.

We can conclude that the principles underlying Humboldt University are no longer implemented in modern conditions, at least in the post-Soviet space.

Therefore, it is necessary to radically transform the approach to the organization of the educational process in universities.

We emphasize that the transition to a high classroom workload for teachers partly took place for objective reasons. In the first decades of the XX century, higher education became widespread. Today, more than half of the relevant age group in Kazakhstan are University students. It is obvious that in such circumstances, maintaining the academic load at the level of the early twentieth century would require a number of teachers that no country in the world can afford. It is appropriate to emphasize that the problems of financial nature (for example, teachers' salaries), most often discussed in the literature on the quality of post-Soviet higher education [6-8], are also related to the fact that higher education has become widespread. In the early XX century, education was effectively for elites only, and there was an opportunity to provide an appropriate standard of living for professors [4].

Thus, there is an obvious contradiction between the number of students and the quality of the teaching staff. This paradox can be solved precisely by using the resource which poses difficulty [9-10].

Indeed, as emphasized above, the situation of ordinary teachers (most lecturers) and students is the same with respect to the abundance of information resources. Both have to study the same material related to up-to-date technology (for the field of information and telecommunication technologies, updates take place in real time and the programmes of lecture courses are often outdated within two to three years).

Consequently, there is an opportunity to convert the process of students studying new material into their creation of textbooks (under the guidance of the teacher, of course). It is quite possible to imagine an option when undergraduates studying in scientific and pedagogical Master's courses are preparing to update the existing textbooks for the bachelor's degree. Such activities can be carried out within the framework of assignments in specific disciplines, the teaching of which is carried out in the Master's programmes.

Moreover, there is every reason to argue that the updating of textbooks for undergraduates fits into the logic of the project activities of postgraduate students. Recall that currently in the post-Soviet space project activity is considered as one of the most promising forms of training. In particular, in the literature [11,12] there is such a term as "knowledge triangle", it implies a certain modernization [13] of the Humboldt principle, implying the unity of the actual training, research and project activities, combined in the educational process.

However, to put before the students the tasks associated with the performance of their projects with real practical (and moreover, commercial) value is difficult. In modern conditions, the commercialization of the results of scientific and technical activities carried out even by full-time University teachers is at a very low level. The number of developments implemented in practice in Kazakhstan does not exceed a fraction of a percent of the total number of conducted scientific and technical research, i.e. the vast majority of publications related to engineering and technology do not find practical application. It is obvious that in such conditions the practical significance of projects aimed at creating technical innovations by postgraduates will be even lower.

Therefore, it makes sense to consider other areas of project activities of postgraduates. It is possible that the creation of textbooks for undergraduate may be its most promising (at least in terms of mass coverage) form.

The prospects of this form of project activity for students associated with the resolution of the contradiction between the quality of education and the mass character of higher education, which was mentioned above.

5. LECTURER AND DISTANCE LEARNING

Distance learning aimed at the widest possible use of video lectures (in the future – artificial intelligence systems) can serve as another tool for resolving the contradiction stated above. We emphasize that from the positions advocated in this work, artificial intelligence systems are considered not as a "replacement" of the teacher with an information product, but as a means of increasing the number of University students per teacher. This approach, among other things, fits into the logic of the strategy for the development of artificial intelligence systems, developed in [14].

This approach, in particular, meets the interests of universities, as it allows significant reduction in the cost of labor of the teaching staff while maintaining the quality of education.

In a sense, we are talking about the creation of an "autocatalytic" system, when education at the University is driven by the students themselves in accordance with principles of modern pedagogy applied in Anglo-Saxon universities.

The first step towards the introduction of such an "autocatalytic" system can be to provide support for video lectures for undergraduate students. The role of the teacher in this case is reduced to curatorial activities, which significantly reduces the labor costs of providing a course of lectures on each individual discipline.

In other words, at the first stage of implementation of the proposed approach, we can offer the following scheme of the educational process in the undergraduate:

The primary phase is the preparation of educational material on specific undergraduate courses in the form of video lectures. Secondly, the students will perform the task of searching for additional material for these lectures. Specifically, we are referring to the creation of additional training tools such as animations and other illustrative materials created with the help of modern computer graphics.

Similarly, it is possible to raise the question of creating information resources that will provide practical training in the bachelor's degree by undergraduates.

In this case, the role of the teacher (Professor) is reduced to supervising the relevant activities, providing guidance and oversight, suggesting novel directions and ideas, etc.

It is appropriate to emphasize that the performance of such tasks by undergraduates will deepen their knowledge and consolidate the material that they studied earlier (especially since, as the current practice shows, it remains unused, quickly forgotten).

This, of course, requires a certain modernization of the existing approaches to teaching in the scientific and pedagogical postgraduate courses, which has long been overdue. Namely, current Master's dissertations, particularly in technical disciplines, are in their overwhelming majority unusable. This is due, among other things, to the fact that in modern conditions it is extremely difficult to provide real practical use of the results obtained during the implementation of Master's dissertations. Much more useful (from all points of view) would be the creation of appropriate teaching materials for undergraduate.

6. CONCLUSION

Thus, at present, there are all prerequisites to reconsider the role and functions of the teacher of a modern University.

It is advisable to examine the possibility of transferring the educational process in universities to an "autocatalytic" mode, when the educational process is largely supported by the students themselves (in particular, postgraduates provide support for video lectures and information resources for practical training in the undergraduate programmes). The modern level of development of information technologies allows this to be done without reducing the quality of education (on the contrary, the quality of the lecture material will increase, as the prerequisites for the identification and elimination of incompetent teachers, the number of which in modern Kazakh universities remains unacceptably large).

In this case, the role of the Professor is reduced to curatorial functions, which allows one to free up time for science classes, leading the workload to those indicators that were characteristic of University education.

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THE SIGNIFICANCE OF THE INTERCONNECTEDNESS BETWEEN BANKERS AND IT EXPERTS: THE IMPORTANCE OF THE TWO-WAY COMMUNICATION

Lidija Barjaktarović*,
Nikola Stefanović

Singidunum University,
Belgrade, Serbia

Abstract:

The article is written for the individuals striving to work, or who have recently been employed by the financial sector, having a bachelor degree in economics, and eager for further professional development. The paper is the result of authors' many years' of experience working in the financial sector. The subject of the research are knowledge and skills which bankers should acquire in order to have better direct communication with colleagues who work in information technology (IT) divisions, and furthermore with other relevant stakeholders.

The key for good communication between bankers and IT experts is that bankers should know how to define precisely their request. It implies that they should be acquainted with the products banks offer, understand client's needs, and should be familiar with processes and procedures within banks, functionality of used software and the actual regulation. Thereby, it is important that all request proposals should be considered through the prism of balance sheet and income statement of the bank, in order to understand on time whether the change is necessity or just a matter of prestige in the market. The contemporary market conditions impose permanent need for monitoring innovations in the field of finance and technology in general, long-life learning process, in order to obtain competitiveness in the labour market.

Keywords:
banking, information technology, communication.

1. INTRODUCTION

The current global movements impose a continuous need for learning and adjustment to challenges in the business environment. In order to achieve it, one must learn basic things of his/her vocation, upgrading them throughout the years, because personal development is the most important step for further development.

The paper is the result of authors 'experience in the financial sector, which is very interesting and dynamic, where the challenges are frequently met on a daily basis. Furthermore, they have had opportunity to work in well-known domestic and international financial companies, to meet and cooperate with renowned experts in the subject area in the country and abroad. They have always tried to learn and adopt knowledge and

Correspondence:
Lidija Barjaktarović

e-mail:
lbarjaktarovic@singidunum.ac.rs

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skills from financial experts and consequently, to apply these positive experiences in every day work in financial intermediaries or to help their associates using acquired knowledge, in order to improve the quality of relationship with customers and colleagues in institutions. [1] In view of the fact that Serbian financial market is cantered around banks; the focus will be on the knowledge within the banking sector.

The focus of the paper is on the knowledge and skills which bankers should acquire in order to have better communication with colleagues working in IT divisions, and, furthermore, with other relevant stakeholders. The aim of both parties within the process, internal customer (banker-economist) – support (IT experts), is to cooperate better, and to provide the institution where they work with benefits of synergetic effects. The term information technology (IT) is explained in the reference [2].

The authors had the opportunity to work within the Serbian financial sector, before and after 2001. The differences in these two periods are related to the environment, ways of performing business, organization, applied software tools and regulation. In this paper, focus will be on the period after 2001.

In addition to the Introduction and Conclusion, the work is structured as follows. In the first chapter, a bank's internal structure will be presented. In the second chapter, IT division activities will be overviewed. The third chapter will cover skills, knowledge and competences which young bankers should require in order to communicate better with IT staff. At the end, in the fourth chapter, examples of successful cooperation between economists and IT staff within banks will be presented.

2. INTERNAL STRUCTURE OF BANKS

There are different definitions of a bank, according to: 1) economic functions which it performs; 2) services offering to the customers; 3) legal basis of existence. [3] In this paper, the bank is defined as business bank, which offers services to legal entities and individuals, collecting deposits and granting loans. [3]

The starting point is to know what the bank offer is, and how those products affect balance sheet and income statement of the bank. [3] They are possible to classify according to balance principle, segment of the customer, type of the income which is generated or according to the risk exposure of the product. Moreover, it is important to understand who the customer, what needs the customer has is and which organizational parts of the bank are involved in providing service, how business flow looks like, i.e. the process of execution of the request. Furthermore, it is important to understand the foundations of the organization and its IT structure, appearance of hierarchic structure of management and operations, and where the organizational part of executor (individual) in this process exists. The hierarchic structure is connected to the corporate governance (form, acts, equity, management and executive bodies, banking management, functions reporting directly to the shareholders). [4] The last, but not the least relevant factor is to be familiar with the business environment (in the widest possible sense, like: the financial system of the country, monetary policy of the central bank, competitions' challenges, consolidation and liquidation, global or regional possible enlargement global trends, changes in customers performances, increased risks, technology which changes, international standardization, world economic crisis, etc.) and regulation which is implemented, and what are the consequences for the executor [4, 5,6].

It is important to understand the fact that success of individual and its organizational part depends on the execution of customer's request. Primarily, the individual/executor of customer's request should be acquainted with the fact whether its organizational part generates income or incurs the costs. For the owners of the equity, it is always important the level of the ratio between achieved revenues and accepted risks, and whether they are in accordance with the regulation. [4]

The key concepts for managing banks are: Asset and Liability Management /ALM/, Risk Management /RM/ and Customer Relationship Management /CRM/. It is important to stress out that IT support ensures more successful implementation of the above mentioned concepts.

Risk represents probability of an unfavourable event, in the case of banking business, a possibility of a loss in a transaction, customer or business (material risk), i.e. a possibility of impairing bank's reputation (non-material risk). [7] Due to the increased volume of transactions, globalization process and higher interconnection, type and exposure of risk is increasing as well. However, risk management enables the risk to be mitigated, and restricted to the reasonable level, and financed through certain levels of buffers.

There are different factors which have impact on business risk, and usual acronym for describing all of them is TRICK (in Serbian language): T – technology risk, R – regulatory risk, I – interest rate risk, C- customer risk, K – capital adequacy ratio. [7]

ALM means strategic approach, indicating connection between obtained figures in balance sheet with bank's strategic orientation, as well as the holistic approach, i.e. universal approach in to the analysis and implementation. The components of balance sheet management are: maintenance of liquidity – money management, managing of capital adequacy ratio, credit and security management, and liability management. [6]

CRM represents the universal approach for establishment, maintenance and expanding the connection with the customer, and the way of thinking and behaving within the process of building the relation with a customer. CRM is the question of data, but the final aim is knowledge. Consequently, data, represent facts, i.e. the quality of data is possible to be considered to be assets, which should generate income for both the bank and the customer. The challenge is to combine information from different sources. [8]

In the practice, economists usually externally communicate with the customers, and IT staff represents their support. Consequently, it would be useful that those two parties effectively communicate.

3. BANK'S INTERNAL IT SECTOR

The IT sector of a bank can consist of: a department for development of IT application, department for IT support, department for IT operations and an organizational department. [1] Accordingly, it is organized for the purpose of creating, planning and permanent development of strategy, policy and management of bank's IT investments, as well as preparing of IT security documentation. Besides regular tasks related to the maintenance and development of applicative solutions for recording and managing of data bases, the sector has a specialised department for managing processes and procedures within the bank (the department for organization). [1]

Among the most important business needs that IT meets these three are emphasized [2]:

1. Increasing the efficiency of doing business processes,
2. Improving communication with customers, and
3. Expanding the scope of cooperation.

It should be kept in mind that a bank uses different applications in daily work, depending on size and target group of customers. There are also some in-house, while others represent externally bought rights of usage needed for applications and/or software. It is essential to connect them properly, respecting products and processes within the bank, in order to obtain adequate information decision.

In order to obtain the long-term profitable business of the bank, the ERP /Enterprise Resource Planning) system is required. It should consider transactions as a part of a comprehensive set of business processes. It can be divided on operative (transaction) and managerial (management) part. [9]

The most important operative information system of the bank is its ERP system, and the whole bank's ERP system can be structured on the following way [9]:

1. Core ERP modules – the most famous local ERP solutions are produced by Asseco.
2. Banking ERP Solution – Core Banking, as support to traditional banking business, and
3. Banking ERP modules as support to e-banking (e-banking solutions).

In Serbia, there are external e-banking solutions (such as Halcom) and in-house solutions (which local banks developed in cooperation with Asseco, or group to whom they belong). Also, there are local and foreign outsource solutions for payment cards processing.

It is the easiest when the complete ERP is provided by the same vendor, but it isn't usually the case. The standard division of banking ERP modules is on: 1) Front Office (in the presence of the customer) and 2) Back Office (without the presence of the customer) application. [9]

Besides ERP solutions: 1) banks as a rule use CRM system, which is responsible for: rationalization of products 'portfolio, reengineering of customer service processes, a greater degree of personalization, maximization of cross-selling and up-selling. [10] 2) Document Management System – DMS, because bank operates with huge number of documents and has obligation of storage it within defined period of time. [10]

Furthermore, next to ERP solutions, banks, as a rule, use: 1) the decision system support based on business intelligence, 2) different tools for serious analysis of big data quantity for internal and external purposes, especially connected to the reported requirements of central bank and other relevant state institutions. 3) Needs analysis for implementing analytic solutions which are being constructed under data base by appliance of OLAP and data mining techniques and reporting tools. [10] Generally, actual regulatory requirements for risk management, demand significant investment first of all in software tools for estimation of expected losses and on the basis of it recording in financial reports of the bank.

Having in mind the above, IT departments' scope of activities is possible to describe as follows [1]:

(I) the department for development of IT applications:

- Designing, developing, maintaining and introducing application support for business functions of the bank,
- System integration of the module and interface of the bank's information system,
- Participation in application development projects at the group level (local banks are mainly foreign equity owned and belong to internationally active banking groups),
- System analysis of the information system, data modelling, and functions,
- Participation in the analysis of requirements for changing and assessing the necessary resources and costs to meet the requirements,
- Development of functional specifications and technical documentation,
- Parameterization of the application support,
- Participate in the planning and implementation of application support testing,
- Managing application support versions,
- Assisting users of the IT system at the level 2,
- Participation in the development of instructions for the use of application support;

(II) The department for IT support:

- Installation of IT infrastructure and equipment, hardware, and standard system and application software,
- Technical maintenance, prevention and monitoring of IT infrastructure and equipment,
- Configuring and administering of IT system services,
- Relocation of IT equipment,
- Technical support for users,
- Maintaining technical documentation and records,
- Assisting IT users,
- Analysis of causes, finding solutions and escalation of problem solving,
- Coordination of support for users of IT systems on Levels 1 and 2,
- Keep track of requests for help and events on an IT system.

(III) The department for IT Operations:

- Design, installation and integration of IT systems and solutions,
- System administration and adjustment of IT systems,
- Analysis and testing of IT systems and solutions,
- Designing, installing, integrating and monitoring the protection of IT systems,
- Management, monitoring, servicing and maintenance of IT systems,
- System programming,
- System support for IT system users,
- Management of IT system documentation,
- Participation in the procurement of IT equipment,
- Implementation of production support activities.

The department for IT operations carries out these tasks on (d) the following IT systems:

- Server systems - IT infrastructure at a central location (server room),
- Database systems - database management systems (MS SQL Server),
- e-mail systems - e-mail transfer systems (MS Exchange),
- Server applications - special purpose server servers (Border Proxy, Unisys Depcon, IBM MQS, MS ISA, MS SharePoint Portal ...),
- External applications - special purpose programs and systems (video conferencing, credit score model, RTGS, SWIFT, core banking system, K + ...),
- Data storage systems - systems for central backup and archiving (Tape Library),
- Communication systems - data transmission systems (computer network) and network equipment,
- Telephone systems - voice transmission systems (mobile, IP, fixed telephony) including IVR and Call centres, and telephone equipment,
- Security systems - all protection systems against program viruses and attacks on server and telecommunication systems and data on them.
- Coordination of procurement in IT,
- Monitoring the activities of IT production systems,
- Analysis and testing of IT systems,

- Creation and management of the IT system database,
- Performing production procedures, reports, placing in circulation and distribution of reports,
- Perform backup and archiving procedures,
- Implementation and management of the telephone system,
- Systemic, technical, and communication support to the Multichannel Management Department.

(IV) The department of organization:

- Establishing and improving the organizational structure of the bank,
- Updating the organizational scheme of the bank,
- Defining, analyzing and optimizing the business and non-business processes of the Bank,
- Cooperation with the Internal Audit Department, the Legal Service Department and the Compliance Department for compliance with the bank's compliance with the bank's compliance with the bank's obligations towards external institutions, as well as the bank group's requirements,
- Defining the standards for drafting the bank's documentation,
- Coordination of the development of procedures with the bank's business and non-business functions,
- Participation in the group's projects and implementation at the local level,
- Planning, coordination and implementation of IT projects and project activities,
- Estimate the required resources, time, investment and costs for IT projects and activities,
- Monitoring the implementation and reporting on the status of IT projects and activities,
- Manage user requirements for creating / modifying IT applications, that is: coordination in defining requirements, feasibility analysis requires defining the resolution priorities, deciding on the development / modification of the software solution in cooperation with the members of the Change Request Board, testing solutions, implementation and coordination of the development of user instructions and coordination of training,
- Coordination of communication and activities in the field of organization and IT with the bank group.

4. BANKERS: SKILLS, KNOWLEDGE AND COMPETENCES IN THE PRACTICE

On the basis of the previous mentioned it is possible to conclude that economists should know very well the basic business i.e. products, processes, procedures and actual regulation, including accounting effects on balance sheet and income statement, in order to communicate adequately with IT colleagues. Furthermore, in the area of IT skills, economists should be familiar with data base, Microsoft office tools, way of functioning basic accounting software, and it will be preferably to have experience in usage of banking applications and relevant software.

The data basis intended for collecting, organizing, storage and manipulation of data, on the basis of which are gained information needed for end users. [11] Furthermore, accounting information systems are based on legal and accounting regulation, transaction processing and integrated business solutions. [12]

5. SUCCESSFUL PROJECTS OF COOPERATION BETWEEN ECONOMISTS AND IT EXPERTS

In practice, development of a bank isn't possible without good cooperation between economists and their IT experts. So, it is important that they understand each other very well in order to obtain long term profitable business for the bank and satisfaction of all stakeholders. In this part of the paper, authors choose two (per bank) successful examples of good cooperation, having in mind achieved results, spent resources and time of execution.

Based on their experience with Raiffeisen bank a.d. Belgrade, the authors chose the following examples:

1. Buying of a new software solution (Globus, foreign vendor) or an improvement of the existing application (in that moment Bapo, the ownership of a local company Antegra /today a part of Asseco/). The expert team formed by representatives of all bank's division look at the vendor's presentation, including functionalities, time of migration, and price. After that, they organized a meeting and made decision that it was cheaper and more functional to develop existing application then to migrate on new solution.

2. Buying of an external CRM application or development of existing one. In that moment, the company Halcom offered the CRM solution for corporate customers and presented it to the front office of the bank and IT experts in charge for development of application. Having viewed all functionalities of the Halcom's solution, the corporate staff suggested that it would be better to develop the existing CRM in Lotus Notes of the bank. Furthermore, the SME staff of the bank further improved CRM with introducing the loan approval process.

Based on their experience with in Erste bank a.d. Novi Sad, the authors chose following examples:

1. Transformation of IT division. It included the migration of the core banking system (NORGIT), providing of an adequate infrastructure on the basis of future expected business, improvement of existing e-banking channel and a transformation of the IT sector. The accompanied modules of the project were: NORGIT, support for data management project, documentation and reengineering of processes (connected to NORGIT) and establishment or the department for organization.

   NORGIT - Novosadska bank used to apply its own in-house solution, before it became the ownership of Erste bank Vienna. The new shareholders decided to migrate to the new IT solution IBIS, which was created by *Erste& Steiermerkische* bank d.d. Zagreb. NORGIT included the migration of the core banking system, providing of an adequate infrastructure on the basis of future expected business, improvement of existing e-banking channel and a transformation of the IT sector.

   The project was held in the period of the third quartile 2005 until 2007. The project team members were from the local bank and Erste group. The consultant on the project was AT *Kearney*. [1]

2. Reallocation of the credit administration from the front-office to the back-office of the bank (PIACA). As the result of the initial transformation of the retail and the corporate division (front-office), all activities connected to customers 'requests were in the front-office. It decreased possibilities for employees to process a larger number of customers' requests and increased the risks that funds of the bank would end up in the impropriate accounts of the customers. So, there were the reasons to consider what would be the most convenient way to transfer administrative jobs from the sale departments to the back-office of the bank. It resulted in reallocating the credit administration for both front-office divisions to the processing (back-office) within 3 months period.

6. CONCLUSION

The key to good communication between bankers and IT experts is that bankers should know to precisely define a request. It implies that they should know very well product offers of the bank, understand client's needs, processes and procedures within the bank, functionality of used software, and the actual regulation. Thereby, it is important that all request proposals should be considered through prism of balance sheet and income statement of the bank, in order to understand on time whether the change is necessity or it is only a new whim in the market. The contemporary market conditions impose permanent need for monitoring innovations in the field of finance and technology in general, long-life learning process, in order to obtain competitiveness in the labour market.

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CURRENT APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN TOURISM AND HOSPITALITY

Sonja Zlatanov[1,*],
Jovan Popesku[2]

[1]Business School of Applied Studies,
Blace, Serbia
[2]Singidunum University,
Belgrade, Serbia

Abstract:
The revolution brought about with the development of ICTs has caused dramatic changes in tourism and hospitality industry. The Travel 2.0 websites characterized by sharing information freely have been prevailing for some time now and are paving the way for the use of even more sophisticated intelligent systems in tourism and hospitality. Considering the complexity of the travel-related decision making process, intelligent systems and tourism fit in perfectly. Service automation, artificial intelligence and robots have provided tourism companies and organizations with vast new opportunities. Artificial intelligence has already been adopted to some extent in various parts of tourism industry, however, the scientific literature on the subject continues to be scarce. This paper intends to continue the discussion on the artificial intelligence applications in tourism which has just started recently, thus providing much needed scientific view of the subject.

Keywords:
Intelligent systems, chatbots, robots, AI empowered travel bots, digital travel assistants.

1. INTRODUCTION

The importance of information in tourism industry has been well documented [1] – [5]. Accordingly, wide adoption of Information and communication technologies (ICTs) in tourism sector was well expected [6], [7]. The acceptance of ICTs brought about extensive changes [8], [9] and a whole new variety of threats and opportunities for tourism companies and organizations. ICTs allow tourists to find, customize and purchase tourism products easily, and they support the globalization of the tourism industry by providing tools for developing, managing and distributing tourism services worldwide [10]. Incorporation of ICTs allows tourism companies and organizations to take advantage of intranets in order to reorganize internal processes, extranets in order to develop transactions with trusted partners, and the Internet in order to easily communicate with all the stakeholders [11]. Use of ICTs allows for combining customer-relationship management and supply chain management into a single source that facilitates a variety of operations - product selection, ordering, fulfillment, tracking, payment and reporting, which are all performed with one easy-to-use tool [12].

Correspondence:
Sonja Zlatanov

e-mail:
sonja.zlatanov@gmail.com

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Evolution of Internet websites into applications that encourage and initiate participation and collaboration among users, known as Web 2.0 applications, have led to the "informatization" of the entire tourism value chain [13] and the development of the concept of Travel 2.0 [14] – [16], that is, internet sites that allow tourists to publicly express their opinion about any travel-related content [17]. These applications have been prevailing for some time now when it comes to the use of Internet by the tourists, and are paving the way for the use of even more sophisticated intelligent systems in tourism industry [18], [19].

2. THE CONCEPT OF ARTIFICIAL INTELLIGENCE

Artificial intelligence is increasingly becoming part of our everyday lives [20], [21]. What differentiates intelligent systems from the not intelligent ones is their ability to understand the situation, to acquire and retain knowledge and to conclude based on the previous experiences, and thus be able to quickly and successfully respond to a new situation [22]. Generally, there are two main characteristics of intelligent systems [19]: their ability to sense the environment and their ability to learn from actions in order to maximize success in achieving particular objectives. Robots, artificial intelligence and service automation are widely used in variety of different sectors [23]. Considering the complexity of the travel-related decision making process, intelligent systems and tourism fit in perfectly. By collecting and processing information about the personal needs of the users, they can facilitate the decision making process and greatly influence tourists' information search. Accordingly, artificial intelligence has already been adopted to some extent in various parts of tourism industry [24] – [26]. Even though the concept of artificial intelligence was introduced by Alan Turing in 1936 [27], and there have been proofs of successful use of artificial intelligence in travel industry at the very beginning of the century [28], the scientific literature on the use of artificial intelligence in tourism industry continues to be scarce. It must be noted that there seems to be an increase in the number of the scientific papers published on the subject in the last two years. It may have something to do with the fact that in 2017 the largest industry intelligence platform providing media, insights and marketing to key sectors of travel, Skift, identified artificial intelligence as a megatrend in tourism industry [29]. This paper intends to continue the discussion on the subject and offers some current applications of artificial intelligence in tourism sector, thus providing much needed scientific view of the subject.

There are two kinds of artificial intelligence systems - pure digital ones and digital-physical hybrids that are usually called robots [30]. Both of the systems are used in different parts of tourism and hospitality industry. When it comes to the pure digital artificial intelligence systems, examples include online check-in systems and mobile boarding passes available in airline industry [23], however, the greatest changes in tourism and hospitality were brought about with the development of different types of chatbots.

3. USE OF CHATBOTS IN TOURISM AND HOSPITALITY

Chatbots controlled by artificial intelligence play a very important role in tourism industry. The term "chatbot" is coined from words "chat" and "robot", thus undoubtedly explaining their purpose. Chatbots are essentially computer programs that stimulate a human conversation using natural language [31]. The first chatbot called ELIZA was developed in 1966 [32] and was developed to trick its users by making them believe that they were having a conversation with a real human being [33]. Chatbots have evolved to a great extent since the introduction of the first model and their main fields of use are in retail, customer services, decision making support, state of the art payment systems and online community building [34].

Since chatbots have proven themselves worthy of investment and have shown tremendous growth and market potential, their use in tourism industry increased accordingly. Tourists' need for reliable sources of information is constantly increasing, so travel chatbots are designed to help fulfill those needs and requirements. Travel chatbots are enhancing travel experience as they guide tourists through each and every aspect of their trip, from booking to general travel advice [35]. Depending on the platform they are incorporated in, as well as on their level of sophistication and ability to recommend, there are three different types of travel chatbots: customer service bots, Facebook chatbots and AI empowered travel bots [36].

Customer service travel bots

Customer service travel bots are the most basic type of chatbots which are incorporated in the travel companies' websites. These bots simply use the list of

previously determined automated answers and are therefore limited to only helping users navigate the website, without being able to help them with booking. Review of scientific literature and web-based resources showed that there were more customer service travel bots available a couple of years ago than today. It seems as if the travel companies realized the downsides of the insufficiently developed chatbots, and have therefore decided to eliminate them from their websites. These companies include Booking.com, On the Beach and Tap Portugal. However, there are also those who continue using customer service travel bots, such as Copa Airlines, [37] Amtrak [38] and Air New Zealand [39].

Facebook chatbots

Chatbots incorporated in Facebook Messenger offer far more possibilities for the tourists. Besides simply helping them navigate a certain page, these chatbots are more interactive and can actually help users with booking through a two-way conversation. Even though the users have to put in the same data as they would by booking the trip by themselves, it seems that Facebook chatbots are achieving good results when it comes to users' satisfaction and are proving to be a good investment. In 2018 there were 300,000 active chatbots on Facebook Messenger, which is three times as many as the year prior [40]. One of the most successful Facebook chatbots is Expedia's chatbot [41]. In order to start communicating with Expedia via their chatbot, the users just need to log in to their Facebook accounts and visit Expedia's page [42], and the chat window will pop up automatically. There is one restriction when it comes to the Expedia chatbot compared to the services normally provided by Expedia, and it is that the chatbot can only help users with booking a hotel or managing their trip, but cannot offer services in search of flights, cruises nor cars.

Another example of a well implemented Facebook chatbot is the Skyscanner chatbot [43]. The distinctive features of this chatbot are offering the cheapest destinations from the nearest airport, as well as categorizing flights in cheapest, shortest and best. In addition, in case the tourist just wants some inspiration, he or she can type "anywhere", and the chatbot will return some interesting suggestions. Kayak Facebook chatbot [44] offers its services for fights, hotels, rental cars, activities and trip updates, which probably makes it the most comprehensive chatbot out there. It also has a memory of previous conversations and uses Kayak search history for personalization. Skyscanner and Kayak chatbots are not only available for Facebook Messenger users, but for Slack, Amazon Alexa, Skype and Google Assistant as well. Most of the travel companies with chatbots available are either airline companies or travel search engines. One of the rare cases of tourist board with Facebook chatbot is Faroe Island tourist board. Besides being available on their official Facebook page, users can also start communication with Faroe Island chatbot on their official website via Facebook Messenger extension [45].

AI empowered travel bots

These chatbots are somewhat different from the previous two groups. Even though they still rely on instant messaging in order to communicate with the users, what differentiates them from the previously mentioned chatbots is their ability to make recommendations. They manage to do it with the help of certain algorithms and access to information, as well as connection with other apps. KLM Royal Dutch Airlines is a good example of a chatbot that went one step further than the ones already mentioned. Besides having Facebook Messenger chatbot offering its help to tourists, this company added one more interesting feature: their chatbot, called BB, can help tourists pack for their trip [46]. It just needs simple information such as the destination, the date and the trip length, and it will tell them everything they need to pack. This feature is available on Google Home Assistant.

Another example is Hello Hipmunk, a virtual travel agent which offers a plethora of services aimed at helping users plan their trip and book all parts of it [47]. However, the most distinguished feature offered by Hello Hipmunk is combining of tourists' emails and calendar information in order to create personalized travel recommendations. It can also build an itinerary for the user's trip and share it with others, such as family or colleagues. It can be accessed on Facebook Messenger and Skype.

There is also HelloGBye travel assistant aimed at frequent fliers and small businesses [48]. The difference between HelloGBuy travel assistant and other ones is the fact that it is an individual app, currently available to IOS users only. However, even though downloading an app, especially the one that is not free, is an obstacle for some users, this app is claimed to be able to address travel requests involving not only one, but

multiple people, with a detailed flight and hotel itinerary in under 30 seconds, thus making up for the troubles caused to a certain extent.

Last but not least example of AI empowered travel bots is called Sam [49]. Like many other virtual travel assistants, it can be used by an individual user, however, its most important features are more useful for frequent fliers and business travelers. First of all, Sam can help users book their flights, and then it will automatically integrate all the trips in a useful itinerary. If anything arises, such as bad weather forecast, Sam will inform the user of it in order to help him or her pack better. In addition, it will offer to organize the transport to the airport by connecting with local services approved by the traveler's organization. Immediately after landing, Sam already has the information on the baggage claim the traveler should go to, and it can also inform traveler's family members about the safe flight. In addition, it can offers travel guide of the destination and it will be in touch with the traveler throughout the whole trip, informing him or her about bad traffic and delayed flights for example. All these features are enabled by integrating with other apps, such as Avis, Uber and Google Maps. Considering the complexity of this travel assistant, it is an app that needs to be downloaded, and is available for both IOS and Android users.

4. USE OF ROBOTS IN TOURISM AND HOSPITALITY

Robots are intelligent physical devices [50] with a certain degree of autonomy, mobility, and sensory capabilities that allow them to perform intended tasks without a human intervention [26], [51]. The least sophisticated industrial robots have been used in tourism and hospitality sector for at least 50 years in different production processes, such as food preparation. As the level of autonomy of robots increases, as well as their ability of social interaction, there are professional service robots and personal service robots, both developed around two decades ago [26] and being further developed on a daily basis. Professional service robots in tourism and hospitality include room cleaning robots [26], self-check-in kiosks and automated border control gates available at many airports, conveyor belt restaurants which are frequent in major cities [23], as well as many others which will be presented below. Personal service robots are the ones used by individuals for non-commercial tasks and will therefore not be further investigated in this paper.

The number of professional service robots used in tourism and hospitality increases every day, as well as their complexity. For example, nowadays there is a robotic suitcase available, which makes traveling a lot easier. It has the ability to follow its owner by itself and avoid any obstacles, thus eliminating the need to carry the suitcase [52]. Robots are being introduced as travel agents [53], as well as airport security [54]. In 2014 a restaurant in China introduced robot waiters [55]. The following year there were testing of the robotic hotel information agents [56], and in 2016, robots were introduced as servers in hotels. A robot server was built and programmed to deliver extra towels, toothpaste or other necessities to the guest rooms [57]. The hotel staff is required in order to introduce the room number on the robot's touch screen, after that the robot uses elevator to go to the designated room. The only way of communicating these robots were capable of was through typed messages that appeared on their screens.

The next step for robots in hospitality industry was a fully automated hotel that opened its doors to visitors. Henn-na hotel in Japan [58] is the world's first hotel staffed exclusively by robots. Robots speaking multiple languages greet and help the customers at the front desk, with one of them being a dinosaur. There are robotic arms which are in charge of storing guests' luggage, and the rooms are excessed by facial recognition systems. This may seem a little over the top, however, this hotel is not the only one introducing robots to all the different positions available in hotels, it is merely the only one using robots exclusively. For example, Hilton Hotel in McLean, Virginia, introduced Connie, robotic concierge that helps guests get around the hotel, answers routine questions about services, and will perhaps one day be able to translate inquiries for guests and staff [59]. Connie is able to interact with visitors by using speech recognition technology in order to respond to their queries. In addition, it also learns from each interaction, meaning the more it is used, the better its responses will become. In addition, there are two Chinese Marriott hotels that have also introduced facial recognition technology to check-in, while Japan Airlines is investigating this idea as well [60].

5. CONCLUSION

The revolution brought about with the development of ICTs has caused dramatic changes in tourism and hospitality industry. Service automation, artificial intelligence and robots have provided tourism companies

and organizations with vast new opportunities. Artificial intelligence is a new form of intelligence which has the ability to synthesize several different ideas simultaneously [34]. It is able to respond to questions and provide valuable information to customers. Modern tourists are more demanding than ever, expecting almost immediate responses on online platforms, and artificial intelligence allows businesses to deliver response times that would be impossible for humans. In addition, chatbots and AI empowered travel bots enable personalization of the tourism offer, as well as improvement of operations and increase of productivity while delivering consistent product quality. However, one of the main downsides of using robots in tourism and hospitality is the lack of personalized service [57], which is one of the most important characteristic of the sector. Artificial intelligence is still not that widespread in tourism sector, but it is expected to be used more often in the future in order to increase the quality of the products and services. This paper relied on scientific journals and web-based resources in order to try to continue the discussion on artificial intelligence applications in tourism which has just started recently. The paper presented numerous applications, however, it only scratched the surface of the subject which is gaining more importance on a daily basis and is being further developed at a very fast pace.

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STUDENTSKA PLATFORMA - ePORTFOLIO

Stevo Jokić*,
Aleksandar Sandro Cvetković,
Saša Adamović

Fakultet za računarstvo i informatiku,
Univerzitet Sinergija,
Bijeljina, Bosna i Hercegovina

Rezime:
Brze promene u tehnologiji uticale su na promene u poslovnom svetu IT industrije koje su se odrazile na visoko obrazovanje i studente. Konstantno učenje i napredovanje, upravljanje karijerom i digitalne kompetencije su veštine koje se danas izdvajaju kao najvažnije. Ovakve veštine se mogu postići uključivanjem studenata u razne projekte i kreiranjem studentskih ePortfolio profila koji će služiti kao dokaz radnih aktivnosti studenata. U ovom radu autori opisuju i predstavljaju ePortfolio rešenje Univerziteta Sinergija na osnovu sumiranog istraživanja koje su sproveli. U radu je objašnjeno od čega se sastoji predloženo ePortfolio rešenje i koje sve mogućnosti pruža. Rezultati rada navode koje sve prednosti ePortfolio platforma omogućava i koliko je ovakva platforma značajna za profesore, studente i poslodavce.

Ključne reči:
ePortfolio platforma, studenti, projekti, razvoj karijere, CV.

1. UVOD

Studentski ePortfolio je jedan od vrednih resursa koje svaki Univerzitet treba da poseduje. To je jedan veoma važan resurs koji koji služi za čuvanje podataka odnosno arhiviranje različitih studentskih projekata kao što su: razvoj aplikacija, razvoja baza podataka, pisanje naučnih radova, sertifikata, znanja iz stranih jezika i još mnogo toga. Za studenta kao pojedinca je ovo od izuzetnog značaja u razvoju njegove karijere jer na veoma pristupačan način omogućava svoje javno predstavljanje poslodavcima. Ova platforma ima potencijal da prikaže profesionalni i lični rad svakog pojedinca kao i da ilustruje praksu zasnovanu na dokazima. Period od završetka srednje škole do diplomiranja na fakultetu za studente predstavlja ambiciozan put ka usavršavanju, počevši od izbora fakulteta odnosno nauke koju žele da izučavaju. [1]

Platforma ima različite primene pa tako postoje i različite vrste ePortfolia a to su: radni portfolio, portfolio za prikazavanje rezultata i portfolio procene. Ovi tipovi se teorijski razlikuju ali često dolazi do njihovog preklapanja u praksi. Sam naziv radni portfolio nazvan je po tome jer sadrži radove koji su toku izrade, kao i gotove uzorke radova. Na osnovu toga on se dalje može predstavljati kao portfolio za prikaz. Ukoliko se uporedi radni portfolio sa radnim direktorijumom može se reći da služe koliko

Odgovorno lice:
Stevo Jokić

e-pošta:
sjokic@sinergija.edu.ba

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sličnoj toliko i različitoj svrsi. Za radni direktorijum jedino zaduženje je sakupljanje posla za svakog pojedinca a nema nikakvu svrhu upotrebe, dok je radni portfolio kolekcija radova vođena ciljevima učenja. Glavna svrha radnog portfolia je da čuva studentske radove. Delovi koji se odnose na određenu temu se čuvaju ovde dok se ne prebace u portfolio za prikazivanje. Na ovaj način profesor može otktriti slabe i jake strane svojih studenata. Primarna publika za ovaj portfolio je student kao i profesori koji ga vode tokom školovanja. Radeći na svojim projektima i šta će biti prikazano studenti postaju samouvereniji i ambiciozniji. Važna publika mogu biti i roditelji koji imaju mogućnost praćenja toka studiranja svoje dece, pogotovo za one roditelje koja ne prihvataju ograničenja trenutnih veština svoj dece ili nemaju realnu sliku načina na koji njihovo dete napreduje u odnosu na drugu decu. Radni portfolio je struktuiran oko jedne određene oblasti. Radovi iz te oblasti se sakupljaju i dokumentuje se napredak studenta.

Najbolja upotreba ePortfolia je prikazivanje najboljih radova studenata odnosno diplomaca. Svrha ove platforme je da se pokaže najviši nivo dostignuća koje je student tokom školovanja postigao. Ova vrsta portfolia se nekim pravilima menja iz godine u godinu iz razloga jer svake naredne godine student treba da ubaci svoje nove projekte na kojima je radio tokom školske godine i koji trebaju da ga predstavljaju za tržište rada. Projekti na kojima se rade mogu se odnositi na stručne predmete koje student pohađa na svom fakultetu uz mentorstvo profesora koji je angažovan tom predmetu. Što se tiče publike koja je značajna za ovu vrstu portfolia prvo su bitni studenti, jer na taj način mogu da prate napredak razvoja pojedinca. Druga, važnija publika koja se tiče studenata-diplomaca su poslodavci, jer poslodavac može da odluči da li će kandidat biti pozvan za razgovor na posao nakon prvog utiska pregledanih radova, biografije, stranih jezika, CV video zapisa itd. Proces rada eportfolia je da mentor odnosno profesor stručnog predmeta prati i nadgleda rad studenta tokom semestra. Na kraju student mentoru elektornskim putem prilaže sav materijal koji uradio što obuhvata kratak opis projekta, slike projekta, sam projekat koji radio, tehnologije koje je koristio, dokumentaciju projekta i na osnovu svih sakupljenih materijala mentor odlučuje da li je taj rad vredan materijal koji student treba da postavi na svoj lični profil platforme ePortfolia.

U portfolio procene može se dokumentovati šta je student savladao tokom slušanja određenog predmeta, zatim komentari i preporuke mentora koji ga je vodio tokom rada na projektu. Njegova primarna svrha je da ocenjuje i dokumentuje napredak studenta na određenim predmetima. Ta procena može da se vrši tokom jednog semestra ili tokom cele školske godine u zavinosti od tipa projekta koji se radi što uključuje kombinaciju predmeta informacionim tehnolgojima gde se nekoliko predmeta sluša kroz jednu ili dve godine da bi se postigao neki konačan cilj. Što se tiče publike koja je zadužena za ovu vrstu portfolia može biti sam profesor koji ocenjuje rad studenta ali još važnije je da postoji publika koja nije imala dodira sa njima radi realne procene kvaliteta. Profesor može biti zadovoljan ispunjenim kriterijumima međutim ostala publika iz iste struke će dati značajanost ukoliko pozitivno oceni rad. Ta publika može biti: profesori sa fakulteta, državni organi, ostale kolege studenti starijih generacija, alumnisti fakulteta koji su već zaposleni na tržištu rada itd. [2]

Sve tri vrste koje su navedene do sada se preklapaju u jednu celinu a to je ePortfolio platforma. Danas, profesionalci u mnogim oblastima kao što je obrazovanje, umetnost, informacione tehnologije već dugo koriste portfolie kao sredstvo za prikazivanje svojih radova potencijalnim poslodavcima ili klijentima. Studenti informacionih tehnologija se susreću sa različitim predmetnim tehnologijama i često koriste poslovnu mrežu Linkedin kao sredstvo za sopstvenu prezentaciju i traženje posla. Navešćemo nekoliko razloga zašto je korisno posedovati platformu ePortfolio unutar Univerziteta a posebno se odnosi na studente koji izučavaju različite informacione tehnologije.

Građenjem ePortfolia studenti mogu kritički i kreativno razmišljati o svojim akademskim i ličnim dostignućima. Mnogi studenti neće razmišljati na taj način dok ne dođu u proces traženja posla a u tom trenutku važna stvar za njih je da se pokušaju pronaći što kvalitetniji delovi koji će govoriti o njihovi veštinama i sposobnostima. Sa druge strane, studenti koji kroz fakultetsko obrazovanje rade na svom ePortfoliu oni imaju stalan uvid u njihove radove te na osnovu toga mogu razmotriti delove koji najbolje ilustruju njihove talente i sposobnosti.

Studentima je današnje vreme upotrebom informacionih tehnologija znatno lakše poslati svoj ePortfolio poslodavcu putem email-a ili slanjem adrese linka na kojoj se njihov lični profil nalazi. Ovo je važno napomenuti jer studenti informacionih tehnologija već na trećoj godmentorini imaju pravo konkurisati za poslove radi obavljanja stručne prakse. Na veoma brz i efikasan način dostavljaju se svi mogući podaci o osobi za koje je nekad ranije trebalo mnogo više vremena da se dostavi. Pomoću dobro osmišljene elektronske platforme ePortfolia

studenti poseduju jedan atraktivan paket koji o njima govori sve što treba da se predstave na tržištu rada. [3]

2. PREGLED U OBLASTI ISTRAŽIVANJA

Autori [4] su utvrdili da je ePortfolio danas postao mnogo više od običnog skladištenja informacija o studentima. Kreiranjem sopstvenih profila povećavaju svoje prisustvo na tržištu. Nakon što se studentima daju smernice kako kreirati sopstveni portfolio neophodno je objasniti etičko korištenje online informacija. Ove smernice utiču na poboljšanje rada i kvalitet studenta odnosno razumevanju digitalne etike.

Autor [5] smatra da kreiranje portfolia predstavlja izuzetan napredak u visokom obrazovanju, gde se upotrebom inofrmacionih tehnologija došlo do sjajnog rešenja za poboljšanje kvaliteta rada i napredak studenata. Istražene su značajne razlike između klasičnog ePortfolia i online platforme jer studenti danas dolaze u takav sektor gde se od njih očekuje iskustvo u radu u određenoj oblasti što se posebno odnosi na sektor informacionih tehnologija. Rad profesora treba biti usmeren na pružanje takve informacije studentima ali neophodna je i adaptacija profesora na takav sistem rada sa studentima tokom njihovog školovanja.

Autori [6] predstavljaju ePortfolio kao novo digitalno okruženje u odnosu na tradicionalni portfolio koji je služio samo za prikazivanje informacija. Danas, on služi za upravljanje svim oblicima i vrstama dokumenata u digitalnom okruženju i softverskih aplikacija koje služe za sastavljanje tih dokumenata za određenu svrhu. Obe stvari u suštini služe za pružanje i stvaranje znanja. Ovaj naučni rad, na osnovu iskustava korišćenja elektornskog portfolia prikazuje kako se ePortfolio može koristiti za rešavanje izazova i problema sa kojima se suočava individualni kontekst stvaranja znanja.

Autori [7] su elektronski portfolio predstavili kao fokus učenja, istražavanja studenata koji sami biraju šta je vredno postaviti kao dokaz o znanju iz određene oblasti bilo da se to odnosi na projekte, radove, veštine. Dokazano je elektornski portfolio realan način da se dokumentuje stvarni napredak studenata, da se prikažu njihovi najbolji radovi, profesionalno predstavljanje na tržištu rada i da se obezbedi metod ishoda učenja studenata kao i evaluacija nastavnog plana i programa. Samim usvajanjem ovog načina rada sa studentima predstavlja značajan aganžman koji zahteva dobro smišljenu strategiju razvoja. Model koji je predstavljen u ovom radu se zove pentagonalni model koji uključuje pet nivoa. Prvi nivo je identifikacija potreba, drugi nivo služi za određivanje, procenu i budžetiranje, treći nivo je izbor sistema i strateško planiranje, četvrti nivo obuhvata razvoj i peti nivo implementacija i dalji razvoj.

Autor [8] prema istraživanju navodi da većina današnjih Univerziteta širom sveta uvode obrazovne proemene u svoju nastavnu praksu kao i u samu strategiju ocenjivanja studenata. ePortfolio je princip bolonjskog rada, učenja i polaganja predmeta koji se mogu poreditи jer na kraju imaju sličan zadatak a to je da student na najbolji mogući način savlada materiju. Tu postiji i drugi aspekti ove platforme kao što je mobilnost studenata, stoga je razvijanje efikasne upotrebe ove platforme u obrazovanju postala važan izazov. Na osnovu ovih zaključaka tema ovog rada bila je da se identifikuju karakteristike okruženja za učenje prilikom primene ePortfolia za nastavu i karakteristiek studenata koje bi mogle da utiču na njihovo učenje.

3. PREDLOŽENO REŠENJE

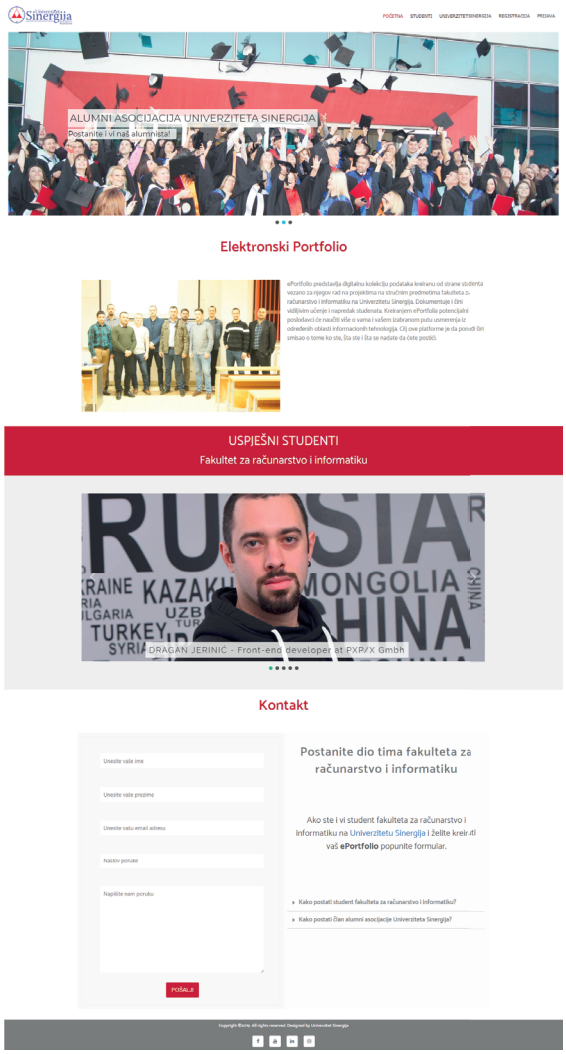
Univerzitet Sinergija je prepoznao prednosti koje studentski ePortfolio omogućava i prateći svetske trendove započeo projekat izrade ePortfolia. Na Univerzitetu Sinergija u sklopu Fakulteta za računarstvo i informatiku studenti još od prve godine počinju da rade na konkretnim projektima iz svakog stručnog predmeta što se pokazalo kao idealno za implementaciju ePortfolia.

Razvoj ePortfolio projekta realizovan je pomoću web tehnologije WordPress CMS u kombinaciji sa custom delovima koda upotrebom PHP, HTML5, CSS3, JavaScript i MySQL-a.

ePortfolio Univerziteta Sinergija sastoji se od:

- početne strane
- liste studenata
- registracije
- prijave
- admin panela

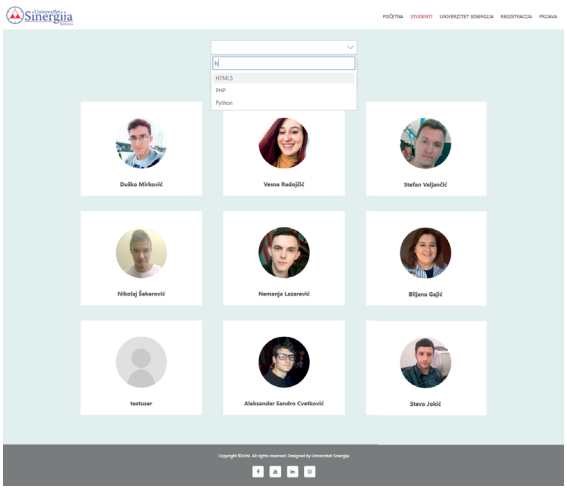
Početna strana (engl. landing page) sastoji se od četiri sekcije koje sadrže najvažnije informacije vezane za studente poput kako postati član studentske kancelarije Univerziteta Sinergija, šta je sve potrebno? Kako postati član Alumni asocijacije i kako se povezati sa alumnistima, kratak uvod u ePortfolio, pregled svih uspešnih studenata i alumnista, kontakt obrazac za dodatne informacije i listu svih besplatnih kurseva koji se redovno organizuju na Univerzitetu (Slika 1).



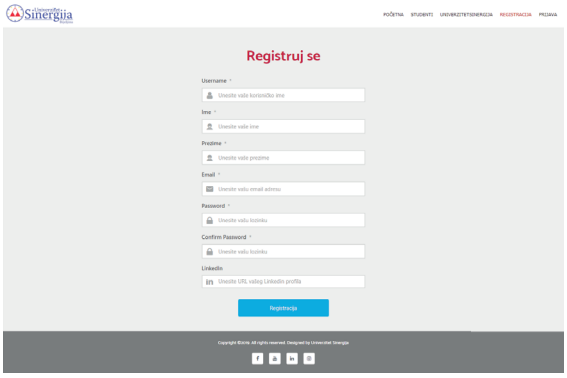
Slika 1. Početna strana

Strana „Studenti“ bazirana je na prikazu studentskih profila. Na jednom mestu grupisani su svi studentski ePortfolio profili. Studenti prilikom kreiranja njihovih profila imaju mogućnost da dodaju stručne veštine koje poseduju (npr. HTML5, CSS3, JavaScript) na osnovu kojih posetioci ePortfolia mogu vršiti pretragu njihovih profila (Slika 2). Sve stručne veštine koje studenti dodaju moraju prvo da budu odobrene od strane mentora.

Studenti imaju mogućnost da kreiraju sopstvene ePortfolio profile ali kako bi kreirali profil potrebno je prvo da se registruju. Strana „Registracija“ omogućava verifikaciju studenata za ePortfolio i samo studenti imaju mogućnost registracije (Slika 3). Administratori upravljaju kontrolom registracije.

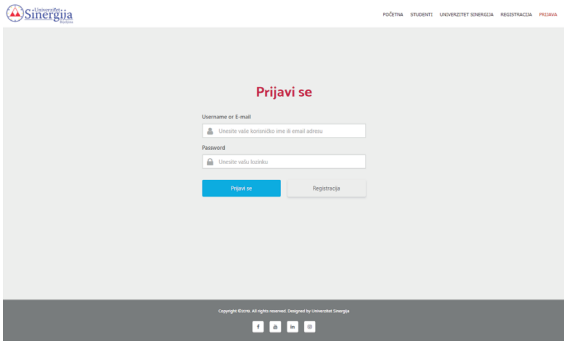


Slika 2. Lista studenata (profili studenata)



Slika 3. Forma za registraciju

Nakon što se student registrovao i kada je zvanično verifikovan od strane administratora, student ima mogućnost da se prijavi preko strane „Prijava“. Student se može prijaviti preko svoje studentske email adrese ili upotrebom korisničkog imena (Slika 4).



Slika 4. Forma za prijavu

Studentski profil

Glavni deo studentskog ePortfolia je studentski profil. Kompletan ePortfolio usmeren je na studenta kao pojedinca i njegov profil. Za razliku od društvenih mreža kao što su Facebook i Instagram, studentski ePortfolio profili su više nalik LinkedIn društenoj mreži. Studenti nemaju mogućnost dodavanja bilo čega što nije profesionalno, stručnog karaktera i usmereno ka usavršavanju i razvoju karijere.

Na Univerzitetu Sinergija studenti kroz svoje školovanje rade na izradi sopsvetnih LinkedIn profila, međutim ePortfolio profil studenta donosi drugačiju vrednost. ePortfolio profil pruža preciznije informacije, npr. pomoću ePortfolia student može detaljno da objasni i prikaže svoje projekate, da navede ko su mentori koji su studenta vodili kroz projekate i na kojim predmetima su rađeni projekti. Takođe, lakše je i brže doći do kontakt podataka i kontaktirati studenta direktno nego na LinkedIn društvenoj mreži.

ePortfolio studentski profil je napravljen tačno po kalupu koji je namenjen za studenta, dok je LinkedIn profil više namenjen za profesionalce. Međutim spona između LinkedIn-a i ePortfolia povećava vidljivost studenata na internetu kao i mogućnost za menadžere ljudskih resursa (engl. Human Resource Manager) da lakše pronađu studente. HR menadžeri nisu samo u potrazi za profesionalcima, kako se IT industrija razvija sve je veća potreba za radnom snagom tako da razne kompanije nude praksu i stipendije za studente treće i četvrte godine.

Studentski ePortfolio profil se sastoji od pet sekcija. Prva sekcija obuhvata profilnu sliku studenta, LinkedIn profil i Youtube profil ukoliko ga student ima, i kao sastavni deo prve sekcije biografija studenta. Druga sekcija namenjena je isključivo stručnim veštinama koje student poseduje. Treća sekcija odnosi se na projekte na kojima je student radio. Svaki projekat ima svoj naziv, mentore, link ka lokaciji na internetu ukoliko je postavljen negde, kompletan fajl projekta, detaljan opis projekta i slike. Četvrta sekcija namenjena je svim radovima na kojima je student radio u toku svog školovanja (seminarski rad, diplomski rad, master rad, prezentacije). Svaki rad se sastoji od naziva, tipa, pdf dokumenta i detaljnog opisa, odosno apstrakta. Peta sekcija služi za prezentovanje svih sertifikata koje je student položio u toku svog školovanja (Slika 5).



Slika 5. Profil studenta

Admin panel

Administratori uz pomoć admin panela upravljaju ePortfoliom, vrše kontrolu registrovanih profila kao i sadržaja koji studenti nakon verifikacije postavljaju na svoje profile. Profesori takođe imaju svoje mentorske profile preko kojih mogu da provere, odobre ili odbiju sadržaj koji student želi da postavi na svoj profil. Nakon što student ažurira svoj studentski ePortfolio profil

i označi odgovarajućeg mentora za novi projekat koji je dodao, profesoru koji je označen kao mentor stiže obaveštenje na email da je postavljen novi projekat iz njegovog predmeta sa imenom i prezimenom studenta i nazivom projekta.

4. PREDNOSTI I MANE EPORTFOLIA

Prednosti

Kao prva prednost izdvaja se mogućnost povezivanja sa lokalnim IT kompanijama koje zapošljavaju IT stručnjake. ePortfolio i jeste platforma koja ima za cilj da što preciznije prikaže stručne sposobnosti posetiocima platforme koji su najčešće poslodavci. Pomoću ePortfolio platforme pruža se mogućnost za osnivanje saradnje sa lokalnim IT kompanijama, takođe kompanije u vidu saradnje mogu da ponude studentima zaposlenje, mogućnost stipendiranja u toku studija i obavljanje stručne prakse. ePortfolio platforma sadrži samo profile najboljih studenata i to poslodavci znaju.

Ostvarivanje saradnje sa lokalnim IT kompanijama pomoću ePortfolio platforme pomaže i prilikom usmeravanja studenata u pravom smeru za tržište rada. IT kompanije na taj način pomažu Univerzitetima da grade silabuse za predmete u koraku sa tehnologijom i prema zahtevima tržišta.

Za IT stručnjake danas važe drugačija pravila kada je u pitanju praksa. Obično studenti završe fakultet i nakon toga apliciraju za obavljanje prakse u raznim kompanijama. Kod IT struke princip je danas drugačiji baš zbog mogućnosti izrade raznih projekata u toku studija, gde student stiče odgovarajuće znanje i obavlja praksu. Od studenta se očekuje da ima odgovarajuće predznanje i dobru podlogu pre nego što počne da radi.

Jedna od značajnijih prednosti jeste povećana vidljivost studentskog CV-a na internetu. Student u kombinaciji sa LinkedIn profilom i studentskim ePortfolio profilom pokriva sve informacije koje su interesantne i važne za HR menadžere. Na ovaj način pomaže studentima jer se šanse da neko prepozna njihov trud i stupi u kontakt sa njima znatno povećavaju, dok sa druge strane olakšava se posao HR menadžerima jer su im svi studenti i sve informacije dostupne kroz par klikova.

ePortfolio pruža motivaciju studentima za rad u grupama, napredak i razmenu ideja. Studenti mogu da izaberu kompleksnije projekte ukoliko se podele u grupe. Studentu je jasno da mnogo više može da postigne radom u grupi nego kao pojedinac. ePortfolio platforma služi kao dokaz i spisak svih projekata koji su uspešno realizovani, zbog toga platforma motiviše studente da praktikuju timski rad i da imaju takmičarski duh. Prednost za studente jeste što se ovakav pristup primenjuje i u kompanijama.

Svi projekti dostupni na studentskim ePortfolio profilima su potpuno besplatni i dostupni svima. Na ovaj način ostvaruju se razni doprinosi u različitim oblastima.

ePortfolio platforma Univerziteta Sinergija uključuje SEO (engl. Search Engine Optimization). Platforma ima minimalni dizajn i napravljena je da bude jednostavna bez viška elemenata što je čini pogodnom za SEO optimizaciju. SEO znatno doprinosti ePortfoliu tako što omogućava da platforma bude dobro optimizovana za bolje pozicioniranje na web pretraživačima čime se dodatno povećava vidljivost studentskih ePortfolio profila.

Takođe kao prednost ePortfolio platforme izdvaja se pomoć prilikom opredeljenja studenata za određene oblasti. Cilj ePortfolia jeste da dokumentuje iskustvo studenta koje je stekao u toku svog školovanja. Studenti obično imaju dilemu, šta je to što ih najviše privlači i čime bi tačno hteli da se bave? U ovom cilju studentima pomažu mentori ali upotrebom ePortfolio platforme stvara se mogućnost da studenti kroz kontinualno ažuriranje svojih profila grade sliku o sebi i podstaknuti su da istražuju, pronađu i odluče koja ih oblast najviše zanima. Pored toga platforma pomaže i mentorima da lakše prepoznaju talenat i pravilno usmere studenta.

ePortfolio omogućava skladištenje projekata na jedno mesto. Ovakav način se pokazao kao dobra praksa zato što studenti vode evidenciju o svojim radovima i projektima. Sve najvažnije materijale imaju dostupne na jednom mestu i ukoliko je potrebno nekome da pokažu, sve to mogu da urade dosta brzo. Ovo je takođe važno za izgradnju IT karijere studenta, jer kasnije studenti mogu koristiti svoj profil za inspiraciju, nadogradnju starih projekata i razvoj novih ideja.

Po čemu se ePortfolio razlikuje od CV-a (engl. Curriculum Vitae)? ePortfolio Univerziteta Sinergija je usmeren ka studentu i generalno ePortfolio obično predstavlja talente koje čovek poseduje. Može da sadrži razne projekte, uzorke, slike itd. ePortfolio je kolekcija uzoraka radnih aktivnosti koje drugi ljudi poput HR menadžera mogu da testiraju.

Dok je CV generalno korišten kada je potrebno sumirati sva iskustva i veštine iz prethodnih godina. Obično se sve navodi u stavkama maksimalno dužine jednog ili dva lista. Suštinska razlika je u tome da se obično

unutar CV-a postavlja link koji vodi ka ePortfoliu u kome se onda precizno mogu videti i testirati radne aktivnosti. Ova spona između CV-a i ePortfolia povećava šanse da kandidat dobije odgovarajući posao za koji je aplicirao.

Mane

Studentski ePortfolio profil često može da sadrži projekte gde su korištene različite verzije softvera zbog čega može da dođe do konflikta prilikom instalacije i pokretanja softvera, ukoliko se verzije ne poklapaju sa verzijama koje su korištene u projektu. Određeni projekti zauzimaju mnogo memorije i zahtevaju dodatne module za instalaciju kako bi ispravno radili što zna da bude komplikovano.

ePortfolio nije namenjen da se koristi bez upotrebe računara u toku razgovora za posao. Bez računara nije moguće testirati projekte osim u slučaju kada student ima projekte dostupne i na nekoj internet lokaciji. U sklopu studentskog ePortfolio profila postoji opcija gde student može da na svoj profil postavi i internet lokaciju projekta kada dodaje novi projekat.

Ukoliko student odgovarajuće radove nema u elektronskoj formi potrebno je da skenira sve radove i da ih pripremi u formatu koji je odgovarajući za ePortfolio.

ePortfolio treba da prezentuje kompletnu i preciznu sliku svih radnih aktivnosti i veština koje je student ostvario. Iz tog razloga potrebno je da mentori i studenti izdvoje određeno vreme kako bi profil izgledao profesionalno.

U određenim situacijama ePortfolio studentski profil se može tretirati kao manje vredan izvor u odnosu na ocene studenata.

Takođe kao mana izdvaja se da ukoliko ePortfolio profil nije dobro isplaniran i usmeren, ukoliko nije jasno definisan cilj i kriterijum, ePortfolio profil može da ostavi utisak kao kolekcija nagomilanih projekata koji ne pokazuju tragove napredovanja i dostignuća. ePortfolio sam po sebi može da sadrži mnogo različitih podataka koje je teško grupisati radi analize koja bi prikazala napredak.

5. ZAKLJUČAK

Studentska platforma – ePortfolio pokazala se kao kvalitetno rešenje za više različitih problema. ePortfolio pruža motivaciju studentima da zadrže kontinuitet učenja i napredovanja, da studenti budu odgovorni i posvete pažnju razvoju svoje karijere i omogućava studentima da razvijaju svoje digitalne kompetencije uz stručnu pomoć mentora.

ePortfolio pored svih prednosti koje pruža studentima, omogućava i prednosti za profesore, poslodavce i roditelje. Platforma Studentima pomaže da digitalizuju svoje radne aktivnosti i trud koji su uložili u toku školovanja čime se znatno povećava njihova vidljivost na internetu kao i šanse za zaposlenje. Profesorima ePortfolio platforma pomaže prilikom procene talenata, prednosti i mana kod studenata i budućeg usmerenja za studente koji su pod njihovim mentorstvom. Poslodavcima platforma olakšava posao tako što izdvaja sve najbitnije informacije za poslodavce i grupiše ih na jedno mesto tako da su jasno vidljive i lako dostupne. Roditeljima ePortfolio platforma omogućava da prate tok studiranja i napredovanja njihovog deteta, kao i za koje stručne oblasti se dete interesuje.

Studentska platforma ePortfolio pruža mnogo više prednosti nego što ima mana.

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PREGLED PRIMENA VIRTUELNIH OKRUŽENJA U OBRAZOVANJU

Tamara Živković[1],
Miodrag Živković[2,] *

[1]School of Electrical Engineering,
University of Belgrade,
Belgrade, Serbia
[2]Singidunum University,
Belgrade, Serbia

Rezime:
Sa razvojem tehnologije rapidno se menja svet oko nas, pa i obrazovanje. Virtuelna stvarnost igra u tome veliku ulogu i menja budućnost učenja i sliku obrazovanja na koju smo navikli. Obrazovne institucije okreću se novim metodama podučavanja koje se ne oslanjaju samo na predavanja, već pomoću virtuelne stvarnosti kreiraju multidisciplinarna obrazovna iskustva koja će olakšati budući razvoj multidisciplinarnih karijera. Virtuelna stvarnost omogućava dostupnost znanja svuda i naglašava važnost studentskog iskustva. Studenti mogu biti uključeni u scenarija u virtuelnom okruženju koja će ih pripremiti za probleme na koje će nailaziti kasnije tokom svoje profesionalne karijere. Komplikovane koncepte je lakše objasniti pomoću demonstracije nego putem intenzivnih predavanja i to je ono što virtuelna stvarnost omogućava. Cilj ovog rada je prikaz trenutnih primena virtuelnih okruženja u obrazovanju.

Ključne reči:
virtuelna stvarnost, obrazovanje, imerzija, interaktivnost.

1. UVOD

Virtuelna stvarnost predstavlja trodimenzionalno, računarski generisano okruženje koje korisnik može da istražuje, a koje omogućava i interakciju. Na taj način korisnik postaje deo tog okruženja i omogućen mu je osećaj imerzije – dok boravi u virtuelnom svetu može da manipuliše objektima u njemu i da sprovodi niz različitih akcija.

Postoje različiti tipovi virtuelnih okruženja, ali svi oni dele iste karakteristike:

1. Korisnik vidi trodimenzionalne slike objekata koji izgledaju kao u realnom svetu;
2. Okruženje se menja u odnosu na pokrete korisnika i izmenama njegovog vidnog polja – cilj je da se postigne neprimetno usaglašavanje pokreta glave i očiju korisnika sa odgovorom sistema, što obezbeđuje realističnost virtuelnom iskustvu i ostavlja dobar utisak na korisnika;
3. Virtuelno okruženje treba da obezbedi odgovarajuće odzive u realnom vremenu. Problemi se javljaju kada postoji kašnjenje

Odgovorno lice:
Miodrag Živković

e-pošta:
mzivkovic@singidunum.ac.rs

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između akcija korisnika i odziva sistema koje ometa korisničko iskustvo. Korisnik postaje svestan da se nalazi u veštačkom okruženju i tako se gubi osećaj imerzije i interaktivnost. Cilj je da se obezbedi prirodan, neometan tok interakcije sa virtuelnim okruženjem.

Rad na daljinu sve je zastupljeniji, pa je vremenska i prostorna nezavisnost sve bitnija i na svim nivoima obrazovanja. Virtuelna stvarnost omogućava učenje na daljinu i pruža studentima mogućnost da se obrazuju nezavisno od vremenske zone i lokacije na kojoj se nalaze. Virtuelna stvarnost ima još jednu prednost – može da omogući studentima da prelaze gradivo tempom koji im najviše odgovara i usmerava fokus na samo gradivo, a ne samo na ispite i ocene. Takođe, moguće je kroz različite scenarije konstantno ocenjivati performanse studenata u toku kurseva, bez potrebe za kumulativnim ispitima, što vodi ka boljem razumevanju gradiva i dužem pamćenju bitnih informacija.

Cilj ovog rada je prikaz trenutnih primena virtuelnih okruženja u obrazovanju. Nastavak rada je organizovan na sledeći način: u prvom poglavlju dat je osvrt na samu tehnologiju i osnovne pojmove vezane za virtuelnu stvarnost, dok se drugo poglavlje bavi postojećim nastavnim metodama. Treće poglavlje daje pregled odabranih primera već postojećih primena virtuelne stvarnosti u obrazovanju. Zaključak je dat u četvrtom poglavlju.

2. VIRTUELNA STVARNOST

Virtuelnu stvarnost najbolje možemo shvatiti ako razumemo šta znači potpuna imerzija. Potpuna imerzija označava tako stvarno čulno iskustvo da ne možemo razlikovati stvaran od virtuelnog sveta. Ipak, ovo ne znači da virtuelni svet mora u potpunosti imitirati stvaran svet i pravila koja u njemu važe – ona može predstaviti svet u kom zakoni fizike ne važe (npr. video igre sa mestom dešavanja na udaljenim planetama bez gravitacije).

Elementi virtuelne stvarnosti

Postoje četiri elementa virtuelne stvarnosti:

1. Virtuelni svet – trodimenzionalno okruženje kom se najčešće pristupa putem medijuma, gde korisnik može da ima interakciju sa drugim korisnicima ili da kreira objekte u okviru takve interakcije. U virtuelnom svetu, vizuelna perspektiva se menja sa pokretima korisnika, a interakcije sa objektima i korisnicima imitiraju one u stvarnom svetu.
2. Imerzija – percepcija korisnika da je fizički prisutan u virtuelnom svetu. Stanje potpune imerzije postoji kada je aktivirano dovoljno čula da kreiraju osećaj prisutnosti u virtuelnom svetu.
3. Senzorski odgovor – virtuelna stvarnost zahteva da što više korisnikovih čula bude aktivirano, što uključuje čulo vida, sluha, dodira, a kod novijih sistema čak i čula mirisa i ukusa. Aktiviranje ovih čula zahteva odgovarajući senzorski odgovor samog sistema, što se postiže pomoću ulaznih uređaja kao što su headset-ovi, specijalne rukavice i ručni upravljači.
4. Interaktivnost – ključni element za virtuelno iskustvo. Ukoliko virtuelno okruženje odgovara na korisničke akcije na prirodan način, osećaj imerzije će biti neometan, ali ukoliko okruženje ne može da odgovori na akciju korisnika dovoljno brzo, osećaj imerzije će nestati. Virtuelno okruženje odgovara na akciju korisnika prateći njegovo kretanje i pokrete glave (promene vidnog polja). [1]

Tipovi sistema virtuelne stvarnosti

Postoji nekoliko tipova tehnologije virtuelne stvarnosti u zavisnosti od stepena imerzije koji pružaju korisniku:

1. Neimerzivni sistemi virtuelne stvarnosti – pružaju najslabiji osećaj imerzije jer je samo deo korisnikovih čula stimulisan, dozvoljavajući korisniku da bude svestan realnog sveta izvan simulacije. Korisnici ulaze u trodimenzionalna virtuelna okruženja kroz portal ili prozor koristeći standardne ekrane visoke rezolucije.
2. Polu-imerzivni sistemi virtuelne stvarnosti – pružaju više imerzije od neimerzivnih i u njima je korisnik delimično uključen u virtuelno okruženje. Polu-imerzivne simulacije koriste tehnologije slične onima koje srećemo u simulacijama letova (npr. u obukama za pilote). U ovim sistemima simulacije su obezbeđene pomoću grafičkih sistema visokih performansi koji su vrlo često uparene sa velikim sistemima projektora kako bi korisnikovo čulo vida bilo stimulisano na odgovarajući način.
3. Potpuno imerzivni sistemi – pružaju korisniku potpunu imerziju u virtuelno okruženje. Kod ovih sistema se koriste HMD uređaji (eng. head mounted display, uređaji sa ekranom predvišeni

za nošenje na glavi) i uređaji za detekciju pokreta kako bi sva korisnikova čula bila stimulisana. Ovakve simulacije pružaju veoma realistična iskustva, pri čemu koriste visoke rezolucije, često osvežavanje slike i visoke nivoe kontrasta u HMD uređajima. [2]



Slika 1. Potpuno imerzivni VR sistem

3. METODE NASTAVE I ZNAČAJ PRIMENE VIRTUELNE STVARNOSTI U OBRAZOVANJU

U današnje vreme susrećemo se sa dva koncepta nastave:

1. Tradicionalna nastava – koncipirana je u obliku časova iz različitih predmeta, gde nastavnik/profesor vodi nastavni proces, a učenici/studenti se nalaze u ulozi slušaoca i primaoca informacija. Prenose se znanje i veštine, nastavne metode su informacione i reproduktivne, a glavni cilj ovakvog vida nastave je pamćenje gradiva i njegovo reprodukovanje bez korišćenja bilo kakve pomoćne literature, što dovodi do pasivnosti i nezainteresovanosti učenika/studenata kao i do usvajanja znanja napamet, bez upotrebne vrednosti.
2. Inovaciona/razvijajuća nastava – podstiče aktivnost i razvoj mišljenja učenika/studenata u cilju sticanja upotrebljivih znanja i veština. Ovakav pristup omogućava posmatranje, istraživanje i eksperimentisanje uz vođstvo nastavnog osoblja, kao i samostalno ili delimično vođeno učenje putem rešavanja problema. Korišćenje ovakvih metoda povećava motivaciju i zainteresovanost učenika/studenata, ali i nastavnika jer je potreban konstantan rad na usavršavanju i primeni novih nastavnih metoda.

Tradicionalna nastava ne može da isprati potrebe učenika/studenata savremenog doba gde tehnologija napreduje i menja se iz dana u dan. Mogućnosti za poboljšanje nastave nalaze se u primeni metoda učenja putem istraživanja i metoda učenja pomoću rešavanja problema.

Učenje putem istraživanja uvodi učenike u „svet otkrića“ kroz izvođenje eksperimenata u okviru sopstvenih istraživačkih projekata. Ovaj metod pobuđuje radoznalost kod učenika, podstiče moć zapažanja, kritičkog razmišljanja i primenu već stečenih znanja.

Učenje putem rešavanja problema je metod gde nastavno osoblje postupno uvodi učenika/studenta u proces otkrivanja rešenja različitih problema. Nastavnik postavlja problem, upravlja radom učenika i podržava ga u samostalnoj analizi problema, dok učenik sa druge strane angažuje svoja prethodno usvojena i stečena znanja. Ovaj metod je pogodan za sve učenike/studente, bilo odlične, bilo one slabije, a najširu primenu ima u nastavi prirodnih i tehničkih nauka. [3]

Virtuelna stvarnost primenjena u obrazovanju upravo omogućava implementaciju oba spomenuta metoda u nastavnoj praksi.

Prednosti i mane primene virtuelne stvarnosti u sektoru obrazovanja

Tehnologija virtuelne stvarnosti ima potencijal da studente učini posvećenijim i motivisanijim i otvara nove horizonte u učenju i podučavanju. Još uvek ne postoji sasvim jasna ideja kako trajno integrisati ovu tehnologiju u obrazovne procese na stabilan način. U tradicionalnim obrazovnim ustanovama javlja se otpor prema ovakvim inovacijama, a i troškovi implementacije i održavanja nisu zanemarljivi. Ipak, sve brži razvoj mobilnih uređaja čini upotrebu virtuelne stvarnosti u obrazovanju sve dostupnijom. Postoje četiri glavne prednosti korišćenja virtuelne stvarnosti u obrazovanju:

1. Virtuelne tehnologije povećavaju motivaciju studenata. Oni se osećaju kao učesnici jer im je pruženo imerzivno iskustvo i to u dopadljivom okruženju koje ih podseća na video igre, a proučavanje 3D modela poboljšava im iskustvo učenja.

2. Virtuelne tehnologije omogućavaju kreativan pristup učenju. Studenti imaju interakciju sa virtuelnim objektima i sa drugim studentima. Kao rezultat, studenti mogu da istražuju, eksperimentišu i dobijaju povratne informacije što poboljšava njihovo učenje.
3. Virtuelna stvarnost je sada sve dostupnija i pristupačnija. Kompleksni uređaji više nisu neophodni, a studenti mogu da pristupe virtuelnim sadržajima i putem svima dostupnih online platformi kao što je YouTube. Studenti sa invaliditetom ili sa teškoćama u učenju imaju lakši pristup virtuelnim okruženjima i mogu da uče pomoću virtuelnih objekata i drugih studenata.
4. Virtuelna stvarnost omogućava potpunu interakciju sa konceptima, objektima i procesima (za razliku od uobičajenih materijala za učenje) pomoću headset-ova, rukavica i senzora pokreta. Imerzija dozvoljava eksperimentisanje sa objektima i okruženjima koji inače ne bi bili dostupni.

Ipak, kako se ova vrsta tehnologije i dalje razvija, njena primena u obrazovanju nosi sa sobom i određena ograničenja:

1. Cena virtuelnih sistema i energetski zahtevi neophodni za njihov rad mogu biti prepreka u primeni u školama, naročito u manje bogatim državama [4];
2. Prezasićenost studenata mnogobrojnim sadržajima u okviru virtuelnog sveta, može dovesti do pada koncentracije. Takođe, edukatorima može biti teško da procene da li studenti zaista uče ili se samo zabavljaju, pošto ponašanje avatara u virtuelnom svetu ne mora biti dovoljno verno realnom svetu [5];
3. Prekomerna upotreba može dovesti do međusobne otuđenosti studenata kao i do nedostatka interakcije sa stvarnim svetom;
4. Uključivanje u nastavni program može biti komplikovan i dugotrajan proces, pošto mnogi članovi nastavnog osoblja nisu naviknuti na korišćenje najnovijih tehnologija, za razliku od novih generacija studenata koji se od rođenja susreću sa istim [6];
5. Zamor očiju i osećaj mučnine nakon dugotrajne upotrebe uređaja za virtuelnu stvarnost.

4. VIRTUELNA STVARNOST I OBRAZOVANJE – PREGLED PO OBLASTIMA PRIMENE

Virtuelna stvarnost koristi se širom sveta u osnovnim i srednjim školama, na fakultetima, u kompanijama i ustanovama kao okruženje za profesionalne obuke, kao i za virtuelne ture po muzejima i pozorištima [7]. Najčešće oblasti primene su prirodne i tehničke nauke, medicina, humanističke nauke, učenje stranih jezika, učenje na daljinu i vojne obuke. Kako ovakvih primena ima svakim danom sve više, nemoguće ih je sve obuhvatiti i opisati, pa ćemo izdvojiti samo najinteresantnije.

Virtuelne ture i PlayVR (edukacioni VR sistem za istraživanje sveta pozorišta)

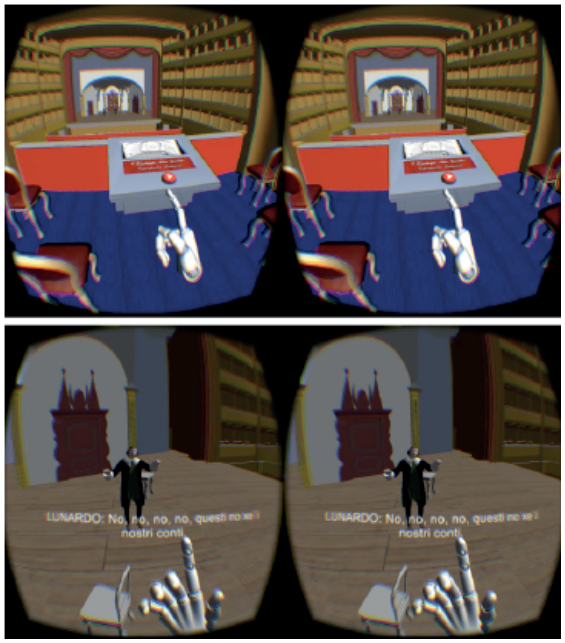
Virtuelne ture su jedna od najpopularnijih primena tehnologije virtuelne stvarnosti u učenju i mnoge škole su počele da ih koriste na taj način omogućavajući svojim učenicima pristup delovima sveta koji bi im inače bili van domašaja.

Aplikacija Google Expedition [8] je besplatna za download na mobilne uređaje i koristi se zajedno sa headsetom na koji se može pričvrstiti mobilni telefon, tako da učenici mogu aktivno istraživati turističke atrakcije, svemir ili pak podvodni svet. Neke škole pomoću VR tehnologije već nekoliko godina vode učenike na virtuelne ekskurzije i posete muzejima [9] kao i u obilaske Sunčevog sistema [10]. Univerzitet u Mičigenu, na primer, omogućava budućim studentima virtuelni obilazak stadiona u okviru svog sportskog programa. [11]

PlayVR je sistem osmišljen za edukaciju u oblasti pozorišta na venecijanskom Ca'Foscari Univerzitetu, koji omogućava korisnicima da dožive atmosferu u jednom od najpoznatijih italijanskih pozorišta La Fenice. Korisnici sistema mogu da uživaju u pozorišnim scenografijama slušajući muziku iz predstavljenih dela, da dobijaju audio uputstva i informacije o odabranim delovima pozorišta kao i da učestvuju u delovima pojedinih predstava.

PlayVR koristi headset Oculus Rift koji je povezan sa računarom jakih grafičkih mogućnosti. Pokreti glave korisnika detektuju se pomoću senzora na samom headset-u, dok se kroz dodatni Leap Motion senzor zakačen na headset prate pokreti ruku korisnika. Reprezentacija virtuelnog sveta omogućena je korišćenjem Unity3D, a vizualizacija ruku i prepoznavanje pokreta omogućena je korišćenjem Leap Motion i Hovercast UI Kit

biblioteka. [12] Mapiranje pokreta korisnika u realnom svetu sa pokretima u virtuelnom okuženju ključno je za uspeh jednog VR sistema. Gestovi koji su podrazumevani i ne moraju da se uče iskorišćeni su u PlayVR sistemu gde god je bilo moguće jer to poboljšava osećaj imerzije kod korisnika (npr. pokret pomeranja zavese kako bi se promenila scenografija ili pritisak dugmeta koji aktivira scenu iz predstave). Kretanje u okviru glavnih lokacija u pozorištu omogućeno je putem teleportovanja korisnika na željenu lokaciju, a korišćenjem Hovercast UI Kit-a urađeno je mapiranje raspoloživih destinacija sa prstima leve ruke korisnika, dok se selektovanje destinacija obavlja kažiprstom desne ruke.



Slika 2. Prikaz Play VR okruženja

Pokreti glave u virtuelnom okruženju direktno su mapirani sa pokretima u stvarnom svetu. Na mestima gde sistem to nije omogućavao (zbog položaja Leap Motion senzora na headsetu i raspoloživosti biblioteka za prepoznavanje pokreta), mapiranje je izvršeno na osnovu istraživanja korisničkih preferencija. Istraživanje je izvršeno na uzorku od 30 studenata, pa je na osnovu njega i tehničkih mogućnosti, akcija kretanja napred mapirana sa gestom pokazivanja prstom napred, a akcija okretanja nazad mapirana je sa pokazivanjem pravca palcem levo ili desno. [13]



Slika 3. Prikaz laboratorije sa Play VR okruženjem

Dve studije su sprovedene kako bi se ispitala uključenost i interesovanje korisnika za različite tipove aktivnosti u okviru PlayVR sistema, kao i njihov osećaj imerzije u samom sistemu. Korisnicima se dopalo da budu deo virtuelnog sveta i ocenili su svoje iskustvo kao jako pozitivno, iako je bilo pojedinih žalbi na estetiku i tehničke mogućnosti pojedinih elemenata (npr. preciznost raspoznavanja pokreta ruke). Navigacija u okviru 3D okruženja je takođe veoma visoko ocenjena, ali najviše ocene su dobile inovativne aktivnosti kao što je samostalno biranje scenografije i mogućnost učestovanja u delovima predstava. Sveukupan zaključak sprovedenih studija je da je PlayVR sistem sa velikim potencijalom da se razvije u ozbiljan alat za virtuelno upoznavanje sa svetom pozorišta. [14]

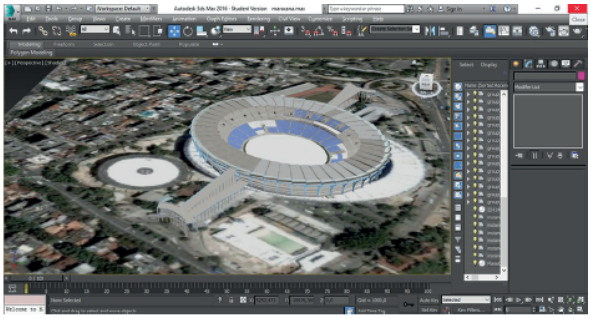
VR sistemi za kolaboraciju sa primenom u bezbednosnim obukama

VR sistem napravljen u Brazilu sadrži model Marakana stadiona i njegovog okruženja, pošto se na tom mestu odvijaju sportski događaji i koncerti, pa je primer adekvatan za obuku agenata koji će sprovoditi sigurnosne mere i na ovom i na drugim stadionima. Predloženi scenariji su kreirani na osnovu intervjua sprovedenih sa agentima koji su radili na Svetskom prvenstvu u fudbalu FIFA 2014. i na Olimpijskim igrama u Riju 2016. godine.

Razvoj virtuelnog okruženja za saradnju obuhvata razvoj različitih komponenti, kao što su: scenario, objekti, avatari, animacije, tekst, video i zvuk. Neophodno je obezbediti i brzo ažuriranje scena (sa garancijom da se ista scena prikazuje svakom od korisnika), korisničko

viđenje avatara (u prvom ili trećem licu), korišćenje poznatih prečica u okruženju, korišćenje miša za pokrete i akcije, kao i korišćenje džojstika i komunikaciju u realnom vremenu. Ovakav pristup obezbeđuje razvoj virtuelnog okruženja za saradnju gde agenti mogu biti trenirani i gde mogu usavršavati svoje veštine. Virtuelno okruženje koje predstavlja fudbalski stadion Marakana jeste jedno takvo okruženje.

Modelovanje stadiona Marakana i njegovog neposrednog okruženja rađeno je pomoću softvera Autodesk 3D Max. Proces je započet dodavanjem topografskog snimka terena koji služi kao referenca za model. Dodatno su definisane teksture i boje, kako bi se obezbedio što verniji model stadiona, kao što je prikazano na slici 4.



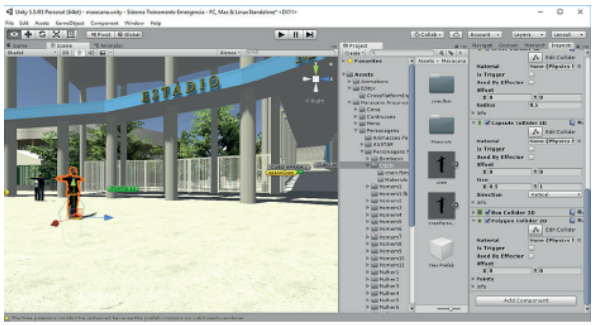
Slika 4. Prikaz Marakana stadiona 3D Max – završni korak

Unity 3D korišćen je za modelovanje terena na Marakani. Kada je modelovanje završeno, tekstura i modifikacije okruženja stadiona su dodate, a potom su ti objekti iz 3D Max ubačeni u virtuelno okruženje u Unity 3D-u. Za interakciju korisnika i okruženja korišćeni su avatari. U ovom okruženju, osim generičkih avatara koji predstavljaju publiku, postoje još i avatari koji predstavljaju agente bezbednosti i osumnjičene. U zavisnosti od implementacije ovi avatari mogu da se ponašaju na različite načine – mogu da predstavljaju vatrogasce, policajce ili CNEN agente (agente zadužene za situacije koji uključuju radioaktivne supstance). Slike 5 i 6 predstavljaju modelovanje avatara u 3D Max i avatara ubačenog u Unity 3D nakon modelovanja, respektivno.

Animacije za hod, trčanje i skakanje su ubačene u sistem, kao i akcije neophodne za trening agenata. Automatski avatari koji predstavljaju publiku generisani su pomoću algoritama zasnovanih na veštačkoj inteligenciji i simuliraju gledaoce koji se kreću ka unutrašnjosti stadiona. Brzina kretanja ovih avatara prilagođava se stvarnoj uobičajenoj brzini kretanja posetilaca na realnom stadionu.



Slika 5. Izgenerisan avatar u 3D Max



Slika 6. Avatar ubačen u Unity 3D

Tokom simulacije, korisnik može da generiše avatare koji predstavljaju osumnjičene pritiskom na taster F2. Svaki put kada se ova komanda izvrši, kreira se novi osumnjičeni. Ovaj mod je veoma koristan za individualni trening. Postoje i avatari osumnjičenih kreirani od strane sistema, što obezbeđuje realnije iskustvo za korisnike aplikacije.

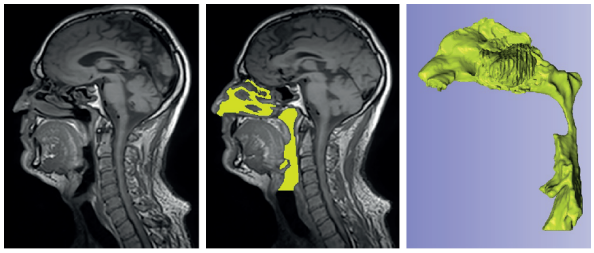
Nakon testova različitih scenarija, procenjeno je da je okruženje uspelo da pruži adekvatan prikaz trening scenarija, sa velikim stepenom interaktivnosti i imerzije. U ovakvom okruženju, agenti su pomoću avatara, mogli da donose odluke i da razvijaju saradnju, što je donelo dodatnu vrednost ovakvom vidu obuke. Sve ovo čini ovo okruženje pogodnim alatom za razvoj novih sistema obuke agenata, a proširivo je i na druge situacije i trening procedure. [15]

VR sistemi u medicini

Jedna od značajnijih i interesantnijih primena VR u oblasti obrazovanja je svakako primena u medicini. Učenje anatomije jedan je od aspekata gde se VR dosta koristi, pa je u ovom radu odabrano rešenje sa Tehnološkog

Univerziteta u Oklandu, Novi Zeland. Oni su pomoću VR tehnologije napravili model ljudske nosne šupljine i simulirali su tok vazduha kroz nju. Nosna šupljina je izabrana jer je njena prirodna veličina samo nekoliko centimetara, a za učenje se koriste knjige ili plastični modeli. U VR rešenju, ona je uvećana čak 15 puta, omogućavajući studentima da je proučavaju na mnogo efikasniji način. [16]

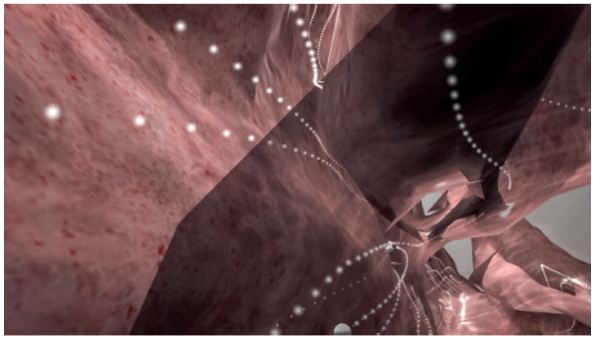
Model nosne šupljine napravljen je pomoću snimaka magnetne rezonance jednog od glavnih istraživača na ovom projektu. Segmentacija snimka izvršena je u softveru ScanIP i označene su funkcionalne zone ljudske nosne šupljine. Krajnji rezultat je 3D model prikazan na slici 7.



Slika 7. Snimak nosne šupljine korišćenjem magnetne rezonance; Segmentirana nosna šupljina; 3D model nosne šupljine

Model nosne šupljine ubačen je u softver SolidWorks u kom je pomoću simulacije fluida dobijen model toka vazduha. Simulacija je urađena za potpun tok disanja, sa udisajem od 2 sekunde i izdisajem od 4 sekunde, na osnovu čega su dobijene 3D putanje vazdušnih čestica u nosnoj šupljini za oba ova procesa. Ovi podaci su ubačeni u VR okruženje zajedno sa 3D modelom nosne šupljine. Virtuelno okruženje dobijeno je korišćenjem Unity3D endžina. 3D model nosne šupljine uvećan je oko 15 puta, tako da je nosna šupljina mogla biti istraživana u prostoru veličine 4mx4m, pomoću HTC Vive uređaja. U alatu za 3D editovanje Blender, dodata je adekvatna tekstura i detalji kako bi prostorno snalaženje i orijentacija bili što lakši.

Dodat je i sken lica osobe čija je nosna šupljina prikazana kako bi se stekao utisak o proporcijama i poziciji šupljine. Ručne kontrole su integrisane u 3D scenu kako bi se omogućila interakcija. Pritiskom na dugme kontrolera, laserski pokazivač se aktivira i korisnik može da pokazuje na određene zone u 3D modelu koje su potom označene i obeležene od strane sistema. U okruženje je dodat i zvuk koji označava udisaj i izdisaj. Dobijen je tako što su zvukovi disanja snimljeni, podeljeni na dve faze, a zatim pušteni usporeni 25% u odnosu na originalnu brzinu tako da se uklapaju u dužinu simulacije toka vazdušnih čestica u šupljini.



Slika 8. Model nosne šupljine

Jedna od evaluacija sistema je izvedena kroz projekat pravljenja 3D modela nosnog stenta na završnoj godini studija. Uvođenjem u model nosne šupljine u 3D, lako su razvili ideje potrebne za dizajn nazalnog stenta. Simulacija deformacije tkiva ubacivanjem stenta nije trenutno dostupna u aplikaciji, ali bi ova opcija mogla biti dodata, pošto Unity 3D to dozvoljava. Kao problemi su navedeni praćenje snimka na projektoru kada predavač koristi HTC Vive u slučaju naglih pokreta glave i problem jasnog razlikovanja unutrašnjosti i spoljašnjosti nosne šupljine u slučaju kada se student nalazi unutar virtuelnog okruženja.

Uporedni prikaz opisanih rešenja

Opisana rešenja je teško uporediti po oblasti primene, ali ona ipak imaju neke zajedničke karakteristike. Rešenja *PlayVR* i Nasal Cavity su potpuno imerzivna, dok je rešenje Security Training poluimerzivno (koriste se avatari). Prilikom procene ovih virtuelnih okruženja od strane korisnika, kod svih je zajedničko da su uključenost i interesovanje korisnika veoma veliki, najviše zbog inovativnog pristupa temi koja se obrađuje u samom rešenju. Korisnički interfejs je jednostavan za korišćenje kod svih rešenja uz manje nedostatke, mada oni nisu značajno uticali na stepen zadovoljstva korisnika virtuelnim okruženjem. Navigacija se pokazala dobro u rešenju *PlayVR*, ali u rešenjima Security Training i Nasal Cavity je bilo prijavljenih nuspojava karakterističnih za virtuelna okruženja kao što su vrtoglavica, mučnina i nepostojanje mogućnosti neverbalne komunikacije.

Najnaprednijim se pokazalo rešenje Security Training, virtuelno okruženje za obuku agenata bezbednosti, jer osim visokih ocena pruža i mogućnost dodatnog proširenja na druge oblasti obrazovanja i tipove treninga. Na kraju, svako od opisanih rešenja nudi inovativan pristup obrazovanju u okviru oblasti za koju je dizajnirano.

5. ZAKLJUČAK

Tehnologija virtuelne stvarnosti je u prošlosti bila veoma skupa i ograničena na oblasti kao što su istraživanja svemira ili nuklearna istraživanja. Danas, međutim, VR tehnologija je postala dostupnija zahvaljujući sve većem razvoju mobilnih uređaja nove generacije i pristupu virtuelnim sadržajima putem Interneta i društvenih mreža.

Očekuje se da će u narednim decenijama virtuelna stvarnost izvršiti revoluciju u komunikaciji na isti način kao što su to učinili pametni telefoni i razvoj Interneta. Jeftini headset-ovi neće biti luksuz, već uobičajen dodatak mobilnim uređajima, što će omogućiti sve većoj populaciji da doživi imerzivna iskustva. Stoga, ima smisla da se ovakve tehnologije što više iskoriste i u obrazovanju.

U odabranim rešenjima opisanim u ovom radu primećeno je da činjenica da korisnici učestvuju u nečem inovativnom i interaktivnom, što se razlikuje od tradicionalnog metoda prenošenja znanja, dovodi do toga da se gradivo savladava brže, interesovanja i diskusije na temu su obimniji, dok se nedostaci primećeni u virtuelnim okruženjima gotovo zanemaruju. VR tehnologija će svakako značajno menjati način obrazovanja na koji smo navikli i proširiće nam vidike na načine koje nismo ni slutili. Ipak, svuda treba pronaći zlatnu sredinu. Stvarnost nije uvek idealna, ali da li će beg u virtuelna okruženja gde je sve moguće i koja ne želimo da napustimo postati naša svakodnevica, kao u Spilbergovom filmu „Ready Player One“, ostaje da se vidi.

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CILJEVI, STRUKTURA I ORGANIZACIJA DODATNIH AKTIVNOSTI IZ OBLASTI IKT U RAČUNARSKOJ GIMNAZIJI SMART

Marina Savić

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Postupak donošenja nastavnih planova za profile koji se školuju u srednjim školama karakterisan je rigidnošću i sporošću koja, posebno za profile orijentisane ka IKT industriji, uzrokuje visok stepen neusklađenosti nastavnih sadržaja sa konkretnim potrebama tržišta radne snage i konkretnim zahtevima za uspešan nastavak školovanja učenika.

Za uspešno sprovođenje nastavnog procesa u savremenim uslovima, neophodan je visok nivo kompetencija nastavnog kadra, kako onog čija je uža specijalnost IKT domen tako i onog kojima su uža specijalnost druge domenske oblasti.

U Računarskoj gimnaziji, osmišljavaju se i realizuju dodatne aktivnosti koje imaju za cilj da obezbede dopunu sadržaja iz redovnog nastavnog plana i programa, te da podignu nivo kompetencije nastavničkog kadra. Posebna pažnja se posvećuje osmišljavanju i realizaciji aktivnosti koje u ovaj proces uključuju učenike.

Ključne reči:
nastava, dodatne aktivnosti, sekcije, hakatoni.

1. UVOD

Savremena nastava podrazumeva upotrebu savremenih tehnologija uključujući upotrebu računara, interaktivnih tabli, projektora, elektronskih adresa, portala i elektronskog testiranja učenika ali se iz godine u godinu menja i sam način realizacije nastave.

Ukoliko je tip časa obrada, izbegava se da oblik rada bude frontalni osim u situacijama kada je to nužno neophodno a preporučuju se projektni rad i metode aktivnog rada (praktičan rad, radionica, debata, diskusija, igra uloga, brainstorming, demonstracije, igra...) uz odgovarajuća nastavna sredstva.

Razvojem informacionih tehnologija nastava je izložena veoma brzim i naglim promenama, pa je neophodno konstantno otkrivati nove trendove za nastavna sredstva i za materijale koji se koriste a u cilju podizanja kvaliteta realizacije nastave iako je sve teže predvideti buduće potrebe obrazovnog rada.

Kako bi sprovođenje nastave bilo što uspešnije, neophodan je visok nivo kompetencija nastavnog kadra (seminari, konferencije, stručna usavršavanja...), kao i efikasnijim nastavnim metodama.

Odgovorno lice:
Marina Savić

e-pošta:
marina.savic.14@singimail.rs

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Samo informisani, kompetentni i motivisani ljudi, spremni za razvoj, mogu biti otvoreni prema društvenim promenama. [1]

U tradicionalnoj nastavi učenici nisu dovoljno angažovani, pa se to negativno odražava na njihov dalji razvoj.

Kako bi se umanjile negativne posledice za razvoj učenika iznadprosečnih sposobnosti i postignuća u jednoj ili više oblasti nauke i tehnike, organizuju se dodatne aktivnosti u okviru nastave i vannastavnih oblika vaspitno-obrazovnog rada što znači da dodatna nastava služi kao korektiv frontalnog oblika nastave. [2]

2. NASTAVNI PROCES, KONAČNI CILJEVI I DIDAKTIČKE SMERNICE

Nastavnik treba da teži da prilagodi nastavu individualnim sposobnostima, zahtevima i potrebama učenika:

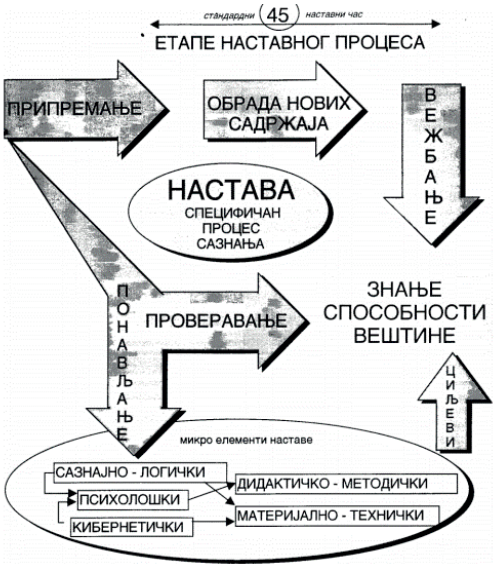
- Razlikovanje po individualnim mogućnostima, zahtevima i potrebama učenik· unutar njihove grupe
- Usvajanje gradiva pomoću primera,
- Obezbeđivanje kapaciteta za samostalno učenje i samostalno korišćenje znanja,
- Povezivanje teorijskog konceptualnog učenja i učenja kroz konkretne primere i eksperimentisanje. [3]

Didaktički sistemi savremene nastave su:

- heuristička,
- programirana,
- problemska,
- egzemplarna i
- mentorska nastava.

Upravo iz ovih razloga, za učenike koji pokazuju veću zainteresovanost ili talenat za računarsku grupu predmeta, organizuju se dodatne aktivnosti, na kojima se dublje obrađuju odgovarajuće nastavne teme i zadaci takmičarskog nivoa.

Termini su utvrđeni rasporedom časova, s tim što je učenicima omogućeno da dodatna uputstva dobiju i putem internog portala, mail-a ili telefonom. Sekcije su podeljene u nekoliko oblasti iako je to prvobitno bila jedna Računarska sekcija.



Slika 1. Etape nastavnog procesa [4]

Kako je primećeno da postoje učenici koji pokazuju veća interesovanja u oblasti programiranja ali i u oblasti grafičkog dizajna i sistem administracije, Računarska sekcija podelila se na sledeće:

- Programerska sekcija,
- Grafička sekcija,
- Hardverska sekcija,
- Hakaton sekcija.

Iako su uvedene i druge sekcije koje nisu iz oblasti IKT, u ovom radu biće opisan način realizacije sekcija koje su u direktnoj vezi sa računarskom grupom predmeta.

Dugogodišnjom analizom postojećih sistema ocenjivana i učenja, praćenjem pozitivnih primera u svetu, kao i zakonskim okvirima koje smo u obavezi da poštujemo, kreirali smo naš sistem SMART LEARNING SYSTEM – SLS primena metodologije logičkog zaključivanja kroz informatičku vizualizaciju i online reprodukciju znanja.

Osnovni ciljevi koje želimo da postignemo su:

- Objektivan sistem vrednovanja stečenog znanja,
- Stvaranje radnih navika i odgovornosti prema obavezama,
- Podsticanje na aktivan pristup nastavi,
- Sistem koji bi omogućio da se naši đaci lako uklope u svetske tokove obrazovanja,
- Primena savremenih tehnologija u službi bržeg i lakšeg trajnog usvajanja znanja.

Učenici se motivišu da samostalno uz primenu savremenih tehnologija istražuju, pripremaju prezentaciono odgovaranje, uz primenu konstantnih provera znanja koje su ujedno i ponavljanje gradiva.

Na ovaj način se kod učenika utvrđuje veza rada i rezultata i pospešuju radne navike, čime se utiče na stvaranje kvalitetnije i stabilnije ličnosti, a znanje učenika je eksplicitno potvrđeno. [5]

Kao jedan od primera dobre prakse je i gostovanje vlasnika IT firmi, koji redovno drže stručne seminare u dogovoru sa profesorom koji vodi sekciju. Tom prilikom prilikom naši učenici slušaju o samom dizajniranju aplikacije, povezivanju sa bazom, REST servisima, softverskoj arhitekturi, primerima iz prakse, izazovima i problemima sa kojima se suočavaju velike kompanije, a samim tim i softver arhitekte, programeri i dizajneri. Vršnjačka edukacija je takođe prisutna na svakoj sekciji.

Interesantna stvar je da sekciju ne vode isključivo nastavnici koji predaju određeni predmet i određenoj godini. Sekciju vode profesori za koje smo doneli odluku da imaju dovoljno energije, volje, želju ali i znanje da takvu sekciju vode kvalitetno i uspešno sa grupom učenika koji su iz prve, druge, treće i četvrte godine.

3. PROGRAMERSKA SEKCIJA

Ovu sekciju vodi profesor računarske grupe predmeta, koji ne predaje programske jezike niti modele i baze podataka, nego predaje operativne sisteme i računarske mreže kao i računarske sisteme. Iako se po nastavnom planu i programu u školi radi C# programski jezik, na programerskoj sekciji se koriste i PHP, Java, Python ali i HTML, CSS, JavaScript, jQuery, Ajax, Bootstrap i slično.

Zatim baze podataka poput MySql, Đango, frejmvorci Laravel, Flask, od razvojnih okruženja koriste se Visual Studio, NetBeans, IntelliJ IDEA kao i sistemi za upravljanje sadržajem poput WordPress-a, Joomla!-e, Drupal-a, ali i Magento-a i WooCommerce-a, koji su namenjeni za upravljanje elektronskim prodavnicama.

Na ovaj način učenici proširuju svoja znanja iz oblasti programiranja koja nisu predviđena nastavnim planom i programom.

Na ovoj sekciji se takođe, deca upoznaju sa realnom problematikom koju analiziraju i rešavaju uz pomoć mentora i u kontrolisanom okruženju.

U praksi se ovaj način rada pokazao kao izuzetno motivišući, jer učenici odlično reaguju na takav pristup i potpuno su skoncentrisani dok im se objašnjava na realnom primeru. To je vreme kada su i gostujuća predavanja raznih programera, dizajnera i QA testera.

Podstiče se i preduzetništvo, te je tako i oformljeno sedam timova koji su osposobljeni za izradu web prezentacija ali i izradu web aplikacija koristeći razne tehnike i tehnologije već u drugom razredu gimnazije.

4. GRAFIČKA SEKCIJA

Na ovoj sekciji učenici imaju priliku da primene svoje znanje iz programiranja, baza podataka ali i da prošire svoja znanja iz ove oblasti, kao i da razviju sposobnost za timski rad i osobine koje se stiču iskustvom i obrazovanjem.

Učenici koji se istaknu na programerskoj sekciji, prelaze na Hakaton sekciju, gde se sa njima radi intenzivnije, na takmičarskom nivou.

Ova sekcija je zamišljenja kao korelacija između predmeta programiranja i umetnosti, te je s toga vode kombinovano profesor programiranja i profesor umetnosti. Ovo je važno, kako zbog web dizajna, tako i zbog dizajna likova u igricama, odnosno animacija i ilustracija koje su svakako jedna od potreba na tržištu rada. Na ovoj sekciji koriste se i grafičke table.

Na početku, učenici se upoznaju sa alatima kao što su Gimp i Krita koji su besplatni odnosno otvorenog koda, a koriste se prilikom crtanja.

Narednih časova, planirano je objašnjenje osnova alata Gimp koji se koriste pretežno za obradu fotografija i Krita, u kojem se crta. Sa profesorom umetnosti se planira dogovor oko teme a nakon toga se grafički rad realizuje upotrebom navedenih alata. Savladane su tehnike izrade i obrade digitalnih fotografija.

Kroz ovu sekciju učenici imaju priliku da budu kreativni i maštoviti, da primene svoje znanje iz programiranja i da razviju sposobnost za timski rad.

5. HARDVERSKA SEKCIJA

Hardversku sekciju vodi profesor koji predaje Primenu računara. Primena računara je predmet koji učenici imaju sve četiri godine.

Na ovoj sekciji, aktivnosti su usmerene na to da se učenici osposobe za samostalno sklapanje konfiguracija, čišćenje računara i umrežavanje računare i perifernih uređaja.

Praktičan rad je pravljenje jezgra jednog jednostavnog operativnog sistema (korišćenjem već naučenog proceduralnog jezika) i na njemu demonstracija najvažnijih funkcija operativnih sistema.

Na ovoj sekciji, učenicima je objašnjeno na šta treba da obrate pažnju usled kupovine novog računara, koje vrste računara postoje, koje su osnovne komponente računara i njihova funkcija. Zatim, naučili su koja je razlika između HDD-a i SSD-a, šta je matična ploča, šta je napojna jedinica odnosno napajanje a nakon čega su sami a pod nadzorom mentora, menjali napajanje na računaru.

Nakon toga, instalacija različitih operativnih sistema i upoznavanje sa okruženjem je za učenike bilo jednako interesantno i korisno. Instalacija i reinstalacija operativnih sistema je jedna od aktivnosti koja se dešava upravo u okviru ove sekcije kao i spašavanje podataka sa HDD-a ili SSD-a.

Na ovoj sekciji se učenicima objašnjava i to da postoje monitori za više namena, i koji sve tipovi ekrana postoje. Zatim veličine ekrana, šta je rezolucija, koji su tipični nivoi osvetljenja i kontrast. Šta je učestalost osvežavanja, koje je vreme odziva, šta je ugao vidljivosti i koje su preporučene rezolucije ekrana.

Zatim se prelazi na kablove odnosno vezu računar-monitor, šta je HDMI, VGA, DVI, Display Port i USB. Nakon toga radi se zadatak kako dobiti najbolji prikaz na monitoru.

6. HAKATON SEKCIJA

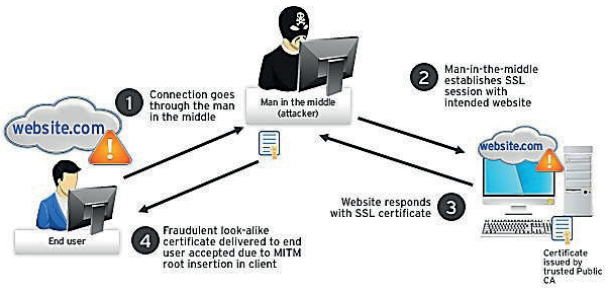
Ovu sekciju vodi profesor računarske grupe predmeta koji vodi i programersku sekciju. Na ovoj sekciji se rade zadaci i projekti na takmičarskom nivou. Učenici dobijaju zadatke koje, za unapred određeno vreme, moraju da reše i predaju. Na ovaj način spremaju se za rad pod pritiskom.

Uče se kako da formiraju timove, kako da biraju članove tima, ko mora da bude tim lider u tom timu i zašto je on potreban. Svi članovi sekcije rešavaju zadatke i iz bezbednosti računarskih sistema. Kako da zabrane pristup neovlašćenim licima, instaliraju bezbednosne zakrpe, naprave rezervnu kopiju podataka, kao i sliku celog sistema. Za taj deo koriste Acronis True Image, preko koga rade i instalaciju operativnih sistema.

Na ovoj sekciji, učenici se upoznaju i sa mrežnim uređajima poput ruter-a, svič-a, hab-a. Kako bi savladali podešavanja rutera, bar u onoj meri koliko je za njihov uzrast dovoljno, imali su jedan ruter na kome su morali da postave ili promene lozinku, podešavanja naziva bežične mreže i slična podešavanja koja su im data u pdf formatu, zajedno sa priloženim fotografijama kako bi se učenici lakše snašli ali i kako bi oni koji su bili sprečeni da dođu taj dan na sekciju, sami kod kuće mogli uspešno da završe zadatak.

Kako bi se bolje upoznali sa računarskim mrežama, koristimo Cisco Network Academy platformu, kao i različite operativne sisteme među kojima je i Kali Linux za testiranje bezbednosti.

Sledeći alat koji se koristi je WireShark, koji služi za analizu saobraćaja.



Slika 2. The Man-in-the-Middle (MITM) Attack [5]

Učenici obrađuju i tehnike socijalnog inženjeringa, kako bi znali da zaštite i sebe i druge u slučaju takvih napada.

Socijalni inženjering je čin prevare, da se otkriju informacije ili preduzme neka akcija i to obično kroz tehnologiju. Ideja socijalnog inženjeringa je da iskoristi prirodne tendencije i emocionalne reakcije potencijalne žrtve.

7. PRAKTIČNA ISKUSTVA I SARADNJA SA DRUGIM KOMPANIJAMA

Kao sastavni deo projektnih timova škole, učenici gimnazije će praktično naučiti kako da projektuju i razvijaju nova rešenja i aplikacije na više različitih platformi.

Učenici tokom školovanja imaju priliku da se i praktično oprobaju u oblasti Informacionih tehnologija za šta se i pripremaju u budućnosti. Imaju priliku da obilaze IT i druge kompanije gde mogu da se upoznaju sa delokrugom rada informatičara kako administratora tako i programera, ali i inženjera informacionih tehnologija.

Kroz stručnu praksu u saradnji sa specijalizovanim IT kompanijama, kroz rad na projektima učenici će imati mogućnost da primene stečeno znanje i da steknu veštine potrebne za dalje zapošljavanje nakon završetka srednje škole. [6]

8. SERTIFIKACIJA

Pored samih veština i znanja, đaci se od samog početka spremaju da grade svoju profesionalnu karijeru. U prilici su da steknu tri Microsoft Technology Associate i ECDL međunarodno priznate sertifikate:

Zvanična Microsoft sertifikacija: Microsoft Technology Associate (MTA):

- MTA Infrastructure
- MTA Database
- MTA Development

Zvanična ECDL sertifikacija: European Computer Driving Licence:

- Osnove informacionih tehnologija i korišćenje računara,
- Obrada teksta, tabelarne kalkulacije i baze podataka,
- Prezentacije, informacije i komunikacije. [6]

ZAHVALNOST

Zahvaljujem se koleginici, dipl. psihologu Ivani Ursić, na nesebičnoj pomoći tokom izrade ovog rada.

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PROCENA KVALITETA DIGITALNIH ARHIVA PRIMARNIH PODATAKA U NAUCI

Aleksandra Bradić-Martinović[1,*],
Jelena Banović[1],
Larisa Malić[2]

[1]Institut ekonomskih nauka, Beograd, Srbija
[2]Institut za književnost i umetnost, Beograd, Srbija

Rezime:

Ponovna upotreba istraživačkih podataka zavisi od stepena do kog se podaci mogu iskoristiti bez ograničenja za akademsku zajednicu. Diverzitet ciljnih grupa takođe je jedan od pokazatelja kvaliteta upotrebe podataka. Otvorena i slobodna upotreba istraživačkih podataka odvija se u unutar relevantnih zakonskih okvira i političkih odluka, određenih od strane nadležnih vlasti. Da bi arhivi imali jasne smernice razvoja, a korisnici garanciju do kog nivoa je rad arhiva usklađen sa najboljom praksom, uvedeni su nivoi sertifikacije. U ovom radu detaljno je opisan CoreTrustSeal okvir sertifikacije, na primeru dva operativna arhiva u društvenim naukama, Data Centra Srbija u društvenim naukama, koji funkcioniše kao nacionalni arhiv podataka i Arhiva družboslovnih podatkov iz Slovenije. Cilj rada je upoznavanje šire naučne zajednice sa kompleksnom temom digitalnog arhiviranja i diseminacije podataka u nauci.

Ključne reči:

digitalni arhivi, sertifikacija, istraživački podaci, Data centar Srbija za društvene nauke.

1. UVOD

Kako bi se obezbedilo kvalitetno i pravilno čuvanje i diseminacija primarnih mikro podataka u nauci, dugoročno pohranjivanje u digitalnim arhivima postalo je nezaobilazan korak svakog istraživačkog ciklusa. Arhiviranje podataka nastalih prilikom naučnih istraživanja može biti od izrazitog nacionalnog značaja, jer njihovo skladištenje omogućuje ponovnu upotrebu u budućnosti, čime se produžuje životni vek podataka i omogućuju longitudinalne i komparativne analize. Osim toga, plan upravljanja istraživačkim podacima sve češće postaje zahtev finansijera projekata, a samim tim i obaveza istraživača. Konačno, svetski renomirani časopisi pokrenuli su inicijativu koja podrazumeva da istraživač uz rad priloži i podatke koje je koristio za analizu. Kao rezultat globalnih kretanja pojavili su se otvoreni (često komercijalni), kao i nacionalni, tematski i institucionalni repozitorijumi - digitalni arhivi podataka. Pojedini, poput *UK Data Service*, imaju tradiciju dužu od pedeset godina.

Revizija i sertifikacija digitalnih arhiva na međunarodnom nivou predstavljaju najbolji pokazatelj (samo)procene i garancije pouzdanosti ovih infrastruktura.

Odgovorno lice:
Aleksandra Bradić-Martinović

e-pošta:
abmartinovic@ien.bg.ac.rs

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Većina država koje finansiraju nacionalne digitalne arhive imaju i zakonske okvire koji utiču na njihov rad, kao i na kvalitet čuvanja i diseminacije podataka. Ovi zakonski okviri obuhvataju raspon od statutarnih (koji su u funkciji zaštite privatnosti ispitanika obuhvaćenim istraživanjem), do kodeksa ponašanja koji uključuju etiku i moral, kao dva najvažnija načela naučnog istraživanja. Situacija se posebno komplikuje u slučaju podataka koji su rezultat istraživanja u društvenim naukama, kao posledica činjenice da su subjekti istraživanja najčešće fizička lica, čija privatnost ne sme biti ugrožena. Iako je oblast digitalnog očuvanja još uvek u povoju, veliki napredak se postiže dobrom infrastrukturom, razvojem politika, preporuka i standarda za sertifikaciju [1]. U slučaju digitalnih arhiva podataka u društvenim naukama sertifikacija predstavlja važnu referencu garancije kvaliteta. Cilj ovog rada je da ukaže istraživačkoj zajednici na činjenicu da je za čuvanje vrednih podataka, koji imaju veliki potencijal za ponovnu upotrebu i za koje se proceni da je opravdano dugoročno očuvanje, potrebno obezbediti kvalitetne i stabilne uslove rada, solidnu infrastrukturu i ekspertska znanja. U protivnom, sačuvani podaci se mogu oštetiti, izgubiti ili se ispitanici obuhvaćeni istraživanjem izložiti riziku ugrožavanja privatnosti.

2. EVROPSKI OKVIR ZA REVIZIJU I SERTIFIKACIJU DIGITALNIH ARHIVA

U cilju efikasne koordinacije revizije i sertifikacije 2010. godine potpisan je memorandum „Evropski okvir za reviziju i sertifikaciju digitalnih arhiva“ (*European Framework for Audit and Certification of Digital Repositories*). Okosnicu ovog memoranduma objedinjuju tri standarda ključna za sticanje pouzdanosti:

- *Data Seal of Approval* i *The World Data System of the International Science Council* (DSA 2009 + WDS 2013), sada objedinjeni kao *CoreTrustSeal* standard; dobijanjem ovog sertifikata digitalni arhiv stiče **osnovni** vid sertifikacije [2];
- Audit and certification of trustworthy digital repositories – *ISO* 16363, 2012: **prošireni** vid sertifikacije i
- Criteria for Trustworthy Digital Archives *DIN 31644*, 2012, **formalni** vid sertifikacije. [3]

Navedeni standardi konstruišu kompletan okvir sertifikacije digitalnih arhiva na svetskom nivou. Nivoi sertifikacije obezbeđuju različite nivoe poverenja i pouzdanosti, odnosno ispunjenja traženih kriterijuma i smernica.

CoreTrustSeal standard pre svega obuhvata osnovni vid sertifikacije za pouzdane digitalne arhive. Njegov katalog smernica i zahteva zasnovan je na principu transparentnosti i otvorenosti, kao i određivanja balansa između jednostavnosti i uloženog truda [2].

Proširenu sertifikaciju mogu steći samo arhivi koju su prethodno ispunili sve uslove *CoreTrustSeal*-a i izvršili krajnju javnu samoprocenu zasnovanu na ili ISO 16363 ili DIN 31644 standardima. ISO standard sadrži više od osamdeset kriterijuma koji se odnose na:

- organizacionu infrastrukturu,
- digitalno upravljanje objektima i
- upravljanje rizikom bezbednosti.

Formalna sertifikacija podrazumeva sertifikaciju koja, pored stečene osnovne, sadrži i spoljnu reviziju koja garantuje ispunjenje svih uslova, kriterijuma i smernica koje propisuju ISO 16363 ili DIN 31644. [3]

U ovom radu fokus je postavljen na *CoreTrustSeal* sertifikaciju, jer je ona usklađena sa zahtevima CESSDA ERIC za arhive u društvenim naukama u Evropi. Kriterijumi za kvalitet i pouzdanost objedinjeni u *CoreTrustSeal* standardu su od velikog interesa i značaja za sve stejkholdere - istraživače i institucije koje proizvode istraživačke podatke, zatim za organizacije koje arhiviraju te podatke, kao i za njihove krajnje korisnike. Kriterijumi su sastavljeni sa ciljem da se podaci sačuvaju, da se osigura visok kvalitet njihovog skladištenja i da se obezbedi njihova pravilna distribucija. *CoreTrustSeal* obezbeđuje istraživačima sigurnost da će njihovo istraživanje biti sačuvano i distribuirano na odgovarajući način i isključivo u naučnoistraživačke svrhe. Ovaj standard baziran je na šesnaest smernica koje služe za proveru i potvrdu kvaliteta i pouzdanosti jednog digitalnog arhiva. Smernice i uputstva se u najvećoj meri odnose na kreiranje, skladištenje, upotrebu i distribuiranje digitalnih podataka iz oblasti naučnog istraživanja. Homogenost svih smernica obeležena je principima koji zajedno definišu da li se podaci mogu smatrati održivim na digitalnom nivou i ti principi podrazumevaju sledeće: da podaci mogu biti pronađeni na Internetu, da se podacima može pristupiti uz određene uslove i odgovarajućim nalogom sa ličnim podacima i svesti o intelektualnoj svojini, da su podaci skladišteni u odgovarajućim i upotrebljivim formatima i da su podaci relevantni.

Svaki kriterijum propraćen je smernicama, kao i numeričkom ocenom koja pokazuje do kog je nivoa uspostavljena usaglašenost sa standardom. Sistem sertifikacije podrazumeva da arhiv vrši samo-evaluaciju i u skladu sa stepenom usklađenosti sa zahtevom određuje jedan od sledećih nivoa:

0 – Nije primenljiv

1 – Digitalni arhiv još uvek nije razmotrio ovaj zahtev

2 – Digitalni arhiv ima teorijski koncept primene ovog zahteva

3 – Digitalni arhiv je u fazi implementacije

4 – Zahtev je u potpunosti primenjen. [4]

U narednom delu rada predstavićemo zahteve koje propisuje *CoreTrustSeal* standard.

3. ZAHTEVI CORETRUSTSEAL STANDARDA

Prilikom ocene kvaliteta digitalnog arhiva podataka polazi se ona sledećih zahteva:

R1. Misija digitalnog arhiva - Digitalni arhiv ima javnu i eksplicitnu misiju u okviru oblasti u kojoj vrše digitalno arhiviranje.

R2. Licence - Digitalni arhiv primenjuje sve adekvatne licence koje se odnose na pristup i upotrebu podataka.

R3. Kontinuitet pristupa, u dugoročnom okviru - Digitalni arhiv ima dugoročni plan za skladištenje svog digitalnog fonda.

R4. Poverljivost - Digitalni arhiv osigurava da su svi podaci proizvedeni, sakupljeni, organizovani i sačuvani u skladu sa svim etičkim normama svojstvenih konkretnoj naučnoj disciplini.

R5. Organizaciona struktura - Arhiv ima odgovarajuće i održivo finansiranje, kao i dovoljan broj stručnog i kvalifikovanog osoblja koje obavlja aktivnosti kroz jasno definisan sistem upravljanja sa ciljem ispunjenja postavljene misije.

R6. Stručno usavršavanje - Arhiv usvaja mehanizme za neprekidno stručno usavršavanje, kao i za pružanje povratnih informacija (*feedback*), na svim nivoima - unutar samog arhiva, kao i konsultacije sa drugim spoljnim ili nadležnim organizacijama.

R7. Integritet i autentičnost podataka - Digitalni arhiv osigurava integritet i autentičnost digitalnih objekata i meta-podataka. Ovo se najpre odnosi na stepen pouzdanosti i približnosti originalnim istraživačkim podacima.

R8. Procena kvaliteta podataka - Repozitorijum prihvata samo one podatke i meta-podatke koji su kreirani u skladu sa definisanim kriterijumima, kako bi osigurao relevantnost i čitljivost za krajnje korisnike.

R9. Dokumentovane procedure za skladištenje - Arhiv poseduje procedure kojima se vodi pri upravljanju skladištenjem podataka. Kada podaci stignu u arhiv, vrši se njihova detaljna provera koja podrazumeva poštovanje standarda o (meta)podacima, obavlja se unifikacija svih fajlova i njihovih formata uz proveru dodatnih tehničkih specifikacija. Skladištenje podrazumeva različite sigurnosne mehanizme koji se sprovode radi utvrđivanja kvaliteta i održivosti podataka, proveravaju se potencijalne greške, vrši se evaluacija materijala.Takođe, arhiv je u obavezi da za sve materijale omogući odgovarajući tip pristupa, kao i odgovarajući nivo zaštite.

R10. Plan očuvanja - Arhiv preuzima odgovornost za dugoročno očuvanje podataka na unapred predviđen i dokumentovan način.

R11. Kvalitet podataka - Arhiv ima odgovarajuća ekspertska znanja koja se odnose na tehnički kvalitet podataka i meta-podataka, a koje omogućuje da se obezbede dovoljne informacije krajnjih korisnicima kako bi bili u stanju da izvrše procenu kvaliteta podataka. U ovom procesu arhiv treba da sarađuje sa provajderima podataka i da ima uvid u sve informacije o podacima koji će se eventualno čuvati u arhivu. Te informacije će poslužiti i arhivu i potencijalnim korisnicima podataka prilikom procene kvaliteta raspoloživih podataka. Arhiv ima pravo, za one skupove podataka za koje ne postoji minimalan broj opisnih informacija, odluči da ih ne pohranjuje. Zbog toga, deponenti moraju da obezbede dokumenta u kojima se vidi kako je istraživanje sprovedeno, na kom uzorku, šta je bio osnovni cilj, da priloži metodologiju rada, spisak članova istraživačkog tima i ostale relevantne informacije.

R12. Tok aktivnosti -Arhiviranje se odvija u skladu sa definisanim tokom, od preuzimanja podataka od deponenta, do diseminacije ka istraživačima koji ih ponovo koriste.

R13. Dostupnost i identifikacija podataka - Arhiv omogućuje korisnica da pronađu potrebne podatke i da ih citiraju na jednoznačan način. Mogućnost lakog pristupa podacima je ključ za dobro deljenje podataka, a većina arhiva obezbeđuje pretražive kataloge u kojima se pored pristupa podacima, obezbeđuju i meta-podaci, kako bi potencijalni korisnik utvrdio da li podaci odgovaraju njegovim potrebama.

R14. Ponovna upotreba podataka - Arhiv je dužan da omogući da se podaci mogu ponovo koristiti, obezbeđujući da odgovarajući meta-podaci budu dostupni kako bi podržali razumevanje i upotrebu podataka.

R15. Tehnička infrastruktura - Arhiv koristi dobro implementirane operativne sisteme i hardverske i softverske tehnologije koje odgovaraju uslugama koje arhiv isporučuje zajednici. Infrastruktura arhiva mora maksimizirati dostupnost usluga krajnjem korisniku.

R16. Bezbednost - Tehnička infrastruktura arhiva mora da obezbedi zaštitu svih digitalnih objekata koji su u njemu pohranjeni, kao i svih elementa koji su uključeni u proces – podataka, proizvoda, usluga i korisnika. Arhiv mora da vrši redovne analize potencijalnih pretnji i rizika, ali i da kreira dosledan sistem zaštite. Takođe, neophodno je da vrši procene potencijalnih šteta koje bi eventualno nastale usled napada malicioznih softvera, zbog ljudskog faktora ili nekog drugog tehničkog problema koji može oštetiti bilo koji entitet u arhivu. Neophodno je meriti verovatnoću i uticaj ovih šteta na arhiv, kao i odlučiti koje mere treba preduzeti kako bi se rizici i pretnje izbegle, a rad arhiva se nastavio neometano. Za ovaj zahtev, neophodno je da arhiv ispuni sledeće zahteve, da opiše procedure i *backup* opcije ukoliko dođe do kolapsa i da opiše sistem zaštite, plan ukoliko dođe do kolapsa, plan za kontinuirani nastavak rada, podelu poslova svih zaposlenih ukoliko do kolapsa dođe. [5]

Do sada je 143 repozitorijuma dobilo *CoreTrustSeal* sertifikat [6]. Da bismo čitaocima približili zahteve i proces sertifikacije odabrali smo dva digitalna arhiva koji skladište primarne podatke u društvenim naukama, Data Centar Srbija za društvene nauke (DCS), čije je sedište u Beogradu i Arhiv družboslovnih podatkov (ADP), čije je sedište u Ljubljani.

4. ANALIZA USKLAĐENOSTI SA ZAHTEVIMA CORETRUSTSEAL STANDARDA NA PRIMERU ADP I DCS

Imajući u vidu kompleksnost teme i oblasti smatramo da je najbolji način za razumevanje i približavanje materije široj naučnoj zajednici i svim zainteresovanim stranama uporedna analiza ispunjenosti zahteva odabranog standarda, na primeru ADP-a i DCS-a. Potrebno je istaći da je ADP dobio *CoreTrustSeal* sertifikat 23. januara 2018. Godine, a da DCS ima za cilj da dostigne kvalitet koji će mu omogućiti sertifikaciju. [7]

Data centar Srbija za društvene nauke (http://datacentarserbia.com/) osnovan je 2014. godine u okviru Instituta ekonomskih nauka u Beogradu. Nastao je kao rezultat FP7 projekta SERSCIDA (*Support for Establishment of National/Regional Social Sciences Data Archives*). Njegov dalji razvoj podržala je Švajcarska nacionalna fondacija za nauku, u okviru SCOPES projekta SEEDS (*South-Eastern European Data Services*) i EC u okviru projekta H2020 - CESSDA SaW (*Strengthening and Widening*). Na osnovu ostvarenih rezultata, Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije prepoznalo je značaj novoosnovane istraživačke infrastrukture i podržalo rad DCS-a kroz učlanjenje Republike Srbije u CESSDA ERIC, u novembru 2018. godine, pri čemu je DCS postao nacionalni pružalac usluga (*Service Provider*). CESSDA je konzorcijum koji okuplja države članice koje u okviru Evropskog istraživačkog prostora imaju operativne digitalne arhive u društvenim naukama [8]. Trenutno DCS čuva i distribuira i kvantitativne i kvalitativne podatke preko portala podataka SEEDSbase, čiji je host švajcarski nacionalni digitalni arhiv FORS i preko ePrints platforme, koja je hostovana na internim resursima.

Osnivanjem i radom DCS-a istraživači u društvenim naukama dobili su mogućnost da čuvaju i preuzimaju mikro podatke prikupljene u primarnim istraživanjima, u skladu sa odredbama „Platforme za otvorenu nauku".

Arhiv družboslovnih podatkov (ADP) je osnovan 1997. godine, kao organizaciona jedinica Instituta za društvene nauke na Fakultetu društvenih nauke, Univerziteta u Ljubljani. ADP je nacionalna istraživačka infrastruktura za društvene nauke, čija je glavna misija upravljanje podacima i uslugama podataka kako bi se podržalo istraživanje, obrazovanje i opšte blagostanje. ADP je, takođe pružalac usluga u CESSDA ERIC. Ministarstvo prosvete, nauke i sporta Republike Slovenije finansira rad ove institucije od osnivanja. Od 2004. godine finansiranje rada ADP-a omogućeno je kroz program finansiranja infrastruktura koje funkcionišu u okviru Univerziteta u Ljubljani – MRIC UL. Arhiv u svom radu odgovara Savetu ADP-a i Slovenačkoj istraživačkoj agenciji. [9]

Zahtev 1: Misija

Misija ADP-ja je „promocija čuvanja podataka iz istraživanja sprovedenih u istraživačkim centrima u Sloveniji". ADP je uspostavljen kao deo nacionalne infrastrukture i kroz svoju misiju potencira čuvanje, deponovanje i promovisanje podataka, kao i mogućnost njihovog kasnijeg korišćenja u naučne, obrazovne i druge [10].

Misija DCS je da „obezbedi podršku istraživačima u procesu upravljanja podacima kroz razvoj pouzdane infrastrukture i kroz uvećanje i deljenje znanja u ovoj oblasti". [11]

Nivo usklađenosti sa zahtevom 1: ADP - nivo 4; DCS – nivo 4

Zahtev 2: Licence

ADP funkcioniše u skladu sa zakonskom regulativom koja se odnosi na pristup i upotrebu digitalnih

objekata. Takođe, vodi računa da zajednica korisnika (*designated community)* bude upoznata sa ovim okvirom i svim zahtevima koji se postavljaju pred njih. Osnovni dokumenti koji se odnose na ovaj zahtev su „Politika digitalnog očuvanja" (www.adp.fdv.uni-lj.si/publikacije_adp/publikacija/248/) i „Zakonski osnov, etičke norme i odgovornosti" [12].

U praktičnom radu, ADP sa provajderima podataka (deponentima) potpisuje se „Ugovor o skladištenju podataka", koji se bazira na poštovanju nacionalnih pravnih okvira o zaštiti podataka i citiranju podataka. Pored toga, Ugovorom se definiše način upotrebe i nivo zaštite Podataka. Sa korisnicima podataka, takođe potpisuje „Ugovor o upotrebi podataka", po kome se korisnik se obavezuje da će koristiti podatke u skladu sa zakonskim i etičkim normama, kao i da anonimizirane podatke koristi kao takve. [13].

Prilikom zaštite autorskih prava, ADP koristi *Creative Commons* licence (CC0 - upotreba bez ograničenja; CCBY – obaveza navođenja izvora (autora) i CCBYNC – obaveza navođenja izvora (autora), uz obavezu upotrebe u nekomercijalne svrhe) [13].

DCS takođe funkcioniše u skladu sa zakonskim i etičkim standardima koji se odnose na privatne podatke i specifičnost njihovog deljenja u skladu sa Opštom uredbom o zaštiti podataka o ličnosti (GDPR), kao i etičkim standardima svojstvenim društvenim naukama. Deponovanje i ponovna upotreba podataka regulisana je odgovarajućim ugovorima, kao i u ADP-u. Konačno, isti sistem zaštite autorskih prava primenjen je i u radu DCS-a.

Nivo usklađenosti sa zahtevom 2:
ADP - nivo 4; DCS – nivo 4

Zahtev 3: Kontinuitet pristupa, u dugoročnom okviru

Kontinuitet rada ADP-a obezbeđen je kroz „Pravila organizacije i implementacije istraživačkih arhiva Fakulteta za društvene nauke Univerziteta u Ljubljani" (2017), kao i kroz „Strategiju očuvanja" i „Digitalno očuvanje podataka" – dva interna dokumenta. ADP radi u sladu sa odredbama Otvorenog pristupa.

DCS, u ovoj fazi razvoja, nema razvijenu pravnu podršku koja bi mu omogućila kontinuitet rada i razvoja, ali postoji svest o potrebi zadovoljenja ovog zahteva i čine se koraci za njegovo ispunjenje, u saradnji sa resornim ministarstvom.

Nivo usklađenosti sa zahtevom 3:
ADP - nivo 4; DCS – nivo 2

Zahtev 4: Poverljivost

ADP je u potpunosti uskladio rad sa zahtevima relevantnih dokumenata koji uslovljavaju zaštitu anonimnosti ispitanika. Za svaku studiju koja se deponuje proverava se da li poštuje sve etičke i pravne norme. To znači da deponent mora da osigura da su svi podaci koji se tiču učesnika studije zaštićeni od zloupotreba, kao i da poseduje potpisani pristanak za deljenje podataka od strane ispitanika, u slučaju kvalitativnih podataka. Deponent je u obavezi da sam izvrši anonimizaciju podataka, ali ADP stoji na raspolaganju za svaku vrstu pomoći. U ekstremnim slučajevima, arhiv vrši anonimizaciju podataka, prateći unapred utvrđene procedure, ali isključivo u slučajevima kada se radi o jako osetljivim podacima koje deponent nije u stanju sam da anonimizira.

Na isti način i DCS zadovoljava ovaj zahtev.

Nivo usklađenosti sa zahtevom 4:
ADP - nivo 4; DCS – nivo 4

Zahtev 5: Organizaciona infrastruktura

ADP je organizaciona jedinica Instituta za društvene nauke u Ljubljani, koji funkcioniše u okviru Fakulteta za društvene nauke, Univerziteta u Ljubljani. Rad arhiva se bazira na pravnim aktima potpisanim između ovih institucija. Takođe, arhiv ima podršku Ministarstva, koje obezbeđuje sredstava za njegovo funkcionisanje [14].

DCS je organizacioni deo Instituta ekonomskih nauka iz Beograda. U Centru rade stručni saradnici za oblasti upravljanja podacima, a obezbeđena je i adekvatna IT podrška. Na žalost, još uvek ne postoji adekvatna i održiva šema finansiranja centra, te se njegov rad i razvoj i dalje oslanja na podršku partnera iz inostranstva, pre svega CESSDA ERIC i njenih članica, što nije dovoljno za ostvarenje postavljene [15].

Nivo usklađenosti sa zahtevom 5:
ADP - nivo 4; DCS – nivo 3

Zahtev 6: Stručno usavršavanje

ADP je dobro integrisan u naučnu zajednicu Slovenije, a i aktivni je član međunarodne istraživačke infrastrukture, što omogućuje praćenje i uključivanje u

globalne inicijative, koje implementira u skladu sa svojim mogućnostima. Vrše stručnu konsultaciju sa partnerima iz zemlje i inostranstva, promovišu svoje podatke putem različitih okruglih stolova, seminara i radionica namenjenih učesnicima naučno-istraživačke zajednice.

DCS, takođe ima jedinstvenu priliku stručnog usavršavanja učešćem u radu CESSDA ERIC, kroz aktivni rad u radnim grupama i radionicama. Jačanje pozicije DCS-a u lokalnom naučnom okruženju je cilj koji će biti realizovan tokom 2019. godine, kroz organizaciju radionica i okruglih stolova.

Nivo usklađenosti sa zahtevom 6:
ADP - nivo 4; DCS – nivo 3

Zahtev 7: Integritet i autentičnost podataka

ADP u svojoj dugoročnoj misiji očuvanja za cilj ima da blisko isprati principe očuvanja integriteta i autentičnosti podataka. Materijali koji stignu u arhiv, podvrgnuti su detaljnim ispitivanjima, gde se fokus stavlja na kompletnost dokumentacije, značaj studije, ispitivanje anonimnosti materijala, usklađenost dostavljenih formata sa preporučenim formatima. Kreirane su brojne procedure koja na formalan način propisuju tok podataka i zahteve koji u tom procesu moraju biti ispunjeni [7].

DCS ima ključni dokument „Politike i procedure“ u kome su definisane odredbe o integritetu i autentičnosti podataka, ali još uvek nema razrađene sve korake pojedinačno.

Nivo usklađenosti sa zahtevom 7:
ADP - nivo 4; DCS – nivo 3

Zahtev 8: Procena podataka

Politika rada ADP-a propisuje da se za skladištenje i dugoročno očuvanje prihvataju oni podaci za koje se proceni da imaju veliki potencijal ponovne upotrebe, da su zanimljivi za slovenačku naučnu zajednicu, da ističu određeni istraživački i naučni problem, kao i da je značajan za slovenačko društvo uopšte. Zadovoljenje ovog zahteva proizilazi iz potrebe da se ograničeni materijalni i ljudski resursi iskoriste na optimalan način [7].

DCS, takođe ima propisane uslove za podatke koje prikuplja, mada u praksi, koja je uslovljena niskim nivoom svesti istraživača u ovoj oblasti, uslovi se ne postavljaju rigorozno. Zbog toga, prihvataju se svi raspoloživi podaci.

Nivo usklađenosti sa zahtevom 8:
ADP - nivo 4; DCS – nivo 3

Zahtev 9: Dokumentovane procedure za skladištenje

U ADP-ju se arhiviranje vrši prateći unapred određeni tok aktivnosti. Sam postupak skladištenja je detaljno opisan u usvojenim internim dokumentima arhiva.

DCS ima teorijski koncept primene ovog zahteva.

Nivo usklađenosti sa zahtevom 9:
ADP - nivo 4; DCS – nivo 2

Zahtev 10: Plan očuvanja

ADP je razvio kompletan sistem digitalnog očuvanja podataka, uključujući i jasno definisan tok aktivnosti sa pravilima za njihovo sprovođenje. Tok aktivnosti usklađen je sa OAIS (*Open Archival Information System*) modelom. Definisani su formati podataka koji se prihvataju od provajdera podataka, kao i formati u kojima se vrši diseminacija [7].

DCS je započeo da razvija dugoročni plan očuvanja i upravljanja podacima, koji će obezbediti održivost arhiva. Takođe, ovim planom DCS obezbediće kvalitetno očuvanje podataka od prijema u arhiv do kasnije mogućnosti za ponovnu upotrebu. Aktivnosti u arhivu će, takođe, biti usklađene se OAIS referentnim modelom. Dokumentom „Politike i procedure“ definisani su formati podataka koji se primaju za arhiviranje i koji se koriste u diseminaciji.

Nivo usklađenosti sa zahtevom 10:
ADP - nivo 4; DCS – nivo 2

Zahtev 11: Kvalitet podataka

Kao što smo već naveli, ADP prati zahteve OAIS modela kroz obezbeđenje dovoljne količine informacija o svakoj studiji (istraživanju) na nivou meta-podataka, tako da su krajnji korisnici u stanju da procene u kojoj meri podaci zadovoljavaju njihove istraživačke potrebe. Šema i zahtevi za meta-podacima raspoloživi su na njihovoj veb prezentaciji.

Ovaj zahtev je na isti način postavljen i u radu DCS-a, s tim što postoji prostor za unapređenje.

Nivo usklađenosti sa zahtevom 11: ADP - nivo 4; DCS – nivo 3

Zahtev 12: Tok aktivnosti

ADP ima jasno definisan tok aktivnosti koje su jasno opisane usvojenim procedurama, usklađenim sa OAIS referentnim modelom. Postoji obaveza praćenja svih transformacija koje se obave na originalno dostavljenim mikro podacima (registruje se svaka izmena), a proces se sprovodi iz saglasnost deponenta, koji zadržava autorsko pravo nad podacima. ADP u najvećem broju slučajeva skladišti kvantitativne podatke koje je lakše anonimizirati i koji su najčešće u SPSS formatu, ali postoje i jasno definisane procedure obrade kvalitativnih podataka. Poštuje se DDI šema meta-podataka, a u upotrebi je ELLST tezaurus za tematsku klasifikaciju [7].

DCS ima za cilj da unapredi svoje politike i procedure koje će jasno definisati tok rada, od prijema do mogućnosti za ponovnu upotrebu podataka.

Nivo usklađenosti sa zahtevom 12: ADP - nivo 4; DCS – nivo 2

Zahtev 13: Dostupnost i identifikacija podataka

Dostupnost podataka pohranjenih u ADP-u moguća je kroz njihov katalog [16] i *Nesstar* platformu. Obe opcije poseduju mogućnost pretraživanja (*search*), a postoje i uputstva za istraživače. Fajlovi sa podacima su u najčešće korišćenim formatima (SPSS (*.sav), SPSS Portable (*.por), Statistica, Stata v.8, Stata v.7. DIF, Dbase, SAS). Korisnicima je stavljena na raspolaganje i opcija direktnog preuzimanja podataka. Svi podaci imaju DOI brojeve.

DCS je još uvek u fazi implementacije platforme, a najveći broj podataka se nalazi na SEEDSbase platformi [17], u kojoj su sačuvani podaci prikupljeni u regionu Zapadnog Balkana, prikupljeni u istraživanjima u društvenim naukama, a u okviru podrške RRPP. U periodu april-decembar 2019. godine biće izvršna migracija podataka u lokalni repozitorijum [18]. U budućnosti se predviđa uvođenje platforme Dataverse-EU. Oba arhiva su aktivno uključena razvoj CESSDA kataloga podataka i usavršavanje pomenute platforme.

Nivo usklađenosti sa zahtevom 13: ADP - nivo 3; DCS – nivo 2

Zahtev 14: Ponovna upotreba podataka

U ADP-u dokument „Opis studije“ i „Ugovor o deponovanju“ definišu koji su obavezni meta-podaci (deskriptivni, strukturni i administrativni). Ukoliko nisu obezbeđeni svi obavezni meta-podaci, studija neće biti objavljena u katalogu i podaci neće biti javno dostupni. U upotrebi je DDI 2.0 šema meta-podataka. Dugoročno arhiviranje vrši se u formatima „otpornim na promene“, kao što su TXT, HTML, XML i sl. [7]

Na isti način organizovani su zahtevi za meta-podacima u DCS-a, uz otvoren prostor za napredak.

Nivo usklađenosti sa zahtevom 14: ADP - nivo 3; DCS – nivo 2

Zahtev 15: Tehnička infrastruktura

ADP implementira politiku tehnološkog razvoja i bezbednosne zaštite u procesu digitalne prezervacije, a koja je kreirana na osnovu liste međunarodnih smernica i procedura. U tehničkom smislu, ADP koristi resurse Slovenačke akademske i istraživačke mreže (ARNES). [7]

U tehničkom smislu, DCS se oslanja na interne resurse Instituta ekonomskih nauka, što bi u jednom trenutku razvoja moglo da postane ograničenje. Takođe, DCS trenutno testira najbolju mogućnost za implementaciju arhiva i kataloga, kao posledica činjenice da je CESSDA prestala da održava *Nesstar* platformu, a još uvek nije završila unapređenje i prilagođavanje *Dataverse-EU* platforme.

Nivo usklađenosti sa zahtevom 15: ADP - nivo 3; DCS – nivo 2

Zahtev 16: Bezbednost

U okviru politike o digitalnoj prezervaciji, ADP je propisao i poštuje procedure za zaštitu osetljivih podataka, prvo kroz fizičku (virtuelnu) zaštitu pristupa, a dalje kroz upravljanje nivoima pristupa podacima. Pristup arhivskom materijalu dozvoljen je samo ovlašćenim osobama ADP-a. U slučaju da je procenjeno da su podaci veoma osetljivi, postoji mogućnost uvođenja dodatnih restrikcija, uprkos opredeljenju za Otvoreni pristup. Redovno se vrše procedure bekapa. [7]

DCS na isti način reguliše svoje bezbednosne aspekte, uz prostor za unapređenje u budućnosti, u skladu sa količinom i vrstom podataka koji će se naći u sistemu.

Nivo usklađenosti sa zahtevom 16: ADP - nivo 3; DCS – nivo 2

5. ZAKLJUČAK

Dugoročno čuvanje mikro-podataka prikupljenih u naučnim istraživanjima ima veliku vrednost. To posebno dolazi do izražaja ako su u pitanju istraživanja u društvenim naukama, jer se presek društva u jednom trenutku nikada više ne može replikovati. Jedan od načina da se omogući kreiranje naučne zaostavštine je deponovanje podataka u digitalne repozitorijume/arhive, a zatim i obezbeđenje lakog i bezbednog pristupa tim podacima. Velike kompanije su prepoznale značaj čuvanja podataka i reagovale tako što su tržištu ponudile otvorene, javne, najčešće komercijalne platforme, kao što su *Figshare, Harvard Dataverse, Open Science Framwork, Zenodo, Mendeley Data* i druge. Države su, takođe procenile obim oportunitetnih troškova koji se generiše gubitkom skupova podataka koji mogu da opišu važne društvene fenomene i zbog toga su spremne da ulože u kreiranje i kontinuiran rad nacionalnih digitalnih arhiva podataka. Konačno, istraživačka zajednica se nalazi pod pritiskom javnih politika, a u Srbiji je sredinom jula 2018. godine usvojena „Platforma za otvorenu nauku" prema kojoj je propisana obaveza otvorenog pristupa naučnim publikacijama, ali i preporuka otvorenog pristupa naučnim podacima, kao prvi korak ka uvođenju obaveze. Međutim, istraživači se u najvećem broju slučajeva nalaze pred dilemom gde da deponuju svoje podatke. Jedan od navedenih, javnih arhiva je opcija, ali ukoliko procene da su njihovi podaci veoma vredni za naučnu zajednicu i za buduća istraživanja, ukoliko žele da budu sigurni da će njihovi podaci biti arhivirani za dugoročno očuvanje, da će biti promovisani na pravi način, što će im omogućiti da izvrše širi uticaj, a obezbedi im i korektno citiranje, kao i da će biti zaštićeni i oni i njihovi ispitanici od zloupotrebe, važno je da shvate značaj kvaliteta rada i organizacije jednog arhiva. Standardi za procenu kvaliteta su jedan od najsigurnijih načina da donesu pravu odluku o izboru virtuelnog prostora na kome će čuvati svoje podatke.

Republika Srbija spada u grupu zemalja koje imaju solidnu infrastrukturu, koja se razvija. Angažovani u Data Centru Srbija za društvene nauke poseduju ekspertska znanja iz ove oblasti i stoje na raspolaganju istraživačima u društvenim naukama.

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PAMETNI GRADOVI KAO DEO DIGITALNE EKONOMIJE

Radmila Živković,
Ivana Brdar*,
Jelena Gajić,
Katarina Čkonjević

Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Uvođenje informacionih tehnologija i unapređenje komunikacije su dve najznačajnije karakteristike digitalizacije koje su dovele do razvoja pametnih ekonomija, pametnih gradova, država, i lokalnih samouprava. Države, gradovi, lokalne samouprave, popularne turističke destinacije suočavaju se različitim izazovima, koristeći prednosti digitalizacije i marketinške kampanje kako za razvoj tako i za bolje pozicioniranje u globalnom okruženju. Gradovi koji koriste sve prednosti digitalizacije su brend gradovi, pametni gradovi a intelektualni kapital, kreativnost i inovativnost su tri glavne karakteristike ovih gradova. Cilj ovog rada je da se ukaže da budući razvoj gradova zavisi od sinergije digitalne ekonomije i upravljanja pametnim gradovima.

Ključne reči:
digitalna ekonomija, pametni gradovi, ekonomija aplikacija, brendiranje gradova.

1. UVOD

Razvoj elektronske trgovine, ujedno i elektronskog bankarstva je doveo do razvoja i digitalne ekonomije. Prodaja i trgovina bez posrednika su danas sve više prisutni, tržišta se razvijaju, manje kompanije ulaze na nova tržišta, dolazi do razvoja novih proizvoda i vrsta usluga, i tako dalje [1].

Koncept digitalne transformacije koji koristi tehnologiju da bi se popravile performanse, u novom veku, zaslužuje mnogo više pažnje [2].

Ekonomija, koja se temelji na komunikaciji, tehnologiji i upravljanju znanjem će biti uspešna i ako se koncentriše na racionalnu, odnosno na efikasnu i efektivnu upotrebu znanja kao jednog od najvažnijeg nematerijalnog resursa kako u proizvodnim, tako i u uslužnim delatnostima. Uslov za realizaciju strategiju ekonomskog i privrednog razvoja predstavlja korišćenje znanja [3].

2. EKONOMIJA APLIKACIJA

Na početku, niko nije mogao da zna kolika će, zapravo, biti app ekonomija. Apple nudi korisnicima veliki izbor softvera u odnosu na druge rivale; BlackBerry je pravio velike „korake“ progresije; Već

Odgovorno lice:
Ivana Brdar

e-pošta:
ibrdar@singidunum.ac.rs

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formirani giganti – Nokia i Microsoft su imali poteškoće da prate nove trendove. Kompanije zarađuju tako što prodaju aplikacije, od reklama van aplikacije, kao i prodajući digitalne usluge putem aplikacija [4]. ICT navodi da „app ekonomija predstavlja zbir svih ekonomskih aktivnosti, proizvode i usluge, koji se prikazuju putem aplikacija korisnicima mobilnih telefona i uređaja“ [5]. Pojam „App“ je skraćenica koja se odnosi na aplikacije na kompjuterskoj platformi [6].

Tržište aplikacija je počelo sa razvojem 2010. godine kada je došlo do kreiranja aplikacija na mobilnim telefonima koje su pokrenute od strane kompanije Apple (Apple App Store) i Google (Google Play). Od tada je došlo do porasta korišćenja „pametnih“ telefona, Interneta i ekonomija aplikacija je postala važan deo svetskog tržišta. Aplikacije igraju veliku ulogu u raznim industrijama: turizam, trgovina, bankarstvo, industrija igrica i zabave.

Dva glavna operativna sistema za aplikacije su Google Android i Apple iOS. Apple zauzima veće tržišno učešće, međutim, Android sistemi su sve popularniji. Za razliku od Apple iOS operativnog sistema koji je zatvoren, Android operativni sistem je otvoren, što podrazumeva da korisnici mogu preuzeti aplikacije ne samo iz Google Play prodavnice, već i od drugih izvora. Kina i Japan su dva najveća tržišta koja koriste Android aplikacije, dok se iOS aplikacije najčešće koriste u Evropi, Americi, Australiji i Kanadi [7]. Iako Apple App Store prodavnica ima manje aplikacija, u odnosu na Android, navodi se da Apple prodavnica ima mnogo veće prihode u odnosu na Google Play prodavnicu, i da korisnici Apple aplikacija više provode vreme na svojim telefonima i kupuju aplikacije, u odnosu na Android korisnike. Međutim, još jedna od razlika jeste da Android aplikacije koštaju upola manje u odnosu na iOS aplikacije [7].

Danas, app ekonomija, zajedno sa digitalnom ekonomijom, je pokrenula sledeće [8]:

- Kreiranje poslova u oblasti IT-a i telekomunikacija širom sveta, a najviše na američkom i evropskog tržištu.
- Porast inovacija u oblasti IT-a koje su povezane sa razvojem pametnih telefona.
- Povećanje rasta i razvoja države i pomoć nerazvijenim državama sveta.

Ekonomski značaj app ekonomije je vidljiv svuda, ali je teško odrediti veličinu app ekonomskog tržišta. Kompanija App Ann definiše app ekonomiju kao „svako ko zarađuje novac i ima posao zahvaljući mobilnim aplikacijama“ i očekuje se, do 2020. godine da će app ekonomija dostići veličinu od $101 milijardi. App prostor najviše zauzimaju sledeće aplikacije WhatsApp (dostigao više od 1.2 milijardi korisnika u januaru 2017. godine, što je više od 700 miliona u januaru 2015. godine); Facebook je platforma koja ima svoja posebna prava i Messenger usluge, koje su do jula 2016. godine imali više od 1 milion aktivnih korisnika; WeChat, komunikacijska platforma popularna u Kini koja je 2016. godine imali više od 846 miliona korisnika [5].

Uloga app ekonomije u ekonomskom razvoju ogleda se u generisanju prihoda, povećanju zaposlenosti i kreiranju mladih, talentovanih zaposlenih u oblasti IT-a, mogućnosti da se aplikacije instaliraju u bilo kom delu sveta, app kompanije mogu da funkcionišu kao tradicionalne kompanije itd. [9].

Mikro, mala i srednja preduzeća širom sveta dominiraju na tržištu app ekonomije u oblasti aplikacija na mobilnih telefonima. App Store predstavlja idealnu platformu za poslovanje za mikro, mala i srednja preduzeća, jer veličina preduzeća omogućava brzo reagovanje na promene i na adaptacije koje digitalizacija donosi. Autori Godfrey, Bernard i Miller navode da 82% mikro, malih i srednjih preduzeća u Americi vode app tržište koje je idealno tržište za rast i razvoj ovih preduzeća [10, 11].

App ekonomija se danas, najčešće primenjuju u američkim zemljama, zemljama EU, i razvijenim azijskim zemljama. Na primer, u Koreji, app ekonomija je veoma značajna zbog porasta radnih mesta. U aprilu 2018. godine kompanija AhnLab je dala oglas u potrazi za programerom u telekomunikacionoj oblasti, a u maju 2018. godine marketinška agencija Incaco Communications je kreirala oglas za potrebom app programera. Veliki broj kompanija je početkom aprila 2018. godine širom Koreje dalo oglase u potrazi za programerima u oblasti kreiranja aplikacija za iOS i Android sisteme u turističkoj industriji, industriji zabave, automobilskoj industriji, u oblasti finansija, bankarstva i revizije, u oblasti obrazovanja, zdravstvenoj industriji i mnogim drugim industrijama [8].

Long i Mandel (2018) su analizirali Čile kao jednu od vodećih zemalja Južne Amerike i došli su do zaključka da primena app ekonomije, kao i kod Koreje najviše doprinosi otvaranju novih radnih mesta. U Čileu se najviše zapošljavaju programeri u oblasti telekomunikacionih tehnologija i u IT firmama kao što su: Baytex SA, ReignDesign, PyS Consultants, Xinergy, i tako dalje [12].

Nedostaci i prednosti uvođenja app servisa

Najznačajniji app onlajn servisi su: Facebook, WhatsApp, Viber, Skype, Snapchat, Facetime, iMessage,

Google Voice, LINE, Netflix i Hulu. Regulatorni problemi korišćenja aplikacija su mnogi, a neki od njih su [5]:

- Za korišćenje određenih aplikacija ne postoje ugovori već korisnici mogu, ili ne moraju da potvrde da se slažu sa uslovima korišćenja.
- Moć telekomunikacionih partnera je ograničena i ne postoji mogućnost ulaska investitora na app tržište.
- Onlajn provajderi usluga mogu, i ne moraju da plaćaju porez.
- Rast Internet tržišta je sve veći i ne postoji specifična zakonska regulativa.
- Klasifikacija onlajn sadržaja nije regulisana zakonskom regulativom.

Korišćenje aplikacije je jedna od najznačajnijih strategija mobilnih operatera, što nas navodi da zaključimo sledeće:

- Mobilne aplikacije grade lojalnost među potrošačima – Mobilne aplikacije su kreirane tako da odgovaraju svim profilima ljudi koji rade u raznim delatnostima. Sem toga, aplikacije se redovno ažuriraju, a korisnici se redovno obaveštavaju o novinama i aktuelnostima, što dovodi do njihove lojalnosti korišćenja određene aplikacije.
- Mobilne aplikacije funkcionišu kao „ekvalajzeri“, nebitno kakav im je kontekst – Nebitno koliko ljudi koristi aplikaciju, koliko su motivisani i koliko godina imaju, istraživanja pokazuju da svi koriste aplikacije na svojim „pametnim“ telefonima, i provode veliki broj vremena koristeći razne aplikacije. Istraživanja pokazuju da 92% Internet korisnika najviše vremena provodi upravo na aplikacijama.
- „Sve u jednom“ hardver omogućava da je sve moguće – Internet korisnici mogu koristiti razne vrste aplikacije za različite svrhe. Svaka aplikacije je specijalizovana za određeni softver, što omogućava korisnicima da koriste razne vrste aplikacija u isto vreme.

Kompanije koje se smatraju najvećim inovatorima aplikacija u Americi su: Aces Health, Bit Source, Convoy, Digi Smart Temps, Fooji, Helix, Lavu, MelviCorp, One Drop, Passport, Soteria, System, Tome, UMMC, Vital Herd, WalkSmart, i tako dalje [12].

Najveći izazov u budućnosti biće bezbednost podataka. Tehnološke kompanije i IT stručnjaci će morati da unaprede sistem zaštite podataka, međutim, rizik će uvek postojati. Inovacije u app ekonomiji će se odnositi na kreiranje novih platformi za interakciju sa zdravstvenim ustanovama, finansijskim institucijama, finansijske transakcije će biti unapređenje, HR menadžeri će moći da kreiraju ugovore putem onlajn aplikacije, čak će se i dozvole za parking digitalizovati. Sa novim mogućnostima koje app ekonomija donosi, pacijenti će moći da pregledaju svoju podatke putem aplikacija i imati kontakt sa osiguravajućim kompanijama. Kompanije će imati svoje aplikacije, putem koje će potrošači moći da dobiju određene informacije i vrše novčane transakcije, i tako dalje.

3. PAMETNI GRADOVI KAO DEO DIGITALNE EKONOMIJE

Pametni gradovi su se počeli pominjati još osamdesetih godina prošlog veka, a pametan grad je onaj koji koristi svoje resurse maksimalno. To podrazumeva da je ekonomija digitalna, pametna okolina, podrazumeva pametnu vlast i pametne ljude. Inovacije, produktivnost, preduzetništvo, ekonomski indikatori, fleksibilnost privrede i međunarodna saradnja sa drugim zemljama podrazumeva pametnu ekonomiju, tj. digitalnu ekonomiju. Digitalna ekonomija je jedan od uslova da grad postane brend grad. Ukoliko grad koristi digitalnu ekonomiju, tada se grad razvija i raste, čime postaje brend grad i atraktivan za turiste [13].

Sem toga, brend gradovi su pristupačni na lokalnom i nacionalnom nivou sa dobro izgrađenom infrastrukturom, inovativnim i sigurnim transportnim sistemima, što takođe podrazumeva i pametni grad. Pametna okolina se odnosi na to da se grad bazira na upravljanju prirodnim resursima i vodi računa o životnoj sredini, što je takođe još jedna od odlika brend gradova. Intelektualni kapital je ono što povezuje pametni i brend grad. Pametni ljudi imaju visok nivo kvalifikacija, afinitet prema učenju, kreativni i fleksibilni [13].

Ono što je zajedničko brend i pametnim gradovima jeste sastav pametnog života. To podrazumeva da pametni, odnosno brend grad ima bogato kulturno-istorijsko nasleđe, dobre zdravstene uslove, dobar kvalitet življenja, obrazovne ustanove i tako dalje. Pametna vlast je koncipirana tako da učestvuje u donošenju odluka, nudi javne i socijalne usluge i donosi političke strategije i planove za razvoj [13].

Ne postoji tačna definicija pametnog grada. Nekoliko izveštaja i časopisa je dalo svoje predloge za tačnu definiciju. Gasco-Hernandez (2018) je definisao šest dimenzija evropskih pametnih gradova [14]:

1. Pametna ekonomija – kompetitivnost ekonomije;
2. Pametni ljudi –ljudski i društveni kapital;

3. Pametna vlada – učestvovanje u svim ekonomskim sferama;
4. Pametna mobilnost – transport, informacione i komunikacione tehnologije;
5. Pametno okruženje – prirodni resursi i briga o životnoj sredini;
6. Pametno življenje – kvalitet života u gradu.

Gasco-Hernandez (2018) takođe smatra da postoje tri konceptualne dimenzije pametnih gradova: tehnologija (ključ transformiranja života i rada u gradu), ljudi (ljudski kapital i edukacija), i zajednica (podrška vlade i politika), zaključujući da se grad smatra pametni gradom onda kada se investira u ljudski kapital, i u IT infrastrukturu, kako bi se poboljšao život u gradovima uz pomoć Vlade [14].

4. PRIMERI PAMETNIH GRADOVA

Desetine digitalnih aplikacija bavi se različitim vrstama problema, poput smanjenje kriminala, bržeg protoka saobraćaja, smanjenje zdravstvenog opterećenja, izbegavanje emisije ugljen dioksida i dr. u funkciji poboljšanja kvaliteta života građana, kroz optimizaciju postojećih sistema. Alati su dostupni u više domena: bezbednost, mobilnost, zdravlje, energija, voda, otpad, ekonomski razvoj i stanovanje i angažovanje zajednice.

Bezbednost obuhvata rad policije, pametan nadzor, optimizaciju reagovanja u hitnim slučajevima, sisteme ranog upozoravanja na katastrofe, lične aplikacije za uzbunu i dr. Meksiko i Japan su uveli rane sisteme upozorenja za zemljotrese koji stanovnicima omogućava da za nekoliko minuta stignu do najsigurnijeg mesta u blizini. [18]

Smatra se da pametni gradovi mogu biti katalizatori za bolje zdravlje. Zdravstvena zaštita obuhvata telemedicinu, daljinski monitoring pacijenata, upozorenja, prvu pomoć, nadzor zaraznih bolesti, zdravlje majki i dece, informacije o kvalitetu vazduha i vode u realnom vremenu, digitalno praćenje i plaćanje odlaganja otpada i dr. Aplikacije koje pomažu u sprečavanju, lečenju imaju proaktivan i preventivan pristup lečenju, sa potencijalom da smanje zdravstveno opterećenje u gradovima za više od 4 posto. Ovi sistemi koriste digitalne uređaje za očitavanje vitalnih parametara, a zatim ih bezbedno prenose doktorima na drugoj lokaciji radi procene. Ovi podaci mogu upozoriti i pacijenta i doktora kada je potrebna rana intervencija, odlaganje komplikacija i hospitalizacija. Gradovi mogu da koriste podatke i analitiku da bi preciznije identifikovali demografske grupe sa povećanim profilima rizika i ciljanim intervencijama. Takozvane *mHealth* intervencije mogu da šalju poruke o vakcinacijama, sanitaciji i pridržavanju režima antiretrovirusne terapije. U gradovima sa niskim primanjima sa visokom stopom smrtnosti odojčadi, intervencije zasnovane na podacima usmerene samo na zdravlje majke i deteta mogle bi se smanjiti za više od 5 posto. Gradovi u razvoju takođe mogu ostvariti smanjenje od 5 posto korišćenjem sistema za nadzor zaraznih bolesti kako bi ostali korak ispred epidemija koje se brzo razvijaju, kao što su to uradili službenici za javno zdravstvo tokom izbijanja Zike 2016. godine koje se proširilo iz Rija u Majami. [18]

Mobinost uključuje informacije o javnom prevozu u realnom vremenu, digitalno plaćanje javnog prevoza, transportnu infrastrukturu i signalizaciju, *smart* parkiranje, putnu navigaciju, opterećenje saobraćaja u pojedinim delovima grada. Mobilnost uključuje i digitalni poslovni porez, online programe za prekvalifikaciju, personalizovano obrazovanje, lokalne centre za e-karijeru, digitalne dozvole za upotrebu zemljišta i gradnju, katastarsku bazu podataka, *Peer-to-peer* platformu za smeštaj, lokalne platforme za povezivanje i druge digitalne usluge građanima i posetiocima. Barselona je kreirala *Decidim* digitalnu platformu za građansko učešće. Korisnicima se nudi način da se uvažavaju odluke gradskih veća, daju predlozi, učešće u diskusionim grupama o njihovim problemima i sl. Moskva je na sličan način razvila aplikaciju *Active Citizen* za pozivanje javnosti da direktno utiče na urbanističko planiranje i tranzitne odluke. Prateći model velikih platformi za zapošljavanje kao što su *LinkedIn, Indeed i Monster*, gradovi poput Los Anđelesa izgradili su svoje digitalne platforme za lokalno zapošljavanje. *The JobsLA Centar* za e-karijeru nudi ne samo popise poslova, već i besplatne online kurseve i resurse.

Kada je energetska efikasnost u pitanju, aplikacije obuhvataju automatizaciju sistema zgrada, automatizaciju energije u stanovima, potrošnju, delimičnu cenu i sl. Sistemi omogućavaju uvid u potrošnju i kvalitet vode, kontrolu curenja, pametno navodnavanje i sl. Sa sjajnim zgradama i zelenim površinama, Južnokorejski Songdo je visoko energetski efikasan i visoko digitalan grad. Kućni otpad je direktno iz kuća prebačen kroz mrežu tunela u procesne centre za sortiranje i tretman, eliminišući potrebu za kamionima.

U Saudijskoj Arabiji je izdvojeno 500 milijardi dolara za novi urbani ekosistem na obali Crvenog mora. Konstrukcija već je počela, u prvoj fazi očekuje se da će biti završen 2025. NEOM je zamišljen kao zona nulte

emisije, jer je bazirana na tehnologiji vetra i solarne energije. Projekat se fokusira se na to kako pametni gradovi mogu implementirati robotiku za rukovanje repetitivnim zadacima.

Gradovi koji planiraju digitalizaciju mogli bi da smanje broj smrtnih slučajeva, broj nezgoda u drumskom saobraćaju i izbijanje požara od osam do 10 procenata. Prediktivni rad policije, mapiranje kriminala i izrada sigurnosnih kućnih sistema bi takođe doprineli smanjenju mnogih neželjih pojava. U Riu de Žaneiru država je implementirala sistem za mapiranje zločina. Platforma je omogućila bolju razmenu informacija između vojske i policije smanjivši kriminal za 30%.[18]

Pametni sistemi mogu optimizovati bezbednost u saobraćaju, a neke aplikacije koje su osmišljene mogu smanjiti vreme putovanja za zaposlene za 15-20 posto. Potencijal koji je povezan sa svakom aplikacijom je veoma promenljiv, u zavisnosti od gustine naseljenosti grada, postojeće tranzitne infrastrukture i obrazaca putovanja. U gradu kao što je Njujork, pametne tehnologije štede prosečnu dnevnu vožnju skoro 15 minuta dnevno. Prikupljanje i analiza podataka o korišćenju javnog saobraćaja takođe može pomoći gradovima da donesu bolje odluke o modifikovanju autobuskih linija, postavljanju saobraćajnih signala, dodavanju biciklističkih staza i dodeljivanju budžeta za infrastrukturu. Mnogi gradski tranzitni sistemi, poput onih u Hjustonu i Londonu, funkcionišu na bazi digitalnih platnih sistema. U bliskoj budućnosti, transport kroz London će biti takav da će za pešake biti bezbedno jer će moći da vide određene senzore vezano za dolaske vozila. Grad planira da ugradi 3D mape za turiste, i tako dalje. Evolucija Londona u proteklih nekoliko godina je i bazirana na digitalnoj tehnologiji kao što su senzori, analiza podataka i slično. Trenutno postoje pilot projekti za pametne gradove širom sveta, a tehnologija se sve više i više razvija [14]. Neki od njih idu korak dalje nudeći pretplatu na mobilnost koja pokriva više načina prevoza. *Helsinki's Vhim* mobilna aplikacija, na primer, naplaćuje mesečnu naknadu za neograničeno korišćenje bilo kojeg tipa javnog prevoza, plus taksi i korišćenje usluge deljenja vožnje.

Pametne aplikacije za parkiranje usmeravaju vozače direktno na dostupna mesta, eliminišući vreme kruženja po gradskim blokovima. Moskva je implementirala razne inteligentne alate za upravljanje saobraćajem, koje je kombinovala sa velikim ulaganjima u javni prevoz i nove politike parkiranja.

Pametne gradske tehnologije mogu stvoriti ili uništiti veliki broj radnih mesta. Procenjuje se da bi čitav niz pametnih gradskih tehnologija mogao imati neznatno pozitivan neto uticaj na zapošljavanje, što bi do 2025. godine dovelo do povećanja za 1 do 3 posto. Ovaj broj kombinuje direktne, indirektne i indukovane efekte posla koji potiču od nekoliko događaja. Prvo, pametne gradske tehnologije će direktno eliminisati neke poslove, kao što su administrativni i terenski poslovi u gradskoj upravi, dok stvaraju druge, kao što su održavanje, poslovi vožnje i privremeni poslovi instalacije. Drugo, centri za e-karijeru i platforme za digitalno zapošljavanje mogu imati skroman pozitivan uticaj stvaranjem efikasnijih mehanizama za zapošljavanje i privlačenje više nezaposlenih i neaktivnih ljudi u radnu snagu, sa programima prekvalifikacije. Konačno, digitalizacija vladinih funkcija kao što su izdavanje dozvola za poslovanje, izdavanje dozvola i podnošenje poreza može osloboditi lokalna preduzeća od birokratije, doprinoseći efikasnijoj poslovnoj klimi. [18]

Najpoznatiji primeri pametnih gradova su [15]:

- Dubai, Ujedinjene Arapske države – U cilju da bude domaćin *World Expo 2020*. Dubai je inspirisan da kreira „*Internet of Everything*" zajedno sa kompanijom Cisco i drugim IT kompanijama koji povezuju ljude putem WI-Fi i real time interaktivnh gradova u sektorima infrastrukture, podzemnog transporta, javne bezbednosti, i turizma.
- Meksiko, Meksiko Siti – Meksiko je pionir u pametnim gradovima u Latinskoj Americi koji koristi digitalnu vladu kako bi se napravili programi pročišćenja vazduha, gde će se koristiti bicikle i određeni programi korišćenja automobila, kao i promocija pametnih i zelenih infrastruktura. Meksiko je jedan od prvih gradova koji je koristio tehnologiju za apsorpciju smoga.
- Songdo, Južna Koreja – Songdo je prvi specijalizovano dizajniran pametni grad u kojem je sve digitalizovano. Zgrade imaju automatsku kontrolu klime i ulaz je kompjuterizovan, sve što se koristi je digitalno i koristi se u cilju očuvanja životne sredine.
- Singapur – Singapur je takođe jedan od gradova koji je počeo da koristi tehnologiju u svrhu zaštite životne sredine. U 2014. godini grad je lansirao Smart Nation program kao viziju koju će grad moći da vidi baziranu na naprednoj tehnologiji koja će postići ekonomski rast i bolji kvalitet života u Singapuru. Singapur želi da privuče što više kompanija kako bi testirali tehnologiju na ostrvu. Singapur ima jako dobru IT infrastrukturu, populacija je visoko obrazovana, i vlada se

sve više zalaže za digitalnu ekonomiju. Najveći izazov u ovom gradu je mobilnost jer populacija raste iz dana u dan. Redukovanje broja putovanja širom zemlje je veliki cilj vlade Singuapura. Vlada Singuapura je uvek otvorena za nove ideje.

- Johanesburg, Južna Afrika – Grad ima partnerstvo sa telekomunikacionim provajderom Bwired kako bi postao prvi afrički pametni grad do 2040. godine investiranjem u brzi Internet i Wi-Fi pristup, glas/video/sadržaji/protok podataka, bolja infrastruktura i korišćenje elektronskog poslovanja za vlade, edukaciju i zdravstvo.
- Barselona, Španija – Barselona je bila domaćin *Smart City Expo* događaja i smatra se da je ova zemlja jedna od lidera u oblasti tehnologije i primene tehnlogije. Barselona ima *BCN Smart City* platformu na kojoj se nalaze sve informacije vezano za ovaj grad. *BCN Smart City* platforma omogućava da se stavi fokus na interaktivne veb sajtove koji imaju sve detalje o pametnih gradovima, sve većem korišćenju društvenih mreža, najbolje aplikacije kako na što bolji način upoznati Barselonu i šta posetiti, *OpenData BCN* projekat koji daje sve neophodne informacije koje su javne, *Smart City* kamp, i tako dalje.
- Peking, Kina – U Kini postoji mnogo pametnih gradova, ali je Peking jedan od najvećih gradova. Ovaj grad ima plan do 2012. godine da se postigne cilj održivosti i održavanja životne sredine. Zagađenje vazduha je jedan od najvećih problema u Kini tako da grad ima plan da se putem senzora na smart telefonima koristi aplikacija kako bi se videlo gde je najveće zagađenje vazduha u gradu. Osim ovog problema, Peking se suočava sa još mnogim izazovima kao pametan grad kao što je rast urbanizma, unapređenje zdravstvenog sektora, unapređenje sektora edukacije i tako dalje.

Što se tiče Evrope, veliki broj gradova koje se nalaze u okviru država Evropske Unije predstavljaju pametne, a ujedno i brend gradove (Madrid, Barselona, Pariz, Rim, Minhen, Kopenhagen, Amsterdam, Oslo, Moskva, i tako dalje). Evropska Unija je formirala strategiju *Europe 2020* za podsticanje razvoja i kreiranje poslova u određenim područjima kako bi se kreirala pametna i održiva ekonomija. Ciljevi koji bi trebalo da se dostignu se tiču povećanja zaposlenosti, smanjenja siromaštva u određenim gradovima, zaštita životne energije, edukacija i socijalizacija stanovništva u određenim evropskim gradovima.

Razvoj pametnih gradova se može smatrati korisnim „alatom" kako bi se ciljevi koji su zadati putem strategije Europe 2020 ispunili. Pametni gradovi su ujedno i brend gradovi u kojima se na uspešan način rešavaju problemi na razne teme, kao što su klimatske promene i zagađenje životne sredine. Rezultati mogu biti veoma vidljivi kod velikih gradova. Ono što je potrebno uraditi jeste aktivirati i manje evropske gradove i uključiti ih u proces oživljavanja pametnog i brend grada kako bi se rešavali problemi siromaštva i nezaposlenosti.

Gradovi kao što su Kopenhagen (Danska), Mančester (UK), Barselona (Španija), Amsterdam (Holandija) i Dablin (Irska) su gradovi koji pokrivaju sve karakteristike, tj. postižu sve ciljeve propisani strategijom *Europe 2020*. Kopenhagen je grad koji se najviše bazira na zaštiti životne sredine, mnogo više nego na ekonomske i političke faktore u zemlji. Amsterdam je jedan od gradova koji se bazira na zaposlenost i inovacije. Barselona je grad koji se najviše bazira na obrazovanje, dok se Dablin, isto kao i Kopenhagen, najviše bazira na održivost životne sredine i na brigu o zagađenju životne sredine [16].

Kada govorimo o američkom tržištu, pojam pametnog grada se odnosi na grad koji koriste visoku tehnologiju u oblasti informatike i komunikacije kako bi postao „inteligentiji" u smislu rasporede resursa i smanjivanja troškova i energije. Tehnologije se koriste kako bi se poboljšao kvalitet života američkih građana, kao i kako bi se smanjili negativni efekti zagađivanja životne sredine. Najznačajniji američki pametni gradovi su [17]:

1. *Boston, Massachusetts*. Boston je grad koji koriste politiku očuvanja energije i životne sredine. Najviše investicija upravo odlazi na tehnologiju kako bi se sačuvala životna sredina.
2. *San Jose, California*. San Hose predstavlja deo Silikonske doline u Kaliforniji koji takođe koristi „čistu" tehnologiju. Veliki broj investicija je uloženo u grad kako bi se koristila „čista" tehnologija koja podrazumeva da kompanije proizvode proizvode koji ne štete životnoj sredini.
3. *San Diego, California*. San Dijego je grad koji, osim što koristi tehnologiju za očuvanje životne sredine, predstavlja i grad koji ima veliki broj kulturno-istorijskih znamenitosti. Proizvod koji se koristi u ovom gradu za postizanje ciljeva očuvanja životne sredine je *CleanTECH*.
4. *Austin, Texas*. Ostin je grad koji je poznat po solarnoj energiji, energiji vetra i geotermalnim izvorima. Najveće tehnološke kompanije, kao

što *su HelioVolt, Xtreme Power, i Green Mountain Energy* se uprave nalaze u Ostinu.Veliki broj istraživanja na temu održive energije se vrši na Teksas Univerzitetu u Ostinu i od strane koledža prirodnih nauka.

5. *Seattle, Washington*. Sijetl je grad koji vodi računa o „zelenim standardima". Grad je formirao projekat *The Green Building Sustainable Communities* Program kako bi se grad što bolje upoznao sa važnošću sprečavanja zagađivanja životne sredine.
6. *Portland, OR*. Portlend je još jedan od gradova koji se visoko rangira kao pametni grad. Još od početka devedesetih godina ovaj američki grad vodi računa o održivosti prirodnih resursa i energije. Portland je grad broj jedan za bicikliste, u kojem se sve manje koriste druga prevozna sredstva.
7. *Chicago, Illinois*. Čikago je jedanod gradova u kojem vlade uspevaju da povećavaju stopu zaposlenosti iz godine u godinu tako što se kreira program očuvanja CO2 emisije. Veliki broj kompanija koristi „čistu" visoku tehnologiju za očuvanje životne sredine kao što su *G-Tech Energy Inc. i SoCore Energy*.
8. *Berkeley, California*. Berkli predstavlja grad koji je izgrađen takođe na korišćenju „čiste" tehnologije gde se koristi gorivo biljnog porekla. To podrazumeva da se koriste određene biljke za proizvodnju goriva kao što su alge ili kukuruz.
9. *Washington D.C*. Kao glavni grad Amerike, Vašington predstavlja vodeći pametni grad koji koristi „čistu" tehnologiju. Vašington je centar svih asocijacija vezanih za održavanje životne sredine kao što su *American Wind Association*, i *American Council on Renewable Energy, the Renewable Energy Incentive Program*, i *the Renewable Energy Policy Project* i tako dalje.
10. *San Francisco, California*. Pored Vašingtona, još jedan vodeći grad u korišćenju „čiste" energije i tehnologije jeste San Francisko. San Francisko predstavlja jedini grad koji će do 2020. godine u potpunosti koristiti obnovljivu energiju. Jedan od najvećih projekata je *Sunset Reservoir Solar Project* za koji se smatra da će biti gotovo do 2020. godine.

5. ZAKLJUČAK

Savremene ekonomije sve intenzivnije postaju digitalne, dok se istovremeno pred razvojem informacionih i telekomunikacionih tehnologija javljaju novi izazovi koji postavljaju drugačiju dinamiku odnosa svih učesnika na tržištu. Nastanak digitalnih tržišta i ekonomija su upravo dovele do razvoja pametnih gradova koji su istovremeno i brend gradovi a koji ostvaruju višestruke koristi (društvene, ekonomske, turističke, itd.). Zaključuje se da brend gradovi, u isto vreme mogu biti i pametni gradovi koji pametno koriste visoku tehnologiju, intelektualni kapital za razvoja grada, formiranje njegovog imidža, za ekonomski razvoj, infrastrukturu i kulturno-istorijske sadržaje i manifestacije a sve u funkciji boljeg pozicioniranja grada na globalnom tržištu.

Digitalizacija je dovela do nastanka velikog broja aplikacija, koje omogućavaju svim učesnicima na tržišu da uspešnije obavljaju svoje poslovanje, državama da efikasnije komuniciraju sa stanovništvom, kompanijama da posluju sa potrošačima i individualnim korisnicima za kreiranje sopstvenog biznisa.

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DIGITALNA TRANSFORMACIJA HR MENADŽMENTA

Jelena Đorđević Boljanović[1,*],
Gordana Dobrijević[1],
Filip Đoković[1],
Nataša Živojinović[2]

[1]Univerzitet Singidunum,
Beograd, Srbija
[2]Služba za upravljanje kadrovima Vlade
Republike Srbije

Rezime:
Proaktivnost funkcije menadžmenta ljudskih resursa (HRM) u 21. veku nužno zahteva i praćenje IT trendova koji neraskidivo povezuju menadžment ljudskih resursa i digitalizaciju. U navedenom smislu, tehnologija menja sve HR procese – od regrutovanja i zapošljavanja do upravljanja učinkom, a sve u cilju efikasnog sprovođenja poslovne strategije. Efikasni IT alati omogućavaju menadžerima ljudskih resursa da postanu strategijski poslovni partneri u pravom smislu reči, da stvore dodatu vrednost za poslovanje i unaprede organizacionu konkurentnost. Na putu ka digitalizaciji kao svakodnevnici, HR menadžerima su potrebna nova znanja i veštine, kao i potpuna podrška organizacije.

Ključne reči:
digitalna transformacija, ljudski resusrsi, informacione tehnologije, poslovna strategija.

1. UVOD

Informacione tehnologije uveliko menjaju savremeno poslovno okruženje. Otuda i potreba za promenom i modernizacijom funkcije menadžmenta ljudskih resursa u navedenom pravcu. U tom smislu ilustrativno je istraživanje kompanije *Deloitte* iz 2017. godine čiji rezultati pokazuju da je više od polovine kompanija već redizajniralo svoje HR programe u pravcu korišćenja digitalne tehnologije i mobilnih alata, 41% HR timova aktivno kreira mobilne aplikacije za pružanje usluga menadžmenta ljudskih resursa, a 33% koristi neku vrstu veštačke inteligencije za pružanje HR rešenja [1]. Internet portali, baze rezimea i biografija kandidata, *online* testiranja i procene samo su neke od metoda koje se koriste u procesu zapošljavanja, a koje omogućavaju unapređenje produktivnosti, uspešan odabir talenata i strategijski pristup regrutovanju i selekciji [2].

Zapravo, zadatak HR menadžera je da vode celokupnu organizaciju u tri pravca njene digitalizacije [3]. Prvi pravac je digitalizacija radne snage i stvaranje tzv. digitalnog DNK, a koje pretpostavlja uspostavljanje kulture inovacija, deljenja znanja i umrežavanje među talentima; drugi pravac je digitalizacija radnog mesta (stvaranje produktivnog i angažovanog radnog okruženja koje omogućava korišćenje savremenih komunikacionih alata kao što su *Slack, Workplace Facebook, Microsoft Teams*) i

Odgovorno lice:
Jelena Đorđević Boljanović

e-pošta:
jboljanovic@singidunum.ac.rs

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treći pravac je digitalizacija same funkcije menadžmenta ljudskih resursa. Možemo zaključiti da je u navedenom smislu zadatak HR menadžera mnogo širi od prostog uvođenja informacionih tehnologija u poslovno okruženje. Njihov zadatak je da pomognu da organizacija bude digitalna, ne samo da posluje digitalno [4].

2. FAZE HR DIGITALIZACIJE

Svestan promena koje pod uticajem informacionih tehnologija HR menadžment mora da pretrpi [5], autor Dejv Ulrih digitalizaciju HR funkcije posmatra kroz četiri faze [6]:

Prva faza: U kojoj meri se koristi tehnologija za pojednostavljenje administrativnog posla u HR sektoru? Mnoge kompanije kao što su *Oracle* ili *SAP*, nude posebne platforme, sisteme i softverske aplikacije za poslovna i HR rešenja koja obavljanje posla čine bržim, jeftinijim i lakšim.

Druga faza: U kojoj meri se koristi IT da bi se inovirale HR prakse? Svaka oblast upravljanja ljudskim resursima se unapređuje kroz tehnologiju. Tako na primer regrutovanje se može učiniti efikasnijim uz pomoć video intervjua i društvenih mreža, obuka zaposlenih uz pomoć *online* obuka, a planiranje sukcesije uz pomoć sistema za upravljanje karijerom. Oblast koja se odnosi na upravljanje performansama može biti inovirana automatizovanim evaluacijama i *online* sistemima za procenu učinka.

Treća faza: U kojoj meri se koristi tehnologija za pristup informacijama? Upravljanje informacijama je ključna za postizanje poslovnih rezultata. Pristup informacijama tradicionalno daje moć liderima zato što imaju više informacija od svojih zaposlenih. Danas, uz otvoreni pristup informacijama uz pomoć tehnologije, informacije se manje odnose na moć, a više na sposobnost donošenja boljih poslovnih odluka. HR odeljenja mogu uticati na poboljšanje upravljanja informacijama na tri načina. Prvo, HR treba da se zalaže za zapošljavanje stručnjaka iz oblasti upravljanja informacijama (*big data* analitičari, stručnjaci za društvene medije, *cloud builders*, *app developers*) Drugo, HR menadžeri mogu omogućiti da spoljašnje informacije dospeju u organizaciju radi donošenja boljih poslovnih odluka. Treće, informacije koje su osnova dobrih poslovnih rezultata mogu biti strukturirane i dostupne, ali i nestrukturirane koje se nalaze u iskustvima korisnika i zaposlenih i kojima HR menadžeri treba da pristupe kroz pažljivo posmatranje i analizu.

Četvrta faza: U kojoj meri se koristi tehnologija za stvaranje društvenih iskustava i veza? HR menadžeri mogu da koriste tehnologiju za izgradnju veza među ljudima koje stvaraju pozitivna društvena iskustva. Zaposleni danas mnogo više teže iskustvima koja će uticati na njihov lični identitet i blagostanje. Tehnologija poboljšava društvene veze ili stvaranjem mreža za rešavanje problema (gde ljudi rade na zajedničkim poslovnim problemima, korišćenjem društvenih mreža u kojima ljudi dele svakodnevne životne situacije) ili korišćenjem mreža u kojima se ljudi povezuju sa drugim ljudima koji dele njihove vrednosti. Ovde je potrebno naglasiti i neophodnost svakodnevnih interakcija ove vrste za mlade generacije.

3. HR DIGITALIZACIJA KAO SVAKODNEVICA

Drastična promena načina poslovanja utiče ne samo na organizaciju i njene klijente, već i na samu HR funkciju. U okruženju u kome kompanija poput *Facebook*-a nije samo društvena mreža, već je i najveća medijska kompanija iako sama ne kreira svoj sadržaj, u kome kompanija *Alibaba* posluje ne samo kao najveća *e-commerce* kompanija, već i finansijska i tehnološka kompanija koja briše granice među industrijama i u kojoj klijenti kupuju ili obavljaju svoje bankarske transakcije preko svojih mobilnih telefona svuda, u svakom trenutku, HR funkcija takođe mora da bude transformisana. U čemu se ogleda navedena transformacija i kako transformisana HR danas izgleda? Tri su glavne oblasti promena u menadžmentu ljudskih resursa – upravljanje performansama, pribavljanje talenata i HR analitika [7].

Promena HR funkcije u oblasti kontinuiranog upravljanja performansama podrazumeva uključivanje razvojnih planova, *online* procena performansi, gemifikacije i alata za upravljanje timom u svakodnevni posao. U oblasti privlačenja talenata budućnost je u brzim, sveobuhvatnim sistemima zapošljavanja koji će se fokusirati na poznavanje tehnologije, u veštačkoj inteligenciji koja će omogućiti iskustva poput virtuelnih obilazaka kancelarijskih i fabričkih lokacija, u avatarima koji će podržavati socijalizaciju i u sistemima za procenu potencijala koji će biti u mogućnosti da predvide uspeh kandidata sve do penzionisanja. Inovacije u oblasti HR analitike omogućiće analizu obrazaca komunikacije i performansi koji će predviđati ponašanje zaposlenih, usklađivati njihovo ponašanje i performanse sa potrebama za sukcesijom i predviđati potencijalne probleme u tim oblastima.

Kako to izgleda u praksi [8]? Kompanija *DuPont* je, na primer, pokrenula veliki projekat da zameni, pojednostavi i kombinuje sve svoje HR sisteme i sisteme za učenje u jedan integrisani portal. Umesto da ponudi tradicionalnu „samouslužnu" aplikaciju, kompanija je razvila moderniji interfejs koji poboljšava produktivnost. *Telstra*, jedna od najvećih telekomunikacionih kompanija u Australiji, koristi aplikaciju kako bi promenila prvo radno iskustvo svojih zaposlenih. Korišćenjem kritičkog razmišljanja, proučavanjem ponašanja i frustracija zaposlenih u prvoj godini rada, i poznavanjem karakteristika ličnosti, *Telstra* je razvila integrisani program socijalizacije koji je drastično poboljšao angažovanje zaposlenih i njihovo zadržavanje u kompaniji. Mnoge kompanije u praksi primenjuju alate koji im omogućavaju bržu i efikasniju digitalizaciju HR funkcije. Pod uticajem digitalizacije se menjaju i metode treninga i obuke zaposlenih. *SmartUp* je platforma za učenje u obliku mobilne aplikacije. Omogućava korisnicima da dobiju i dele znanje veoma brzo. Svaki zaposleni može kreirati onoliko zajednica za deljenje znanja koliko želi. Praksa pokazuje da veliki broj HR odeljenja danas uveliko povezuje tehnologiju i analitiku kako bi predvideli i procenili sve, od zadržavanja zaposlenih do strategija zapošljavanja. Tako npr. *chatbot* [9] omogućava kandidatima i zaposlenima automatizovane, personalizovane razgovore sa računarom. Zaposleni bi mogao da koristi *chatbot* da sazna koliko mu je ostalo dana za bolovanje ili odmor ili kakve procedure pokriva zdravstveno osiguranje kompanije. Takođe, kandidat za posao može odgovoriti na pitanja, kompletirati testove i pratiti status svoje prijave putem personalizovanog asistenta koji ima ime, lice i prijatno ponašanje. Naravno, sve ove funkcije su generisane kompjuterom.

Jedan od pionira u razvoju *online* učenja, ne samo u poslovnom okruženju, nego i na mnogim univerzitetima (*Stanford, Harvard, MIT, Princeton*), je baza *online* kurseva *MOOC* (*Massive Open Online Courses*). U sedmoj godini postojanja (2018), imala je već preko 100 miliona korisnika i 11.400 kurseva [10]. Nekoliko karakteristika ovih kurseva ih čine posebno prilagodljivima korporativnom učenju i razvoju: korisnici mogu da napreduju tempom koji im odgovara; učenje se ne odvija putem predavanja, nego putem istraživanja koje korisnik sam treba da sprovede; za mnoge kurseve zaposleni dobijaju sertifikate koji mogu da im pomognu u napredovanju [11]. Osim toga, *MOOCs* donose velike uštede kompanijama, jer ne moraju da kupuju ili kreiraju, a kasnije i održavaju poseban sistem *online* učenja [12].

Upotreba mobilnih telefona i aplikacija u menadžmentu ljudskih resursa još jedan su primer HR digitalizacije. Kvalitetne mobilne aplikacije omogućavaju produktivno korišćenje novih tehnologija, kao i menjanje stavova i praksi svih uključenih u HR procese. One su relativno jeftine, brzo se instaliraju, lako se koriste, mobilne su i stoga fleksibilne za upotrebu. One treba da budu jednostavne i fokusirane samo na jednu funkciju, na primer povratne informacije (*feedback*). Važno je da bude omogućeno merenje i analiza njihove upotrebe, tj. važno je znati koliko ljudi koristi određenu aplikaciju i na koji način [13]. Savremene mobilne aplikacije i alati poboljšavaju iskustvo zaposlenih, a organizaciju čine zaista digitalnom uz mogućnost mobilnog učenja, regrutovanja i zapošljavanja. Pomenućemo neke od njih [14]:

- *Workday* je HR alat koji pomaže organizacijama da integrišu zajedničke globalne prakse i istovremeno podrže jedinstvene potrebe. Ovaj alat pomaže u stvaranju kataloga radnih mesta, u upravljanju ugovorima o radu, uključujući probne periode, kolektivne ugovore i podatke iz ugovora. Takođe, omogućava upravljanje učinkom, pregled talenata i mesečno praćenje povratnih informacija na svom mobilnom telefonu.
- *HireVue* je alat koji radikalno menja proces zapošljavanja kandidata koji najbolje odgovaraju potrebama organizacije, i to sve preko „pametnih" telefona. On pruža menadžerima mogućnost da pregledaju strukturirane video zapise kandidata za posao, umesto preuranjenih intervjua licem u lice i da dobiju pregled podataka o kandidatu. Kandidati na ovaj način demonstriraju svoje sposobnosti, a ocenjuju se i rangiraju po *HireVue* algoritmima.
- *Attendify* [15] - za socijalizaciju. Razvijena je za pojednostavljivanje prijave i registracije, kao i poboljšanje celokupnog iskustva prilikom prisustva različitim događajima. U nekim kompanijama se koristi u fazi socijalizacije novih zaposlenih.
- *Looop* [16] – za učenje na radnom mestu. To je fleksibilna platforma za učenje, zasnovana na ideji da učenje treba da se desi kad i gde to zaposlenima odgovara, o temama koje su im potrebne.
- *Vibe* [17] – za ispitivanje posvećenosti zaposlenih bez uobičajenih anketa. *Vibe* postavlja pitanja korisnicima kako se osećaju povodom nagrađivanja, učenja ili komunikacije, a zaposleni odgovaraju slikom. Ovaj pristup omogućava brže odgovore, više intuitivne, jer slike više utiču na emotivni deo našeg mozga umesto racionalnog.

- *Smarp* [18] – za poboljšanje komunikacije i posvećenosti zaposlenih. Predstavlja društvenu mrežu za deljenje relevantnog sadržaja zaposlenima.
- *Next Jump* [19] – za nagrađivanje zaposlenih. Omogućava zaposlenima pristup svim beneficijama koje nudi njihova kompanija i pomaže HR menadžerima da naprave najbolje programe nagrađivanja zaposlenih.
- *Clear Review* [20] – za merenje performansi zaposlenih. Ova aplikacija kombinuje povratne informacije u realnom vremenu, česte provere performansi (umesto jednom godišnje kao kod tradicionalnog pristupa) i ocene kolega.
- *Facebook Workplace* [21] – za komunikaciju i učenje. Predstavlja društvenu mrežu jedne organizacije, koja omogućava povezivanje preko *Facebook* grupa, audio i video pozive, učenje, testove i igre. Odvojena je od ličnih naloga korisnika na *Facebook*-u.

Uprkos sve većem prisustvu tehnologije u upravljanju ljudskim resusrsima, relativno malo istraživanja je bilo posvećeno njenoj efektivnosti, tj. u kojoj meri tehnologija omogućava organizacijama da ostvare ciljeve vezane za ljudske resurse. Kako smo analizirali u prethodnom delu članka, tehnologija je promenila način sprovođenja HR procesa (sakupljanje, čuvanje i deljenje informacija o kandidatima i zaposlenima). Ovde treba pomenuti i druge promene izazvane tehnologijom, npr. sve češći rad od kuće i saradnja u virtuelnim timovima, koji su promenili samu prirodu poslova i odnose među zaposlenima. Ne samo da je tehnologija omogućila interakciju između zaposlenih iz udaljenih geografskih područja, nego je i omogućila kompanijama da angažuju pojedince sa specijalizovanim znanjima iz bilo kojeg dela sveta.

Sa druge strane, postoji zabrinutost da uticaj nivoa poznavanja rada na računaru ili anksioznost pri izradi testova mogu biti naročito problematični za osetljive društvene grupe (stariji kandidati, manjine, ljudi slabijeg socioekonomskog statusa). Za ljude iz pomenutih društvenih grupa je manje verovatno da imaju pristup računaru i/ili internetu i često imaju niže nivoe informatičkih veština od većinskog dela stanovništva. U tom smislu, kompanije treba da obezbede, osim ranije navedenih savremenih metoda, i tradicionalne načine regrutovanja i selekcije [22].

4. VEŠTINE HR MENADŽERA I DIGITALIZACIJA

Najčešće se u spisku veština koje HR menadžeri treba da poseduju nalaze veština odnosa sa ljudima, veština donošenja odluka, veština liderstva i tehničke veštine. Tehničke veštine koje su danas zaista multidisciplinarne, u novije vreme je neophodno proširiti i na tzv. „*data skills*" koje bi podrazumevale veštinu upravljanja i korišćenja podataka. Ova veština je preduslov za rukovođenje procesom HR digitalizacije, što je svakako prioritetan zadatak HR menadžera. U tom smislu, organizacije treba da podrže svoje HR lidere u sledećim koracima [23]:

- Organizovanje internih partnerstava – u većini kompaniji druga odeljenja (npr. marketing ili finansije) najčešće već koriste podatke i tehnologiju na način koji HR može primeniti na vlastiti rad. Takva interna saradnja može ne samo da pomogne HR menadžerima da steknu nove veštine, već i da pomogne u podsticanju kulture koja se bazira na korišćenju podataka.
- Mapiranje i povezivanje HR analitike sa poslovnim rezultatima - HR menadžeri treba da znaju kako da povežu svoje podatke o zaposlenima sa rezultatima poslovanja. Ovaj proces mora početi prikupljanjem podataka o veštinama, sposobnostima i ponašanju zaposlenih, često kroz procene. Prikupljanjem podataka o veštinama i iskustvu zaposlenih i njihovim povezivanjem sa poslovnim rezultatima, HR može naglasiti ključne oblasti rizika i prilika za dalji razvoj kompanije.
- Razviti veštinu vizualizacije podataka - jednostavno prikupljanje podataka i analiza neće pomoći HR menadžerima da unaprede svoje napore ukoliko ne znaju kako da iskoriste te podatke, a kako bi uticali na druge. HR menadžeri bi trebalo da kreiraju npr. grafičke prezentacije podataka. Takođe, HR menadžeri treba da savladaju sofisticirane softverske programe kao što su *Power BI*, *Tableau* ili *R Studio*, koji pružaju vizuelni kontekst podacima.
- Implementirati modele planiranja liderstva - pored korišćenja podataka kako bi se istakli trenutni trendovi i nedostatak talenata, HR menadžeri bi trebalo da ih iskoriste za predviđanje budućih potreba za talentima, posebno za rukovodeće pozicije. HR menadžeri treba da koriste modele planiranja kako bi povezali dugoročni strateški plan sa

liderima koji će ih implementirati. Modeli za planiranje liderstva omogućavaju HR menadžerima da kreiraju projekcije na osnovu podataka o broju potrebnih lidera, o veštinama koje će im biti potrebne i pozicijama na kojima će raditi. Ovi modeli mogu da uporede kvalitete i karaktersitike lidera sa onim što im je potrebno za obavljanje posla.

Korist razvoja navedenih veština se ogleda u mogućnosti HR menadžera da sugerišu korekcije u postavljanju prioriteta u sistemu zapošljavanja, razvoja zaposlenih i upravljanja učinkom.

5. ZAKLJUČAK

Digitalizacija omogućava pozicioniranje HR menadžera kao strategijskih poslovnih partnera koji u promenjivom poslovnom okruženju traže mogućnosti za nove poslovne izazove. U tom smislu, zadatak HR menadžera je ne da se pitaju kada će koristiti IT u svojim svakodnevnim aktivnostima, već kako će promeniti mentalni sklop svojih zaposlenih da bi se pripremili za budućnost koja je već tu. Digitalizovani HR procesi olakšavaju donošenje poslovnih odluka, efikasno procesuiranje informacija i znanja, pojednostavljivanje i ubrzavanje poslovnih procesa, a sve to omogućava ostvarivanje osnovnog cilja savremenog menadžmenta ljudskih resursa - privlačenje i zadržavanje zadovoljnih i motivisanih talenata koji su ključni za organizacioni uspeh i koji su optimalnom brzinom usmereni ka budućnosti.

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UTICAJ DIGITALNIH TEHNOLOGIJA NA ODLUČIVANJE IZVRŠNIH DIREKTORA I MENADŽERA U CIRKULARNOJ EKONOMIJI

Verica Bulović[1,*],
Marija Pasuljević[2]

[1]Smart Agency,
Subotica, Srbija,
[2]Société BIC,
Paris, France

Rezime:

Razvoj Interneta i digitalnih tehnologija promenio je način na koji organizacije komuniciraju sa svojim potrošačima, a kao rezultat toga menjaju se strategije digitalnog marketinga. Digitalne tehnologije i proces donošenja odluka u digitalnom okruženju identifikovani su kao veoma značajno područje istraživanja, a cirkularna ekonomija je jedan od ključnih ciljeva savremenih preduzeća za postizanje konkurentskih prednosti u smislu povećanja profita i udela na tržištu. Istraživanje je deskriptivno s ciljem da se prikaže uticaj digitalnih tehnologija na proces donošenja odluka od strane izvršnih direktora i rukovodioca uključenih u proizvodnju, i trgovinu robe široke potrošnje u cirkularnoj ekonomiji. Kvantitativno istraživanje je sprovedeno putem online upitnika, dok kvalitativno istraživanje istražuje pojedinačno ponašanje izvršnih direktora i menadžera u predućima uključenim u cirkularnu ekonomiju.

Ključne reči:

digitalne tehnologije, proces donošenja odluka,, ponašanje potrošala, marketing društvenih medija, cirkularna ekonomija.

1. UVOD

Mnoga istraživanja govore o tome da je digitalni marketing moćan marketinški alat koji dopire do velike grupe potrošača. Postoje različiti načini povezivanja s potrošačima putem digitalnog marketinga, kao što su web stranice, e-pošta, društveni mediji, blogovi i recenzije. Profesionalci obično pribegavaju korišćenju više društvenih mreža u poslovne svrhe, poput društvenih medija po grupama (SMPG). Društvene mreže kao što su LinkedIn, Facebook i Twitter pojavile su se kao profesionalne mreže. Koristeći profesionalne mreže i online zajednice, donosioci odluka povezuju se i sarađuju sa kolegama, stručnjacima i istraživačima širom sveta, na zahtev. Kroz društvene medije, ciklusi profesionalnog uticaja odvijaju se brzinom koja nikada ranije nije viđena i, na mnogo načina, kompanije gube sposobnost kontrole svojih poruka. Učešće u SMPG odnosu zahteva promenu ponašanja od strane organizacija - u kojima dominiraju vredni sadržaji, transparentna iskrenost i predanost da se sledi pravac gde donosilac odluka želi voditi.

Cirkularna ekonomija je najnoviji u nizu koncepata, kao što je nulti otpad, koji je korišten da bi se opisao pristup koji je efikasniji u korištenju sirovina u našoj ekonomiji. Ekološki proizvodi su dobri za ljude i

Odgovorno lice:
Verica Bulović

e-pošta:
bveruska74@gmail.com

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prirodu. Neki ekološki prihvatljivi proizvodi su skuplji od 'tradicionalnih' vrsta proizvoda, ali osobe koje su uključene u proces donošenja odluka u kompanijama i dalje donose odluku o kupovini zelenog proizvoda. Možemo reći da je to koncept koji sve više dobija na značaju, uključujući i kompanije koje će morati u svojoj proizvodnji da koriste određeni procenat sirovina sa oznakom CE.

2. DIGITALNE TEHNOLOGIJE

Digitalni marketing se može definisati kao upotreba digitalnih kanala za plasman brenda. Da bi se nadovezali na ovu definiciju, može se reći da u digitalnom marketingu kreiranje potražnje pokreće internet. Digitalni marketing se koristi tokom čitavog ciklusa kupovine, od kreiranja svesti o brendu do ohrabrivanja za kupovinu, podrške prilikom kupovine, pomoći pri korišćenju brenda i upravljanju servisom nakon prodaje. Istraživanje koje su sproveli Moreno, Calderon i Moreno[1] pokazuje da se digitalni marketing kroz društvene medije koristi kanalima marketinške komunikacije, te je zamena za tradicionalne marketinške kanale prilikom povezivanja sa potrošačima. Ovi nalazi pokazuju da su društveni mediji moćan marketinški kanal koji privlači i utiče na odluke potrošača prilikom kupovine. U sledećoj tabeli možemo naći glavne digitalne kanale marketinga:

Tabela 1.

	Digitalni marketing kanali	
	Vrste digitalnih marketing kanala	***Definicije***
1.	Email marketing	Digitalni marketing koji šalje poruke publici putem elektronske pošte.
2.	Affiliate marketing	Oglasi koji se prikazuju na internetu. Online affiliate prodaje proizvode organizacije i dobija nagradu za preporuke.
3.	Search engine marketing	Marketing koji se odnosi na pretraživanje na internet
4.	Social media marketing	Kreiranje, objavljivanje i deljenje sadržaja od strane pojedinaca kao što su blogovi, slike i video zapisi na internetu.
5.	Pay per click advertising	Sistem online oglašavanja kojim oglašivač plaća klikove na njihov oglas.

Izvor: Vrste digitalnih marketing kanala [2]

Prema istraživanjima Tiaga i Verissima [3] veb je veoma važan i moćan alat za organizacije koje planiraju da kreiraju snažne brendove i steknu konkurentsku prednost. Kompanije su iskoristile prednosti interneta putem usvajanja društvenih medija kako bi pružile informacije i povezale se sa potrošačima i zainteresovanim stranama na taj način generisale prodaju. Da je marketing društvenih medija važan za komunikaciju i upravljanje odnosima sa potrošačima, pokazalo je istraživanje koje su sproveli Kumar, Bezvada, Rishika, Janakiraman i Kannan [4]. Prema Rasool [5] društveni mediji omogućili su potrošačima da budu u središtu aktivnosti organizacije i novi alat za interakciju. Istraživanje koje su sproveli Hudson, Huang, Roth i Madden [6] pokazalo je da su potrošači koji se bave svojim omiljenim brendovima na društvenim medijima izgradili čvrste veze s tim brendovima.

Radimo u okruženju u kojem kompanije nemaju takvu kontrolu u odnosu na reputaciju svojih brendova, proizvoda i usluga. kao što je to bio slučaj u prethodnom periodu Kroz korišćenje društvenih medija, korisnici i perspektiva sada imaju skoro trenutnu platformu za diskusiju o svojim idejama, iskustvima i znanju. Upotreba društvenih medija igra važnu ulogu u profesionalnom životu donosilaca odluka, jer oni koriste alate i medije koji su im na raspolaganju kako bi ih uključili u procese donošenja odluka. Društvena priroda odlučivanja se impresivno povećala, povezujući generacije stručnjaka jedne s drugima, menjajući dinamiku upravljanja odnosima s klijentima, marketinga i komunikacija - zauvek.

3. UTICAJ DIGITALNIH TEHNOLOGIJA NA INDUSTRIJU

Zbog tehnološkog napretka i unapređenja digitalnog marketinga u marketinškom miksu, došlo je do promene u angažovanju potrošača i njihovom ponašanju. Postoji novi B2B kupac - onaj koji ne očekuje, i u mnogim slučajevima ne želi, da se bavi prodavcem sve dok ne dođe vreme da se posao završi.

Više od tri četvrtine svih B2B (business-to-business) kupaca danas, uključujući i mala preduzeća i poslovne korisnike, imaju ograničenu interakciju sa prodavcima. Umesto toga, ovi kupci se oslanjaju na digitalne resurse - kao što su veb sajtovi dobavljača i treće strane - video snimci, kritike kupaca, blogovi i društveni mediji. I sve više koriste mobilne telefone kako bi dobili te informacije, posebno putem pretraživača i društvenih medija. Danas, polovina svih klijenata očekuje da će veb sajt dobavljača biti koristan kanal, a više od trećine očekuje da

će sajt biti njihov najkorisniji kanal. U ovom digitalnom okruženju, „guranje" proizvoda ili usluga klijentima nije toliko efikasno. Marketing i prodaja moraju postati više orijentisani na „povlačenje".

Novi B2B kupci tragaju za istim online mobilnim iskustvima i karakteristikama s kojima se susreću kao potrošači. Žele poboljšanu funkcionalnost pretraživanja, ocene i recenzije, preporuke za personalizovane proizvode i usluge i neposredno iskustvo. Kupci očekuju sadržaj koji priča priču o proizvodima i uslugama proizvođača bez prekida kroz sve digitalne medije (veblokacija, video, interaktivnost), kanale (određene stranice, časopisi za štampanje, vebinari), uređaje (računar, tablet, pametni telefon) i faze istraživačkog procesa, od svesti kroz kupovinu i zadržavanje na kraju tog procesa.

Više od polovine svih B2B kupaca u procesu kupovine gleda najmanje osam sadržaja, a dodatnih 30% gleda na pet do sedam. Oni žele sažetu i koherentnu interakciju, kako god da se desi - i kada je ne dobiju, često eliminišu prodavca prilikom razmatranja, pre nego što dođe do bilo kakvog direktnog kontakta.

Pored toga, ovi novi B2B kupci su podržani od strane mladih, tehnološki pametnih istraživača. Googleova studija pokazala je da su Milenijci (ispod 35 godina starosti) činili skoro polovinu B2B istraživača u 2015. Članovi ove generacije odrasli su sa internetom i mogli su mu pristupiti preko svojih telefona najmanje deceniju. Mnogi takođe imaju značajna ovlaščenja nad kupovinama u ime kompanije u kojoj rade. I oni kupuju digitalno - više od polovine je koristilo veb stranice dobavljača za kupovinu, a gotovo 20% koristi Amazon.

Mnogo novih kompanija na tržištu nudi hiljade proizvoda i usluga osmišljenih da pomognu B2B marketerima da se kreću u digitalnom svetu uopšte, a posebno u smenama generacija. Novi softveri i aplikacije generišu efikasnost i omogućavaju sofisticiranije mogućnosti. Ali njihova sve veća složenost čini izgradnju marketing tehnologije izazovima i za marketinške i za IT lidere.

Najbolji trgovci su shvatili kako da se nose sa personalizacijom u ovom složenom okruženju. Oni koriste podatke, tehnologiju i naprednu analitiku za kreiranje sofisticiranih profila za svakog klijenta (ili člana tima, u slučaju većih nabavnih organizacija) i onda pristupaju tom klijentu kao pojedincu i angažuju se na osnovu njegovih ili njenih potreba i uloge.

Klijenti i top menadžment sve više očekuju od trgovaca da efikasno koriste podatke i alate kao što su prediktivna analitika, brzo testiranje i učenje, mašinsko učenje i veštačka inteligencija za kreiranje klijentovih putovanja zasnovanih na podacima, što rezultira visokokvalitetnim prednostima. Trenutni nedostatak integracije marketinške analitike je veliko ograničenje za mnoge. Istraživanje koje je sproveo Forrester Research (2015) pokazalo je da je samo 26% trgovaca zadovoljno svojim marketinškim analitičkim alatima, dok su ostali nezadovoljni [7]. U međuvremenu, finansijska očekivanja najvišeg menadžmenta takođe se povećavaju. Izvršni direktori i finansijski direktori očekuju dokaze koji pokazuju da digitalne kampanje i sadržaj rezultiraju povećanom prodajom. Otprilike polovina B2B trgovaca danas ima direktnu odgovornost za prihode, a taj broj brzo raste, navodi Forrester.

Sve ove promene transformišu marketing u digitalnu funkciju u organizaciji. Mnoge kompanije će morati radikalno da promene svoju organizaciju kako bi ostali u toku sa svojim klijentima i uspostavili prednost nad svojim konkurentima.

4. BUDUĆI TRENDOVI KOJI IMAJU UTICAJ NA INDUSTRIJU

Napredne organizacije shvataju da je iskustvo korisnika veoma važno u procesu odlučivanja o kupovini. Ne treba potcenjivati važnost kulture u vođenju ove transformacije. Personalizacija je i dalje veoma važna. Međutim, AI i VR će sve više napredovati. Takođe, kompanije moraju kapitalizovati mogućnosti mobilne tehnologije koje već postoje i strateški ulagati u nove tehnologije kao što su AI i VR.

Evo nekih budućih trendova koji će uticati na B2B industriju [8]:

1. *Kognitivni marketing* – može postaviti sistem marketinga da automatski predviđa informacije orijentisane ka cilju, pa čak i da postavi poslovne kampanje na više kanala na osnovu složenog ciljanja ponašanja.
2. *Personalizacija* - vodeća platforma za eksperimentisanje koja omogućava organizacijama da pružaju kontinuirano eksperimentisanje i personalizaciju na veb sajtovima i mobilnim aplikacijama.
3. *Psihografska segmentacija* - sposobnost da se odrede i identifikuju korisnici na osnovu geografskih i demografskih podataka, kao i neposredna dostupnost podataka ima stvarni potencijal za preoblikovanje svijeta marketinga.
4. *Facebook prednosti* - Facebook je upravo predstavio novi servis za snimanje koji marketinški

stručnjaci mogu koristiti na svojim Facebook oglasima zvanim Lead Ads. Vodeći oglasi su dostupni za korišćenje putem Facebook menadžera oglasa. Mogu da se kreiraju i prilagode oglasi, tražeći da posetioci podnesu različite vrste informacija, kao što su adresa e-pošte, poštanski broj i broj telefona. Informacije unete u ovaj sistem mogu se preuzeti i obraditi kako bi se povećao doseg marketinških kampanja.

5. *Angažovanje uživo i realno vreme* - Facebook živi u realnom vremenu i definitivno ima veoma veliku ulogu u privlačenju više ljudi da se uključe sa svojim vestima u realnom vremenu.

5. METODOLOGIJA ISTRAŽIVANJA

Za potrebe ovog istraživanja, ali i radi ispunjavanja osnovnih metodoloških zahteva, pre svega, korišteni su određeni stupanj sistematizacije, objektivnosti i pouzdanosti kao osnovnih metoda i tehnika. Kvantitativno istraživanje je izvršeo online upitnikom, dok je kvalitativno istraživanje bilo fokusirano na istraživanje pojedinačnog ponašanja direktora i menadžera.

Cilj rada je da se identifikuje uticaj digitalnih tehnologija i kako utiču na odlučivanje o kupovini direktora i menadžera u okviru cirkularne ekonomije. Svrha istraživanja je analiza uticaja digitalnih tehnologija na donošenje odluka potrošača iz perspektive organizacija u cirkularnoj ekonomiji.

Za primarno istraživanje korišten je online upitnik kako bi se došlo do šire publike u nekoliko zemalja i kontinenata, kao i intervjui licem u lice sa menadžerima kompanija koje posluju u Srbiji i Sloveniji.

On-line anketa je sprovedena tokom februara 2019. preko Google Forms na uzorku od 73 ispitanika koji su radili u 21 zemlji na 4 kontinenta, za kompanije koje su različitih veličina i broja zaposlenih, kao i iz različitih industrijskih sektora. Autor je lično poslao pozivnice učesnicima i ciljanim kompanijama iz različitih industrijskih poslovnih područja, prvenstveno putem direktne e-pošte, ali i koristeći osobne Instagram, Facebook i LinkedIn za postizanje višeg i globalnijeg pregleda. Poziv je poslat putem e-maila na 90 adresa, upitnik je popunilo 73 ispitanika (81,1%). Upitnik se sastoji od 20 pitanja, zatvorenih (18) i otvorenih (2). Kroz zatvorena pitanja ispitanici su mogli da izaberu neke od ponuđenih stavki unapred, kao i da definišu rangiranje njihovih odgovora (kao što je rangiranje digitalnih medija koji su važni pri izboru novog dobavljača). Kroz otvorena pitanja ispitanici su mogli slobodno da izraze svoj stav o digitalnoj tehnologiji, ponašanju prilikom kupovine eko-proizvoda i njihovim prednostima i nedostacima, kao o obimu korišćenja digitalnih tehnologija, kako danas tako i u budućnosti.

Preduzećima i zaposlenima upućen je poziv za učešće u anketi. Autor je lično poslao pozivnice učesnicima i ciljanim kompanijama iz različitih industrijskih poslovnih područja, prvenstveno putem direktne e-pošte, ali i koristeći osobne Instagram, Facebook i LinkedIn za postizanje višeg i globalnijeg pregleda. Poziv je poslat putem e-maila na 90 adresa, upitnik je popunilo 73 ispitanika (81,1%).

Intervju sa stručnjacima može otkriti više informacija o njihovim navikama, izjavama i ponašanju prilikom kupovine ekoloških proizvoda. Kvalitativni polustrukturirani intervju (licem u lice i putem Skipe-a) sproveden je u okviru 6 kompanija na osnovu 8 pitanja u kojima se od lokalnih kupaca tražilo da izaberu svoje dobavljače i koje digitalne tehnologije utiču na odluke o kupovini.

Intervju je vođen sa menadžerima iz sledećih kompanija:

- Specijalista za merchandising i merchandising pripravnik iz L'Oreala
- Trade Marketing Key Account Executive iz IMLEK-a
- Senior Buyer iz Atlantica
- Direktor prodaje iz Ulkera
- Menadžer brenda i obuke iz Lavazze
- Menadžer trgovine i brenda iz BIC-a

Intervjui su sprovedeni tokom januara 2019. godine

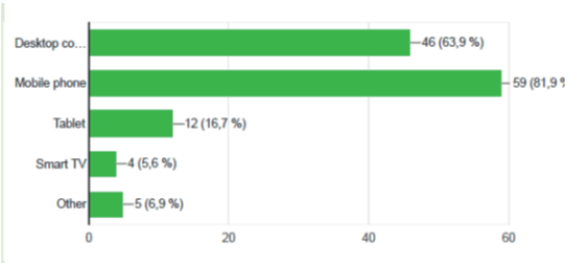
6. REZULTATI ISTRAŽIVANJA

Odgovori na pitanja iz intervjua menadžera pokazali su da je cena bila prva tema koju su posmatrali, sekundarni je bio odnos materijala i kvaliteta / cena. Nijedan menadžer nije naveo kao razlog kupovine cirkularnu ekonomiju ili ekološki proizvod. Na pitanje gde su pronašli informacije o svom dobavljaču, oni su odgovorili da su to digitalne mediji kao što su veb sajtovi dobavljača ili online reference koje su uzete u razmatranje.

Tokom pitanja koja su se ticala cirkularne ekonomije, mnogi su odgovorili da ne znaju šta zapravo taj pojam znači, već da je njihova kompanija fokusirana na obezbeđivanje dobrih proizvoda za potrošače. Kao što je Googleov Vise predsjednik Jim Miller (2016) izjavio u intervjuu "Google je kompanija koja gradi svoje principe oko kružne ekonomije, čak i ako nismo znali da je to kružna ekonomija".

Menadžer L'Oreal-a je izjavio da nakon aktivacije bacaju sve POS materijale i da su koristili plastiku. Razmatranje o uicaju na životnu sredinu nije bilo lokalno uključeno. Međutim, oni su dobili informacije od svoje centrale da bi trebalo pronači alternativu za plastiku.

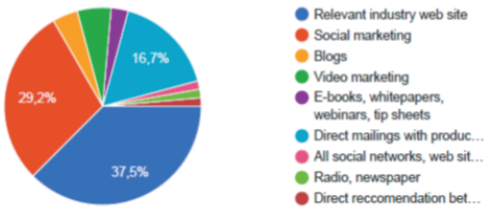
Anketno istraživanje je sprovedeno online (februar 2018). Rezultati su pokazali da većina ispitanika koristi mobilne telefone kada traže informacije za kupovinu eko proizvoda (82,2%) i koriste relevantne veb stranice kompanije (84,9%). Za pretragu informacijakoristi se najčešće mobiloni telefon (81,91%), desktop računar (63,9%), potom sledi tablet (12%) , Smart TV (5,6%) i drugi uređaji.



Slika 1. Uređaji koji se koriste prilikom prikupljanja informacija

Izvor: Autorova izrada

Relevantni industrijski veb sajt je najvažniji za organizacione kupce (37%), nakon toga slede društvene mreže (28,8%) i direktni mailing (17,8%). Što se tiče faktora koji su najvažniji prilikom donošenja odluka o kupovini Eko proizvoda iz cirkularne ekonomije, kvalitetni proizvodi su na prvom mestu (59,7%) prije nego ekološka i socijalna svest (43,1%) ili ekološka održivost (43, 1%).



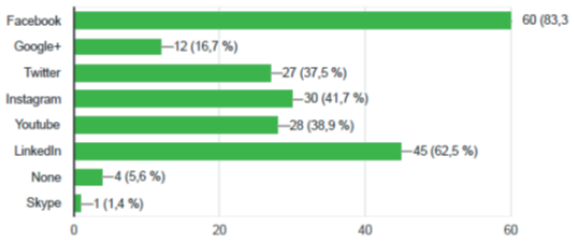
Slika 2. Digitalne tehnologije koje se koriste u procesu odlučivanja o kupovini

Izvor: Autorova izrada

Informacije koje se distribuiraju putem društvenih medija su relevantne (49,3%) jer 38,4% kompanija uvek koristi usluge društvenih medija.

U otvorenom pitanju o efektima digitalnih tehnologija na način na koji ta kompanija kupuje, postoje odgovori: "Učinili smo ga efikasnijim, bržim i jeftinijim", "to će snažno uticati na povećanje prodaje našeg novog proizvoda - putarine", ' Efekat digitalne tehnologije će biti vidljiv kroz novi ukupni pristup klijentima, sa snažnim fokusom na njihove potrebe. Oni se u potpunosti slažu da digitalne tehnologije utiču na sve njihove marketinške aktivnosti u kompaniji (43,3%). U narednih nekoliko godina biće veoma važno razumeti kako mobilni korisnici istražuju i kupuju proizvode (44,4% ispitanika se veoma slaže s tim).

Razmatrajući relevantne informacije prilikom donošenja odluka o kupovini, menadžeri najviše od društvenih medija koriste Facebook (83,3%), tek onda LinkedIn (62,5%), Instagram (41,7%) i dr. Interesantno je da se i poslovni korisnici u većoj meri oslanjaju na Facebook nego poslovnu mrežu LinkedIn. Ispitanici su naveli da im veoma pomažu video snimci (na Youtube) koji pokazuju demonstracije proizvoda koje traže (38,9%).



Slika 3. Društvene mreže koje se najčešće koriste prilikom pretrage

Izvor: Autorova izrada

Analizirani podaci iz kvalitativnog i kvantitativnog istraživanja pokazuju da je većina ispitanika muškaraca (skoro 60%) srednjih 36-45 godina (60%), visoko obrazovanih 80%), a njihova radna uloga u kompaniji je uglavnom direktor (42,5%) i direktor / viši direktor (31,5%). Oni uglavnom rade za globalne kompanije sa velikim godišnjim prihodima (iznad 150 mil EUR) koje su više fokusirane na marketing poslovanja. Pretežno koriste mobilne telefone (82,2%) i desktop računare (64,4%) kada traže informacije za kupovinu EKO proizvoda. Na osnovu dobijenih podataka kompanije će moći kreirati ciljne grupe i razraditi osobine svake od njih kako bi se mogla kreirati kvalitetna digitalna marketing strategija.

7. ZAKLJUČAK

Današnji poslovni svet sve više postaje deo globalnog virtualnog i kolaborativnog radnog okruženja. Online zajednice i profesionalne mreže su verovatno promenile način na koji posluju kompanije.

U današnjoj globalnoj mreži koja povezuju ljude i uređaje:

- Jedna milijarda ljudi priključena je na internet,
- Četiri milijarde imaju pametne telefone sa sposobnošću prenosa podataka,
- Više od četiri stotine miliona ljudi deli milijarde komada sadržaja i iskustava svake sedmice putem online razmene.

Navedeni podaci ukazuju da kompanije moraju uvažavati činjenicu da se obraćaju potrošačima koji su uveliko online, a menadžeri prilikom donošenja odluka o kupovini treba da konsultuju digitalne medije koji predstavljaju jedan od najznačajnijih izvora informacija.

Profesionalne mreže, veb, e-pošta i SMS su među alatima koji omogućavaju višekanalni pristup za pojedince (zaposle, klijente, partnere i dobavljače). Digitalizacija takođe transformiše proces donošenja odluka o kupovini, uključujući način na koji korisnici traže informacije, razmatraju i procenjuju proizvode i usluge, komuniciraju sa organizacijom i kupuju.

Prema Forrester Research-u 35% tržišne potrošnje sada je na on-line naporima, što je za 19% više od 2011 [7]. Od digitalnih tehnologija E-mail je i dalje važan, ali za B2B kompanije najbolji način da se potroši marketing budžet da bi se ostvarili odgovarajući rezultati je na dizajn veb stranice, SEO, email marketing, društvene medije, blogove i video zapise i događaje.

Cirkularna ekonomija predstavljena je kao rešenje za porast ekološke decimacije uz rastući globalni ekonomski prosperitet uvođenjem novih sistema proizvodnje, potrošnje i odlaganja. Kao sasvim novo rešenje za kompanije, koje teži da smanji troškove i korišćenje plastike, a koje od strane menadžera obuhvaćenim istraživanjem još uvek nije dovoljno prepoznat, budući zadatak marketara je da putem digitalnih tehnologija osnaže sve prednosti koje pruža cirkularna ekonomija na duštvo uopšte.

ZAHVALNOST

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ULOGA MEDIJSKE KONVERGENCIJE U RAZVOJU KULTURNIH I KREATIVNIH INDUSTRIJA

Danica Čigoja Piper*,
Tijana Radojević,
Milica Čolović,
Nikica Radović

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Imajući u vidu medijsku konvergenciju kao jedno od obeležja medija i medijski posredovanog poslovanja u digitalnom svetu, glavni cilj ovog rada je razumevanje medijske konvergencije kao izazova savremenog društva i to kroz prizmu globalne ekspanzije kulturnih i kreativnih industrija. Cilj ovog rada je i da ponudi analizu povezanosti procesa medijske konvergencije i razvoja kulturnih i kreativnih industrija. Glavna teza predstavljena u radu je da proces medijske konvergencije pozitivno utiče na razvoj kulturnih i kreativnih industrija, te da su medijska konvergencija – u najvećoj meri podstaknuta informacionim tehologijama i digitalizacijom sveta oko nas – i različiti kreativni procesi u društvu usko povezani.

Ključne reči:

mediji, telekomunikacije, digitalizacija, kultura, kreativnost.

1. UVOD

Munjeviti razvoj digitalnih tehnologija u 21. veku doveo je do stvaranja novih medijskih formi koje se, upravo zbog brzine tehnoloških promena i tržišnih prilika, suočavaju sa neprekidnom transformacijom. Najveća promena u pojavnim oblicima medija ogleda se u kreiranju svojvrsne mreže medijskih usluga zasnovane na sinergiji mobilne tehnologije, tradicionalnih elektronskih medija, informacionih tehnologija i interneta. Tako ukršteno delovanje medija, IT sektora i telekomunikacija dovelo je do razvoja pojma medijska konvergencija koji podrazumeva novi oblik komuniciranja u postojećem digitalnom prostoru. Ovakav vid razmene sadržaja smatra se težnjom ka univerzalizaciji medija, odnosno ka kreiranju iskustva upotrebe jedinstvenih medijskih i različitih komunikacionih usluga posredstvom različitih uređaja, a sve zahvaljujući snažnoj mrežnoj povezanosti i visoko razvijenoj tehnološkoj podršci.

Prema Henriju Dženkinsu (Henry Jenkins), koji je fokus svog teorijskog rada i istraživanja postavio u sferi ispitivanja kulturne konvergencije, medijska konvergencija nije samo proizvod novih dostignuća u domenu digitalnog, već predstavlja proizvod „povezanosti postojećih tehnologija, industrija, tržišta, žanrova i publika" [1]. Medijska konvergencija, prema ovom autoru, nije krajnji rezultat delovanja više ukrštenih

Odgovorno lice:
Danica Čigoja Piper

e-pošta:
danica.cigoja@fmk.edu.rs

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faktora sa zajedničkim ciljem – pravovremeno, jasno i tačno informisanje – već je to proces promene medijske logike koji traje i koji će, kao uvek iznova tehnološki uslovljen, trajati. „Zahvaljujući ubrzanom rastu kanala (komunikacije) i mogućnosti brzog prenošenja novih kompjuterskih i telekomunikacionih uređaja, ulazimo u eru gde će mediji biti svuda i koristićemo različite vrste medija povezane jedne sa drugima" [1]. Ovo više decenija građeno teorijsko predviđanje Dženkinsa, danas je i empirijski potvrđeno. Savremeno društvo u velikoj meri se oslanja na niz medija bez kojih ljudi ne mogu zamisliti svoju svakodnevicu. Najčešće su brojni medijski sadržaji dostupni u mobilnom telefonu korisnika, a kada korisnik, uz mobilni telefon, poseduje i računar ili tablet, onda su, kao po komandi, svi posedujući uređaji povezani posredstvom odgovarajućeg softvera – recimo nalozi podržavajući od strane Gugla (Google) ili Epla (Apple). Ukoliko korisnik ima mogućnost da živi u domu koji je organizovan po principu *pametne kuće* onda je sigurno da je i taj aspekt života umrežen sa mobilnim telefonom, posredstvom odgovarajuće aplikacije. Reč je o medijskoj konvergenciji na delu. Takav vid tehnološkog upliva u svakodnevni život sve je prisutniji i zbog toga je neophodno da stalno preispitujemo proces medijske konvergencije i da ga usavršavamo, posebno u onim poljima gde je moguće da dođe do izostanka neophodnog nivoa kontrole ovog procesa od strane njegovih kreatora u različitim industrijama (programeri i drugi stručnjaci u IT sektoru i u telekomunikacijama, urednici medija, dizajneri, novinari, zaposleni u različitim kreativnim i komunikacionim delatnostima...).

U složenom procesu konvergencije medija posebnu ulogu igraju telekomunikacione kompanije koje poseduju visok nivo finansijske podrške za razvoj digitalizacije medijske komunikacije, imaju razvijen sistem održavanja mreže krajnjih korisnika i sposobnost brzog prilagođavanja novim tehnologijama. Kao takve, one „poseduju potencijal da preuzmu centralnu ulogu u oblikovanju i popularizaciji novih informacijskih usluga" [2]. Prema Crnobrnji, na taj potencijal moraju računati svi koji se bave medijima i imati na umu da „telefonske organizacije ne nameravaju da prihvate samo ulogu izvođača i konstruktora u razvoju globalne informacijske infrastrukture"[2], već da je njihov cilj da preuzmu i kontrolu nad sadržajem medijskih proizvoda, kao i da postanu vodeće organizacije na medijskom tržištu. Otud i sve češći upliv telekomunikacionih kompanija u poslovanja medijskih kuća (kupovinom postojećih medija i kreiranjem sopstvenih medijskih platformi).

2. MEDIJSKA KONVERGENCIJA U KULTURNIM I KREATIVNIM INDUSTRIJAMA

Kulturne i kreativne industrije predstavljaju spoj različitih delatnosti koje se zasnivaju na razvoju kreativnih potencijala. Kreativne industrije obuhvataju različite vrste dizajna, izdavaštvo, telekomunikacije, medije, modu, film, video i fotografiju, softvere, kompjuterske igre, igračke, muziku, vizuelne i izvođačke umetnosti, zanate, advertajzing i drugo [3]. Kreativne i kulturne industrije postale su neumitni pokretači razvoja mnogih privreda širom sveta i, kao takve, doprinose ubrzanim promenama na različitim tržištima. „Ekonomski doprinos kreativnih industrija ogleda se u nizu ekonomskih i neekonomskih efekata, kao što su: prihodi od izvoza, nova radna mesta, unapređenje informaciono-komunikacionih tehnologija, jačanje kolektivizma, kreiranje mišljenja pojedinca, brendiranje područja i sl." [4]. Međutim, vrednost kulturnih i kreativnih industrija nije ograničena samo na izraženi doprinos ekonomiji. „Njihova važnost ne proizilazi samo iz utvrđene činjenice da pokreću ekonomiju znanja i omogućuju rad drugih delatnosti. One uspostavljaju nove obrasce društvenog razvoja i društvene strukture"[5].

U novijoj literaturi srećemo i autore koji smatraju da kreativne industrije obuhvataju šire polje od kulturnih industrija [6], ali u ovom radu kulturna i kreativna industrija posmatraju se kao neodvojive celine jednog pravca u savremenoj ekonomiji – prostor upotrebe ljudske kreativnosti radi sticanja profita u konkretnom poslovnom projektu.

Kako se medijska konvergencija može dovesti u vezu sa kulturnim i kreativnim industrijama, ovim sve ekspanzivnijim sektorima, u savremenom svetu? Ta veza je veoma logična – kao i kod drugih sektora kojima su medijski proizvodi platforma za stvaranje proizvoda, a medijska vidljivost garancija za opstanak – mediji su vodeći kanal za prenošenje informacija od pošiljalaca do primalaca, te je bilo koja ideja koju je neophodno sprovesti u delo ili promovisati, okrenuta ka upotrebi medija. Neki autori smatraju da su promene koje dovode do procesa konvergencije medija i kreativnost (kao talenat koji je nužni potencijal za razvoj kreativnih i kulturnih sektora, a time i čitavih industrija u tom polju) neraskidivo povezani i da nije moguće jasno sagledati koja je od dve strane inicijator postojanja druge. Prema Dženkinsu, „upravo sada, kulturne promene, pravne bitke i ekonomska konsolidacija koje podstiču medijsku konvergenciju prethode pomacima u tehnološkoj infrastrukturi" [1]. Rezultat ove uzročno posledične veze

ukazaće na to gde će se zadržati koncentracija kapitala i moći. „I u teoriji i u praksi postoji opšta saglasnost oko sledeće teze: ko bude raspolagao infrastrukturama spremnim za elektronski prenos i brzi pristup informacijama, imaće presudnu prednost u budućem ekonomskom, socijalnom i kulturnom razvoju" [2].

Prema Kisić, kulturne i kreativne industrije podrazumevaju sposobnost brze reakcije na sve češće promene u tehnološkim aspektima poslovanja. „Digitalna eksploatacija prava autora nudi mnoge nove mogućnosti i prilike na polju kreativnih industrija. Softveri, razvoj novih aplikacija, upravljanje podacima i elektronsko umrežavanje od velike su važnosti za sektor. To je razlog zašto je informatička i tehnološka pismenost među profesionalcima i širom populacijom jedan od preduslova za stalni razvoj sektora i konkurentnosti na globalnom tržištu" [6].

Mogućnosti koje medijska konvergencija nudi korisnicima medija sa jedne (pošiljaoci medijskih poruka) i sa druge strane (primaoci medijskih poruka) sve su brojnije i sve neophodnije za svaku delatnost, a ponajviše za delatnosti koje se oslanjaju na kreativnost. U tom smislu, upotreba medijskih kanala dostupnih zahvaljujući sve razvijenijem IT sektoru na globalnom medijskom tržištu (podjednako i hardverskom i softverskom) postaje vodeća potreba kreativnih sektora u različitim industrijama, čime se neprestano obnavlja potreba za posmatranjem kreativne industrije kao grane *per se* u savremenoj – novoj – ekonomiji.

U svetu koji svakodnevno postaje iznova posredovan medijima, konvergencija u domenu ekonomije podrazumeva proces koji je ponekad vođen od strane korporacija, a ponekad je određen isključivo aktivnošću potrošača. Dženkins objašnjava zbog čega medijska konvergencija biva inicirana, odnosno oblikovana, iz dva izvora: „medijske kompanije uče kako da ubrzaju protok medijskih sadržaja kroz kanale isporuke kako bi obezbedili veće mogućnosti prihoda, proširili tržišta i pojačali obaveze gledalaca. Potrošači uče kako da koriste ove različite medijske tehnologije kako bi potpunije kontrolisali protok medija i kako bi ostvarili interakciju sa drugim korisnicima" [1]. Tako postavljena logika poslovanja u kreativnom sektoru stvara mogućnosti za pozicioniranje različitih proizvoda ili usluga u dominantno vizuelnim medijima. Na primer, u filmskoj industriji, danas se podrazumeva da će nekoliko proizvoda iz asortimana sponzora konkretnog projekta biti deo niza kadrova u filmskom ostvarenju i to kroz koncept pozicioniranja proizvoda, odnosno brenda (product - brand placement) koji podrazumeva postavljanje specifičnih (odabranih) proizvoda u određeni kadar i upotreba naziva brendova u filmskim i televizijskim scenarijima. [7]. Takav vid upotrebe medijskog sadržaja – radi promocije brenda – nije novina, prisutan je u javnosti još od pojave prvih audio-vizuelnih medija, ali u 21. veku postaje sve prisutniji i dovodi do toga da se pojedini filmovi snimaju isključivo radi promocije proizvoda onih koji finansiraju produkciju tog filma (reč je najčešće o filmovima koji pripadaju žanru komedije i čiji je glavni cilj puka zabava gledalaca – uz, naravno, meko ubeđivanje gledalaca da postanu kupci proizvoda koji se u filmu pojavljuju). I sve popularnija rijaliti (reality) forma televizijske zabave podrazumeva obavezu reklamiranja određenih proizvoda pod plaštom upotrebe istih u toku programa, a od strane učesnika datog programa. Tako će akteri određenog rijaliti formata tokom čitave sezone konzumirati isključivo jednu vrstu, odnosno odabrani brend, gaziranog ili alkoholnog pića, nosiće garderobu ili modne detalje u boji karakterističnoj za sponzore tog programa i slično. Ovi primeri već uveliko su empirijski potvrđeni u gotovo svakom rijaliti programu na lokalnim televizijskim stanicama, ali i globalno, u mnogim stranim medijima.

Važan aspekt izražavanja zaposlenih u kulturnim i kreativnim industrijama je naracija posredstvom medija, odnosno umeće kreiranja priče koja interesnoj grupi može učiniti dopadljivom ili prodati određenu ideju, neki proizvod ili uslugu. Ovaj koncept u savremenim studijama medija označen je terminom storiteling (storytelling), ili tehnika storitelinga, a u osnovi predstavlja veštinu pričanja priča radi ispunjenja određenog cilja. Prema Salmonu, storiteling je neodvojivi deo života savremenih ljudi i upravo narativi oko nas utiču na to šta ćemo birati u moru nametnutih izbora [8]. Oslanjajući se na pričanje priča, kreativci danas mogu prilagoditi jedinstvenu ideju izrazu različitih medijskih platformi i medijskih žanrova, čime se omogućava "opkoljavanje" ciljnih grupa datom idejom i navođenje na akciju (recimo, kupovinu ili očekvano delovanje).

Medijska konvergencija omogućila je savremenom svetu da pojedinac samostalno organizuje upotrebu medijskog sadržaja. Ova pojava veoma je interesantna za istraživače u oblasti medija, jer podrazumeva da više nije neophodno da postoji profesionalna selekcija sadržaja u medijima. Pored novinara i urednika, transformaciju medija vrše i korisnici medija. Dovoljno je da je korisnik medijski i tehnološki opismenjen i on će, kao takav, samostalno vršiti selekciju dostupnog sadržaja i kreirati lični program za informisanje, zabavu i edukaciju. Pored toga, pojavom interneta, javnost odavno nije prostor informisanja isključivo posredstvom medija koji imaju

jasnu uredničku i novinarsku strukturu i koji su kao takvi registrovani, već prosečan korisnik interneta brojne (dez)informacije saznaje na različitim društvenim mrežama ili na portalima sa sadržajem sumnjivog porekla i nepostojećeg impresuma. Takva promena predstavlja izazov upravo za radnike u kreativnim sektorima – u tradicionalnim medijima, ali i u drugim sferama koje zahtevaju povezanost sa medijima (film, dizajn, umetnost, pozorište i druge kulturne institucije...). Prema Snježani Milivojević „urušio se poslovni model na kojem postoji medijska industrija kakvu poznajemo" [9]. Dakle, medijski radnici više nisu jedini tvorci sadržaja, a njihova uloga nije ograničena na pripremu i objavljivanje vesti, već je proširena obavezom filtriranja i provere autentičnosti vesti koje sa svih strana dolaze kao rezultati javne razmene u digitalnoj sferi, preciznije na internetu (na već pomenutim društvenim mrežama, na forumima i sl.)

Kulturne i kreativne industrije u velikoj meri koriste mogućnosti koje novi mediji omogućavaju u procesu konvergencije i to kroz njihove tri vodeće odlike. Reč je o multimedijalnosti, interaktivnosti i povezanosti tekstova u vidu hipertekstualnosti. Ova tri principa pomažu da se razume priroda novih medija koji su osnova medijske konvergencije, ali i da se shvati potencijal koji savremeni mediji imaju u polju kulturnih i kreativnih industrija. Prema Kljajiću, pojam multimedijalnost odnosi se direktno na medijsku konvergenciju i spajanje tradicionalnih i novih medija u novi medijski pojavni oblik koji čine tekstovi, grafike, tabele, audio i video programi. [10]. Interaktivnost podrazumeva aktivno učešće javnosti u komentarisanju medijskih sadržaja, čime se omogućava dvosmernost u komunikaciji[10]. Iako dvosmerna, ova komunikacija uvek je kontrolisana od strane medijske kuće koja omogućava datu razmenu informacija i koja obavezno vrši moderaciju poslatih komentara. Za medijsku konvergenciju takođe je važan hipertekst koji podrazumeva povezivanje tekstova u vidu mreže. Različiti tekstovi na internetu su na određeni način umreženi i usmereni jedni ka drugima, posredstvom linkova, a kao takvi, prema Levu Manoviču (Lev Manovich), liče na svojevrsne korene rizoma – razbacane i naizgled nepovezane [11]. Iako rizomski postavljeni, linkovani tekstovi, zapravo, omogućavaju lakšu navigaciju kroz tekstove na istoj ili na različitim platformama, a ujedno utiču na korisnika da ide putanjom koju mu kreator sadržaja namenjuje. Tri navedena principa medijske konvergencije ukazuju na mogućnosti koje mediji današnjice pružaju u kulturnim i kreativnim industrijama. Povezivanje nebrojene količine informacija u formama koje uključuju tekst, fotografije, video, različite grafike, zvuk, pomažu distribuciju poruka do što veće grupe primalaca istih. Kod milenijalaca (millennials), odnosno mladih koji su rođeni krajem 20. i početkom 21. veka, medijsko postojanje – posredovano mobilnim telefonima, tabletima i drugim, najčešće lako prenosivim uređajima najnovije generacije – često je jedino uvaženo postojanje ono digitalno. Njihova vodeća navika je informisanje putem savremenih tehnologija, kompeticija u digitalnim izazovima (video igrice, zabavni i ponekad opasni izazovi na društvenim mrežama) kao i lična afirmacija posredstvom (u datindikatori kulturnih i kom trenutku) popularnih medijskih kanala, pa se može pretpostaviti da će medijska konvergencija imati veliki uticaj na njihov svakodnevni rad (ako pretpostavimo se da će deo korisnika kreativne industrije posredstvom medija razviti sopstvenu kreativnost i sklonost ka traganju za karijerom upravo na poljima kreative) na njihove izbore u budućnosti.

Evropska komisija kreirala je program „Kreativna Evropa" u cilju jačanja evropskih kulturnih i kreativnih sektora, na putu prilagođavanja digitalnom dobu i globalizaciji. Ovaj program izgrađen je na uspehu programa *Kultura, MEDIA i MEDIA Mundus* [12], a obezbeđuje podršku mnogobrojnim projektima koji imaju za cilj saradnju između kulturnih i kreativnih organizacija unutar EU i šire, putem realizacije projekata prekogranične saradnje.

U cilju uspešne saradnje medijskih kuća u državama EU, 1989. godine usvojena je direktiva o „televiziji bez granica", kojom se uređuje minimalan skup pravila koja važe u svim državama EU. Jedan od ciljeva programa „Kreativna Evropa" je da se na nivou cele EU formira jedinstveno tržište audiovizuelnih medija uz uspostavljanje bezbednijeg internet programa kako bi se širom EU zaštitila deca pri korišćenju interneta. „Kreativna Evropa" obuhvata 33 zemlje učesnika od Norveške do Tunisa, kako članice EU, tako i države pridružene i predpristupne članice. Međudržavna saradnja pomaže očuvanju kulturnog nasleđa i raznolikosti uz digitalizaciju i globalizaciju [12], pogotovo imajući u vidu bogatstvo koje Evropka unija ima - 24 zvanična jezika, 3 pisma i oko 60 zvanično priznatih manjinskih jezika.

Prema istraživanjima Evropske komisije kulturni i kreativni sektori u zemljama članica čine 5,3% BDP-a EU i zapošljavaju više od 12 miliona ljudi tj. 7,5% radne snage EU [12], doprinoseći ekonomskom rastu, inovacijama, razvoju veština, utičući na unapređenje industrije turizma i informaciono komunikacionih tehnologija.



Slika 1. Konceptualni okvir i indikatori kulturnih i kreativnih gradova

Izvor: www.ec.europa.eu [13]

Program „Kreativna Evropa“ obuhvata i razvoj i finansiranje projekta „Evropska prestonica kulture“. Ovaj program se temelji na ideji da se gradovi kroz kulturu, umetnost i kreativnost razvijaju i unapređuju kvalitet života i smisao življenja stanovnika u njemu, sa aspekta ekonomskog, kulturnog i socijalnog razvoja. Od formiranja i početka realizacije ovog programa 1985. godine preko 40 gradova na prostoru Evrope bilo je nosilac titule „Evropska prestonica kulture“.

Veoma značajno za Srbiju je realizovanje programa „Kreativna Evropa“ kroz projekat „Evropska prestonica kulture - Novi Sad 2021“ [14]. Dosadašnji pristup promotivnih kampanja u tradicionalnim medijima inoviran je implementacijom digitalnih/mobilnih aplikacija, sa idejom da se turisti/posetioci Novog Sada, a i stanovništvo upoznaju na interaktivan način sa bogatom kulturnom i istorijskom baštinom Novog Sada i okoline.

Prema Planu rada Fondacije „Novi Sad 2021“ [15] marketinške aktivnosti u vezi sa projektom „Evropska prestonica kulture Novi Sad 2021“ realizovaće se u formatima novih i tradicionalnih komunikacionih kanala: štampanim i elektronskim medijima, web prezentacije, mediji na otvorenom, audio i video produkcija, društvenim mrežama i sl. Implementacija mobilnih aplikacija, virtuelnih tura u sinergiji sa angažovanjem na društvenim mrežama na najsavremeniji način može doprineti promovisanju i razvoju kulturnih i kreativnih industrija na našem prostoru. [16]

3. ZAKLJUČAK

Analiza aspekata procesa medijske konvergencije i uticaja koji ovaj proces ima u radu kulturnih i kreativnih industrija ukazala je na dominantnu ulogu novih tehnologija i medija u domenu kreativnog poslovanja. Niz primera ukazuje na činjenicu da se kreativnost može potpuno ispoljiti zahvaljujući upotrebi različitih tehnoloških ostvarenja, a da se njen puni domet može ostvariti tek kada se u date akcije uvedu različiti mediji. Danas je često moguće čuti da ako nešto nije na internetu, onda verovatno ne postoji. Takva tvrdnja može da nam posluži da objasnimo gore pomenutu tezu da bez medija kreativni izrazi ne bi bili vidljivi. S ozbirom na to da su (različiti) mediji vodeći kanali informisanja u 21. veku, svaki kreativni impuls moguće je poslati do krajnje adrese ukoliko se odabere adekvatan medij (vrsta medija, žanrovska pripadnost medijskog sadržaja i slično). Posmatrano iz drugog ugla, važno je pomenuti da ni medijska konvergencija kao proces ne bi bila izvodljiva kada ne bi bile razvijene kulturne i kreativne industrije, jer, bez obzira na informaciono-tehnološki razvoj, konvergencija medija ne bi ispunila svrhu svog postojanja bez postojanja kvalitetnog (dakle, kreativnog) sadržaja. Ovde možemo izneti zaključak da će u budućnosti medijska konvergencija, kao – kako kaže Dženkins – proces koji traje i koji se neće završiti, biti u velikoj meri oslonjena na kreativne impulse u različitim sektorima medija, a da će kulturne i kreativne industrije imati otvorena brojna medijska polja za kreaciju i promociju najrazličitijih vrsta poslovanja i stvaralaštva.

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ADVANCED COMPUTING AND CLOUD COMPUTING SESSION

THE PRINCIPLE OF CONSTRUCTING THE ALGORITHM OF THE FUNCTIONING OF THE NEURAL NETWORK - THE BASIS OF THE EXAM SYSTEM OF ARTIFICIAL INTELLIGENCE

Ibragim Suleimenov[1, *],
Alimzhan Baykenov[1],
Tolganay Abisheva[1],
Ilyas Kopishev[2]

[1]Almaty University of Power Engineering and Telecommunications,
Almaty, Kazakhstan
[2]S. Toraighirov Pavlodar State University,
Pavlodar, Kazakhstan

Abstract:
A new approach to the development of artificial intelligence systems aimed at improving the quality of higher education in post-Soviet countries has been proposed and substantiated. The purpose of the system is to set examination marks in an automated mode based on the student's ability to assimilate new scientific and technical information for him (reading and subsequent retelling of the text). This approach is designed to ensure a reduction in the level of corruption in post-Soviet universities, the scale of which already poses a real threat to the intellectual sovereignty of the post-Soviet states.

Keywords:
corruption, higher education, artificial intelligence, neural networks, examination marks.

1. INTRODUCTION

Prospects for the use of artificial intelligence systems (AI) in the educational process are actively discussed in the current literature [1]–[3]. In particular, the possibilities of using AI as an instrument to combat the bureaucratization of the educational process and corruption in higher education are being analyzed [4], [5].

In many post-Soviet states, including in Kazakhstan, the scope of corruption in universities has de facto reached a level at which there is a question about its impact on national security [4], [5], although the authors of most of the works on this subject speak with some a touch of "bashfulness", accompanying their judgments with various reservations [6]–[9].

The existing scale of corruption, flourishing in universities, really represents a direct threat to the geopolitical level, since a significant reduction in the quality of higher education associated with corruption manifestations already calls into question both the intellectual sovereignty of the post-Soviet states and their ability to ensure the development of promising technologies, including including in the military-technical sphere [4], [5]. However, it should be noted that the issue of corruption in universities is actively discussed in the world literature [10]–[12], and the growth in the number of publications on this topic is indicative (Figure 1).

Correspondence:
Ibragim Suleimenov

e-mail:
esenych@yandex.kz

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Proceeding from this, as well as from the basic provisions of the strategy for the development of AI systems in the Republic of Kazakhstan, built on the principles of ensuring the intellectual sovereignty of the country [13], for countries such as Kazakhstan, when developing an AI system, they should first of all be considered as a promising means of fighting corruption in universities.

In this paper, we propose an algorithm for the functioning of the neural network, the basis of the AI system, which provides for counteracting corruption in exams by damping the human factor in grading. It is obvious that in modern conditions it is the evaluation of a student's knowledge that maximizes the subjective factor, which, among other things, creates a fertile ground for corruption. Therefore, the development of any means to maximally eliminate or dampen the human factor in grading can be considered, including as a means of countering corruption.

The basic idea of this algorithm is as follows. As it was emphasized in [14], the modern conditions make no sense to try to assess the student's intellectual potential based on the amount of knowledge that he currently has. In favor of this consideration, in particular, the following circumstance. In the vast majority of areas of modern science has accumulated more than a significant amount of information. Accordingly, the formation of curricula becomes an extremely complex process, since it is required to isolate the information that forms the basis of this particular profession. The selection of this information is a very nontrivial task, for the solution of which various approaches are proposed [4]. However, this question remains essentially controversial, since it is still unclear on which particular principles the above mentioned selection should be made.

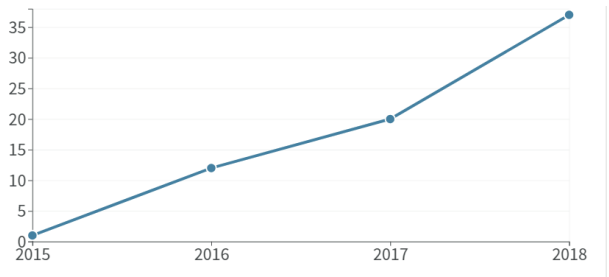


Fig. 1. Dynamics of growth in the number of publications devoted to the discussion of corruption in higher education, according to the database Web of Science (search by keyword "Corruption" and "higher education")

Currently, the method of expert assessments is used de facto, that is, each specific university compiles a curriculum based on its own capabilities and points of view of the faculty on the maintenance and further development of a particular discipline. As a result the content of the curricula of the overwhelming majority of post-Soviet universities in each particular discipline is de facto random. (The determining factor here, obviously, is the area of their scientific interests of specific teachers and the amount of knowledge that they possess.) However, the non-systemic nature of the formation of curricula is not a determining obstacle to the formation of a modern specialist. It is especially true in relation to the field of information technology.

Indeed, in the overwhelming majority of cases at particular workplaces, university graduates do not use the specific information that they received during their university studies. (This is especially clearly shown by the fact that more than half of university graduates from post-Soviet countries do not work in their specialty.) Accordingly, the main result of university studies (the main professional skill) in modern conditions is, de facto, the student's ability to absorb new information.

The presence of basic knowledge, in the first place, determines precisely this skill, which becomes the base for a specialist of any qualification. It is important to have a certain set of basic knowledge that will further allow us to adequately assimilate new information (for example, the information contained in the descriptions of technical systems or the information contained in highly specialized scientific and technical works).

Based on this, in modern conditions, at least for students in the last undergraduate courses or students in the magistracy, it is advisable to use an approach based on the assessment of the student to process and assimilate new information. Schematically, is illustrated in Figure 2.

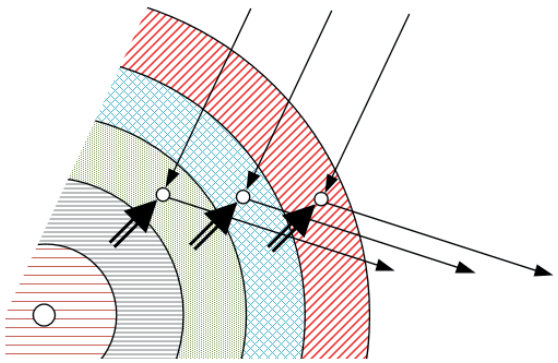


Fig. 2. A scheme for assessing a student's ability to absorb new information

The figure schematically shows the areas of competence, and the learning process is seen as a transition from one level to another.

The figure emphasizes the following circumstance: information relating to the next level of knowledge can be learned by a student if and only if he has adequately learned the information that relates to the previous one.

Consequently, for making judgments about the level of competence of the student, user can use an approach based on reading and subsequent retelling of a text of a scientific and technical nature. As an example of such text, an article from a highly specialized journal or a technical description of a specific device can be used.

Such an approach, as will be shown below, allows the development of an artificial intelligence system that allows the assessment of the level of competence in an automated mode.

The work of the neural network underlying the proposed system, artificial intelligence, is based on the following circumstance: each level of competence is inevitably associated with a specific terminological basis. In other words, each level of competence corresponds to a specific set of keywords that can be included in the text used for testing (Figure 3).

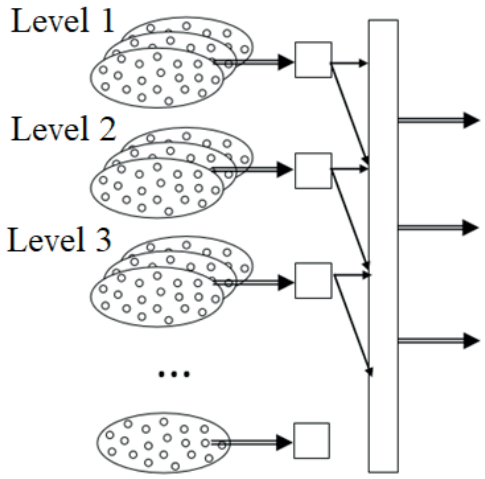


Fig. 3. Levels of competence

Keywords are divided into several groups, each of them belongs to a certain level of competence, in turn, divided into subgroups in certain areas within the same level of competence.

In the text used for testing, keywords are highlighted in color and provided with hyperlinks. If this term for the learner is unfamiliar, then he can reach by a hyperlink directly to that information resource where an explanation is contained. As such resources, publicly available sources of information are used: academic dictionaries, textbooks that are publicly available, etc.

Obviously, if the student is at the level of competence, when he is aware of the relevant groups of terms, he will not follow these links. Breaking up the links into several levels, thus allows identify the level at which the student is located, due to the fact that he goes on to higher level links.

The proposed technology involves not only tracking the links on which the student passes, in order to understand the text, but also fixing the time that he, approximately, spends on reading a third-party source. Obviously, the indicator can be analyzed from two points of view. More precisely, two options are possible: the material is viewed quickly or it takes quite a long time to read (obviously, if a student reads the material carefully enough, that is, he is assimilated to the student). If a student views additional material for a short time, then it either serves to recall previously known information, or it is completely incomprehensible, and the corresponding information resource will simply be closed.

Information about the links used, as well as the length of time spent on reading a third-party information resource, is stored in the program's memory, and then processed using an artificial neural network that is trained in the testing process.

For this purpose, expert assessments are also used, which are made by the teacher as a result of the retelling of this text by students.

More precisely, from a formal point of view, the assessment procedure is as follows. The student is invited to read the text on the computer screen. He explains that, for convenience, those terms that may not be known to him are already provided with hyperlinks that he can pass. Further, the student is invited to retell the text in a compressed form, on the basis of which the teacher gives an expert assessment. In this case, the student's response is recorded and processed by appropriate software. The retelling converted into text is used to work with the artificial intelligence system and its settings.

The scheme of using the proposed artificial intelligence is shown in Figure 4. This system is based on a comparison of the terms that the student used to go through the hyperlinks, as well as the terms that he

used in the retelling. For such a comparison, an oral speech recognition system is used, which is currently quite well developed.

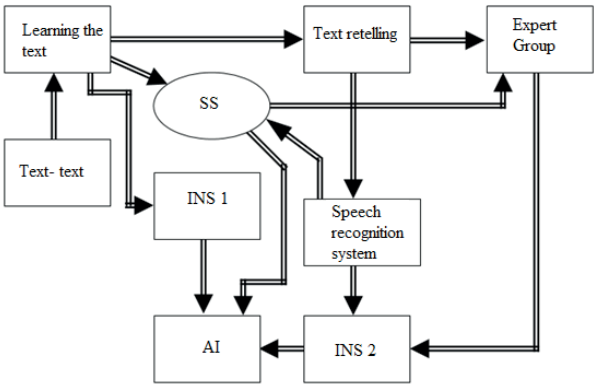


Fig. 4. Block diagram of the artificial intelligence system

Comparison of these two sets of keywords allows us to judge what terms the learner who carries out the retelling really has. (In other words, what terms he uses actively.) This principle is the basis of the diagram shown in Figure 4. The top line of diagram reflects the actions that are carried out directly during the formal exam: the learner studies the text for a specified time, then given a fixed time to retell this text, and on the basis of this retelling, the examiner gives his formal peer review.

The system conducts a quantitative comparison of the used keywords, on the basis of which a preliminary judgment is made, which the expert can use to refine his assessment. Next, the artificial intelligence system itself comes into effect, it is based on processing the results of keyword recognition in the retelling of an artificial neural network (INS 2), and the processing of those keywords that the student undergoes in the process of reading the text of an artificial neural network (INS1). The purpose of each of these neural networks in accordance with Figure 3 is to make judgments about the level of student competence.

This judgment is based on a combination of the principles of fuzzy logic with the principles of functioning of the neural network. Namely, a sequence of zeros and ones is considered as the inputs of a neural network, with each neuron of the input layer of network corresponding to a specific keyword. If a student passes a corresponding hyperlink when reading a text, then it is considered that a logical unit is supplied to the input of the corresponding neuron, if not, a logical zero.

The first layer of neural network also contains neurons that correspond to the duration of the transition time between links. Some critical threshold is set and it is considered that if the transition time between links exceeds a certain critical value, then a logical unit is supplied to the input of the corresponding element of the neural network, and if not, then a logical zero.

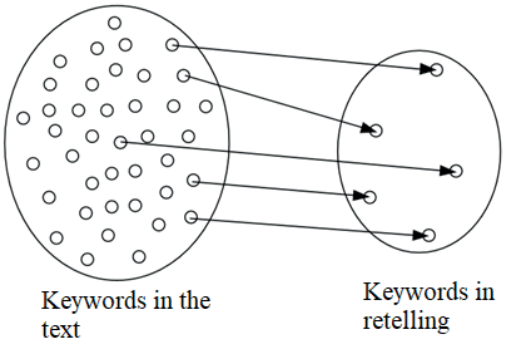


Fig. 5. To the principle of the proposed system of artificial intelligence

This approach allows, in an acceptable approximation, to estimate the time that a student spends reading materials, passing by hyperlink number N. It is believed that if the transition time between the links with the number N and the number N + 1 was long enough, it means that the student spent quite a long time reading the resource associated with the reference number N.

Such an approximate estimate is valid provided that the text is supplied with a sufficiently large number of references (determined empirically). Further, according to the standard scheme, the neural network is trained, and at its output, signals are generated corresponding to the levels of the student's competence.

Another group of inputs of neural network determines the assessment made by the teacher according to the relevant set of criteria.

The use of criteria sets corresponds to the fact that the teacher makes a comprehensive assessment, but does not give points, but converts the judgment made by him into a system of logical zeros and ones, which allows him to further process his judgments using neural network methods. The training of this system also assumes the use of foresight methods in order to eliminate subjective factors.

We emphasize that the principle described above is based on the work as INS1, as well as INS2. In both cases we are talking about the recognition of a certain system of terms that the student used in retelling and reading the text.

Next, the results of the student's response processing by artificial neural networks are transmitted to the basic system of artificial intelligence. Its allocation as a separate module is justified for the following reasons. INS1, like INS2, are trained on a specific array of texts that are used as "exam questions". These text arrays contain certain keyword arrays, the totality of which serves as an indicator of competence.

During the exam, the student works with texts of two or more levels of difficulty (several "exam questions") according to the method described above, which allows to specify the used results. In other words, he answers two or more different questions with different levels of difficulty.

This component of the general scheme can and should be trained not only in the course of the experiment related to the retellings being made by students, but with the analysis of the source texts that provide the identification of the connection between the concepts. The revealed connections between concepts are also supposed to be used when working with INS1 and INS2. Specifically, it is assumed that the artificial intelligence system, trained in this way, gives the INS1 and INS2 the necessary information as to what kind of connections exist between the concepts; therefore, these neural networks make judgments based on the above two criteria.

We emphasize that the allocation of INS1 and INS2v separate modules due to the fact that these neural networks are trained in the course of experiments with students, and the artificial intelligence system is trained directly on the array of source data available in the open press. The corresponding relationships are shown in Figure 4, with arrows showing the presence of feedback.

2. CONCLUSION

Thus, there is every reason to radically reconsider approaches to assessing the level of competence of students in modern conditions. The traditional approach, based on the grading of exam grades based on the opinions of a particular teacher, has outlived its usefulness both in its methodological aspect and in that it creates fertile soil for corruption in universities.

The proposed algorithm, based on the student's ability to perceive new information of a scientific and technical nature, allows one to eliminate the basic drawbacks of the traditional approach, primarily because it is algorithmizable; on its basis, a rather simple artificial intelligence system can be implemented, ensuring that the assessment of the student's competence level is carried out automatically.

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THE OVERVIEW OF INTRUSION DETECTION SYSTEM METHODS AND TECHNIQUES

Ali Elsadai[1,*],
Juma Ibrahim[2],
Fathi Hajjaj[2],
Petar Jakić[1]

[1]Singidunum University,
Belgrade, Serbia
[2]School of Electrical Engineering,
Belgrade University,
Belgrade, Serbia

Abstract:
System and network security is still the main concern for researchers and system administrators. Different types of software and hardware devices are used to eliminate the dangers of hacking, attacks, breakthroughs, and cybercrimes. With the increasing creativity of attackers, the development of a complete security system is impossible. In network security, no other tools are available as Intrusion Detection System (IDS), which has the ability to locate and identify malicious activities by examining network traffic. It provides administrators with reliable network monitoring and control. In this paper, we give an overview of the Intrusion Detection System principles, types, methods, and detection techniques.

Keywords:
Flow, IDS, IPS, Signature-based, Anomaly-based.

1. INTRODUCTION

In light of the tremendous progress in technology and communications, most of our daily activities have become dependent on the Internet and its applications. It has entered in everything and almost there is no home free of this technology to benefit from its services in everything related to daily life such as news, Sport, art, education, media exchange and makes free phone calls with other people and groups of people from all over the world. The use of the Internet saves a lot of effort and time where you can communicate with other people, transfer files and access different services from anywhere, at any time where you have access to the Internet.

With this amazing progress in technology and communications and with these services and possibilities provided by the Internet, in contrast, there are many problems and obstacles that affect the utilization of the Internet service. For example, the disruption of a network device such as router or switch and loss of communication with these devices or other devices likes hosts or servers. Such problems are predictable by the network team, and they are ready to overcome such problems or provide alternative solutions. There is another kind of invisible problems that come to its utterance without warning and cannot be discovered by ordinary users. Also, specialists difficultly predict and identify the so-called

Correspondence:
Ali Elsadai

e-mail:
aelsadai@singidunum.ac.rs

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cyber-attacks or hackers who target computer networks to stop the services and servers of these networks or the information that is transmitted through the network to prevent possible sabotage and corruption.

This conflict between good and evil doesn't stop until the end of the cessation of life. Because at the beginning of each new day, systems and networks face a new type of these electronic attacks in an attempt to break into a database and steal data or sabotage or stop services and web sites.

But as we mentioned earlier, in this amazing progress in technology and communications, the high-speed of the Internet networks and the huge amount of data passing through computer networks, require the presence of reliable techniques for monitoring and controlling the network where the specifications of speed and accuracy are not affected by the flow of data through the network and does not affect users experience concerning speed and quality.

Many of the scientific papers published in this regard [1][2][3][4][5][6], searching for a solution to protect computer networks or, more precisely, how to distinguish between normal traffic from anomaly traffic passing through the network. Traditional security tools such as firewalls and anti-virus programs are no longer capable of detecting these sophisticated attacks. Intrusion Detection Systems (IDS) is imperative to achieve confidentiality, integrity and availability of data and services. So, it's considered as an important component for computer networks; it is a kind of protection for network systems, and devices and a set of measures to be taken when an attempt is made to penetrate the security objectives of a network.

2. FLOW MONITORING

The concept of network flows was introduced by Cisco and is currently standardized by the Internet Engineering Task Force (IETF). According to the IETF IPFIX working group, "A flow is defined as a set of IP packets passing an observation point in the network during a certain time interval" [7]. All packets belonging to a particular flow have a set of common properties. In the simplest form, these properties are the source and destination addresses and ports. Flow is typically defined as a unidirectional sequence of packets, which means that there are two flows for each connection between two endpoints – one from the server to client and one from the client to the server.

Recently, bidirectional flows (one record for each session between two endpoints) are also supported by vendors.

There are two approaches to network traffic monitoring, namely, packet-based and flow-based.

1. Packet-based is the traditional representation way of network traffic which monitors the whole packets' headers and payloads in the form of time-stamped row packets. All network packets passing through a particular monitoring device are captured without losing or filtering any information. Packets are captured in the same format that occurs in the wire containing information of layer 2 to layer 7 of the Open Systems Interconnection (OSI) model. Therefore, capturing should be made at an edge point of the network where incoming and outgoing traffic can be monitored [8].
2. TcpDump [9] and Wireshark [10] are two common software applications that can be installed on the capturing point for the packet-based capturing. The main advantage of the packet-based representations is the availability of all necessary information for IDS such as payload, header, and time of the packet.
3. Flow-based traffic representation is a more advanced representation way of network traffic and depends on formatting the traffic in flow forms. A flow is defined as a set of packets that shares the same characteristics. These characteristics vary according to the targeted attacks and the IDS detection criteria. For example, the IPv4 dataset KDD99 [11] uses five-tuple keys to form its records (flows) including IP source, IP destination, port source, port destination, and protocol values as the flow characteristics. Unlike packet-based, flow-based representation provides only a chosen set of information to achieve the detection of the targeted intrusion [12]. The main advantage of flow-based representation is that it does not form a lot of traffic compared to packet-based representation.

The flow-based network monitoring is more scalable in the context of network speed. This approach is based on the ability of network devices to aggregate packets in flows. Each flow is cached by a device and when it is finished or timeout is exceeded, it is exported to an element called the collector. Table-1 compares the two traffic representations.

Flow-based NIDS	Packet-based NIDS
Pros	**Pros**
NIDS operability is not influenced by encrypted payloads	Consists of complete payload and header up to layer 7
Less privacy problems	Data available to NIDSs without delay
Scalability to high-speed network	**Cons**
Cons	Processing packets before any filtering accomplished
Limited data availability	Exposing confidential
Additional component for pre-processing flows	No signature matching possible for encrypted payload cases
Latency between capturing and the availability to the NIDS	

3. WHAT IS AN IDS

Intrusion Detection is the process of monitoring events in a computer or network system and analysing them to identify any indications of potential violations, breaches, threats or imminent threats to computer security policies, acceptable use policies or security practices. Malicious software (such as worms and spyware), attackers gain unauthorized access to the system through the Internet, or users who are not authorized or authorized by the authorities trying to obtain privileges that are not their right. Although all of these incidents are inherently harmful, some other incidents may result in a coincidence, figure-1 shows the concept of IDS.

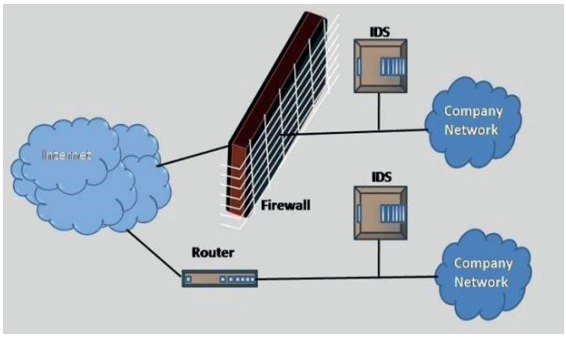


Figure-1 Intrusion Detection System

Intrusion Detection System (IDS) is a program that performs a monitoring operation. This process is to scan the data and compare it to a large database that contains logical rules or fingerprints for previous attacks. It checks the malicious traffic, and if it finds a match, sends a warning to the network administrator. The system does not deter or prevent attacks, but its only function is to detect, record and warn when it occurs.

Intrusion Prevention System (IPS) is a program that has all the capabilities of the Intrusion Detection System; it also has the ability to prevent intrusion. It has the ability to stop or block network traffic based on logic or fingerprint it is capable of detecting network traffic, analysing ports, recording events, checking and matching content, and can detect physical operations, attacks, and port scans all in real time and can be combined with other reporting and performance analysis equipment and records [13].

4. USES OF IDS TECHNOLOGIES

The main functions of the intrusion detection systems are the possibility of identifying possible incidents. For example, hackers can be detected if they have successfully penetrated the system because of security vulnerability. They report security to the system administrators quickly and do what is appropriate to minimize the damage caused by this intrusion. It also records the information so that it can be used by incident handlers later in terms of digital forensics; IDS settings can also be set to identify violations of the security policies of the institution. It can also monitor file transfers and identify those that may be suspicious, such as copying a large database to a user's mobile device. It can also challenge reconnaissance activities, which may indicate an imminent attack because some of the attacking tools and malicious programs, such as scanning activities of the host and ports to determine the targets for subsequent attacks. IDS may be able to block the survey and notify security officials, who can take action if necessary to change other security controls to prevent related incidents. Because reconnaissance activity is very frequent on the Internet, the survey is mostly conducted on protected internal networks.

In addition to identifying incidents and speeding up the response to these incidents, organizations found that other uses of IDS beside intrusion detection or system penetration are as follows:

Identifying security policy issues, IDS can provide a certain degree of quality control to implement a security policy, such as repeating firewall and alert databases when it sees network traffic that should have been blocked by the firewall but is caused by a firewall configuration error.

Documenting the Organization's Current Threat IDS records information about the threats it detects. Understanding the frequency and characteristics of attacks against computer resources in the organization is useful in identifying appropriate security measures to protect network resources. Information can also be used to educate management about threats faced by the organization.

Deter individuals from violating security policies; if individuals notice that their actions area unit is monitored by IDS techniques for security policy violations, they will be less probably to commit such violations because of the risk of disclosure.

Due to the increasing reliance on information systems and the proliferation of potential impacts of interventions against these systems and their attendant, IDS has become a necessary addition to the security infrastructure of all its institutions.

5. TYPES OF IDS

There are two main types of intrusion detection systems according to the place where it's located in case of Hardware or deployed if it is software, as shown in figure-2.

1. Host-based Intrusion Detection System (HIDS): monitors characteristics of a single computer, it is special software on a computer try to detect intruders; it monitors what happens in that computer with the aim of detecting suspicious activities. Generally, monitoring what happens in computers such as login, sessions, activities, transferring documents, file access and programs access.

   The main purpose of HIDS is usually only to monitor changes to basic operating system files. They may not have awareness of what applications have been installed or proprietary data to save, defining critical data on the assets and create a policy to detect changes in that data also may be using custom application.

2. Distributed host-based Intrusion Detection system (DHIDS): intrusion detection software is distributed in many computers which trying to monitor what happens and they report back to some other central computer to improve the chance of detecting the intrusions, it's a Host-based IDS on multiple computers with an organization LAN or internetwork.
3. Network-based Intrusion Detection system (NIDS): Monitor network traffic to identify suspicious activity, monitoring the packet through a network what is being sent and received, different points across the network monitoring the traffic and doing that with some sensors which are devices that basically keep track of the packets coming in or out, then some analysis of that traffic is taking place to identify whether it is an intruder or not by looking at the packet behaviour based on the traffic. The analysis may be done in the sensors or by sending information back to the management server that does the analysis for all of them.
4. Distributed Network-based Intrusion Detection system (DNIDS): Although the traditional design captures the packets, it is vulnerable to lose. In Distributed Design / Distributed Technology, it puts sensors in all network devices, communicating sensors exchange information with each other to report events and breakthroughs. A command console will be used as a centre for decision making and alarms; the difference between Distributed Network-based and Distributed Host-based is the place where the sensors/agents are located. If the IDS works on each device in the network and analysis the events of the operating system on which it works, then it is Host-based, If the IDS works on each device in the network and analysis all the events it receives from the network card whether it belongs to the operating system on which it works or not, then it is a Network-based.

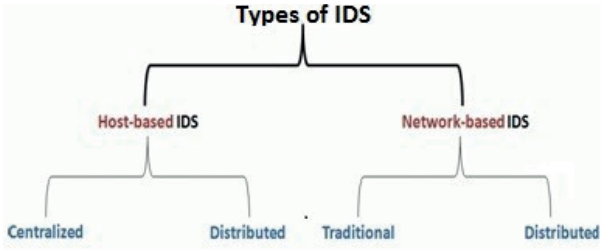


Figure-2 Types of IDS

6. OVERVIEW OF THE IDS DETECTION METHODS

Network traffic measurement is a well-developed and highly active field for network security specialists. Firewalls which were considered the main line of defence in networks are no longer able to carry out this mission as required. With the variety of methods and processes of cyber-attacks, also the intelligence put on the firewall does not provide protection from internal network usage. The intrusion detection system which is one of the measurement tools used for measuring network traffic operates through two main approaches:

1. Signature-based Intrusion Detection System (sometimes called a knowledge-based or misuse-detection) in this type, the information that is already present is used to represent specific and known types of existing attack patterns (signatures). The data moved through the network are compared with these patterns or signatures, if there is a consensus, it means that it is malicious data and the instructions are issued to stop it. One of the features of this type is the accuracy in identifying attacks but it suffers from a lack of detection of new attacks that are not stored patterns or signatures, which require an update of signatures and patterns of new attacks.
2. Anomaly-based Intrusion Detection System (or Behaviour-based), this type works by creating a profile from normal patterns and considers any deviation from this profile as an attack. Advantages of this system, it has the ability to detect new attacks but suffers from the problem of false positive alarm.

Some researches propose hybrid intrusion detection approach. Most of them focus on the anomaly detection approach. It is better than the signature-based detection [14].

In recent years different approaches of IDS based on anomaly detection have emerged using data mining, entropy, machine learning, statistical analysis, and artificial intelligence techniques such as genetic algorithms, artificial intelligence, etc. Table-2 shows the comparison between these two approaches of intrusion detection systems.

Since most of the current existing intrusion detection systems in enterprises are signature-based, they are still unable to detect new forms of attacks even if these attacks are derived slightly from the known attacks. Furthermore, the signature-based intrusion detection methods are inefficient in detecting cryptographic traffic and zero-day attacks, so they are unable to detect modern and recent attacks and need to be updated continuously. It is reactive in the sense that they use a set of signatures and needs to be updated frequently.

7. DATASETS

This section provides an overview of publicly available, network-based evaluation data sets and traffic generators, most of the researches use a synthetic dataset to conduct research and test their studies. The synthetic dataset is collected for this purpose and certainly will not be given the accuracy required as the real data to detect the attacks, but the real data is not easy to obtain for the most important reasons is the security reasons, there are many datasets but the famous and most widely used are:

Signature-Based IDS (SIDS)	Anomaly-Based IDS (AIDS)
It depends on a specific pattern of the behaviours in the effort to distinguish between legitimate and malicious network traffic.	The main concept of AIDS is that attackers should generate network activities that are different from normal user's activities.
Pros and Cons:	**Pros and Cons:**
1. It is inefficient to detect attacks because of their detection nature that is limited by attacks that are previously recorded in their database. 2. Unable to detect zero-day (new) attacks which do not have a stored pattern in the database. 3. Very accurate. 4. Very fast. 5. Easy to configure.	1. Detecting new (zero-day) attacks, if their activities fall out of the normal predefined profile without any need for signature matching. 2. More overhead. 3. Processing capacity. 4. May not detect minor changes to system variables. 5. Generate many false positives alarms.

1. KDD 99 was created in 2009; it represents the recording of the state of communication between two devices for a limited period of time using one of the known protocols and it is characterized by information known as attributes [11]. This dataset suffers from many flaws. The most important ones are outdated and do not contain any contemporary and attack behaviours. This explains the high accuracy rate achieved by many works.
2. UNSW-NB15 This Dataset is newer than the KDD cup 99, it was prepared in 2005 and contains 9 modern attacks compared to 14 attacks in KDD cup 99 and contains 2540044 records and 49 attributes [15].
3. In 2009 the first flow-based data set was introduced [12]. The authors collected network data; this data set is based on data collected from a real honeypot (monitored trap) featuring HTTP, SSH and FTP services. Some authors have gathered about 14 million malicious flows however most of them cited to the activity of internet and network scanners
4. CTU-13 malware is another flow-based data set which contains normal and malicious network traffic for the modern attacks like Denial Of Service (DOS), Distributed Denial Of Service (DDOS) and Robot Networks (BOTNET's), this dataset which has just been made public is much richer and consist of traces of several bots, namely Neris, Rbot, Sogou, Murlo, Menti [16].

8. CONCLUSION

Modern research, therefore, focuses on the development of new techniques, algorithms and security tools that uses intelligent methods such as network anomaly detection based on behaviour analysis which recognized as a mandatory part of modern security protection. Anomaly detection is one of the data mining tasks which analysis the large quantities of data to identify items, events or observations which do not conform to an expected pattern. A large number of scientific papers address this subject and reports that entropy and machine learning approaches provide promising solutions to this problem to overcome the weakness of traditional volume and rule-based approaches to network flows analysis

The main challenges with the anomaly-based intrusion detection system are setting up precise boundaries between normal and anomaly network behaviour, also to avoid false positive errors and the low rate for detecting the anomalies. Another problem with this technique the computation time needs for anomaly details extraction and root-cause identification.

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INFORMATION FUSION BY EXTENDED POWER-BASED AGGREGATION IN IMAGE SEGMENTATION

Endre Pap[1,*],
Marija Delić[2],
Ljubo Nedović[2]

[1]Singidunum University,
Belgrade, Serbia,
[2]University of Novi Sad,
Faculty of Technical Sciences,
Department of Fundamentals Sciences,
Novi Sad, Serbia

Abstract:
In this paper we construct two extended aggregation functions, extended powers product and extended weighted arithmetic mean of powers. Their basic properties are examined, as well as certain properties of distance functions constructed by them. In addition, one pixel descriptor, which is motivated by Local Binary Pattern family of descriptors (LBPs), is introduced. We give an application of the introduced extended aggregation functions and descriptor, by a construction of a new distance function, used in Fuzzy c-Means Clustering Algorithm (FCM) for image segmentation.

Keywords:
extended aggregation function, distance function, image segmentation, pixel descriptor, fuzzy c-Means algorithm.

1. INTRODUCTION

The procedure of combining several values into a single representative one is called aggregation, and the function performing this process is called aggregation function, see [1], [2], [3], [4]. In this paper we introduce two extended aggregation functions which change their values of weights depending on their number of variables and we apply them on distance functions. With appropriate selection of the aggregation function and the initial distance functions, it is possible to model some of the desired properties of the newly constructed distance function, which we apply in an image segmentation algorithm. Distance functions have basic role in image processing, see [5], [6], [7], [8], [9], [10], [11], [12], [13]. In image segmentation algorithms, distance functions represent a decision criterion for grouping pixels into segments, see [6], [8], [14], [15], [11]. In this paper we investigate the construction of distance functions and metrics using special aggregation functions, which we further apply in image segmentation. This paper is a continuation of the research carried out in [15], [16], [11]. With an appropriate choice of aggregation function, we model the criterion used to distinguish two objects by constructed distance function, see [11]. There are several clustering algorithms suitable for tasks considered in this paper, and among all we select FCM for this purpose. Although it does not belong to the class of fast algorithms, it gives good results regarding the compactness of the obtained

Correspondence:
Endre Pap

e-mail:
epap@singidunum.ac.rs

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segments, and it is widely accepted in practice. In Section II, definitions and properties of distance functions and aggregation functions relevant for our research are listed. In Section III extended aggregation function is defined. Then in Section IV two new extended aggregation functions, named extended powers product and extended weighted arithmetic mean of powers, are introduced and their properties are examined. In Section V we introduce one new pixel descriptor, which is used in the segmentation criterion. This descriptor is a modification of LBP descriptor, see [17], [18], motivated by one fuzzyfied LBP member α -LBP, see [19]. Section VI is devoted to an application of the introduced extended aggregation functions and descriptor for distance function construction, which is used in image segmentation. In the evaluation of the presented method, one image is used. For more experimental details, images and segmentation results see [20].

2. PRELIMINARIES

We give here some basic concepts related to distance functions and aggregation functions.

Definition 1: Let X be an arbitrary non-empty set. The distance function in set (space) X is a function $d: X^2 \to [0,\infty[$, which have the following properties:

(d01) $\forall x, y \in X, d(x,y) = d(y,x)$ (*symmetry*),

(d02) $\forall x \in X, d(x,x) = 0$ (*reflexivity*).

Ordered pair (X,d) is a distance space.

Definition 2: On a non-empty space X, distance function $d: X^2 \to [0,\infty[$ may have following additional properties:

(d03) $\forall x, y \in X, d(x,y) = 0 \Rightarrow x = y$,

(d04) $\forall x, y, z \in X, d(x,z) \le d(x,y) + d(y,z)$

(*triangle inequality*).

A distance function $d: X^2 \to [0,\infty[$ is a metric on the set X if it satisfy the implication (d03) and the triangle inequality (d04).

We start with a basic aggregation function, the arithmetical mean $AM: [0,1]^n \to [0,1]$ of n numbers $x_1, x_2, \ldots, x_n \in [0,1]$, given by

$$AM(x_1, x_2, \ldots, x_n) = \frac{x_1 + x_2 + \ldots + x_n}{n} = \frac{1}{n}\sum_{i=1}^{n} x_i .$$

Basic property of the arithmetical mean is the monotonicity, i.e., if in the arithmetical mean $\frac{x_1 + x_2 + \ldots + x_n}{n}$ we take instead of the number x_n a greater number $x_n^{'}$, then the new arithmetical mean $\frac{x_1 + x_2 + \ldots + x_n^{'}}{n}$ will be greater than the previous one. The second basic property of the arithmetical is the following. The arithmetical mean of n zeros is again zero and the arithmetical mean of n ones is again one. Just these properties characterize the general aggregation functions, see [1].

Definition 3: A function $A: [0,1]^n \to [0,1]$ is called an *aggregation function* in $[0,1]^n$ if

1. A is nondecreasing: for $x_1 \le x_1^{'}, \ldots, x_n \le x_n^{'}$ we have

$$A(x_1, x_2, \ldots, x_n) \le A(x_1^{'}, x_2^{'} \ldots, x_n^{'});$$

2. A satisfies the boundary conditions

$$A(0,0,\ldots,0) = 0 \text{ and } A(1,1,\ldots,1) = 1 .$$

Example 4: Some basic aggregation functions are listed below (for many of them see [1]):

1. Geometric mean: $GM(x_1, \ldots, x_n) = \left(\prod_{i=1}^{n} x_i\right)^{1/n}$.

2. Harmonic mean: $HM(x_1, \ldots, x_n) = \frac{1}{\frac{1}{n}\sum_{i=1}^{n} \frac{1}{x_i}}$.

3. Minimum: $Min(x_1, \ldots, x_n) = \min(x_1, \ldots, x_n)$.

4. Maximum: $Max(x_1, \ldots, x_n) = \max(x_1, \ldots, x_n)$.

There is a general classification of aggregation functions, see [1]:

1. Conjunctive: $0 \le A \le Min$;

2. Internal (means): $Min \le A \le Max$;

3. Disjunctive: $Max \le A \le 1$;

4. Mixed.

3. EXTENDED AGGREGATION FUNCTIONS

The notion of aggregation for various number of input values leads us to the definition of extended aggregation function, see [21], [1].

Definition 5: (Extended aggregation function): An *extended aggregation function* is a mapping $A: \bigcup_{n=1}^{\infty} [0,1]^n \to [0,1]$

such that the restriction $A_{[n]} : [0,1]^n \to [0,1]$ of this mapping, for every $n \in N$, is an n-ary aggregation function.

Let $A : \bigcup_{n=1}^{\infty} [0,1]^n \to [0,1]$ be an extended aggregation function. Let X be an arbitrary nonempty set, and $d_i : X^2 \to [0,1]$, $i \in N$, be a family of bounded function. Let us consider the function $d : X^2 \times N \to [0,1]$ defined by

$$d(x, y; n) = A_{[n]}\left(d_1(x, y), \ldots, d_n(x, y)\right),$$

for all $x, y \in X$ and $n \in N$. For $n \in N$ we have

$$d_{[n]}(x, y) = d(x, y; n), \quad \forall x, y \in X$$

is a function that maps X^2 into $[0,1]$ range, same as all above defined functions d_i. It is interesting to consider, which properties the new constructed functions $d_{[n]}$, $n \in N$, inherit from functions d_i, $i \in \{1,2,\ldots,n\}$, depending on the applied aggregation function.

4. EXTENDED WEIGHTED ARITHMETIC MEAN OF POWERS

First we introduce one new extended aggregation function, which we call extended powers product. This function is a generalization of the extended product aggregation function, see [1]. Its properties are examined in details in [20].

Definition 6: (Extended powers product): For arbitrary family of non-negative coefficients

$$\omega = \{\omega_{n,i} > 0 \mid n \in N, i \in \{1,\ldots,n\}\},$$

function $\prod_{\omega} : \bigcup_{n=1}^{\infty} [0,1]^n \to [0,1]$ defined by

$$\prod_{\omega}(a_1,\ldots,a_n) = \prod_{i=1}^{n} a_i^{\omega_{n,i}}$$

for $n \in N$, and $(a_1,\ldots,a_n) \in [0,1]^n$, is called *extended powers product*. For the family of non-negative coefficients ω with the property $\forall n \in N, \sum_{i=1}^{n} \omega_{n,i} = 1$, operator $\prod_{\omega}$ is called *extended 1-powers product* and denoted by $\prod_{|\omega|}$.

Example 7:

1. For the family of coefficients ω that satisfy $\omega_{n,i} = 1, \forall i \in \{1,\ldots,n\}$, for all $n \in N$, $\prod_{\omega}$ is an *extended product operator* $\prod$.
2. Exceptionally, for the family of coefficients

$$\omega_{n,i} = \frac{2i}{n(n+1)}, n \in N, i \in \{1,\ldots,n\},$$

extended powers product operator $\prod_{\omega}$ is also called *extended weighted geometric mean*, and noted as G_{Δ}. Extended weighted geometric mean G_{Δ} is a special extended 1-powers product aggregation function.

We introduce another new extended aggregation function, which we call extended weighted arithmetic mean of powers. The experimental results presented in [20], and partly in Section VI, show that this operator is very suitable for application in image segmentation.

Definition 8: (WAMP): For families of coefficients

$$\omega = \{\omega_{n,i} > 0 \mid n \in N, i \in \{1,\ldots,n\}\},$$

$$\lambda = \left\{\lambda_{n,i} \geq 0 \mid n \in N, i \in \{1,\ldots,n\}, \sum_{i=1}^{n} \lambda_{n,i} = 1\right\},$$

function $WAMP_{\lambda,\omega} : \bigcup_{n=1}^{\infty} [0,1]^n \to [0,1]$ given by

$$WAMP_{\lambda,\omega}(a_1,\ldots,a_n) = \sum_{i=1}^{n} \lambda_{n,i} a_i^{\omega_{n,i}},$$

for $n \in N$, and $(a_1,\ldots,a_n) \in [0,1]^n$, is called *extended weighted arithmetic mean of powers*.

The function $WAMP_{\lambda,\omega}$ is an extended aggregation function. Namely, function is monotonically non-decreasing in each component, since it is a composition of monotonically non-decreasing functions.

Example 9: For coefficients

$$\omega = \{\omega_{n,i} = 1 \mid n \in N, i \in \{1,\ldots,n\}\},$$

the operator $WAMP_{\lambda,\omega}$ is reduced on *extended weighted arithmetic mean* WAM_{λ} operator, see [20].

5. DESCRIPTORS

In this section we introduce one pixel descriptor, which will be used in the construction of distance functions that have application in image segmentation, presented in Section VI. In gray-scale images, pixel is 8-bit, i.e., 1-byte nonnegative number from the $0,\ldots,255$ range, which represents the gray-scale level. In color images, the color of the pixel is a mixture of certain basic color components. The intensity of each component is presented as 8-bit non-negative number from the $0,\ldots,255$ range. The pixel of the color image in RGB technique is written by 3 bytes and it is a mixture of red (R), green (G) and blue (B) component, respectively. Besides the color or gray-scale compo-

nent, other features relevant from the aspect of automatic image processing can be assigned to a pixel, e.g., saturation of color component, or characteristics that describes relations between adjacent pixels. In the literature such characteristics are known as descriptors, see [22]. For gray-scale image (for color image, for more details, see [20]) we have for $m \times n$ pixels in size, with the matrix of pixels $S = \lfloor p_{i,j} \rfloor_{m \times n}$ The pixel in i i-th row and j -th column is marked as $p_{i,j} = (s_{i,j})$, where $s_{i,j} \in \{0,\ldots,255\}$ is the gray-scale level. For the pixel $p_{i,j}$, its closest by the spatial distance neighboring pixels are observed. Let us mark the central pixel with $p = p_{i,j}$, and its neighbors as follows: $n_1 = p_{i-1,j-1}$, $n_2 = p_{i-1,j}$, $n_3 = p_{i-1,j+1}$, $n_4 = p_{i,j+1}$, $n_5 = p_{i+1,j+1}$, $n_6 = p_{i+1,j}$, $n_7 = p_{i+1,j-1}$ and $n_8 = p_{i,j-1}$. Arbitrary $p_{i,j}$, $i \in \{2,\ldots,m-1\}$, $j \in \{2,\ldots,n-1\}$, in the interior of the image, has 8 neighbors that are shown in Figure 1.

n_1	n_2	n_3
n_8	p	n_4
n_7	n_6	n_5

Fig. 1. Neighbors for a pixel in the interior of the image

Let $\alpha \in \{0,\ldots,255\}$ be a predefined threshold value, which represents the limit measure for the similarity of two pixels in their colors or gray-scale levels. Let us first define the indicator of α -similarity for the central pixel $p = p_{i,j}$ and each of its neighbors $n_k, k \in \{1,\ldots,8\}$. Indicator value 1 denotes that the color difference is bigger than the previously selected $\alpha \in \{0,\ldots,255\}$, otherwise indicator value is 0, as a measure of α -similarity for central pixel and its neighbor.

Definition 10: For an arbitrary $p_{i,j}$, the selected threshold value $\alpha \in \{0,\ldots,255\}$, and each of the neighboring pixels $n_k, k \in \{1,\ldots,8\}$, α -similarity indicator $I_{i,j;\alpha}(k) \in \{0,1\}$ is defined by

$$I_{i,j;\alpha}(k) = \begin{cases} 0, & |p_{i,j} - n_k| \le \alpha \\ 1, & |p_{i,j} - n_k| > \alpha \end{cases}, \quad k \in \{1,\ldots,8\},$$

where $p_{i,j}, n_k \in \{0,\ldots,255\}$ are single-byte gray-scale levels of pixels. For the pixel $p_{i,j}$ that is on the edge or in the corner of the image and hence does not have some of the neighbors n_k, we define $I_{i,j;\alpha}(k) = 1$.

6. APPLICATION IN IMAGE SEGMENTATION

We give an application of extended weighted arithmetic mean of powers aggregated distance function in image segmentation through FCM algorithm. By using FCM, one color image is segmented. Next to the images, input parameters of the algorithm are the following.

- Number c of clusters that are going to be acquired by segmentation, we select $c = 4$.
- Weight coefficient m, which affects the quality and speed of segmentation. This parameter is intuitively selected. From the literature, it is known and experimentally confirmed that values around 2.0 give good performance. Hence, we choose $m = 2.0$ in our experiments.
- Distance function $d : P^2 \to [0,\infty[$, which defines mathematical model for desired segmentation criterion, where P is the set of pixels. For pixels $p_1, p_2 \in P$, value $d(p_1, p_2) \in [0,\infty[$ represents a measure of the difference or dissimilarity between them. In order to compare the achieved results and the used distance functions, all distance functions are normalized to the corresponding mapping in the $[0,1]$ range, i.e., $d(p_1, p_2) \in [0,1]$.

Some values that represent a measure of the quality of the obtained segmentation and the speed of the algorithm are listed below. These values are the output parameters generated by the segmentation algorithm.

- PI - performance index, measures the compactness of the clustered data. The lower value of this coefficient means a stronger grouping of pixels, i.e., more compact clusters.
- IT - the number of preformed iterations.
- RT - the execution time of the algorithm, in seconds.

For the families of coefficients, $\omega = \{\omega_i > 0 \mid i \in \{1,\ldots,5\}\}$, $\lambda = \left\{\lambda_i \ge 0 \mid i \in \{1,\ldots,5\}, \sum_{i=1}^{5} \lambda_i = 1\right\}$, a new distance function $d_{\lambda,\omega} : P^2 \to [0,1]$ is constructed by applying $WAMP$ operator on the distance functions d_1 and d_2:

$$d_{\lambda,\omega}(p_1, p_2) = \lambda_1 d_1^{\omega_1}(r_1, r_2) + \lambda_2 d_1^{\omega_2}(g_1, g_2) +$$

$$+ \lambda_3 d_1^{\omega_3}(b_1, b_2) + \lambda_4 d_2^{\omega_4}(s_1, s_2) + \lambda_5 d_2^{\omega_5}(q_1, q_2)$$

for pixels $p_i = (r_i, g_i, b_i, s_i, q_i) \in P$, $i \in \{1,2\}$ (for more details see [20]), where normalized distance function $d_1 : \{0,\ldots,255\}^2 \to [0,1]$, which is defined below, is observed on each of the color components:

$$d_1(c_1,c_2)=\frac{1}{255}|c_1-c_2|,$$

while on the introduced pixel descriptors, the distance function $d_2:[0,1]^2\to[0,1]$ is applied:

$$d_2(t_1,t_2)=|t_1-t_2|.$$

With intuitively selected values of the parameters λ and ω, the distance function $d_{\lambda,\omega}$ is applied in FCM algorithm for the image segmentation. The evaluation of the parameters and quality of the executed segmentation is done by comparing the obtained results with the ones achieved using the Euclidean metric. We use $d_E:\overline{P}^2\to[0,1]$ as a referent distance function,

$$d_E(p_1,p_2)=\frac{1}{255\sqrt{3}}\sqrt{r^2+g^2+b^2},$$

where $r=|r_1-r_2|$, $g=|g_1-g_2|$ and $b=|b_1-b_2|$, for pixels $p_i=(r_i,g_i,b_i)\in\overline{P}$, $i\in\{1,2\}$, and $\overline{P}=\{0,\ldots,255\}^3$.

7. TEST

In this test we observe an image that is made by one of the authors with a mobile phone, see Figure 2.



Fig. 2. Original image

The image is 225×300 pixels in size. The original image is segmented using d_E metric and the $WAMP$ aggregated distance function with ten different parameter values, $d_i=d_{\Lambda(i),\Omega(i)}$,

$\Lambda(i)=\{\lambda_1,\lambda_2,\lambda_3,\lambda_4,\lambda_5\}$,

$\Omega(i)=\{\omega_1,\omega_2,\omega_3,\omega_4,\omega_5\}$, see Figure 3.



Fig. 3. Segmentation

For many further details see [20].

8. CONCLUSION

Based on the applied distance functions and the evaluation parameters obtained in the segmentation we obtained very good results. With suitably selected parameters, $WAMP$ aggregated distance function gives very good results in image segmentation. We can notice that the obtained results are significantly dependent on the values of ω parameter. Excellent results are produced for $\omega_i>1$, while for $\omega_i<1$ they are very poor.

Further investigation on applications of extended product operator from Section IV in image segmentation will be managed. It will be examined the possibility of generalizations of $WAMP$ aggregation function with some other types of functions instead of power functions, and their applications in image processing and other fields where decision making based on uncertain information fusion plays a significant role.

ACKNOWLEDGMENT

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eAGRO – WEB APPLICATION FOR AGRICULTURE

Ana Vesić,
Sava Lakićević,
Bojan Gutić,
Vuk Ignjatović,
Miodrag Živković*

Singidunum University,
Belgrade, Serbia

Abstract:
The main idea of this project is to adapt to the current state of agriculture in Serbia. Animal abuse, usage of dangerous pesticides and global warming have become more evident than ever through new studies and subsequent documentaries. This has sparked a new wave of regulations and laws, as well as a new trend of organic food and a greater need for sustainability. People still often operate in the gray area of the law and corporations are known to take advantage of farmers. The goal of this project is to provide people with a platform that could help people put themselves on the map, promote communities of farmers and protect the interests of all members in the industry, from the producers to the consumers. Furthermore, this project serves as a way to adapt new trends and satisfy new customer demands. This document contains the purpose, the scope and the design of the project. In addition, this document includes the execution, current progress and the plan for finishing the task at hand.

Keywords:
agriculture, e-governance, platform, web.

1. INTRODUCTION

When given the opportunity to work on a project with a mentor, we were motivated to take it upon ourselves to do something truly useful and meaningful. Taking into consideration that agriculture is one of the most important branches of economy, we decided to research the difficulties the government and the agriculturists face in Serbia with the goal of finding solutions. These solutions are in accordance with the plan of technological development in Serbia. In addition to studying the steps taken by the Serbian government, we also studied what other countries have done with an introduction of e-governance. Subsequently, we decided to construct a project around solutions for challenges in Serbia, composed in part by necessary improvements yet to be implemented in this country. These solutions will be implemented into a web application by providing a variety of types of user profiles, by advertising users' offers, demands and organized events and by grouping and analyzing data, intended to increase the quality of user experience. As mentioned previously, this project is also intended for governing bodies. This will give our application two different sides: one oriented at trade and one oriented at e-governance.

Correspondence:
Miodrag Živković

e-mail:
mzivkovic@singidunum.ac.rs

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The part of the project aimed at trade and its participants – farmers, buyers, suppliers, resellers and communities – has the goal of simplifying communication between affiliates, serve as a facilitator for trade, induce education and improve development in this branch of economy/government. Another objective is encouraging and promoting event organizations, such as fairs and festivals, with the idea of preserving local traditions, allowing self-promotion and further strengthening local communities. This has the intention to fuel the growth and expansion of the agricultural lifestyle of Serbia. We intend to give members of agriculture this platform that would serve as a stepping stone and additional space to advertise their manifestations. These functionalities of our web application will enable creation of new communities, improve communication between the farmers themselves and respectful governing bodies, and interconnect communities. However, we intend to have this project create a favorable environment for new and old businesses. Providing the ability to advertise and sell online, as well as having the website in multiple languages, will allow putting people on the map for foreign markets.

For the part of the project oriented around e-governance, we have implemented the requirement to provide detailed information during the creation of a new profile. This will form new databases, with data about ownership, scale and type of production, specifications put in place, owned certificates. This will additionally create a detailed map of Serbian agricultural communities and farms. In addition, we aim to add already implemented solutions in the domestic market, like weather forecasts, education on crop production, recommended fertilizers, advertising competitions and fairs, as well as information on how to more easily get certificates, licenses and any sort of necessary documents.

2. BACKGROUND

Considering the growing need for digitalization, global trends, and ever-evolving government plans due to EU requirements, we had a look at what branch was most in need of digitalized aid to be able to increase its performance. Accordingly, we took into consideration what Serbia´s biggest attribute to its economy is, and what difficulties it faces. We decided to take a closer look into what is specifically being done on the foreign markets and their e-governance plans, as well as our own national plans. The following analysis and research were carried out by analyzing concrete resolutions to given problems in various countries. We followed the myriad solutions offered over the course of several years, the political trends and decisions that accompanied them, as well as the results that they gave, and the future plans that they have now.

There are many worldwide organizations that support the development of IT in agriculture. Their support includes everything from providing concrete solutions and new machinery, to organizing governmental procedures and tasks in favor of the manufacturers and other stakeholders, to protecting people's rights and promoting healthy lifestyles. One of these organizations is Momagri, which was founded in December 2005, "to provide objective analyses and concrete solutions to current and future key international agricultural issues". It advocates a global agricultural governance system that reconciles free trade and regulation. The reason that this organization is of big importance is that it is being referred to in many other documents and statements. Its goals are those of the future, what everyone is aiming for, e.g.: "They aim to provide an institutional framework and economic regulation tools that encourage international cooperation."[1] "Development of trade when it contributes to improving the condition of all farmers, particularly in developing countries, and optimizing supply security for all countries."[2]

In addition to Momagri, there is Map of Ag, which is based in New Zealand but do work for and on a global scale. It enables users to enter the required data to have all of the variables calculated and well presented in order to make a business decision. It is specifically tailored for agriculture. "It has pioneered predictive marketing in agriculture. We use state of the art data modelling and analytics to create insights for our clients and agriculture industry as a whole"[3]. On a smaller scale, but equally significant, are the world-trend affecting policies that are spearheaded by the EU. CAP, or the Common Agricultural Policy, has been around since 1962. Its main goals today are "fostering knowledge transfer and innovation in agriculture, forestry and rural areas, enhancing the viability and competitiveness of all types of agriculture, and promoting innovative farm technologies and sustainable forest management, promoting food chain organization, animal welfare and risk management in agriculture, restoring, preserving and enhancing ecosystems related to agriculture and forestry, promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in the agriculture, food and forestry sectors, promoting social inclusion, poverty reduction and economic development in rural areas."[4] This project is the EU's largest investment, and has re-

ceived a lot of attention and funding. It is important, not only for making policies within the EU and acting accordingly, but for applying them in the countries that are in the process of negotiating their future integration.

What is also receiving attention as a big asset provided to the users is the management of businesses, including risk calculations, trends, predictions, statistics, etc., in order to improve and make decision-making easier. Moreover, numerous advice, tips, and education, including developing IoT technologies aiming at developing and improving food production.

In Serbia, one quarter of the population works in agriculture, and makes up 10% of value added in percent of the GDP, 57% of the entire land area is dedicated to agricultural purposes.[5] Associations, local societies, and organizations are vanishing from the rural areas, making it harder for the manufacturers to place their products on the market, promote them, and enrich their profession. Since 2005, efforts for digitalization, especially projects of e-governance, have been implemented in many fields, but not in agriculture. EU Integrations are strong drivers for the development of ICT in agriculture, which require actions, and are the ones providing the funds for it. "This is explained by the legal obligation set by the EU to operate an integrated information system in relation with the Common Agricultural Policy." Looking ahead, the attention paid to agriculture development and the implementation of ICT in its processes is a matter of the whole world at the moment and, accordingly, the world's common bodies and organizations, such as the United Nations, are doing research in the field across the globe. Some of the advice and conclusions that the Food and Agricultural Organization have come up with are: "The farmer should be in the center of the strategy, which should not be 'forgotten' during the process driven by the governmental authorities and other stakeholders isolated from the 'end users'… the strategy should be planned and implemented to ensure a win-win for farmer and government (and other stakeholders)…The pace of high-tech innovation is increasing in agriculture… for this reason we will need a functional e-strategy on national and international level that may be the pillar of the future farming regulations and sustainable smart agriculture"[5] In addition to many other instructions, it mentions the need to "Stimulate collaboration and knowledge sharing via online communities of practice, including existing regional networks…" What is also noted is that, in order for Member States of the EU to obtain the funds and subsidies within the CAP, they must operate an Integrated Administration and Control System (IACS), and fulfill certain conditions such as having computerized and interconnected databases which are used to receive and process aid applications and respective data. Thus it provides for: a unique identification system for farmers, an identification system covering all agricultural areas called land parcel identification system, an identification system for payment entitlements, a system for identification and registration of animals [5]. In an overall review of what is trending, what is evolving, and what has already been done worldwide and in the region, we were able to ascertain the requirements for a country like Serbia, which is still in the development stage. Comparing it with other EU-funded projects focusing on e-governance in the field of agriculture, the following stood out: developing and continuously updating databases useful for the government, providing advice, education, tools, fostering the conditions and opportunities necessary for the manufacturers in agriculture and other stakeholders, and last but not least, developing rural areas in social and infrastructural aspects by connecting people and providing the content and conditions for growth on the local level. With these requirements and existing problems, we adjusted our functionalities

3. FUNCTIONS AND USER INTERFACE OF EAGRO APPLICATION

The application is consisted of the following functionalities: registration/login, searching for the offers and products, as well as for people, associations and other users, viewing their profile and connecting with them so that their posts and news would appear on the user's homepage and have one-to-one communication, editing user's profile and personal information, posting events, offers, polls etc., accessing educational materials, subsidies and other opportunities for their business, easy communication and work with the government.

Registration and login

Only registered users can fully access all information of a profile and fully utilize functionalities of the application. Logging in will be done with a username/e-mail and password, and registration is open to everybody. When creating a profile people will have an option to select the type of profile being created, i.e. is it a community page, a company, a person, or another type of a group. Certain personal information and business in-

formation will be required, as in name, birthdate, birthplace, e-mail, as well as information like location, land area, capacities, production, equipment, fertilizers and owned certificates or licenses. Depending on the user profile type and on the type of information entered, different information will be required and some proof, reviewed by a governing body, regarding licenses, certificates, land area, etc.

Some of this information will be mandatory to be displayed: name, location, products and certificates. The user will have the option to select how much of other information will be publicly displayed: groups joined, birthplace, birthdate (or founding year), reviews, career highlights and other business information. Sharing a person's ID, passport or social security number will be prohibited. Groups will display information about its central location, admin, members, affiliations with other users or groups, certificates and licenses.

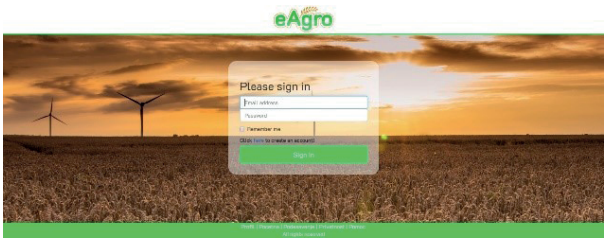


Fig. 1. Registration and login page

View profile, connect and join a group

A profile will have information about its validity, i.e. if its information, private and business, is verified or not. This is made to prevent certain scams, abuse and misinformation. If a user is connected to another profile, or a member of a group, its recent activities and new developments will be displayed on the home page. If a member of a group, notifications about updates will be automatically turned on, and if connected to another profile, notifications will be automatically turned off. These can be features can be disabled or changed at any given point depending on the person's preferences. When trying to contact and message another user, a request to message will be sent to the profile, and the recipient has the option of accepting or declining it. If a user requests to join a group, a notification will be sent to the admin. Users also have the option of reporting or blocking users. Reporting will be allowed for dishonest business, harassment, spam, bots or hacked accounts.

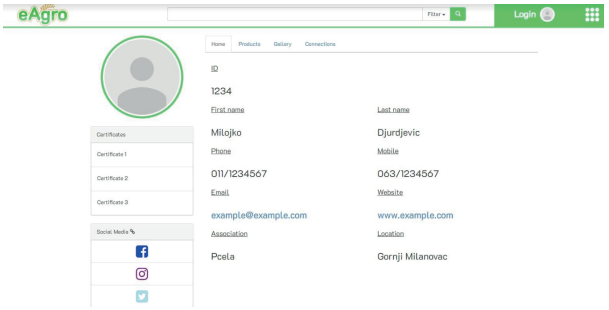


Fig. 2. eAGRO profil page

Post

Posting will enable our users to utilize this platform in multiple ways, like event promotion, offers, renting land, parcels or equipment and polls. Promotion of events is mostly aimed at fairs, festivals, or other (e.g. wine or liquor tasting). Offers for selling, buying or ordering will cover a range of necessities, i.e. seedlings, machinery, fertilizers, food for livestock, land for sale or rent, requests of fruit arching, etc. These posts can also serve for recruitment of workers, especially seasonal work for certain crops, like berries, nuts, grapes and other. Polls can serve as opinions on what the public or other workers, or whoever thinks on certain topics, like preferred types of fertilizers, sharing ideas, gathering opinions and reviews about a past or future event etc.

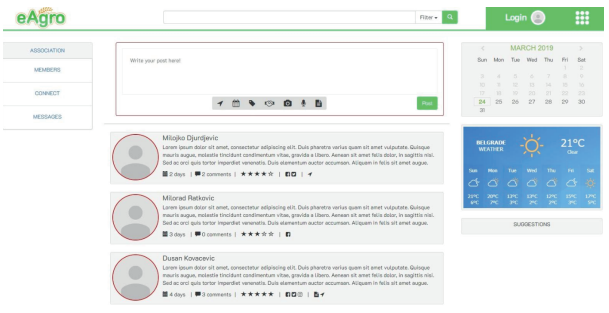


Fig. 3. eAGRO posts

Home page, search and filter

A profile will have information about its validity, i.e. if its information, private and business, is verified or not. This is made to prevent certain scams, abuse and misinformation. If a user is connected to another profile, or a member of a group, its recent activities and new

developments will be displayed on the home page. If a member of a group, notifications about updates will be automatically turned on, and if connected to another profile, notifications will be automatically turned On his home page a user will be able to scroll through posts from the groups he is a member of and from users he has connected with, where his prioritized pages will be the first one to show up. This information will consist of latest updates, certain posts, buy or sell offers, upcoming events and other information of interest. The home page will also include a weather forecast, a search bar, a notification bar and a calendar. A user will be able to search for anything and utilize the application's filters, such as groups, people, manufacturers, transportation, events, posts, offers, location, products or certificates and licenses. A notification bar will display most important updates, with the first ones to be from the user's local community. The user will have the ability to control the amount of notifications he receives from certain profiles. Concerning the weather forecast, we will be looking to collaborate with certain meteorologists to bring their information onto the website for the people in as high detail as possible. The calendar will contain the user's community upcoming events, as well as events he has marked as interesting or important to him. The user will be able to put his own information into the calendar, which can serve as a reminder and organizer for his own work.

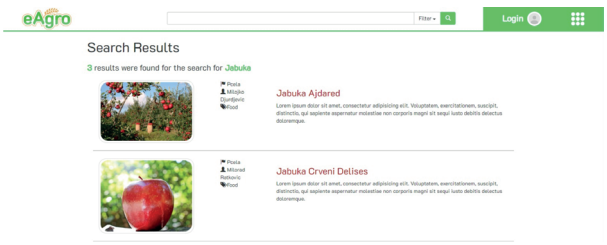


Fig. 4. Different search results in eAGRO application

Education and e-governance

When it comes to education, some parts of what we intend to provide is intertwined with e-governance. We will provide guides of how to work with the government, how to stay compliant with laws and regulations, how to get certain approvals, licenses and certificates, and inform people on insurance policies. Next we will provide information on how to protect one's production and their work. This will be done with education on storage, on which fertilizers are preferred and recommended, how to protect one's crops from diseases, weeds and other pests. Furthermore, we will promote and provide links to studies and seminars related to the agricultural field. In addition to studies, we will promote and provide links to any kinds of open calls and contests, implement information on standardized prices about their products, and how to potentially acquire subsidies.

Concerning the part of e-governance, we will help expedite the process of gathering information and helping users acquire any sort of necessary documents. We will be connecting users to appropriate governing bodies and allow them to more efficiently finish the job. They will be able to submit requests for all aspects of their work, like acquiring licenses, certificates and insurance, have quality and safety checks of their samples. In addition, they will have the ability to report any sort of problems, like complaints of their local authority or local community, as well as any kind of malicious activity.

Settings

In settings, user will have a choice to adjust a number of things: priority of connections and groups, notifications, home page, privacy, login information, profile information and blocking. Priority of connection and groups, notifications and home page are pretty self-explanatory. The user will have the ability to change who he is connected to, which groups he is a member of and whether or not he wants to receive notifications of their activities. The notification settings will give the user the choice of what he wants to be notified about, and how much information he wants to receive in that manner. The home page settings concern whether the user receives only information from people and groups he is affiliated with, but as well as other offers, events and additional information. In his privacy settings the user will have control over what exactly he wishes to display to other members on the web application, who can see his activities and posts, who he can be contacted by and how his profile can be found, for example by searching by name, or by e-mail, or by username, or by location. Login information settings will contain the possibility to change e-mail, password or other important information concerning the user's profile. In profile information settings he will have the ability to add new certificates, licenses, remove expired ones, and edit any other information. Certain changes in profile information will require some proof and oversight by governing bodies,

just like when registering and creating a profile. Lastly, in the settings for blocking, he will have the ability to remove or add users to his blocked list, as well as block certain users from sending invites to groups and events.

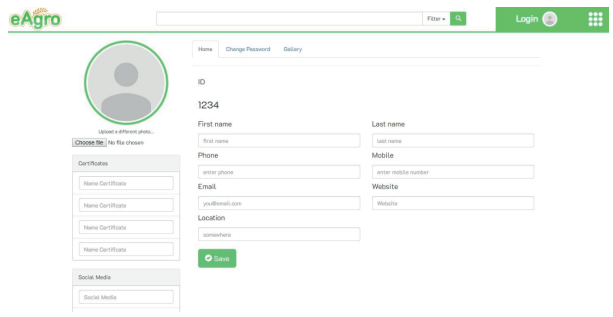


Fig. 5. Settings screen of eAGRO application

4. ARCHITECTURE OF EAGRO APPLICATION

eAGRO web application is designed as a standard three-tier client-server application. This is a common choice in developing modern web applications. Typical three-tier web application is consisting of:

- Presentation tier (frontend) – user interface, which is responsible of taking user input and displaying results in a way user can understand.
- Business logic tier (backend) – layer in the middle, responsible of processing user request, making necessary logical decisions and calculations. This layer communicates with both surrounding layers to provide desired functionality.
- Data tier (database) – stores application data, and when requested passes it to the business logic tier for data processing.

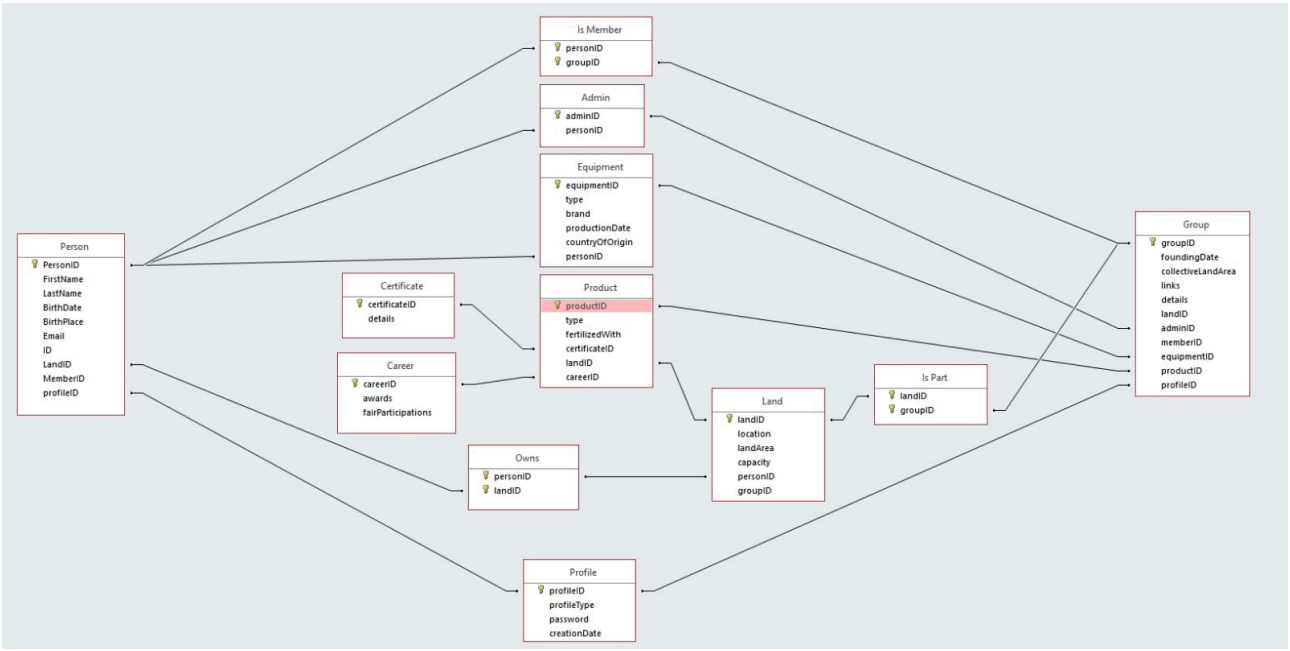


Fig. 6. Data model of eAGRO application

5. IMPLEMENTATION

Frontend

In development of frontend we used HTML, CSS, Bootstrap, JavaScript and jQuery, to provide a modern user interface which will be interactive and attractive to end users. Design of the page was inspired with green color which is traditionally considered as a color of agriculture, and naturally calming.

Backend and database

Backend was developed as a RESTful web service in Java Spring framework. RESTful web service was chosen as it is generally light weight, easy for maintenance and

highly scalable. Additionally, it is a common choice for creating API for different types of web applications.

Spring Boot was used for developing backend, as it provides very good support for enterprise web application development. RESTful API was implemented in traditional way, in three layers:

- REST controllers level
- Service level
- Data Access level (DAO level)

REST controllers define the business logic, and provide responses in JSON. With the @RequestMapping annotiation we defined REST Endpoints. Example of the REST controller implementation is given with the following code, which shows UserController.java class. It maps HTTP requests to the route /users. All basic CRUD operations are implemented, including GET (return one user by id and return all users), POST (create new user), PUT (update user with given id), and DELETE (delete user with given id). The other controllers are implemented in similar fashion.

```
@RestController
@RequestMapping("/users")
class UsersController {

    @Autowired
    private IUserService service;

    @GetMapping
    public List<User> getUsers() {
        return service.getUsers();
    }

    @GetMapping(value = "/{id}")
          public User findUserById(@
PathVariable("id") int id) {
        return service.findUserById(id);
    }

    @PostMapping
     public int create(@RequestBody User
newUser) {
        return service.create(newUser);
    }

     @PutMapping(value = "/{id}")
    public User update(@PathVariable("id")
int id, @RequestBody User user) {
          return service.update(id, user);
     }

     @DeleteMapping(value = "/{id}")
    public void delete(@PathVariable("id")
int id) {
          service.deleteById(id);
     }

}
```

Database was created in MySQL, according to the model shown in figure 6.

6. CONCLUSION

Since agriculture is Serbia's largest branch of economy, we have decided to contribute to its further development in compliance with the existing governmental plans in this area. After our analysis of the status quo and of previous actions taken in other countries, we have developed a uniform solution to many current problems. We constructed the functionalities of the applications according to world trends and the standards of EU integrations, the latter of which primarily focuses on funding for agricultural and governmental development. Our solution ranges from connecting subjects in the agricultural system to increasing information and education levels of the manufacturers, to making and regularly updating databases of the appropriate organizations and bodies, to improving communication between end-users and the government. This project is in the early phase of conception, which includes developing the interactive user-friendly UI/UX frontend components, but which shows great potential for additional functions. Some of the intended features will incorporate business management and risk calculation functionalities, with an overview of statistics and real-time updates. This will allow running a business in agriculture to gain more perspectives and stability, while ensuring further improvement in this branch of the economy. Moreover, we are planning to introduce a new type of user account that would connect all users on a local level, manufacturers, associations, and independent stakeholders alike. This will be designed for the

better development of rural societies, to provide a space for those individuals who do not wish to be affiliated with any associations, thereby allowing for more accessible collaboration, communication, problem-reporting, and problem-solving. A feature that we will work on as well is the online market/shop, with intention to enable users to place their products on the market in real time. All of this will be realized in the form of mobile application for Android and iOS, besides the already developing web platform.

However, this application has a few potential disadvantages. One of these drawbacks is that this application relies on users adapting this new platform. The application relies on people having an interested in it, and in turn having this online presence in order for it to thrive and achieve all of the intended goals. In addition, some of the older generations, which are a large part of the agricultural community, might find moving to the platform too difficult and filled with too much information, even though we intend to provide a suitable tutorial for new users.

ACKNOWLEDGE TO THE TEAM

We would like to point out that not all of them who made this happen for Sinteza 2019. are signed above. Big thanks to **Dušan Dotlić** the developer of Databases and the contributor to the idea development, and to other team members. We would also like to thank our mentor **dr. Miodrag Živković** for his help and guidance on this project.

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MULTIMEDIA SERVICES IN CLOUD COMPUTING ENVIRONMENT

Andreja Samčović

Faculty of Transport and Traffic Engineering,
University of Belgrade
Belgrade, Serbia

Abstract:
For multimedia applications and services over the internet, there are strong demands for cloud computing, due to the massive storage and computation required for serving millions of wired internet or mobile network users. In this new multimedia cloud computing paradigm, users can store and process their multimedia data in the cloud in a distributed manner, eliminating full installation of the media application software on local computers or devices. An overview of cloud computing will be provided in this work, focusing on its impact on multimedia services. The case study of *Netflix* video provider is presented, as well.

Keywords:
cloud computing, multimedia services, video streaming, gaming.

1. INTRODUCTION

It is necessary to have an installed application for every computer operation (word processing, listening to music, making presentations, photo processing...). More complex applications are required for complex computer tasks, and therefore a stronger machine is necessary, which further requires more investment in the computer itself. If there is a need to access all data from different locations, an older solution was to personally carry an external hard drive or laptop, which is not practical et al.

The concept that allows these problems to be avoided is computing in the cloud, or cloud computing. The advantage of this technology is that it provides a number of new business opportunities. For example, simple data sharing and collaborative work on documents increase flexibility and faster execution of tasks. In addition, the extremely important characteristic of cloud computing technology is its lower cost. This technology actually responds to the growing need for increasingly complex IT (Information Technologies) services, causing a reduction in budgets reserved for IT.

Cloud has made great improvements, especially for small and medium-sized enterprises, as they can use the new opportunities offered by clouds and have previously not invested in expensive infrastructure.

Correspondence:
Andreja Samčović

e-mail:
andrej@sf.bg.ac.rs

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We can say that cloud is a revolution in the IT world. This technology can be freely called the technology of saving, for many reasons. However, organizations are still not completely safe with this technology, and the main reason is that information security is beyond their environments [1]. This is also evidenced by the research of the Statistical Office of the Republic of Serbia in 2017, which showed that only 19.5% of the internet population uses cloud storage and data services [2]. In many organizations, business policy bans the storage of data on non-owned systems. Such organizations generally have a private cloud computing format, which certainly has great advantages.

Speaking about cloud computing, we need to define what is cloud computing. It is well known in the IT world that cloud computing has many definitions. One of them was defined by the US National Institute of Standards and Technology (NIST) in October 2011. This definition is often taken as a reference point for any discussion about cloud: "Cloud computing is a model that allows a common presence, a flexible network access at the user's request, a shared set of computer resources (e.g. network resources, servers, hard disk space, applications and services) that can be quickly enabled with minimal effort to manage or interact with a service provider" [3].

On the other hand, research marketing agencies, such as Gartner and Forrester offer the following definitions: "The field of computing where scalable and elastic information capabilities are delivered in the form of internet services to a number of external consumers" [4].

Simply, cloud computing involves the use of renting of computer resources from specialized companies that offer these services. The essence is that companies that use cloud services pay just as much computer resources as they are using.

Different definitions exist because of the comprehensive concept from which it is difficult to derive an individual element which is the most important factor for the very idea of the cloud. The term cloud comes from the internet experts, in the early period of the global network. The space and all properties among networked computers were labeled as a cloud. Hence, we can simplify that the name cloud computing comes from the applications that exist on the "cloud" of the web server [5].

Cloud computing has emerged over the past few years as a new environment for hosting and delivering multimedia services over the internet. Cloud computing has became attractive to service providers, because there is a rise in multimedia service demand. However, despite that cloud computing offers important advantages, there are many questions still to be answered.

This paper is organized as follows: some important multimedia services based in a cloud are described. The characteristics of multimedia cloud are presented in the next section, followed by the explanation of media sharing. Advanced multimedia services, such as interactive multimedia gaming and video streaming, are presented further. Concluding remarks are discussed in the final part of the paper.

2. CLOUD COMPUTING FOR MULTIMEDIA SERVICES

The emergence of cloud computing has largely changed existing service models for modern information and communication applications. By utilizing elastic resources in powerful data centers, cloud provides end-users with practical access to computer infrastructure, platforms and software. It is usually provided by remote cloud providers (e.g. *Amazon, Google* and *Microsoft*) on a pay-as-you-go method or on a long-term lease. This new generation of computer paradigms, which offer reliable, elastic and cost-effective resource allocation, can significantly reduce the costs of building and maintaining own computer, storage and network infrastructure. Cloud provides a large number of options for new and existing applications.

Existing applications, from content sharing applications and file synchronization to media transfer applications, have made progress in terms of system efficiency and usability through the cloud computing platform. These improvements come mainly from the exploitation of massive cloud resources, with elastic reservation, pricing and by unloading local devices from demanding computing operations. On the other hand, start-up companies can easily implement their new ideas into real products with minimal investments in the initial phase and can later expand their business without much effort.

Representative of such platforms is *Dropbox*, a typical cloud storage space and a file synchronization provider, which is realized on *Amazon*'s S3 cloud storage servers from the very beginning. *Dropbox* uses the *Amazon* EC2 cloud platform to provide key features such as synchronization and collaboration among different users. Relatively new multimedia cloud services such as cloud-based VoD (Video on Demand) and cloud-based games that appear on the market have also emerged and can change the business model in the coming years [6].

A prominent example of such services is *Netflix*, the main internet provider of video streaming content that switched its infrastructure to the *Amazon* cloud platform in 2010 and has become one of the most important cloud users. Totally, *Netflix* has over one petabyte of multimedia data stored in *Amazon*'s cloud. *Netflix* pays for bandwidth and storage resources, and therefore long-term costs become lower than those with excessive security on owned servers.

Another example of multimedia cloud platforms is *Cloudcoder*, an adaptive video transcoding service that transfers most of the processing into the cloud. Built on the *Microsoft's Azure* cloud platform, *Cloudcoder* can support a large number of transcoder services at the same time, which can also be automatically configured to resolve the burst of the request.

Since 2000, *Amazon* has played a leading role in the development of cloud computing by modernizing its data centers. *Amazon* launched in 2006 the new products to provide cloud computing to external customers, such as AVS (*Amazon Web Services*), which has become one of the most common used cloud computing platforms.

Multimedia cloud

There are strict requirements for cloud computing due to the high storage and required calculations to provide multimedia applications and services to internet users. They can store and process multimedia data in the cloud in a distributed manner, whereas installation of application software can be done on local computers or devices. Multimedia cloud computing shares many common features with cloud computing in general. However, multimedia services are very heterogeneous. There is a wide range of media types and related services, such as Voice over IP (VoIP), video-conferencing, image sharing and editing, image retrieval, or image-based rendering [7]. Clouds should support different types of media and their services for large user databases at the same time. In addition to service heterogeneity, different types of devices, such as smart TVs, computers and smart phones, have different multimedia processing capabilities. The cloud should have a flexible ability to fit into these types of devices, in terms of CPU (*Central Processing Unit*) and GPU (*Graphics Processing Unit*), displays, memory and storage.

A multimedia cloud also needs to provide a certain level of QoS (*Quality of Service*) to meet different requirements. There are two ways to provide QoS for multimedia: one is adding QoS to the current cloud computing infrastructure, and another is adding QoS between cloud infrastructure and multimedia applications. The first approach focuses on design and improvement within the cloud infrastructure. The other way focuses on improving QoS in middle layers, such as QoS on the transport layer, and QoS mapping between cloud infrastructure and media applications.

In short, the strict requirements for access, processing and transmission of multimedia data would create bottlenecks, or cloud congestions for general purposes. Today's cloud design has mostly focused on allocating computer and warehouse resources through various usable mechanisms, while QoS requirements in terms of bandwidth, latency, and jitter have yet to be resolved. In order to realize a multimedia cloud, there is a need for inertia between cloud and multimedia services; that is, multimedia-aware cloud computing (a cloud that is "conscious" multimedia) is needed with enhanced QoS support for multimedia applications and ease of content storage, processing, adaptation and rendering with optimized use of resources.

3. MEDIA SHARING BY USING CLOUD

The first association on cloud is its use for media exchange. Media sharing services like *YouTube* are developing extremely fast. In general, it is difficult, perhaps impossible, to predict in advance the impact and development of new multimedia services. Providing resources is a huge challenge, as each service comes with new ideas. Moreover, advanced techniques and smart marketing strategies can progress in a similar proportion to *YouTube*. However, there is a great dilemma at an early stage of service delivery. On the one hand, providing enough large resources at the beginning is expensive and risky, and if the service is not as popular as it was expected to be, the resources would be lost. On the other hand, the launch of the new service usually encounters problems of scalability. New features and increased user base will lead to high pressure on insufficient infrastructure, which reduces the QoS.

Cloud, which offers a reliable, resilient and cost-effective resource with a pay-as-you-go payment service, is an elegant solution that allows designers to launch service at a lower level. In addition to launching new services, migration of content into the cloud is also useful for existing media services, in the presence of scalability challenges.

Content sharing is an integral part of the cloud service. The demand for easy and scalable interchange is the main reason why multimedia content now occupies a large part of the storage space in the cloud. Centralized data exchange systems can make highly efficient one-to-many exchanges, and synchronous content can be easily shared by large populations, either immediately or with a little delay. Cloud computng can also offer better QoS because links to data centers are generally good and avoid firewall and Network Address Translation (NAT) problems commonly encountered by peer-to-peer networks.

Figure 1 shows a generic framework that facilitates the migration of existing streaming services to a cloud-assisted solution. There is a split into two layers, namely, *Cloud Layer*, and *User Layer*. *Cloud Layer* consists of content sources that transmit live and dynamically booked cloud servers. Upon receipt of user requests, *Cloud Layer* will redirect users to the properly selected cloud server. Such a redirect is, however, transparent to the user, i.e. the entire *Cloud Layer* is considered to be one of the original servers from the perspective of users. Since user requirements change over time and are also dependent on location, *Cloud Layer* will adjust accordingly the amount and locations of rented servers. It will intuitively lend more server resources to increase demand during peak times and terminate leases after reduction. Application of *User Layer* can be flexible. It can be made by individual users that rely solely on *Cloud Layer*, or users connected to a peer-to-peer or CDN (*Content Distribution Network*) infrastructure, but they require additional support from the cloud during load. In other words, *Cloud Layer* can migrate from different existing live streaming systems into the cloud [4].

There are, however, a number of critical theoretical and practical issues to be addressed. Although cloud services are improving, there are still delays in providing resources, for example, to start or shut down a virtual machine may take a few minutes in the current implementation of Amazon EC2. Although such delays are gradually reduced with improved cloud design, they can be difficult to eliminate. Therefore, the system must make good predictions when to hire new servers to meet changing requirements, and when to terminate the server lease in order to reduce costs. This can be done by the cloud forecasting algorithm.

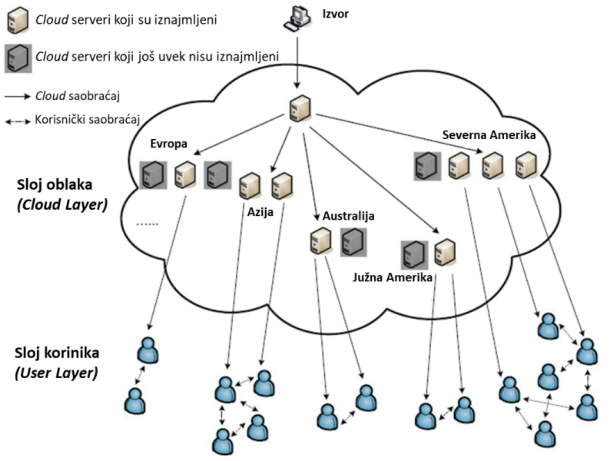


Figure 1. Generic framework for migration of existing live streaming services into a cloud

Netflix application

One of the most successful migration applications for the media sharing into the cloud is *Netflix*, which now occupies one-third of the US internet download traffic during the peak load period, the so-called peak traffic hours. Founded in 1997, *Netflix* has begun to develop from its original business model - sending DVDs (*Digital Versatile Disks*) by post to video-on-demand via internet in early 2007. The original *Netflix* digital video distribution is based on several large *Oracle* servers with *Java* front end. Later in 2008, there were errors in the storage of data that was dropped by the service. Rapid development has created many challenges, which can hardly be foreseen when building private server clusters, without mentioning the staff and skills needed to run a large data transfer infrastructure with a high rate of development. Since 2009, Netflix has started to use *Amazon*'s AWS (*Amazon Web Services*) for part of its services and moved the entire technology infrastructure to AWS in 2012.

To support a combination of massive traffic and unpredictable demand, *Netflix* has developed a global video distribution system that uses the AWS cloud. Figure 2 shows the cloud-based *Netflix* architecture that includes the following key modules:

- *Content conversion* - *Netflix* purchases master copies of digital movies from movie studios and, using powerful EC2 cloud machines, converts them into over 50 different versions with

different video resolutions and sound quality, targeting a variety of client video players on computers, smart phones, even on DVD players or game consoles connected to television;

- *Content storage* - main copies and many converted copies are stored in S3. In total, *Netflix* has over 1 petabyte of data stored on *Amazon*;
- *Distribution of content*. To serve users around the world data is sent to content delivery networks CDN (including *Akamai, Limelight and Level* 3) that distribute content to local internet service providers.

With different formats and data rates, dynamic adaptive streaming over HTTP DASH (*Dynamic Adaptive Streaming over* HTTP) is available for streaming to end users. All these services are distributed in the three AWS availability zones. *Netflix* only maintains a minimum hardware infrastructure for user registration and credit card payment. Using Amazon's cloud and CDNs, *Netflix* can respond much better and faster to the users' needs. Such costs, without clouds, can be extremely high for dedicated content providers.

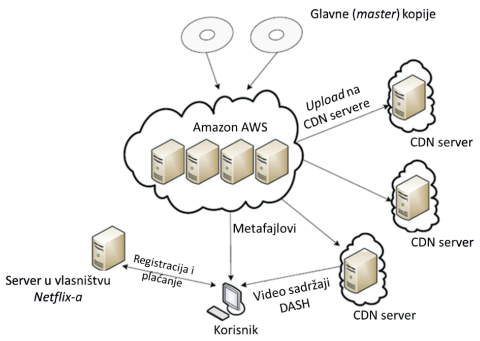


Figure 2. Netflix architecture based on a cloud

Computer requirements for multimedia services

In addition to storing, computing is another rich resource that cloud offers. Many tasks that require intensive computing can now migrate to the cloud, and users do not need to maintain ultra-expensive high-performance servers or clusters of servers, but only to pay the cost on-demand. Computer deployment effectively extends the usability of local devices beyond their physical limitations, which is particularly useful for mobile devices. Today's smart phones and tablets increasingly penetrate into everyday life of people as efficient and practical tools for communication and entertainment. The touch screen and all types of sensors provide even richer user experiences than desktop computers.

Despite the rapid development of key components such as CPU, GPU, memory, wireless access technology and efforts to integrate both handheld and desktop computers, there is a general conclusion that mobile terminals will not completely replace laptop and desktop computers in the near future. The migration of popular software to mobile platforms is still limited due to limited computing, as well as the uniqueness of operating systems and hardware architectures. To make things worse, the battery, as the only power source for most mobile terminals, has achieved relatively little improvement over the past decade. This is what constitutes a major obstacle in providing reliable and sophisticated mobile applications to meet user needs.

By combining the strength of the cloud and the benefits of mobile terminals, there is great progress. For example, *Apple's Siri* service - after launching a voice message over the iPhone, a local recognizer will perform speech recognition and decide whether to turn back to the end cloud to respond in the right way. Other examples include MAUI and *CloneCloud*. The first allows for energy-efficient offloading of mobile codes into the cloud, based on the history of energy consumption. *CloneCloud* uses input variables and offline cost model for dynamic sharing of applications on "bad" devices and cloud.

QoS requirements must also be taken into consideration for multimedia applications. It is necessary to respect critical QoS requirements (e.g., delay, image/video quality, accuracy of computing), so offloading does not affect the user experience. A simple solution for calculating offloading is to move the entire computing mechanism to a distant cloud, then upload all the data needed to calculate and download the calculated results. Although this is common for many implementations, complex applications for organizations are usually composed of multiple service components, which can hardly migrate to the cloud as one entity.

This is further complicated by wireless communication with mobile terminals. Compared to its wired counterparts, mobile terminals are generally more limited in resources; in particular the capacity of wireless communication and the capacity of the battery are inherent bottlenecks. Energy consumption depends on a large extent of the workload characteristics, the data transmission scheme and the used technologies. As such, offloading of the entire application's computer module

on a remote cloud is not necessary efficient, if the data volume is large. This may not be a serious problem for users who have a high speed wired connection, but can greatly reduce the benefits for mobile users.

It is necessary to consider video encoding/compression as an important task in a wide range of mobile multimedia applications. The local user uses his mobile terminal to record video in real time, expecting to encode video and then transfer to other users in real time. Directly uploading "raw" video signals without efficient coding inevitably leads to high bandwidth costs and high power consumption for transmission. On the other hand, for video encoding, complex computing is often required, which leads to high energy consumption. For example, for a video coding of 5 seconds (30 frames per second with a resolution of 176×144 and a pixel depth of 8 bits) using a H.264/AVC encoder requires a total of 1×1010 CPU cycles total or 2×109 CPU cycles per second in average, which means that a 2 GHz CPU is required for real-time encoding [4]. Considering that the latest smart phones and tablets are equipped with high definition cameras, the workload of the processor can be 5-10 times higher than in the previous example.

However, offloading the entire cloud video compression task is not practical, because it is identical to the direct transmission of raw video data. Wireless transmission can be either too expensive or simply impossible due to limited bandwidth. For instance, it is well known that motion estimation in video signals is the most computationally demanding operation. Certainly, this operation should be in the offloading focus.

4. INTERACTIVE CLOUD GAMING

Cloud technologies are expanded to enable offloading not only for traditional computing, but for complex tasks such as 3D high definition display, which brings cloud gaming from the level of idea to the level of reality. Cloud gaming in the simplest form represents an interactive game on a remote cloud and involves streaming the scenes over the internet to the user who plays the game. The cloud gaming player interacts with the application through the thin client, which is responsible for displaying the video from the cloud server, as well as for collecting player controls and sending cloud interactions [8]. Figure 3 shows the high-level architecture of this cloud system with thin clients and cloud-based display.

Cloud gaming can bring great benefits by expanding the user base to a large number of less powerful devices that support only thin clients, especially smart phones and tablets. As such, mobile users can enjoy quality video games without performing computer-intensive display of images at the local level.

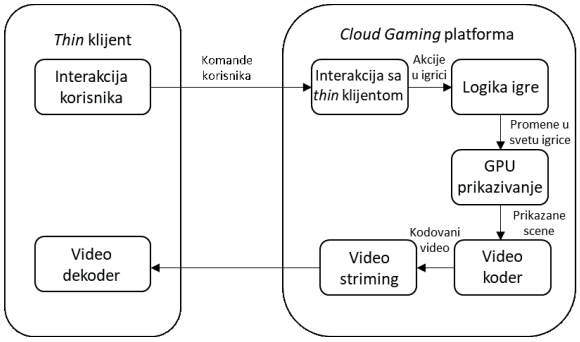


Figure 3. Interaction of a thin client with cloud gaming platform

Moreover, mobile devices have different hardware/software architecture from personal computers, lower memory, limited bandwidth, and limited battery capacities [9]. The traditional console model of games is not always feasible for such devices, which on the other hand becomes the goal of cloud gaming. Cloud gaming also masks the discord between different operating systems through standard web development tools such as HTML5, *Flash*, and *JavaScript*. It further reduces customer support costs because computer hardware is now under the complete control of cloud hosting providers.

As shown in Figure 3, player controls in cloud gaming must be sent over the internet from a thin client to a cloud gaming platform. When the commands arrive at a distant cloud, they are converted into corresponding actions in the game. The logic game turns these actions into certain changes in the game world. Changes in the world of games are processed by GPUs cloud system in the displayed scene. The scene is then compressed by the video encoder and it is sent to the video streaming module, which delivers the video stream back to the thin client. Finally, the thin client decodes the video and displays the video frame of the player.

In order to ensure interactivity, all these operations must be carried out during the millisecond period. This time period is defined as a delay in interaction, and it must be as short as possible that a rich user experience can be passed to cloud players. However, there are always compromises: the player has less tolerance for the interaction delay, the system has less time to perform critical operations such as displaying scenes and video

compression. On the other hand, as this time threshold is lower, it is more likely that the delay in the network will adversely affect the player's experience in interaction.

5. VIDEO STREAMING AND CODING

Cloud gaming's requirements for video streaming are similar to live streaming requirements. Cloud gaming and live video streaming must quickly encode/compress incoming video and distribute to end users. In both cases, only a small set of new video frames is interesting and there is no need or ability to access future frames before they are produced, which suggests that encoding must be done in relation to very few frames.

However, conventional live video streaming and cloud gaming have important differences. First, compared to live video streaming, cloud gaming practically does not have the capacity to buffer video frames on the user's side. This is because, when a player issues a command to a local thin client, the command must reach the cloud through the internet, must be processed with the game, displayed by the processing unit, compressed by the video encoder and streamed back to the player. Since all has to be done in less than 100-200 ms, it is obvious that there is not much room for the buffer. Live video streaming, on the other hand, can afford a buffer of several hundred milliseconds, even a few seconds with a very small loss of QoS to the end user.

Sensitive coding needs of cloud gaming in real time make the choice of video encoders to be of importance to any cloud gaming provider. Currently, the main providers of cloud gaming, such as *Gaikai* and *Onlive*, use versions of H.264/AVC (*Advanced Video Coding*) encoders [4]. *Gaikai* uses an encoding-based approach, while *Onlive* uses specialized hardware to compress video stream in cloud gaming. In any case, the choice of the H.264/AVC encoder is motivated by the fact that the encoder has not only a very high compression rate, but also can be configured to work well with strict real-time requirements.

Onlive and *Gaikai* are two industrial pioneers of cloud gaming. *Sony*'s new *Playstation* 4 console will also use *Gaikai*'s cloud platform. *Gaikai* is implemented using two public clouds, namely *Amazon* EC2 and *Limelight*. Figure 4 provides a practical view of *Gaikai*'s workflow. When a user selects a game at *Gaikai* (step 1 in Figure 4), the virtual machine EC2 will first deliver the *Gaikai* game to the user (step 2). It then forwards the proxy IPs ready to run the game by the user (step 3). The user will then select a proxy to run the game (step 4). The proxy starts running the game and the game images will be transmitted to the user via the UDP (*User Datagram Protocol*) (step 5 and step 6). For multiplayer online games, these proxies will also forward user operations to gaming servers and send feedback to users (step 7).

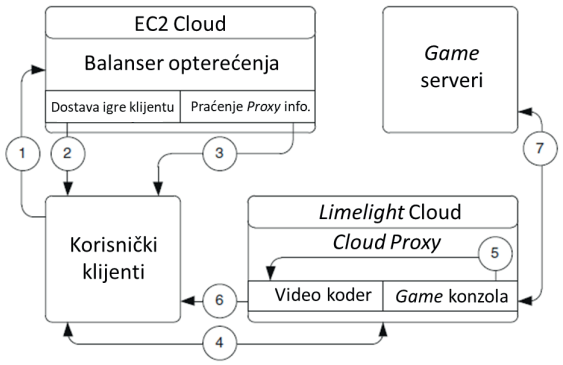


Figure 4. *Gaikaki* cloud gaming platform

Onlive's workflow is similar, but it is applied in a private cloud [10]. The use of public clouds reduces implementation costs and increases scalability; yet a private cloud can offer better performance for playing games.

Table 1 illustrates the effect of compression on a single frame of the video sequence for the popular game, *Batman Arkham Asylum*, streamed at 1280x720 pixels (720p) by *Onlive*. The video quality from the local game console is compared. One can see that the compression effect is noticeable, especially when the amount of available bandwidth is reduced. Although the video quality is good with bit rate 10 Mb/s, there is still room for improving cloud gaming performances.

Table 1. Comparison of video quality for the game Batman Arkham Asylum [4]

Video	PSNR (dB)	SSIM
Master image	n/a	n/a
Local image (without cloud)	33,85	0,97
Onlive (10 Mb/s)	26,58	0,94
Onlive (6 Mb/s)	26,53	0,92
Onlive (3 Mb/s)	26,03	0,89

Video frames are analyzed using two classical metrics, i.e. Peak Signal-to-Noise Ratio (PSNR) ratio and structural similarity (SSIM). The SSIM method calculates similarities in image structures between two video frames. As can be seen, local recording was achieved by high PSNR and SSIM; but that's not perfect, which indicates a certain difference between the recorded video and the master file. Much of this difference is probably due to the slightly different illumination and color settings used by the internal video player in the *Batman* gaming engine. When the local recording is compared with *Onlive* at any connection speed, it can be seen that there is a large drop in terms of PSNR and SSIM. Since PSNR and SSIM are not on a linear scale, the decrease actually indicates a significant degradation of video quality.

6. CONCLUSION

A huge amount of multimedia data can be found on the internet, taking into account rapid development and spread of social networks, smart phones with high resolution cameras, video games, podcasts and other multimedia services. Multimedia services play now a big role in different applications, such as e-health, smart grid, smart cities, image and video forensics, digital cinema and similar. Multimedia cloud systems represent a logical solution for big multimedia data for storage, processing, distribution and service.

One of the rapidly increasing multimedia services is cloud gaming, with many exciting features. In addition to software and service providers, hardware vendors also showed strong interest in cloud gaming and began working on dedicated hardware solutions to address such issues as fast and simultaneous displaying and encoding game scenes, which surely illuminates the future of cloud gaming.

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SIMPLE NEURAL MODEL FOR APPROXIMATE LOCALIZATION OF MOBILE STOCHASTIC EM SOURCES WITH VARIABLE SIGNAL LEVEL AND LINEAR TRAJECTORY IN THE AZIMUTHAL PLANE

Ivan Milovanovic[1, *],
Zoran Stankovic[2],
Nebojsa Doncov[2],
Bratislav Milovanovic[1]

[1]Singidunum University,
Belgrade, Serbia
[2]University of Niš,
Faculty of Electronic Engineering,
Niš, Serbia

Abstract:
In this paper, a simple neural model is presented for approximate determination of the angular position of stochastic radiation sources that move along the linear trajectory at azimuthal plane and whose incoming signal level fluctuates with the change of their position. The neural model is based on a multilayer perceptron network (MLP). In order to perform the localization of stochastic sources, the signals of these sources are sampled with a linear uniform antenna array, and then based on the output of the antenna sensor, spatial correlation matrix is formed, and at the end, the values of this matrix are input to the MLP network determining the angular positions of the source.

Keywords:
Stochastic EM sources, DoA estimation, Neural networks, Neural model.

1. INTRODUCTION

Either deterministic or stochastic radiation presence in the sources of electromagnetic interference (EMI), can degrade the performance of today's wireless communication systems, gravely [1-3]. The negative impact can be muffled by a spatial signal filtering using adaptive antenna arrays [1]. Adaptive beamforming of such antenna arrays is usually based on the Direction of Arrival (DoA) estimation techniques commonly based on the super-resolution algorithms such as MUSIC and its modifications [1,4]. Implementing these algorithms may be faced with hardware constraints of different types so they may not be applicable for real-time applications. Therefore, the usage of artificial neural networks (ANNs) in the DoA estimation process was proposed in [5-7] as a good real-time alternative.

Multilayer perceptron (MLP) neural networks were used by the authors of this paper for the realization of a neural model for 2D DoA estimation of deterministic [8] and 1D DoA estimation of stochastic sources of electromagnetic (EM) radiation [9,10]. For stochastic EMI, either uncorrelated [9] or partially correlated sources [10] were taken into consideration. It was presented that in both stochastic cases, it is sufficient enough to take just the values of the first row of spatial correlation matrix obtained by an antenna array sampling, for the training of a

Correspondence:
Ivan Milovanović

e-mail:
imilovanovic@singidunum.ac.rs

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neural model that provides 1D DoA estimation with an accuracy close to super-resolution algorithms but with much faster run-time.

In all previous cases [9-10], it was assumed the stochastic EM sources are with constant radiation power during their movement. In [11] we consider for the first time, the more general scenario in which movable stochastic EM sources are with fluctuated incoming signal level (ISL). Cascade two-stage neural model is proposed to efficiently perform 1D localization of such mobile stochastic EM sources in ideal conditions, when noise is not present.

This paper presents an alternative neural network solution for the same problem of spatial localization considered in [11]. Unlike [11] where a complex two-stage neural model is used, a simpler MLP model is used to solve the problem, which is less accurate than the model in [11], but it therefore has a simpler architecture and is easier to train and implement. The model proposed in this paper is suitable for use in conditions where high precision is not required in determining the spatial position of stochastic sources, and when noise is collected by antenna series is very small so it can be ignored.

2. STOCHASTIC SOURCE RADIATION MODEL

Our Initial assumption in research presented in this, as in our previous papers [9-10], is that a stochastic EM source in the far-field can be represented by a short dipole, fed by stochastic current. Sources are moving in the azimuth plane along the straight 1D path and the orientation of each dipole representing that one source can change during the movement, allowing us to simulate the fluctuation of stochastic source radiation power in time. Equal level of correlation between the stochastic EM sources is expressed through the correlation between fed currents of dipoles as [2,3]:

$$\mathbf{c}^{I}(\omega) = \lim_{T\to\infty} \frac{1}{2T}\left[\mathbf{I}(\omega)\mathbf{I}(\omega)^{H}\right] \tag{1}$$

Where is $\mathbf{I} = [I_1, I_2, \ldots, I_S]^{\mathrm{T}}$ a vector of fed current of dipoles and S is the number of stochastic EM sources. Using the Green function in free space we get:

$$\mathbf{M}^{(\mathrm{A})} = \mathbf{M}^{(\mathrm{A})}(\theta_1,\ldots,\theta_s,\ldots,\theta_S,\phi_1,\ldots,\phi_s,\ldots,\phi_S,r_1,\ldots,r_s,\ldots,r_S) = \frac{jz_0}{2\pi}\left[\frac{F_1(\theta_1,\phi_1)e^{jkr_1}}{r_1}\ldots\frac{F_s(\theta_s,\phi_s)e^{jkr_s}}{r_s}\ldots\frac{F_S(\theta_S,\phi_S)e^{jkr_S}}{r_S}\right] \tag{2}$$

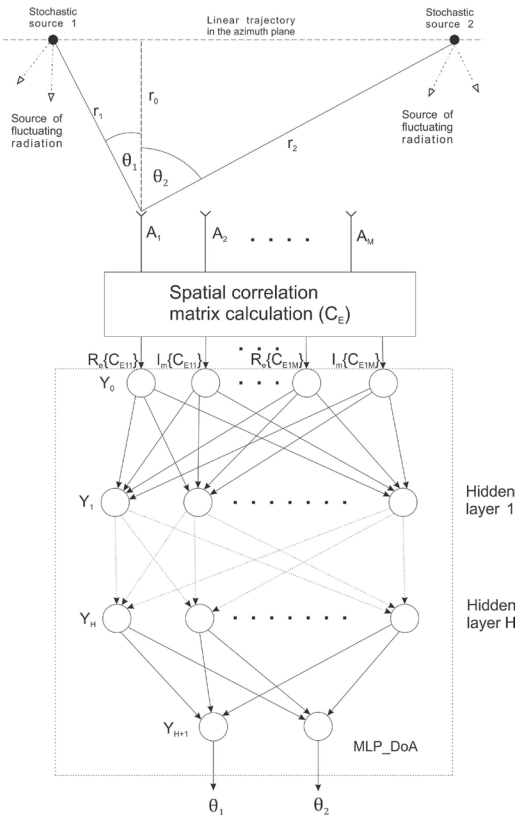


Fig 1. Angular position of mobile stochastic EM sources with fluctuating radiation with respect to the sensors of antenna array performing the sampling of the received signals and architecture of MLP_DoA neural model

The electric field in a specific sampling point A in the far-field, can be calculated as:

$$E^{(A)}(\theta_1,\ldots,\theta_s,\ldots\theta_S,\varphi_1,\ldots,\varphi_s,\ldots\varphi_S,r_1,\ldots,r_s,\ldots r_S)=\mathbf{M}^{(A)}\mathbf{I} \quad (3)$$

In the Eq. (2), $F_s(\theta,\varphi)$ is the radiation pattern of the s-th stochastic EM source, r_s is distance between the s-th stochastic EM source and the sampling point. z_0 is the impedance of free space, k is the phase constant (k=2π/λ), while θ and φ are angles used to describe the angular position of stochastic EM source relative to the particular sampling point in the far-field.

Spatial correlation matrix in the far field is acquired by sampling the signals using a uniform linear antenna array with M sensors (Fig. 1, the shown scenario of movement and DoA estimation of two stochastic sources). Axis of the antenna array is parallel to the direction of movement of stochastic EM sources, while the sensor positions are described by points A_1, A_2, ..., A_M. Sensors are at equal mutual distance y_d.

Combining Eqs. (1), (2) and (3), the correlation matrix in the far field is expressed as:

$$\tilde{\mathbf{C}}_E[i,j]=\mathbf{M}^{(A_i)}\mathbf{c}^I(\mathbf{M}^{(A_j)})^H \quad i=1,\ldots,M \;\; j=1,\ldots,M \quad (4)$$

As it was initially assumed, EM sources are moving only in azimuth plane, angle φ is equals zero for any position of the stochastic EM source and the matrix $\mathbf{c}^I$, is a unit matrix due to uncorrelated sources. Therefore, the azimuth angular position and the distance of s-th stochastic EM source relative to m-th antenna array sensor is [11]:

$$\theta_s^{(m)}=\arctan\left[\tan\theta_s^{(1)}-\frac{(m-1)\cdot y_d}{r_0}\right] \quad r_s^{(m)}=\frac{r_0}{\cos\theta_s^{(m)}} \quad (5)$$

Angle θ_s represents the azimuth angular position of s-th source relative to the antenna array and it can be determined as an angle position in relation to the first sensor of the antenna array when $\theta_s=\theta_s^{(1)}$. Using Eqs. (2), (4) and (5) for the given angular position of the radiation source we may determine the mapping function **M**, and after that also the elements of the correlation matrix using the Eq. (4). Fig.1 illustrates movement of the two stochastic EM sources (S = 2) with variable radiated power. For development of the neural model, we used the correlation matrix, normalized with the first matrix element:

$$\mathbf{C}_E=\frac{1}{\tilde{C}_{E11}}\cdot\tilde{\mathbf{C}}_E \quad (6)$$

In this scenario, the changes in radiation power of s-th stochastic source are modeled through a variable relative ratio of radiation pattern functions:

$$p_s(\theta_s,\phi_s)=10\log\left[\frac{F_s(\theta_s,\phi_s)}{F_1(\theta_1,\phi_1)}\right] \quad (7)$$

3. NEURAL NETWORK MODEL

A neural model based on a single MLP network along with its architecture and connection to the antenna array is shown in Figure 1. As shown in [8,9,11], it is sufficient to consider only the elements of the first row of the correlation matrix CE for the training of the MLP model, performing 1D DoA estimation of uncorrelated radiation sources whose ISL is fluctuated during the movement. Accordingly, the fundamental task of the MLP_DoA model is to map the first row of the correlation matrix $\mathbf{x}(\mathbf{C}_E)=[C_j]_{1\times M}, i=1, j\in\{1,\ldots,M\}$, sampled under the condition of variable radiation power of stochastic sources during their movement, to the azimuth position of stochastic sources:

$$[\theta_1\;\theta_2]^T=f_{MLP_DoA}(\mathbf{x}(\mathbf{C}_E)) \quad (8)$$

MLP networks used in the MLP_DoA neural model is described by the following function:

$$\mathbf{y}_l=F(\mathbf{w}_l\mathbf{y}_{l-1}+\mathbf{b}_l) \quad l=1,2,\ldots,H \quad (9)$$

where $\mathbf{y}_{l-1}$ vector represents the output of (l-1)-th hidden layer, $\mathbf{w}_l$ is a connection weight matrix among (l-1)-th and l-th hidden layer neurons, $\mathbf{b}_l$ is a vector containing biases of l-th hidden layer neurons and H is number of hidden layers. F is the activation function of neurons in hidden layers and in this scenario it is a hyperbolic tangent sigmoid transfer function $F(u)=(e^u-e^{-u})/(e^u-e^{-u})$. Real and imaginary parts of correlation matrix elements are individually brought at the input point of the network. Therefore, the input layer of MLP network is in the form of: $\mathbf{y}_0=[\mathrm{Re}\{\mathbf{x}(\mathbf{C}_E)\}\;\mathrm{Im}\{\mathbf{x}(\mathbf{C}_E)\}]_{1\times 2M}$, while output of the MLP_DoA network model is: $[\theta_1\;\theta_2]^T=\mathbf{w}_{H+1}\mathbf{y}_H$.

In these notations $\mathbf{w}_{H+1}$ connects in weight matrix between neurons of the last hidden layer and neurons in the output layer. During the training of the neural network, weight matrices $\mathbf{w}_1$, $\mathbf{w}_2$,…, $\mathbf{w}_H$, $\mathbf{w}_{H+1}$ and biases values are optimized to get the desired mapping accuracy. The general notation used to describe the

MLP neural model in the first or second model stage is: MLPH-N_1-…-N_i-…-N_H where H is the total number of hidden MLP network layers, and N_i is the total number of neurons in the i-th hidden layer.

4. MODELING RESULTS

A MLP neural model, whose architecture is shown in the Fig. 1, is used to determine the angular position in the azimuth plane of two uncorrelated stochastic EM sources with fluctuated ISL. Sources are moving along a straight line trajectory that is outlying from the sampling place at r_0 = 1000 m. Parameter p, gives information about the change of difference between signal level of two sources, varies in the range $0\,\text{dB} \le p \le 10\,\text{dB}$. The signal is sampled by the antenna array consisting of, M=4 sensor elements at the frequency of f = 28 GHz. The distance between the neighboring antenna sensors is y_d =0.5l. Implementation, training and testing of neural models were conducted in MATLAB software environment. Method used for training is Quasi-Newton, with the prescribed accuracy of 10^{-4}.

Based on relations presented in Eqs (2), (4) and (7), an inverse mapping is established here:

$$\mathbf{C}_E^t = f_{DoA}^{-1}\left(\theta_1^t, \theta_1^t, p\right) \tag{10}$$

Table 1. Testing results for six MLP_DoA neural networks with the best test statistics

MLP network	WCE [%]	ATE [%]	r^{PPM}
MLP_DoA_2-23-23	10.23	0.95	0.9984
MLP_DoA_4-22-20	9.97	0.97	0.9983
MLP_DoA_4-22-22	10.87	0.98	0.9982
MLP_DoA_4-18-18	10.68	1.02	0.9982
MLP_DoA_4-18-16	11.01	1.06	0.9980
MLP_DoA_4-18-14	10.45	1.12	0.9977

By using this mapping, the training and testing sets for MLP networks are generated and they are in the form $\{(\mathbf{x}^t(\mathbf{C}^t_E(\theta^t_1, \theta^t_2, p^t)), \theta^t_1, \theta^t_2)\}$. Thereby the following distribution of samples is used [11]

$$\left\{\begin{array}{l}(\mathbf{x}^t(\mathbf{C}_E^t(\theta_1^t, \theta_2^t, p^t)), \theta_1^t, \theta_2^t) \mid \\ \theta_1^t \in [-30 : \theta_{step}^t : 30], \theta_2^t \in [-30 : \theta_{step}^t : 30], \theta_1^t > \theta_2^t, \\ c^t \in [0 : p_{step}^t : 10]\end{array}\right\} \tag{11}$$

where values used to generate training and testing sets are θ^t_{step} = 1, p^t_{step} = 1 and θ^t_{step} = 1.3, p^t_{step} = 1.3 respectively. 20130 training samples and 8648 testing samples were generated by using Eqs. (10) and (11). For the development of the model, networks with two hidden layers were used. Accordingly, using the training set, training of a number of MLP2-N1-N2 networks with variable number of N1 and N2 neurons in hidden layers was carried out. After testing all trained grids, the selection of the appropriate grids had the best test characteristics. Testing results for six MLP_DoA neural networks with the best test statistics are shown in Table 1. Testing metrics is WCE - worst case error, ACE - average test error and correlation coefficient rPPM [6]

For modeling, the MLP_DoA_2-23-23 network was selected to show the best test characteristics. Scattering diagram of the MLP_DoA model realized by using MLP_DoA_2-23-23 networks is shown in Fig. 2.

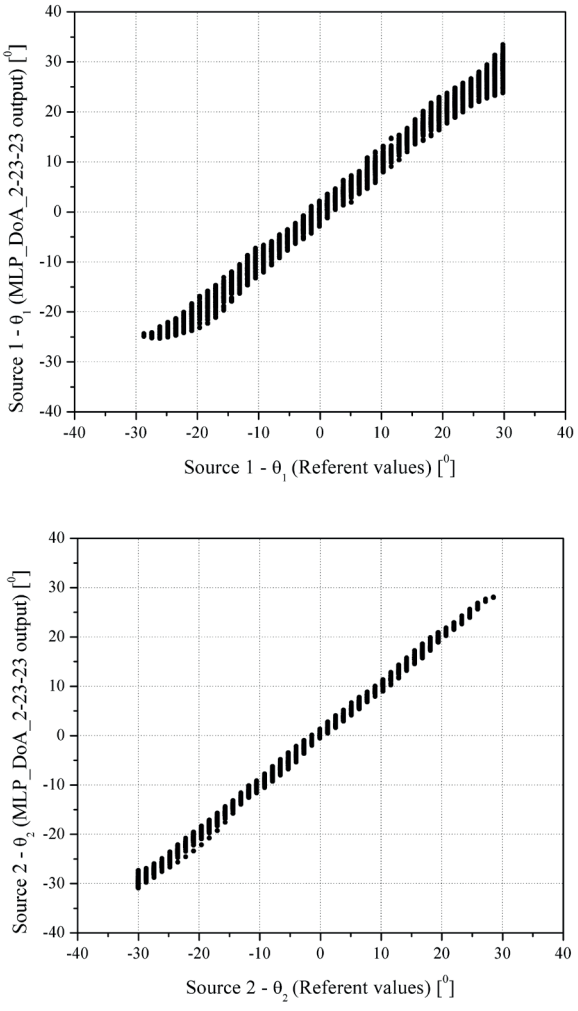


Fig 2. Scattering diagram of MLP_DoA_2-23-23 model on test set: (a) θ_1 output and (b) θ_2 output

5. CONCLUSION

The proposed neural model can be a good alternative to other neural models that deal with 1D DoA estimation and spatial localization of stochastic EM sources in the azimuthal plane that have a source of fluctuating radiation in the case when the priority is not the high accuracy of the model but its training speed and simple implementation. The model avoids complex mathematical calculations that are present in classical superresolution algorithms and hence has a very high simulation rate. The model is only applicable when the noise collected by the antenna array is very minor and can be ignored.

ACKNOWLEDGMENT

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INTRODUCTION TO CLOUDSIM

Dejan Bulaja,
Kristina Božić,
Nikola Penevski
Nebojša Bačanin Džakula

Singidunum University,
Belgrade, Serbia

Abstract:
Cloud computing is a subscription-based service where networked storage space and other computer resources can be obtained. Due to its high availability, easy accessibility, scalability and adaptability, cloud computing is highly desirable in the rapidly growing world of computer technology. Because of this high demand, the Cloud Computing and Distributed Systems (CLOUDS) Laboratory built the CloudSim framework, which became very popular open source cloud simulator among the researchers and students. CloudSim is new simulation framework which allows uninterrupted modeling and simulation of cloud computing infrastructure. It helped open up the possibility of evaluating the hypothesis in a controlled environment where experimental results can be reproduced easily. This basic goal of this paper is helping the researchers to understand CloudSim's most important functions and its practical usage, and to take insights on hands-on example of creating a simulated cloud environment.

Keywords:
CloudSim, Cloud Computing, Job Scheduling, Load Balancing.

1. INTRODUCTION

Cloud computing provides affordable, scalable and ubiquitous computing over distributed networks. It is based on reliable, secure, fault-tolerant, sustainable and scalable infrastructure for hosting Internet-based application services. Cloud computing often experiences problems of different load and energy performance, while modeling and scheduling different applications and services for the cloud infrastructure, which can be solved by using CloudSim. CloudSim is a self-contained platform that provides an extensible simulation toolkit which enables modeling and simulation of cloud computing systems and application provisioning environments. CloudSim has the following basic properties that make it convenient for simulating cloud:

1. Provides controlled and a repeatable environment to create and simulate cloud entities
2. Can be extended to include user defined policies for cloud

Correspondence:
Nebojša Bačanin Džakula

e-mail:
nbacanin@singidunum.ac.rs

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3. Provides changeable infrastructure modeling, changeable network architecture, federated cloud support
4. Provides VM provisioning, Host provisioning, network provisioning and application provisioning.

2. BACKGROUND

Cloud Computing

Cloud computing can be defined as "a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resourced based on service-level agreements established through negotiation between the service provider and consumers" [1].

The National Institute of Standards and Technology (NIST) defines cloud computing as: a pay-per-use model for enabling available, convenient, on demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [2].

Some examples of popular cloud computing infrastructures include Amazon Web Services, Microsoft Azure, Google Cloud Platform and Heroku [3].

Cloud Computing Models

Cloud Computing Models can be grouped into three categories listed below:

1. Software as a Service (SaaS) - this model offers a complete application to the customer. A single instance of the service is running on the cloud and multiple end users can be served simultaneously.
2. Platform as a Service (PaaS) - in this model, a layer of software or development environment is offered to end users as a service. Utility is that the customer can build his own application which runs on the provider's infrastructure freely.
3. Infrastructure as a Service (IaaS) - basic storage and computing capabilities as standardized services over the network are provided by this model. Servers, storage systems, data center space are made available to customers to handle workloads.

Enterprises can deploy application on one of the three clouds, and those are Public, Private and Hybrid clouds. Public clouds are owned and operated by third party. All customers share the same infrastructure pool with limited security protection and configuration [4], but the cost of this service is low and supports "Pay-as-you-go" model. Private clouds, on the other hand, are built exclusively for a single enterprise. The aim is to address the existing concern of data security and offer greater control over the infrastructure. Hybrid clouds are a combination of both previously addressed cloud models. By allowing workloads to move between private and public clouds as computing needs and costs change, hybrid cloud gives businesses greater flexibility and more data deployment options [5].

3. CLOUDSIM ARCHITECTURE

ClousSim provides an emulation of all the processes that happen in the cloud as shown in figure 1. CloudSim contains 12 packages that are used to create a simulation. The most relevant one is called cloudsim and contains the classes for modeling the various cloud entities like a Datacenter, a Host, a Cloudlet and VMs.

Datacenter is a virtual representation of a real datacenter and contains several computing nodes known as Hosts that are responsible for providing the services desired by the end user. It is described by the following parameters:

1. Total available processing power in MIPS (Million Instructions Per Second)
2. Total available RAM in MB (Random Access Memory)
3. Total storage represented in MB
4. Total bandwidth in mbps. Bandwidth is crucial for delivering burstable stable services [6].

Datacenter Broker represents a broker acting on behalf of a user. It hides VM management such, as vm creation, submission of cloudlets to this VMs and destruction of VMs.

Host executes actions related to management of virtual machines (e.g. creation and destruction). A host has a defined policy for provisioning memory and bw, as well as an allocation policy for Pe's to virtual machines. A host is allocated to a datacenter. It can host virtual machines.

Virtual machines are portable, inter-operable, logically independent. Each VM created is allocated to a Host where all its computational requirements are met. VM is described by the following properties:

1. CPU power represented in MIPS
2. Number of processing cores
3. Amount of RAM memory
4. Size of the virtual disk image
5. Bandwidth in mbps
6. Name of the virtual machine

Cloudlet is a representation of a submitted task in the cloud. Each cloudlet is assigned to a VM. Cloudlet has the following attributes:

1. Id of cloudlet that is used by the broker to assign them to a virtual machine
2. Length of a task that is to be executed represented in bytes
3. Output file size is the size of the cloudlet after executing.
4. Number of processors that are required to run the cloudlet

VmScheduler supports two ways of executing Cloudlets: time shared and space shared policies. In the time shared policy Cloudlets are run simultaneously while the MIPS of the VMs is divided evenly among them. In the space shared policy VMs will execute cloudlets in a chronological order using full capacity for each cloudlet.

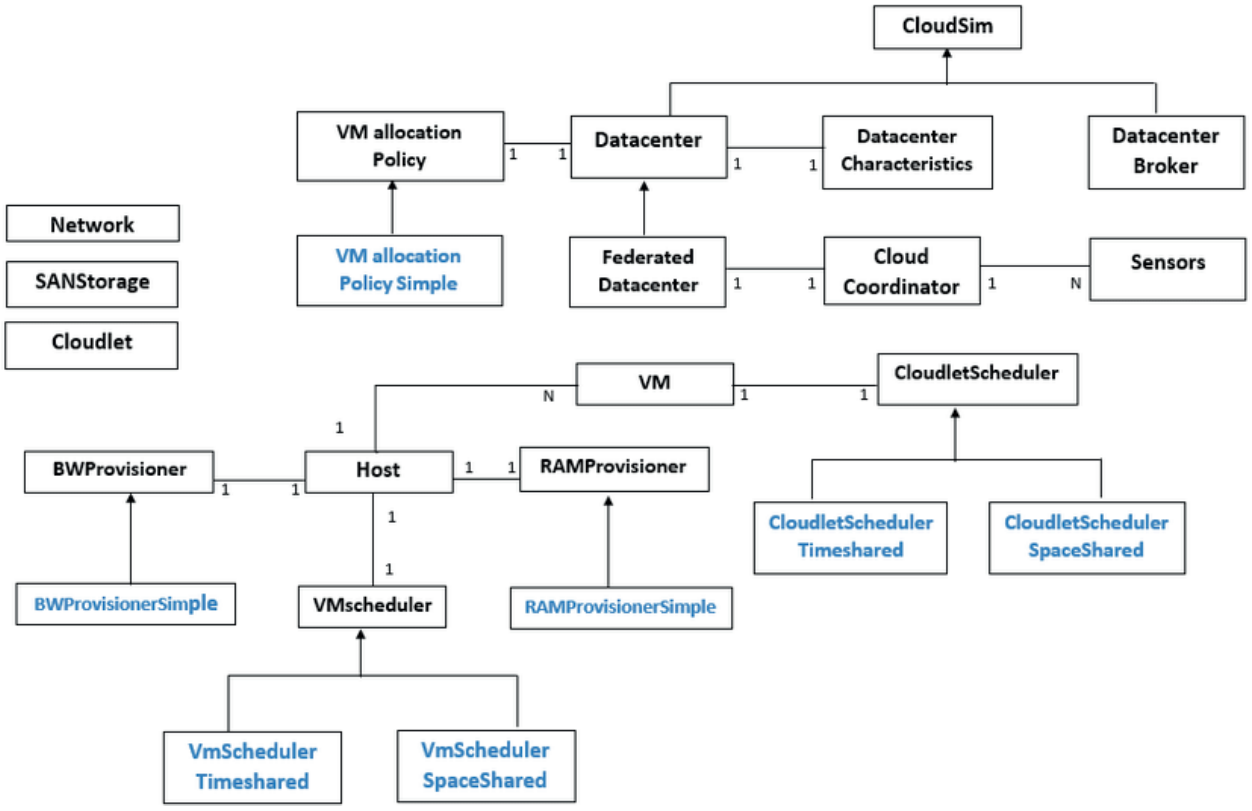


Figure 1. CloudSim Diagram

4. USING CLOUDSIM

CloudSim can be run as a standalone simulator to simulate cloud computing scenarios using any popular java IDEs. CloudSim can be used to research variety of existing policies, but it is also possible to change those policies for cloud operations, depending on the requirements.

Some of the most used Packages in CloudSim are listed below:

1. org.cloudbus.cloudsim.core - this package contains core functionalities which are required for simulation
2. org.cloudbus.cloudsim.distribution - contains variety of mathematical distributions, where Random Number Generator and Exponential Distribution are most common

3. org.cloudbus.cloudsim.network - where all the classes required for the network topology are contained
4. org.cloudbus.cloudsim.network, datacenter - which defines a network within a Datacenter
5. org.cloudbus.cloudsim.util - package contains classes that can provide specific mathematical functions
6. org.cloudbus.cloudsim.lists - containing the lists of operations on the list of resources like Hosts, VM, cloudlets and so on

All the packages and classes are contained within a jar (in folder CloudSim3.0.3\jars\CloudSim-3.0.3.jar). If one needs to add new policies to the existing toolkit, it must be done by overwriting the methods in existing classes. Some of the major classes along with their uses is shown in the figure 2. The class org.cloudbus.cloudsim.vmAllocationPolicy is important because it can be extended and used for Host Load Balancing. Load Balancing is the process of spreading the load across available resources so as to decrease the overall response time of a task and to simultaneously increase the utilization of the resources [7].

Cloudlet	Host	Virutal Machine
getStatus()	allocatePesForVm()	getBw()
getCloudletId()	getAllocatedMipsForVm()	getHost()
getCloudletLength()	getId()	getId()
getCloudletOutputSize()	getDatacenter()	getMips()
getCostPerSec()	getBw()	getSize()
getProcessingCost()	getAvailableMips()	getCurrentAllocatedRam()
getVmId()	getNumberofFreePes()	getCurrentAllocatedBw()
getWaitingTime()	getRam()	getCurrentAllocatedMips()
getUserId()	getStorage()	getCurrentAllocatedSize()
getExecStartTime()	getTotalMips()	getCloudletScheduler()
getFinishTime()	getVmList(0	getVmm()
isFinished()	getBwProvisioner()	getUserId()
getCloudletFinishedSoFar(0	getRamProvisioner(0	getNumberOfPes()
getSubmissionTime()	addMigratingInVm()	isInMigration()

Figure 2. CloudSim Classes

Example of a CloudSim simulation

Initialising...

Starting CloudSim version 3.0

Datacenter_0 is starting...

Datacenter_1 is starting...

Broker is starting...

Entities started.

0.0: Broker: Cloud Resource List received with 2 resource(s)

0.0: Broker: Trying to Create VM #0 in Datacenter_0

….

0.0: Broker: Trying to Create VM #19 in Datacenter_0

0.1: Broker: VM #0 has been created in Datacenter #2, Host #0

….

0.1: Broker: VM #19 has been created in Datacenter #2, Host #1

0.1: Broker: Sending cloudlet 0 to VM #0

0.1: Broker: Sending cloudlet 1 to VM #1

0.1: Broker: Sending cloudlet 2 to VM #2

….

0.1: Broker: Sending cloudlet 18 to VM #18

0.1: Broker: Sending cloudlet 19 to VM #19

0.1: Broker: Sending cloudlet 20 to VM #0

0.1: Broker: Sending cloudlet 21 to VM #1

…..

0.1: Broker: Sending cloudlet 37 to VM #17

0.1: Broker: Sending cloudlet 38 to VM #18

0.1: Broker: Sending cloudlet 39 to VM #19

2.0980547945205483: Broker: Cloudlet 0 received

2.239450143357758: Broker: Cloudlet 1 received

2.359450143357758: Broker: Cloudlet 2 received

….

5.098571022478637: Broker: Cloudlet 20 received

5.098571022478637: Broker: Cloudlet 21 received

5.098571022478637: Broker: All Cloudlets executed. Finishing...

5.098571022478637: Broker: Destroying VM #0

…..

5.098571022478637: Broker: Destroying VM #19

Broker is shutting down...

Simulation: No more future events

CloudInformationService: Notify all CloudSim entities for shutting down.

Datacenter_0 is shutting down...

Datacenter_1 is shutting down...

Broker is shutting down...

Simulation completed.

Simulation completed.

========== OUTPUT ==========

Cloudlet ID	STATUS	Data center ID	VM ID	Time	Start Time	Finish Time
0	SUCCESS	2	0	2	0.1	2.1
1	SUCCESS	2	1	2.14	0.1	2.24
……						
20	SUCCESS	2	0	5	0.1	5.1
21	SUCCESS	2	1	5	0.1	5.1

*****Datacenter: Datacenter_0*****

User id	Debt
4	21699.5

****

Analysis of the simulation

In the given example a total of 40 Cloudlets are run across 20 VMs in a total of 2 data centers. The process starts by first creating the data centers and brokers for them. Brokers try to create the required amount of virtual machines in the data centers. In our example all VMs are created successfully in Datacenter_0 as it has enough resources. If some resources become insufficient due to the amount of VMs being created, e.g. not enough RAM for the creation of n-th VM, the broker will print an error that it's missing resources to create the given VM and try to create the next one. Even if not all VMs are created the simulation would continue with VMs that were successfully created. Broker will then assign each Cloudlet that is to be executed to a VM with a given scheduling algorithm. After receiving all the Cloudlets VMs would run simultaneously and simulate the time and resources that were needed to execute the Cloudlet. In the given example that start time is 0.1 ms and the finsh time is 5.1 ms. It is worth noting that time in CloudSim is simulated and and is not affected by real time and the speed that the program executes. It may take longer or shorter to finish but the time of finishing will not change when there are no random elements added to the equation.

Cost of simulation

Much like the pay-per-use model CloudSim supports simulation of the cost required to run tasks submitted by users [8]. Each data center has its attributes that describe the cost of running VMs. The cost is determined by the VM specifications and the time the VM ran in order to execute the given Cloudlets. Data center has costs per amount of memory, storage and processing power. These costs are multiplied by the VM specifications and the time the VM ran. In our example there are a total of 20 VMs so each of them is subjected to this calculation. The total cost or debt is the sum of costs of all VMs. It is displayed in an arbitrary unit. For the given example it is 21699,5. CloudSim is also capable of simulating different aspects multi-tenant data centers and calculating cost per user [9].

5. CONCLUSION AND FUTURE WORK

The progress of cloud technologies calls for novel approaches of better understanding processes that happen within the cloud infrastructure. CloudSim is a completely customizable tool that can simulate all parts of the cloud infrastructure making it suitable for testing different setups, algorithms, models and topologies in order to see the results, compare them and make improvements. After reading this work we hope that the reader has a firmer understanding of processes that happen on the cloud and ways to create and test their own.

Future works include incorporating a job scheduling algorithm such as cuckoo search algorithm (CSO) and particle swarm optimization (PSO) to achieve better load balancing of Cloudlets that are to be executed on VMs. The utilization of mentioned metaheuristics approaches instead of classical deterministic scheduling algorithms may significantly improve simulation results. With the current algorithms in CloudSim the way the Broker schedules Cloudlets is less than ideal. The time required to run multiple Cloudlets on multiple VMs can be decreased by using stochastic methods to find the near optimal order of running Cloudlets. Even the smallest improvements make a big difference on the large scale and produce large savings.

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REVIZIJA OPŠTIH KONTROLA INFORMACIONIH TEHNOLOGIJA

Mile Stanišić

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Opšte kontrole informacionih tehnologija su kontrole nad komjuterskim sistemima i služe da obezbede kontinuiran i pravilan rad aplikacionih kontrola. One obično sadrže kontrole rada računarskog centra, nabavke i održavanja sistemskog softvera, obezbeđenja pristupa i kontrole razvoja i održavanja sistema aplikacija. Istraživačko pitanje odnosi se na razvoj metodologije revizije ovih kontrola. Metodologija revizije opštih kontrola treba da obuhvati sledeće faze: upoznavanje sa poslovanjem entiteta i ključnim poslovnim procesima; utvrđivanje ključnih oblasti od interesa za reviziju; preliminarnu ocenu rizika informacionih sistema; utvrđivanje kritičnih/značajnih kontrolnih tačaka i nakon utvrđivanja kontrolih ciljeva i rizičnih oblasti dolazi faza razvijanja procedura revizije i ocenjivanje i testiranje postojanja adekvatnih kontrola i njihove efikasnosti.

Ključne reči:

revizija IT, opšte kontrole IT, proces IT revizije, program revizije IT, rizici informacionih tehnologija.

1. UVOD

Informacione tehnologije se menjaju rapidnim tempom i predstavljaju nove izazove sa kojima se sve organizacije moraju suočiti, čak i ako one odluče da ne prihvate takve izmene i način da razviju IT u svojoj organizacionoj strukturi. Za njihovo funkcionisanje nephodne su adekvatne i efikasne opšte i aplikacione kontrole. Zbog veoma raširenog oslanjanja na informacione sisteme, potrebne su kontrole svih takvih sistema: finansijskih, poslovnih, za usaglašavanje, velikih i malih. Kada je tehnologija ugrađena u poslovne procese entiteta, kao što je robotska automatizacija u pogonu za proizvodnju, kontrolne aktivnosti su potrebne da bi se smanjio rizik kojim sama tehnologija neće nastaviti da pravilno upravlja, da bi se podržalo postizanje ciljeva organizacije.

Stvari su se promenile početkom 1970-ih godina sa prevarom Equity Funding. Eksterni revizori su primenili svoje sopstvene revizijske softverske programe za pregled fajlova Equity Funding da bi otkrili veliku prevaru sa nevažećim podacima evidentiranim u datotekama sistema [1]. Kao posledica afere Equity Funding organizacije, kao što su American Institute of Certified Public Accountants (AICPA) i Institute of Internal Auditors (IIA) su počele da naglašavaju značaj obavljanja pregleda tada

Odgovorno lice:
Mile Stanišić

e-pošta:
mile.stanisic@singidunum.ac.rs

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nazvanih kontrolama obrade podataka i aplikacionim kontrolama. Nova profesionalna specijalnost nazvana kompjuterskom revizijom je lansirana i svake godine metodologija IT revizije se sve više usavršava bilo da se obavlja finansijska ili poslovna revizija. Istraživačno pitanje upravo se odnosi na razvoj metodologije revizije opštih IT kontrola.

2. RAZUMEVANJE OPŠTIH KONTROLA INFORMACIONIH SISTEMA

Opšte kontrole su politike i procedure koje se primenjuju na sve ili veće segmente informacionih sistema entiteta i pomažu da se osigura njihovo pravilno funkcionisanje. Primeri primarnih ciljeva za opšte kontrole su zaštita podataka, zaštita aplikacionih programa poslovnih procesa, i da obezbedi kontinuirani rad kompjutera u slučaju neočekivanih prekida. Opšte kontrole se primenjuju na ceo entitet, sistem i nivoe aplikacija poslovnih procesa. Efikasnost opštih kontrola predstavlja značajan faktor prilikom utvrđivanja efikasnosti kontrola aplikacija poslovnih procesa koje se primenjuju na nivou aplikacija poslovnih procesa.

Kontrola se definiše kao proces uključen u upravljanje rizicima i obavljan od strane uprave u cilju ublažavanja rizika do prihvatljivog nivoa. Kontrole informacionih tehnologija (IT kontrole) se obično klasifikuju kao opšte ili aplikacione kontrole, opisane kao [2]:

- *Opšte kontrole,* koje se primenjuju na sve sistemske komponente, procese i podatke za datu organizaciju ili sistemsko okruženje.
- *Aplikacione kontrole,* odnose se na područje individualnih poslovnih procesa ili aplikacionih sistema i uključuju kontrole unutar aplikacije u vezi sa ulaznim podacima, obradom podataka i izlaznim rezultatima.

Pored navedene podele kontrola na opšte i aplikacione kontrole, COSO klasifikuje kontrole na automatizovane i manuelne. Mnoge kontrolne aktivnosti u entitetu su delimično ili u celini automatizovane korišćenjem tehnologije. Ovi postupci su poznati kao automatizovane kontrolne aktivnosti ili automatizovane kontrole. Automatizovane kontrole obuhvataju automatizovane transakcijske kontrole koje se odnose na finansijske procese, kao što je usaglašavanje na tri načina koje se obavlja u okviru ERP sistema koji podržava podprocese nabavki i plaćanja, i kompjuterizovane kontrole u operativnim procesima ili procesima usaglašavanja sa propisima i zakonima, kao što je provera da li pravilno funkcioniše pogon za električnu energiju (napajanje strujom). Ponekad je kontrolna aktivnost potpuno automatizovana, kao kad sistem otkriva grešku prilikom prenosa podataka, odbacuje prenos, i automatski zahteva novi prenos. Međutim, postoji nekad kombinacija automatizovanih i manuelnih postupaka. Na primer, sistem automatski otkriva grešku prilikom prenosa, ali neko mora ručno da ponovi prenos. U nekom drugom slučaju manuelna kontrola zavisi od informacija iz sistema, kao što su kompjuterski izveštaji kao podrška analizi planiranog u odnosu na ostvareno [3].

Većina poslovnih procesa koristi kombinaciju automatizovanih i manuelnih kontrola u zavisnosti od raspoloživosti tehnologije u entitetu. Automatizovane kontrole su pouzdanije, zavisno od toga da li su primenjene i funkcionišu opšte kontrole tehnologije, pošto manje zavise od ljudskog rasuđivanja i manje su podložne ljudskim greškama, i po pravilu su efikasnije. Pored ovih podela kontrola postoje i podele na preventivne, detektivne i korektivne kontrole, kao i podela svih kontrola na: kontrole upravljanja, menadžment kontrole i tehničke kontrole [4].

U revizorskoj profesiji se počelo da gleda na IT kontrole u smislu kontrola u okviru specifične aplikacije i onoga što nazivamo opštim kontrolama ili kontrolama infrastrukture, kontrolama koje se odnose na funkcionisanje svih informacionih sistema. IT opšte ili kontrole infrastrukture se odnose na celokupno IT poslovanje i obuhvataju [5]:

Kontrole rada računarskog centra. One sadrže grupu poslova i njihovo planiranje, operaterske poslove, procedure za backup i oporavak i planiranje za slučaj nepredviđenih okolnosti ili oporavak od katastrofičnih situacija. U kompleksnom okruženju, ove kontrole se odnose i na planiranje kapaciteta i raspodelu i korišćenje sredstava. U najsavremenijem tehnološkom okruženju, redosled izvršavanja poslova je automatizovan a jezik za upravljanje obradom je on-line. Alati za upravljanje memorisanjem podataka automatski učitavaju datoteke sa podacima na jedinice za memorisanje sa brzim pristupom u očekivanju sledećeg zadatka. Kontrolor smene više ne mora da ručno startuje protokol konzole zato što nije odštampan; protokol ostaje u sistemu. Stotine poruka bljesne svake sekunde na zajedničkoj konzoli koja opslužuje više centralnih računara. Miniračunari rade cele noći bez nadzora.

Kontrole sistemskog softvera. One se sastoje od kontrola za efikasnu nabavku, implementaciju i održavanje sistemskog softvera – operativni sistem, sistem za upravljanje bazama podataka, telekomunikacioni softver,

zaštitni softver i uslužni programi - koji upravlja sistemom i omogućuje funkcionisanje aplikacija. Glavni dirigent rada sistema, sistemski softver, takođe upravlja podizanjem sistema, i funkcijama trekinga i monitoringa. Sistemski softver izveštava o korišćenju uslužnih programa, tako da ako neko pristupi ovim moćnim funkcijama koje menjaju podatke, njihovo korišćenje će u najmanju ruku biti zabeleženo i prijavljeno da se ispita.

Kontrole bezbednosti pristupa. Ove kontrole su dobile na važnosti sa razvojem telekomunikacionih mreža. Korisnici sistema mogu biti na drugom kraju zemlje ili u susednoj sobi. Efikasne kontrole bezbednosti pristupa mogu zaštiti sistem sprečavanjem neodgovarajućeg pristupa i neovlašćenog korišćenja sistema. Ako su dobro osmišljene mogu zaustaviti hakere i druge prestupnike.

Adekvatne mere za kontrolu pristupa, kao što su česta promena brojeva koji se pozivaju ili uvođenje povratnog pozivanja – gde sistem uzvraća poziv potencijalnom korisniku preko ovlašćenog broja, umesto da se dozvoli direktan pristup sistemu – mogu biti efikasne metode za sprečavanje neovlašćenog pristupa. Kontrole bezbednosti pristupa ograničavaju ovlašćene korisnike samo na pristup aplikacijama ili aplikativnim funkcijama potrebnim da obave svoj posao, što je podrška adekvatnoj podeli zaduženja. Treba da postoji učestalo i blagovremeno preispitivanje profila korisnika koji omogućuju ili zabranjuju pristup. Bivši ili nezadovoljni radnici veća su pretnja sistemu nego hakeri; lozinke i korisničko ime radnika koji tu više ne rade treba odmah ukinuti. Sprečavanjem neovlašćenog korišćenja i menjanja sistema, integritet podataka i programa je zaštićen.

Kontrole za razvoj i održavanje aplikacija. Razvoj i održavanje sistema aplikacija je po tradiciji veoma skupa oblast za većinu organizacija. Ukupni troškovi za MIS resurse, potrebno vreme, stručnost osoblja za obavljanje tih zadataka i potrebni hardver i softver su znatna stavka. Da bi kontrolisali ove troškove, mnogi entiteti imaju neku vrstu metodologije za razvoj sistema. Ona daje okvir za projektovanje i implementaciju sistema, navodeći u kratkim crtama specifične faze, zahteve u pogledu dokumentacije, odobrenja i kontrolne tačke za praćenje projekta razvoja ili održavanja. Ova metodologija treba da omogući adekvatnu kontrolu nad izmenama sistema što podrazumeva potrebno odobrenje za traženje izmena, razmatranje promena, odobrenja, rezultata testiranja i protokola za implementaciju da bi bilo sigurno da su izmene izvršene korektno.

3. TRETIRANJE OPŠTIH KONTROLA TEHNOLOGIJE U COSO 2013

Prema COSO-u opšte kontrole tehnologije obuhvataju kontrolne aktivnosti koje se odnose na infrastrukturu tehnologije, upravljanje zaštitom, i kupovinu, razvoj i održavanje tehnologije. One se primenjuju na sve tehnologije – od IT aplikacija na glavnom kompjuteru, do klijenta/servera, desktop-a, kompjutera krajnjih korisnika, portabl kompjutera, i okruženja mobilnih uređaja, do operativne tehnolgije, kao što su kontrolni sistemi pogona (fabrika) ili robotike za proizvodnju. Nivo i rigoroznost kontrolnih aktivnosti se razlikuju za svaku ovu tehnologiju zavisno od raznih faktora, kao što je kompleksnost tehnologije i rizik osnovnih poslovnih procesa koje podržavaju. Slično kontrolama poslovnih tarnsakcija opšte kontrole tehnologije mogu obuhvatati i manuelne i automatizovane kontrolne aktivnosti.

Opšte kontrole informacionih tehnologija COSO razmatra u principu 11 COSO okvira postavljajući određena pitanja. Organizacija vrši izbor i razvija opšte kontrolne aktivnosti koje se odnose na tehnologiju kao podršku postizanju ciljeva. Sledeća pitanja mogu pomoći menadžmentu prilikom utvrđivanja da li je princip 11 prisutan i da li funkcioniše [6]:

- *Utvrđivanje zavisnosti između korišćenja tehnologije u poslovnim procesima i opštih kontrola tehnologije* - Menadžment se upoznaje i utvrđuje zavisnost i povezanost između poslovnih procesa, automatizovanih kontrolnih aktivnosti i opštih kontrola tehnologije.
- *Utvrđivanje relevantnih kontrolnih aktivnosti koje se odnose na infrastrukturu tehnologije* - Menadžment vrši izbor i razvija kontrolne aktivnosti koje se odnose na infrastrukturu tehnologije, koje su planirane i primenjuju se da bi pomogle da se obezbedi kompletnost, tačnost i raspoloživost tehnologije.
- *Utvrđivanje relevantnih kontrolnih aktivnosti koje se odnose na proces upravljanja zaštitom* - Menadžment vrši izbor i razvija kontrolne aktivnosti koje su planirane i primenjuju se da bi se ograničila prava pristupa tehnologiji ovlašćenim korisnicima proporcionalno njihovim odgovornostima za posao i da bi se zaštitila sredstva entiteta od spoljnih opasnosti.
- *Utvrđivanje relevantnih kontrolnih aktivnosti koje se odnose na proces nabavki, razvoja i održavanja* - Menadžment vrši izbor i razvija kontrolne

aktivnosti koje se odnose na akviziciju (nabavke), razvoj i održavanje tehnologije i njene infrastrukture da bi se postigli ciljevi menadžmenta.

Pouzdanost tehnologije u okviru poslovnih procesa, uključujući automatizovane kontrole, zavisi od prisustva i pravilnog funkcionisanja aktivnosti opštih kontrola koje se odnose na tehnologiju, i na koje se ovde poziva kao na opšte kontrole tehnologije. Opšte kontrole tehnologije se moraju rasporediti tako da automatizovane kontrole funkcionišu pravilno kada su prvi put razvijene i primenjene (na primer: pomenuta automatizovana kontrola vrši provere editovanja podataka usaglašavanja sa pravom datotekom transakcija ili stalnih podataka, svaka poruka o greškama odražava šta je pogrešno, i o svim izuzecima se izveštava u skladu sa politikama entiteta.) Opšte kontrole tehnologije takođe pomažu da informacioni sistemi i dalje pravilno funkcionišu pošto su primenjeni. Automatizovana kontrola za usaglašavanje transakcija će funkcionisati pravilno samo ako su opšte kontrole tehnologije planirane, primenjene i funkcionišu tako da se koriste prave datoteke u procesu usaglašavanja i da su datoteke kompletne i tačne. Takođe, pravilna zaštita omogućava pristup sistemu samo onima kojima je to potrebno, i smanjuje mogućnost neovlašćenog editovanja datoteka. Kontrolne aktivnosti koje se odnose na promene tehnologije pomažu da ona i dalje funkcioniše kako je planirano.

4. PLANIRANJE REVIZIJE KONTROLA INFORMACIONIH SISTEMA

Ciljevi planiranja su da se utvrde ciljevi revizije, upozna sa ključnim poslovnim procesima, utvrde ključne oblasti od interesa za reviziju, prelimiranrno oceni kontrolni rizik, utvrde kritične kontrolne tačke i sačini program revizije. Proces revizije kontrola informacionih tehnologija prolazi kroz nekoliko faza: faza planiranja, terenski rad i dokumentacija, otkrivanje problema i provera valjanosti, razvoj rešenja i praćenje problema [7].

A. Upoznavanje sa poslovanjem entiteta i ključnim poslovnim procesima

Revizor treba da se upozna i dokumentuje saznanja o entitetu dovoljna da planira i obavi reviziju u skladu sa primenjivim revizijskim standardima i zahtevima. Prilikom planiranja revizije revizor dobija informacije koje će obezbediti celokupnu sliku entiteta, kao što su: njegov zadatak (misija), veličina i lokacija, organizacija, poslovanje, strategije, rizici, i struktura internih kontrola. Upoznavanje sa poslovanjem entiteta prilikom planiranja procesa omogućava revizoru da utvrdi, reaguje i reši probleme u ranoj fazi revizije.

Revizorovo upoznavanje sa entitetom uključuje sledeće:

- menadžment i organizaciju entiteta,
- eksterne i interne faktore koji utiču na poslovanje entiteta, i
- ključne poslovne procese.

Da bi planirao reviziju revizor se upoznaje sa organizacionom strukturom entiteta i IT funkcijom, uključujući ključne članove entiteta i IT menadžmenta. Revizorov glavni cilj je da upozna kako se upravlja entitetom i kakva je organizaciona struktura.

B. Utvrditi ključne oblasti od interesa za reviziju

Revizor treba da utvrdi ključne oblasti od interesa za reviziju a to su one koje su značajne za postizanje cljeva revizije (na primer: opšti sistemi za podršku i sistemi i datoteke aplikacija poslovnih procesa (ili njihove komponente)). Za finansijsku reviziju to bi uključivalo ključne finansijske aplikacije i podatke i odgovarajuće *feeder* sisteme odnosno sisteme koji pružaju informacije ili podatke koji podržavaju glavnu aplikaciju. Na primer, u sistemu platnog spiska sistem za evidenciju radnog vremena i pisustva je sistem dodavanja za glavnu aplikaciju. Za reviziju poslovanja to bi obuhvatalo ključne sisteme koji će vervatno biti značajni za ciljeve revizije. Za svaku ključnu oblast od interesa za reviziju revizor treba da dokumentuje opšte sisteme za podršku i važnije aplikacije i datoteke uključujući (1) operativne lokacije svakog ključnog sistema ili datoteke, (2) značajne komponente odovarajućeg hardvera i softvera (na primer: zaštitni zid *(firewalls)*, ruteri, hostovi, operativni sistemi), (3) druge značajne sisteme ili resurse na nivou sistema koji podržavaju ključne oblasti od interesa, i (4) ranije prikazane probleme revizije.

C. Preliminarno ocenjivanje rizika informacionih sistema

Revizor treba da preliminarno oceni i dokumentuje prirodu i nivo IS rizika koji se odnosi na ključne oblasti od interesa za reviziju. Indikatori mogu da upozore na visok nivo rizika u procesima informacione tehnologije. Njih treba razmotriti prilikom ocenjivanja rizika opštih

IT kontrola [8]. IS rizik se odnosi na verovatnoću da se može dogoditi gubitak poverljivosti, integriteta ili raspoloživosti što bi značajno uticalo na ciljeve revizije (na primer: za finansijsku reviziju, lažno prikazivanje od materijalog značaja.) Ocenjivanje IS rizika obuhvata ocenu verovatnoće da takav gubitak poverljivosti, integriteta ili raspoloživosti se može dogoditi, kao i materijalni značaj ili važnost gubitka poverljivosti, integriteta ili raspoloživosti za ciljeve revizije. Revizor treba da dokumentuje faktore koji značajno povećavaju ili smanjuju nivo IS rizika i njihov potencijalni uticaj na efikasnost IS kontrola. Globalni vodič za reviziju tehnologija (GTAG) je u svom dokumentu "Rizici i kontrole informacionih tehnologija dao analizu rizika informacionih sistema [9].

Preliminarni pregled IT opštih kontrola podrazumeva ocenjivanje kontrolnog rizika. Njegov cilj je da se revizor dobro upozna ili dobije opštu sliku okruženja IT kontrola. Brings prikazuje široki spektar ciljeva pregleda opštih kontrola IT sistema od kojih se ovde prikazuju samo neki [10]:

1. Utvrditi da li je IT oprema smeštena na bezbednom i kontrolisanom prostoru.
2. Prodiskutujte o procedurama za fizičku kontrolu i kontrolu okruženja sa menadžmentom informacionih sistema da biste utvrdili tekuće politike, važnije promene i druge buduće planove.
3. Obiđite prostor gde se nalazi serverska oprema i utvrdite koje su jake a koje slabe strane fizičke zaštite, uključujući:
   - » Postojanje mehanizama za zaključavanje radi omogućavanja pristupa kompjuterskom prostoru samo ovlašćenim licima
   - » Postavljanje opsežnih zidova i prozora u kompjuterskom prostoru da bi se ograničio pristup
   - » Postavljanje mrežnih transformatora, vodenog hlađenja, ukoliko je potrebno, i ventilacije radi pravilne zaštite
   - » Postojanje detektorske opreme, uključujući detektore za kontrolisanje toplote i dima, i lokalnu zaštitu.
4. Obavit kratak pregled evidencija o održavanju da biste se uverili da se fizičke i kontrole okruženja nadgledaju i održavaju.
5. Takođe preko intervjua opisati telekomunikacione mreže kompjuterskog sistema, uključujući rutere, povezanost sa radnim stanicama, kompjuterske centre.
6. Obaviti pregled standarda za dokumentaciju za ponovni početak (restart) i nastavak poslovanja
7. Obaviti pregled procedura, automatizovanih ili manuelnih, radi uvođenja novih aplikacija ili revidiranih aplikacija u proizvodnju da biste utvrdili da li postoji pregled poslovanja u skladu sa standardima.
8. Utvrditi da li politike zabranjuju kompjuterskom operativnom osoblju da obavljaju zadatke programiranja ili neovlašćene poslove.
9. Utvrditi procedure kojima se zabranjuje neovlašćeni unos ili pristup proizvodnim datotekama i programima.

Pre direktnog upuštanja u detaljnu ocenu opštih kompjuterskih kontrola, korisno je razumeti rizike povezane sa IT i ciljeve kontrole na relativno visokom nivou. Neka od pitanja na koja treba da odgovorite uključuju:

- Da li je bilo značajnih pormena u sistemu IT u subjektu, uključujući promene na hardveru, softevru, u procesima i osoblju? Ako jeste, koje opšte rizike te promene stvaraju? Ako nije bilo značajnih promena, koji su raniji rizici ostali? Kako se rizici identifikuju i kako se njima upravlja?
- Koliko različitih kompjuterskih platformi ili okruženja postoji u subjektu? Kakav je interfejs višestrukih sistema, na primer, kako se razmenjuju podaci i kako se ta razmena kontroliše?
- Šta može da umanji pouzdanost sistema IT u subjektu ili da na drugi način negativno utiče na sposobnost subjekta da prikupi, obradi i drži podatke?
- Kako se može ugroziti integritet sistema IT u subjektu? Koji postojeći rizici mogu da utiču na sposobnost subjekta da zaštiti svoje podatke i sisteme od neovlašćenog pristupa, oštećenja ili gubitka?

Ocenjivanje IS rizika koje se odnosi na reviziju se razlikuje od ocenjivanje rizika menadžmenta. Prilikom ocenjivanja IS rizika od revizora se ne zahteva ili očekuje da ponovo obavi ocenjivanje rizika menadžmenta. Radije će revizor preliminarno ocenjivati IS rizik korišćenjem podataka koji će biti sakupljeni za vreme planiranja revizije, to uključuje korišćenje ocena rizika entiteta i obavljanje drugih procedura revizije. Revizorova ocena rizika treba da odražava uticaj efikasnosti IS kontrola na ciljeve revizije.

Za svaki utvrđeni rizik revizor treba da dokumentuje prirodu i nivo rizika; uslove koji povećavaju taj rizik; i (specifične infomacije ili poslovanje na koje utiče).

Revizor takođe treba da dokumentuje kompenzirajuće kontrole ili druga razmatranja koja mogu da ublaže efekte utvrđenih rizika.

D. Utvrditi kritične kontrolne tačke

Revizor treba da utvrdi i dokumentuje kritične kontrolne tačke prilikom planiranja informacionih sistema entiteta na bazi revizorovog upoznavanja sa takvim sistemima, ključnim oblastima od interesa za reviziju i IS rizikom. Značajne kontrolne tačke su one kontrolne tačke sistema koje, ukoliko su dovedene u pitanje (kompromitovane), omogućavaju pojedincima neovlašćeni pristup ili da obavljaju neodobrene ili neodgovarajuće aktivnosti na sistemima ili podacima entiteta što može voditi direktno ili indirektno ka neovlašćenom pristupu ili ka modifikovanjima ključnih oblasti od interesa za reviziju. Kontrolne tačke po pravilu obuhvataju eksterne tačke pristupa mrežama, međusobnu povezanost sa drugim eksternim i internim sistemima, komponente sistema koje kontrolišu tok informacija kroz mreže entiteta ili do ključnih oblasti od interesa za reviziju, značajne uređaje za čuvanje i obradu, i odgovarajuće operativne sisteme, aplikacije infrastrukture, i relevantne aplikacije poslovnih procesa.

E. Upoznavanje sa IS kontrolama

Revizor treba da se upozna sa i dokumentuje plan IS kontrola entiteta, uključujući organizaciju, osoblje, odgovornosti, ovlašćenja i resurse funkcije za upravljanje zaštitom. Revizor treba da dokumentuje preliminarna saznanja o kontrolama u entitetu (ili kontrolama komponeneta ukoliko se vrši revizija samo određene komponente), odgovarajućem upravljanju zaštitom, kontrolama pristupa, upravljanju konfiguracijama, podeli dužnosti, i planiranju nepredviđenih događaja.

Revizor treba da se upozna sa planom svake od dve vrste IS kontrola (opšte i kontrole aplikacija poslovnih procesa) do stepena potrebnog za privremeno zaključivanje da li je verovatno da su ove kontrole efikasne. Ukoliko je verovatno da su efikasne revizor treba da razmotri odnosno uzme u obzir specifične IS kontrole prilikom utvrđivanja da li su postignuti relevantni kontrolni ciljevi. Ukoliko nije verovatno da su efikasne revizor treba da se u dovoljnoj meri upozna sa kontrolnim rizikom koji je rezultat IS kontrola, da bi ocenio revizijski rizik, planirao odgovarajuće procedure za reviziju i pripremio odgovarajuće nalaze.

Na bazi ovih saznanja revizor treba da preliminarno oceni da li je verovatno da su IS kontrole efikasne da bi utvrdio prirodu, vreme i obim testiranja. Ova ocena je bazirana pre svega na diskusijama sa osobljem u entitetu, uključujući menadžere za programe, operatore sistema, menadžere za informacione resurse, i menadžere za zaštitu sistema; na posmatranjima IT poslovanja i kontrola; na pregledu primera dokaza obavljanja kontrola; na ranijim revizijama ili radu drugih.

5. TESTIRANJE KONTROLA INFORMACIONOG SISTEMA

Revizor treba da planira i obavi testove ključnih kontrola, da proveri da li su adekvatno planirane i da li efikasno funkcionišu. Obično je efikasnije da revizor testira IS kontrole slojevito počev od opštih kontrola na nivou entiteta i sistema, zatim opšte kontrole na nivou aplikacija poslovnih procesa, i da zaključi sa testovima kontrola aplikacija poslovnih procesa, interfejsa i sistema za upravljanje podacima na nivou aplikacija poslovnih procesa. Takvo testiranje strategije se može koristiti zato što neefikasne IS kontrole na svakom nivou (sloju) uglavnom isključuju efikasne kontrole na sledećem nivou.

Ocenjivanje opštih kontrola uključuje sledećih pet kategorija opštih kontrola:

- upravljanje zaštitiom kojim se obezbeđuje okvir i kontinuirani ciklus aktivnosti za upravljanje rizikom, razvoj politika za zaštitu, podelu odgovornosti, i monitoring adekvatnosti kompjuterskih kontrola u entitetu;
- kontrole pristupa koje ograničavaju ili otkrivaju pristup kompjuterskim resursima (podacima, programima, opremi i drugim kapacitetima), i time ih štite od neovlašćenog modifikovanja, gubitka i obelodanjivanja;
- upravljanje konfiguracijama koje sprečava neovlašćene promene resursa informacionih sistema (na primer: softverskih programa i hardverskih konfiguracija) i obezbeđuje objektivno uveravanje da su konfiguracije i funkcionisanje bezbedni kako je planirano;
- podela dužnosti koja obuhvata politike, procedure i organizacionu strukturu za upravljanje ko može da kontroliše ključne aspekte rada kompjutera; i
- planiranje nepredviđenih događaja tako da kada se desi neočekivani događaj značajno poslovanje se nastavlja bez prekida ili se brzo nastavi, i značajni i osetljivi podaci su zaštićeni.

Za svaki značajni element revizor donosi zaključak o efikasnosti odgovarajućih kontrola u entitetu na nivou entiteta, sistema i aplikacija. Ukoliko određeni značajan element nije postignut odgovarajuća kategorija kontrola verovatno neće biti postignuta. Revizor treba da koristi profesionalno rasuđivanje za donošenje takvih odluka.

A. Testovi opštih kontrola na nivou entiteta i sistema

Revizor može da testira opšte kontrole kombinovanjem procedura uključujući posmatranje, ispitivanja, inspekciju (koja uključuje pregled dokumentacije na sistemima i procedurama), i ponovnog izvođenja korišćenjem odgovarajućih softvera. Mada se uzorkovanje obično ne koristi za testiranje opštih kontrola revizor može da koristi uzorkovanje da bi testirao izvesne kontrole kao što su one koje obuhvataju odobrenja.

Ukoliko opšte kontrole na nivou entiteta i sistema nisu planirane i ne funkcionišu na efikasan način kako je planirano, revizor će uglavnom biti u nemogućnosti da bude zadovoljan da su kontrole na nivou aplikacija poslovnih procesa efikasne. U takvim slučajevima revizor treba (1) da utvrdi i dokumentuje prirodu i nivo rizika koji je rezultat neefikasnih opštih kontrola, i (2) da utvrdi i testira sve manuelne kontrole koje postižu kontrolne ciljeve koje je trebalo da postignu.

Međutim, ukoliko manuelne kontrole ne postižu kontrolne ciljeve revizor treba da utvrdi da li su specifične IS kontrole planirane da postignu ciljeve. Ukoliko nisu, revizor treba da pripremi odgovarajuće nalaze uglavnom da bi obezbedio preporuke za unapređenje internih kontrola. Ukoliko su specifične kontrole planirane da postignu ciljeve, ali su u stvari neefikasne zbog slabih opštih kontrola, testiranje po pravilu ne bi bilo potrebno sem da bude podrška nalazima.

B. Testovi opštih kontrola na nivou aplikacija poslovnih procesa

Ukoliko revizor dođe do povoljnog zaključka o opštim kontrolama na nivou entiteta i sistema on treba da oceni i testira efikasnost opštih kontrola za one aplikacije u okviru kojih kontrole aplikacija poslovnih procesa ili kontrole korisnika treba da budu testirane. Ukoliko opšte kontrole ne funkcionišu na efikasan način u okviru aplikacije poslovnih procesa, kontrole aplikacija poslovnih procesa i kontrole korisnika će biti neefikasne. Ukoliko revizija IS kontrola predstavlja deo finansijske revizije ili revizije poslovanja specijalista (specijalni stručnjak) za IS kontrole treba da prodiskutuje o prirodi i nivou rizika koji su rezultat neefikasnih opštih kontrola, sa timom za reviziju. Revizor treba da odluči da li će da nastavi sa ocenjivanjem kontrola aplikacija poslovnih procesa i kontrola korisnika.

C. Testovi kontrola aplikacija poslovnih procesa

Revizor obično treba da obavi testove onih kontrola aplikacija poslovnih procesa (poslovni proces, interfejs, upravljanje podacima), i kontrola korisnika potrebnih da se postignu kontrolni ciljevi gde je utvrđeno da su opšte kontrole na nivou entiteta, sistema i aplikacija efikasne.

Ukoliko nije verovatno da su IS kontrole efikasne revizor treba da se dovoljno upozna sa kontrolnim rizicima koji su rezultat informacionih sistema:

- da bi utvrdio uticaj na ciljeve revizije,
- planirao procedure revizije,
- pripremio odgovarajuće nalaze.

Takođe, u takvim okolnostima, revizor razmatra da li manuelne kontrole postižu kontrolne ciljeve uključujući manuelne kontrole koje mogu ublažiti slabosti u IS kontrolama. Ukoliko nije verovatno da su IS kontrole efikasne i ukoliko manuelne kontrole ne postižu kontrolne ciljeve revizor treba da utvrdi i oceni specifične IS kontrole koje su planirane da se postignu kontrolni ciljevi da bi se dale preporuke za unapređenje internih kontrola.

IS kontrole koje nisu efikasno planirane nije potrebno testirati. Ukoliko je revizor utvrdio u prethodnoj godini da kontrole u nekoj posebnoj računovodstvenoj aplikaciji nisu bile efikasne i ukoliko menadžment ukaže da kontrole nisu značajno unapređene revizor ne treba da ih testira.

6. IZVEŠTAJ O REZULTATIMA REVIZIJE

Kao konačnu etapu revizije kontrola revizor treba da donese zaključak o pojedinačnom zbirnom efektu utvrđenih slabosti u opštim IT kontrolama i postizanju utvrđenih kontrolnih ciljeva. Pre sastavljanja izveštaja o reviziji obično je prikladno obavestiti o utvrđenim slabostima menadžment da bi se dobila njihova saglasnost sa činjenicama i da se sazna da li postoje dodatni faktori koji su relevantni za revizorovo ocenjivanje efekta slabosti. Informisanje menadžmenta o utvrđenim slabostima po pravilu uključuje sledeće informacije: prirodu i nivo rizika; kontrolne ciljeve, kontrolnu aktivnost, nalaze i preporuke.

7. ZAKLJUČAK

Opšte kontrole su primenjuju na nivou entiteta, sistema i aplikacija, i stoga revizor treba da uzme u obzir opšte kontrole na svakom od ovih nivoa. Kontrolne tehnike i odgovarajući revizijski testovi se razlikuju prema nivou na koji se primenjuju. Prilikom planiranja ocenjivanja IT kontrola revizor utvrđuje oblasti od interesa za reviziju i kritične kontrolne tačke. Prilikom utvrđivanja ovih oblasti revizor razmatra aplikacije poslovnih procesa koje su relevantne za ciljeve revizije. Prilikom planiranja ocenjivanja opštih kontrola revizor razmatra najefektivniji i najefikasniji način da skupi dokaze da bi utvrdio efikasnost opštih IT kontrola kritičnih kontrolnih tačaka.

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INTELIGENTNI AGENTI ZA BERZU

Danilo Jovanović,
Katarina Krivak,
Marko Milić*,
Toma Joksimović,
Miodrag Živković

Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Poslovanje na berzi je od velikog značaja za ekonomiju zemlje, samim tim se sve promene i inovacije u ovom sektoru pomno i detaljno prate. Softver u berzi je veoma bitan radi sigurnosti poslovanja, bržeg donošenja odluka i sigurnosti ishoda koje berza nosi sa sobom. U ovom radu predstavljamo jedno softversko rešenje koje ima za cilj da pomoću kompjuterske inteligencije u nekoliko sekundi obradi podatke iz prošlosti i takođe sagleda kretanje ostalih hartija od vrednosti i time korisniku pomaže u analizi i donošenju odluka. Ovim se na tržištu postiže veća stabilnost i umanjuje se potreba za mentorima koji obučavaju početnike kako da donose odluke.

Ključne reči:
agent, berza, inteligencija, softver, analitika.

1. UVOD

Softver potiče iz porodice poslovnih softvera, koji imaju ugrađenu poslovnu inteligenciju. Predstavlja novu verziju konkretne vrste softvera koji služe za trgovinu na berzi. Softver preko javnog API komunicira sa postojećom aplikacijom za analizu i trgovanje. Softver ima privatni API gde se uređeni podaci, preuzeti iz baze, prosleđuju inteligentnom agentu za obuku. Korisnički interfejs obuhvata popunjavanje određenih formi, trgovanje na berzi, vizuelni pregled kretanja cena, statističke prikaze kod administratora (za berzu i korisnike) i kod korisnika (samo za berzu i lično trgovanje), dijalog između korisnika i administratora u vezi razrešavanja žalbi.

2. MOTIVACIJA

Napretkom veštačke inteligencije, pojavila se želja da inteligentni sistemi zamene ljude u poljima koja su matematički zahtevnija, kao jedno od tih je i praćenje cena na berzi. Najveći razvoj u ovom polju dogodio se u Americi, gde su agenti kompleksnog tipa korišćeni da zamene ljude u proračunima na berzi. Shvatili smo koliko bi ovakvi agenti doprineli kao sistem za podršku u poslovnom odlučivanju, konkretno u ovom slučaju u trgovini akcijama. Pokazalo se da obrada velike količine numeričkih podataka određenim matematičkim algoritmima daje vrlo efikasne

Odgovorno lice:
Marko Milić

e-pošta:
marko.milic.16@singimail.rs

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rezultate koji u ovoj oblasti u većini slučajeva daju bolje rezultate odluka od samog čoveka, gde smo prepoznali potrebu za primenu određenog efikasnog algoritma Veštačke inteligencije (LSTM – Long Short-Term Memory)[1].

Sama aplikacija po svojim karakteristikama pokušava da parira takvim sistemima, a u nekim budućim fazama optimizacije i da ostvari potencijalnu prednost u odnosu na većinu ovakvih postojećih sistema.

3. OPIS FUNKCIONALNOSTI

Korisnik

- Registruje se ili prijavljuje na sistem.
- Ima pregled svih hartija od vrednosti po kategorijama, popularnosti.
- Može da trguje akcijama određene hartije od vrednosti.
- Može da kupi inteligentnog agenta za određenu hartiju od vrednosti.
- Može da šalje žalbu tj. zahtevnu poruku za otklanjanje određene neregularnosti u sistemu.
- Ima statistički uvid u stanje akcija na berzi i ličnog trgovanja.

Administrator

- Ima pregled svih hartija od vrednosti po kategorijama, popularnosti itd...
- Može da prihvati i nakon toga razreši žalba ukoliko se identifikuje kvar i ukloni, u toku ovog procesa je moguć dijalog sa korisnikom tekstualnim porukama
- Ima statistički uvid u stanje akcija na berzi i trgovanja svih korisnika koji su prijavljeni

4. IMPLEMENTACIJA

Softver se sastoji iz tri sloja:

- Prezentacioni sloj se prikazuje kod korisnika na računaru. Tehnologija koja je korišćena za izradu prezentacionog sloja je Angular. Dalji opis i prikaz strana u delu frontend.
- Sloj logike koji obrađuje podatke je podeljen na više arhitekturnu strukturu. Na softverskom nivou je korišćena Java 8 uz radne okvire poput Spring, Maven i Hibernate. Dalji opis i prikaz strana u delu backend.
- Sloj podataka je obrađen kao relaciona baza i za tehnologiju je odabran MySQL. Dalji opis i prikaz strana u delu model baze.

5. FRONTEND

Za razvoj frontend-a izabrana tehnologija je Angular radni okvir [2]. Sve strane aplikacije su tako i rađene u Angular-u.

Počev od glavnih stranica sajta kojima svako ima pristup poput:

- Glavne strane – sadrži uopštene informacije
- Demo agent strane – strana koja daje uvid u način rada inteligentnog agenta koji vrši analizu berze.
- Kontakt strane – kontakt forma
- Strane za prijavu i registraciju na veb sajtu

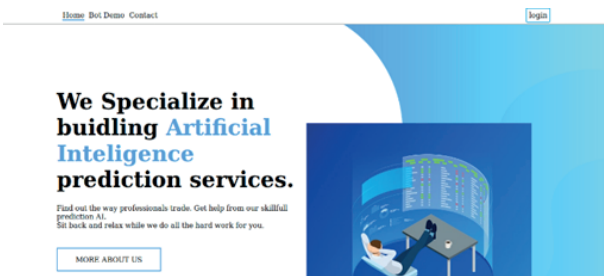
Pored ovih strana, kada se korisnik uloguje postoje strane za administratora i određenih registrovanih korisnika.

Administratori imaju uvid o širem spektru rada aplikacije kao i pristup tiket sistemu za održavanje kontakta sa klijentima.

Klijenti imaju uvid u sve ono što im je potrebno, poput: biranja hartija sa berze, dobijanje validnih informacija o analizama, pristup tiket sistemu itd.

Za iscrtavanje grafika je korišćena moćna biblioteka charts, dok upotreba drugih se može uračunati poput bootstrap-a.

6. FRONTEND – MOCKUP, MAKET



Slika 1. Glavna strana



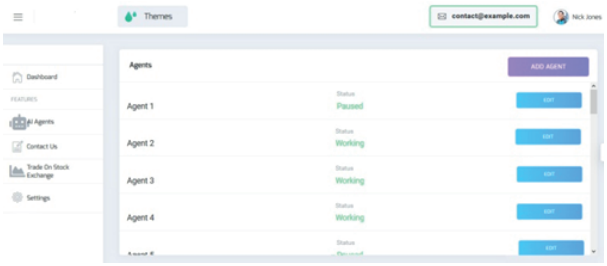
Slika 2. Login strana



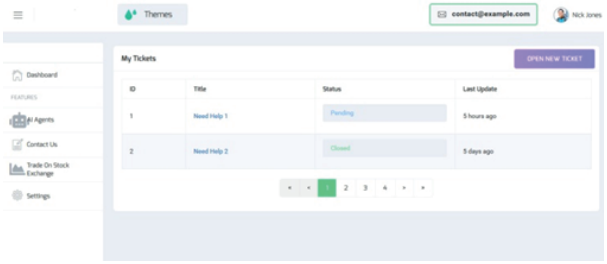
Slika 3. Registracija strana



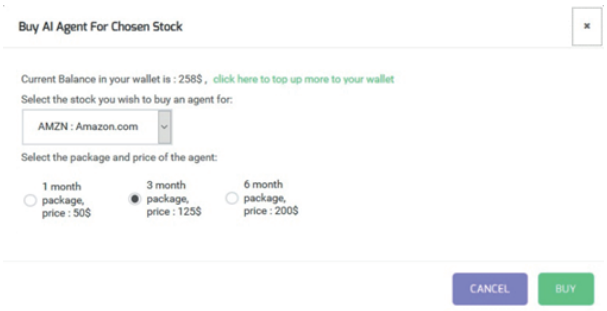
Slika 4. Kontrolna tabla strana



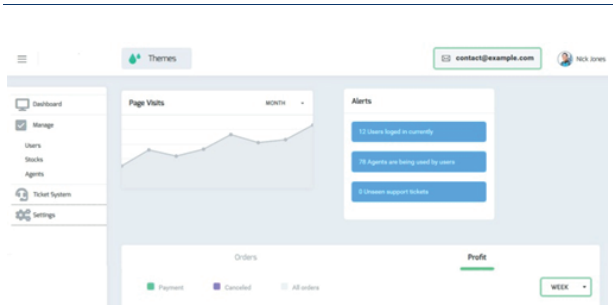
Slika 5. Korisnik strana - kupovina agenta



Slika 6. Korisnik prijava žalbi strana



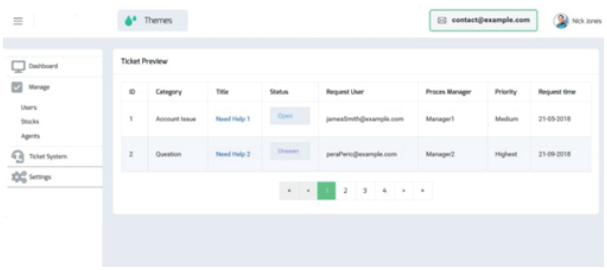
Slika 7. Kupovina agenta forma



Slika 8. Administrator kontrolna tabla strana 1. deo



Slika 9. Administrator kontrolna tabla strana 2. deo



Slika 10. Korisnik pregled žalbi strana

7. BACKEND

Prilikom razvoja poslovne logike korišćen je Spring Boot kao radni okvir uz Hibernate [3],[4]. Sama aplikacija je razvijena po MVC modelu i dodato je više slojeva koji čine kompleksnost aplikacije.

Softver se sastoji iz pet slojeva:

- Model objekata, mapiranje sa bazom
- DAO, Data Access Object
- DTO, Data Transfer Object
- Servis sloj
- Kontroler sloj

Za prvi sloj je korišćen Hibernate, koji se koristi za ORM, Object Relational Mapping. Java objekti su mapirani ka bazi koja je opisana u poglavlju model baze.

DAO sloj je patern koji se koristi kako bi aplikacija komunicirala sa bazom i to je najniži sloj aplikacije. U ovom sloju su prikazani osnovni upiti ka bazi.

DTO sloj je patern koji služi kako bi se podaci iz baze konvertovali u objekte koji će biti poslati preko viših slojeva na prezentacioni sloj cele aplikacije.

Servis sloj služi da poveže sloj kontrolera i sloj baze. Ovaj sloj u našoj aplikaciji vrši i logičku proveru podataka.

Kontroler sloj služi da se daju putanje koje će prezentacioni sloj gađati, i koje će dalju obradu podataka da vrši na servis sloju.

8. INTELIGENTNI AGENT

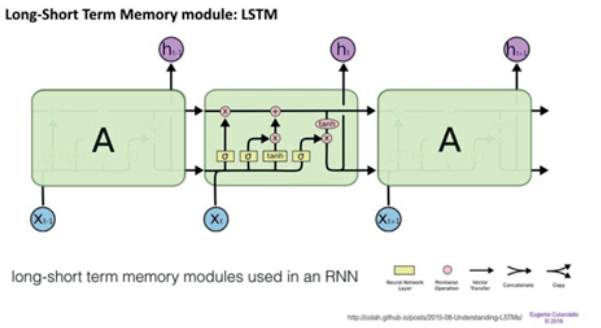
Posebna softverska komponenta predstavlja primenu Veštačke inteligencije i to je ujedno i glavna komponenta ovog softvera. Koristi se LSTM neuronska mreža što praktično predstavlja arhitekturu veštačke rekurentne neuronske mreže. LSTM je superioran po tome što ima povratne (feedback) konekcije koje ga čine „računarom opšte namene". Pored procesiranja slika odličan je i za procesiranje čitavih sekvenci podataka bilo da su struktuirani u JSON, XML, CSV ili XLS fajlove do nestruktuiranih u vidu govora ili videa. LSTM mreže su pokazale odlične performanse u klasifikaciji, procesiranju i kreiranju predikcija baziranih na vremenskim serijama.

Arhitektura LSTM mreže se sastoji iz sledećih glavnih komponenti:

- Ćelije (memorijskog dela LSTM jedinice)
- 3 regulatora (ulazna, izlazna i zaboravna kapija) protoka informacija unutar LSTM jedinice

Funkcije aktivacije mogu biti Sigmoid i Hiperbolična tangentna funkcija

Na slici ispod je prikaz jednog LSTM modula primenjenog u Rekurentnoj neuronskoj mreži. Svaka LSTM jedinica pamti informaciju za dug ili kratak vremenski period bez eksplicitnog korišćenja aktivacione funkcije u rekurentnim komponentama.



Slika 11. LSTM model

Treba napomenuti da je bilo koje stanje ćelije pomnoženo samo sa izlazom zaboravne kapije, koje varira između 0 i 1. Tako da je zaboravna kapija u LSTM ćeliji odgovorna za težine i aktivacionu funkciju u ćeliji. Prema tome, informacija iz prethodnog stanja ćelije se može proslediti ćeliji nepromenjena umesto eksponencijalnog povećanja ili smanjenja u svakom koraku ili sloju, i težine mogu time konvergirati optimalnim vrednostima u prihvatljivom vremenskom periodu.

LSTM mreža je idealna za ispitivanje kako variranje cena jedne hartije od vrednosti utiču na variranje cene drugih hartija od vrednosti na berzi u dužem vremenskom periodu. Takođe može da odredi koliko dugo informacija iz prošlosti treba biti zadržana u svrsi preciznijeg predviđanja budućih trendova varijacija cena na berzi.

9. MODEL BAZE

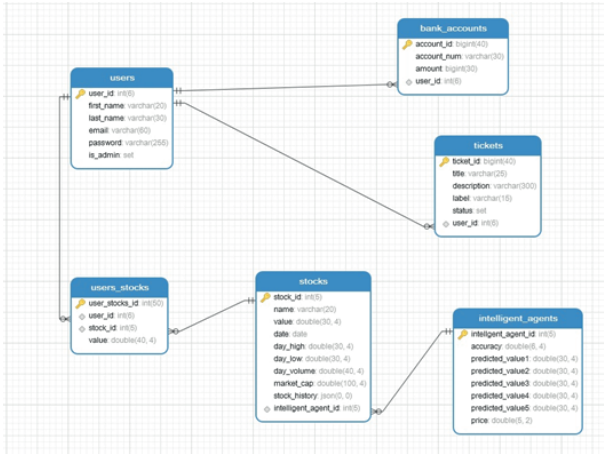
Sloj podataka je na apstraktni način prikazan modelom baze.

Model baze čini 6 tabela:

- „users“
- „stocks“
- „users_stocks“
- „bank_accounts“
- „tickets“
- „intelligent_agents“

Tabela „users“ predstavlja kolekciju korisnika u sistemu gde svaki korisnik može imati više računa, te je tabela „users“ povezana tabelom „bank_accounts“ vezom 1:N . Takođe korisnik može da šalje tikete (prijave grešaka na sistemu) tehničkoj podršci, pa je tabela „users“ takođe povezana sa tabelom „tikcets“ vezom 1:N.

Glavni deo baze predstavljaju tabele „users_stocks“, gde jedan korisnik može trgovati sa više elemenata na berzi, dok istovremeno jednim elementom može trgovati više korisnika, što predstavlja vezu N:N. Problem ove veze je rešen pomoćnom tabelom „users_stocks“. U toj tabeli je pored stranih ključeva dodat atribut za vrednost akcija određenog korisnika za određeni element na berzi. Na kraju je kardinalnost veze „users“ – „users_stocks“ 1:N, dok je za „stocks“ – „users_stocks“ takođe 1:N. „Stocks“ je tabela koja će se često ažurirati, a po kreiranju zapisa u tabelu, određena softverska komponenta će preko javnog API nabaviti istoriju kretanja cena i vrednosti tog elementa na tržištu u prošlosti. Ti podaci će se čuvati u JSON fajlu na koje će određeni atribut imati referencu. Tabele „stocks“ i „intelligent_agents“ su povezane vezom 1:1, jer za svaki element na berzi će biti dodeljen jedan agent koji će se obučavati na dosadašnjim podacima. U tabeli „intelligent_agents“ se nalaze atributi za predviđene cene za narednih 5 dana, koliko najviše agent i može da predvidi, kao procenat tačnosti predviđanja do sada i cena agenta koji korisnik kupuje.



Slika 12. Model baze class diagram

10. ZAKLJUČAK

Ekonomija je jedna od najbitnijih grana jedne države, a njen značajan deo čini poslovanje na berzi. Nakon naše analize i uočavanja nedostatka odgovarajućih aplikacija na domaćem tržištu, odlučili smo se za implementaciju jednog mogućeg rešenja za podršku u poslovnom odlučivanju. Odlučivanje u kratkom vremenskom roku je ključno u poslovanju na berzi. Šta više, uočeno je da inteligentni agenti mogu donositi bolje odluke u kratkom vremenskom intervalu od čoveka.

Funkcionalnosti našeg rešenja su odabrane na osnovu svetskih trendova, kao i po ugledu na već postojeća rešenja koja postoje na tržištu. Ovaj projekat je još uvek u fazi razvoja, ali pokazuje veliki potencijal i veliku mogućnost proširenja dodatnim funkcionalnostima. Krajnji cilj naše aplikacije je da olakša poslovanje na berzi, što bi doprinelo većoj perspektivi i stabilnosti ovakvog vida trgovine, kao i daljem razvoju kompletne ekonomije.

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[3] M. Živković, N. Bačanin Džakula, E. Tuba, “Programski jezici, Veb servisi i napredno Java programiranje u Spring okruženju”, 1. izd., Univerzitet Singidunum, Beograd, 2019.

[4] C. Walls, “Spring Boot in Action”, 1st ed., Manning Publications Co., Greenwich, CT, US, 2016.

IMPLEMENTACIJA MICROSOFT SQL SERVER BAZE PODATAKA PREKO HYPER-V TEHNOLOGIJE

Miloš Mravik*,
Marko Šarac,
Saša Adamović

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Porast broja korisnika i uređaja koji pristupa Internetu doveo je do toga da praćenje i upravljanje IT infrastrukturom postane problematično. U radu je detaljno opisana pravilna implementacija Microsoft SQL baze podataka na klijentskoj i serverskoj strani. Radom je obuhvaćen i bezbednosni aspekt zaštite informacija implementiranog rešenja. Implementacija je vršena po pravilima dobre prakse sa fokusom na pouzdanost sistema. Kompanije koje poseduju velike i komplikovane sisteme ne smeju da dozvole da ih kompjuterska infrastruktura sputava u ostvarivanju sopstvenih ciljeva. Razvoj hardverske infrastrukture omogućio je neograničen broj softverskih mogućnosti koje su uvidele svetlost dana, a za koji je potrebna odgovarajuća IT implementacija. Rad se bavi analizom pravilne implementacije u modernom virtuelnom okruženju.

Ključne reči:

Microsoft SQL Server, Hyper-V, Virtualizacija.

1. UVOD

Upotreba Microsoft SQL Server baze podataka je veoma dominantan način skladištenja velikih količina podataka generisanih sa klijentske strane. Sprega između klijenata i baze podataka ostvarena je preko aplikacije čija je uloga da manipuliše sa podacima u bazi podataka.

Jedan od najvećih i često diskutovanih problema vezanih za baze podataka predstavlja njihova zaštita. Glavni problem zaštite javlja se u vidu nedozvoljenog pristupa delovima baze, korisnicima koji nemaju privilegije. [1]

U radu je opisan jedan od načina sigurne konekcije između klijentskog i serverskog dela baze podataka. Preporuka Microsoft-a je da se radi kompatibilnosti svih servisa i njegovih mogućnosti koriste Microsoft tehnologije, iz tog razloga testiranje je prikazano i implementirano samo uz pomoć Microsoft tehnologija.

Odgovorno lice:
Miloš Mravik

e-pošta:
mmravik@singidunum.ac.rs

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2. KONCEPT VIRTUALIZACIJE SAVREMENIH RAČUNARA

Polazeći od navoda u apstraktu rada virtualizacija podataka nije u potpunosti nova tehnologija u IKT okruženju. Svakako, potrebno je napomenuti tipove virtualizacije i načine implementacije:

- Hardverska virtualizacije
- Softverska virtualizacija
- Mrežna virtualizacija
- Virtualizacija podataka

Ako se osvrnemo na popularnost gore navedenih tipova virtualizacije, najpopularniji i najrasprostranjeniji vid virtualizacije jeste hardverska virtualizacija. Ovaj tip virtualizacije predstavlja kreiranje velikog broja virtualnih mašina na jednom fizičkom računaru. Sve to je moguće uz pomoć softvera hipervizor (engl. *hypervisor*).

Takođe, osvrnućemo se na još jedan tip veoma popularne tehnologije a to je mrežna virtualizacija. Ovaj pristup virtualizaciji predstavlja kombinovanje realnih mrežnih adaptera u cilju pravljenja više različitih virtualnih mrežnih adaptera. Svaka virtualna mašina može da poseduje svoj jedinstveni mrežni adapter koji će da se nalazi u mreži koja je definisana samo za tu virtualnu mašinu i na taj način fizički razdvajamo mrežu baze i mrežu klijenta koji pristupa istoj. [2]

3. IMPLEMENTACIJA MICROSOFT SQL SERVER BAZE PODATAKA

Implementacija serverske strane zahteva dodatnu osposobljenost administratora sistema. Koraci koji su potrebni za uspešnu implementaciju Microsoft SQL Server baze podataka su:

- Omogućavanje virtualizacije na hostu na kome će biti instalirane virtualne mašine;
- Kreiranje virtualnih mašina (definisanje virtualnog hardvera);
- Instalacija Windows Server 2019 sistema;
- Instalacija Microsoft SQL Server baze (u ovom radu je prikazana simulacija sa upotrebom *Express* verzije baze);
- Instalacija Microsoft SQL Server MS-a;

Podešavanje hosta na kome će biti smeštene i pokrenute virtuelne mašine, kao i instalacija dodatnog softvera gore već pomenutog softvera ne zahteva dodatne IT veštine za administratora sistema.

Važno pitanje posle svih instalacija je - da li je implementirana instanca SQL servera u potpunosti zaštićena za bezbedno skladištenje podataka?

Po pitanju bezbednosti u bazama podataka, administratori sistema imaju ozbiljan i važan zadatak prilikom instalacije baze podataka i dodeljivanju privilegija korisnicima. Naime, u toj situaciji nije dovoljna samo konfiguracija sistema za upravljanje bazom podataka , već je podjednako važna konfiguracija host-a na kome su pokrenute virtuelne mašine. [3]

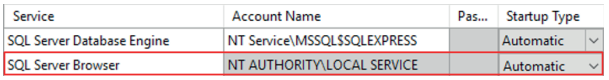
4. KONFIGURACIJA SERVERA ZA SKLADIŠTENJE PODATAKA

Nakon instalacije Microsoft SQL Server baze podataka prvenstveno je potrebno da se sam host zaštiti uz pomoć *firewall*-a, a to obično podrazumeva zatvaranje slobodnih portova koje ne koristi nijedan servis u datom trenutku i koji nisu dinamički dodeljeni nekom servisu ili aplikaciji.

Svaka aplikacija koja koristi neki servis koji nije direktno ugrađen u nju samu, mora da upotrebljava jedan od portova koji je unapred definisan. Zatvaranjem portova na *firewall*-u ublažava mogućnost prisluškivanja portova i opserviranja saobraćaja između aplikacije i baze podataka. Omogućavanje pristupa bazi podataka od strane korisnika koji se ne nalaze u lokalnoj mrežim sadrži dva koraka:

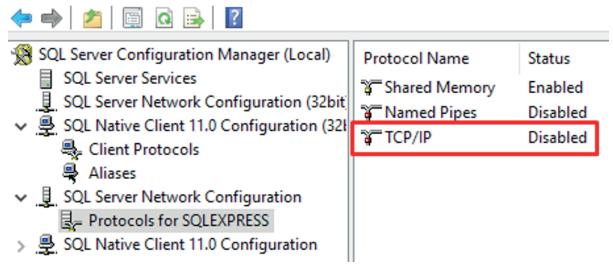
- Omogućavanje servisa SQL Server Browser;
- Omogućavanje TCP/IP protokola za pristup željenoj bazi;

Prilikom instalacije baze podataka, na administratoru sistema je da odluči koji sve to servisi treba da budu aktivni nakon startovanja samog računara. Ovo je prvi korak u kome administrator sistema ima mogućnost definisanja automatskog startovanja servisa SQL Server Browser.



Slika 1. Prikaz SQL Server Browser servisa

Drugi korak u omogućavanju pristupa bazi podataka na osnovu javne instance je omogućavanje TCP/IP protokola.

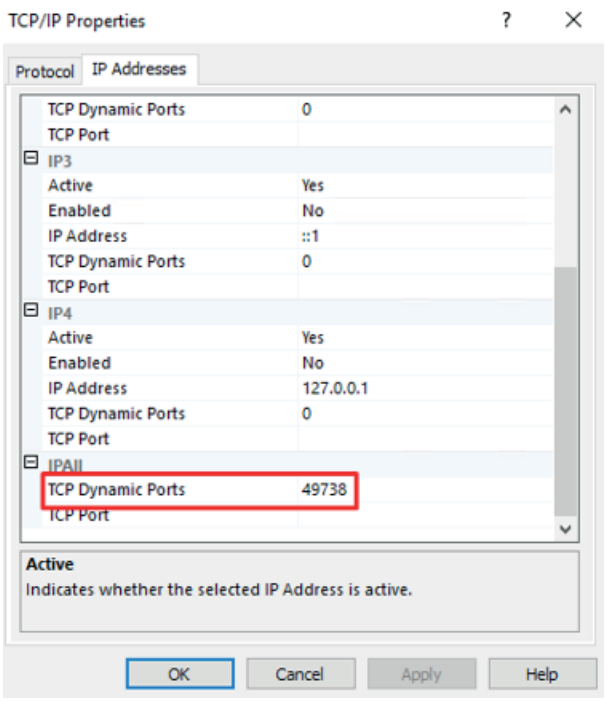


Slika 2. Prikaz omogućavanja TCP/IP protokola

Omogućavanjem TCP/IP protokola dolazimo do prvog velikog problema koji se tiče sigurnosti baze podataka. [4] Međutim, ukoliko je u ovom koraku *firewall* u potpunosti isključen dolazimo do toga da korisnik koji poseduje i zna jednu od dole navedene tri stavke može da pristup nesmetano bazi podataka, a to su:

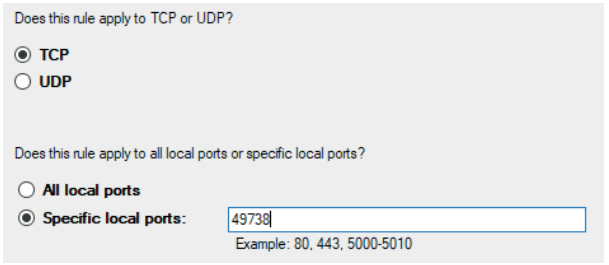
- Ime računara i ime instance baze podataka (MS-SQL-SERVER\SQLEXPRESS) – SQLEXPRESS predstavlja ime instance na osnovu koga korisnik odabire kojoj bazi podataka želi da pristupi u datom trenutku
- Lokalnu IP adresu i ime instance baze podataka (10.8.8.2\SQLEXPRESS) – Ukoliko se baza podataka nalazi u lokalnoj mreži u kojoj se nalazi i sam korisnik, korisnik će biti u mogućnosti da pristupi bazu na osnovu saznanja IP adrese.
- Javnu IP adresu i ime instance baze podataka (154.76.22.167:49738\SQLEXPRESS) – Ukoliko korisnik dođe do saznanja o javnoj IP adresi same baze i portu uz pomoć koga sama baza funkcioniše, biće u mogućnosti da pristupi svim podacima u bazi.

Da bismo izbegli gore pomenute probleme potrebno je pravilno definisati pravila na *firewall*-u virtualne mašine na kojoj se nalazi Microsoft SQL Server Express. Prvenstveno je potrebno da saznamo na kom portu radi baza podataka, prikazano na slici ispod:



Slika 3. Prikaz osnovnog porta komunikacije baze

Otvaranje porta na *firewall*-u je prikazano na slici ispod:



Slika 4. Prikaz otvaranja porta na firewall-u

U ovom delu rada nećemo se baviti samo definisanjem aktivnih i neaktivnih portova. Ukoliko su portovi dobro konfigurisani to nam ne omogućava potpunu sigurnost i sigurnost baze podataka. Drugi problem koji se javlja je vezan za korisnike i grupe korisnika sa korisničkim privilegijama za pristup bazi podataka. Pri instalaciji Microsoft SQL Servera, administrator sistema je imao mogućnost da izabere dve vrste pristupa bazi podataka:

- Windows authentication mode (pristup bazi podataka sa pristupnim parametrima sa kojima je sam korisnik ulogovan na računar sa koga želi

da pristupi bazi. Svakako, ovaj deo može da uključuje lokalni i domenski nalog, uključujući i Security group-e)

- Mixed Mode (SQL Server authentication and Windows authentication) – Ovaj režim omogućava pored gore pomenutog pristupa i definisanje novih korisnika direktno u bazi podataka.

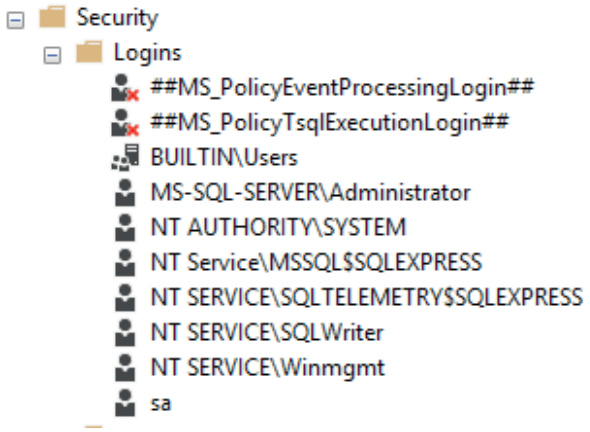
Administratorima sistema se preporučuje da izaberu vrstu Mixed Mode jer je iz više razloga sigurniji, o tome će biti više diskusije u nastavku rada. [5]

Podrazumevana podešavanja Microsoft SQL Server baze podataka definišu četiri osnovne baze i nekoliko podrazumevanih korisnika za pristup.

Četiri osnovne baze su:

- Master
- Model
- Msdb
- Tempdb

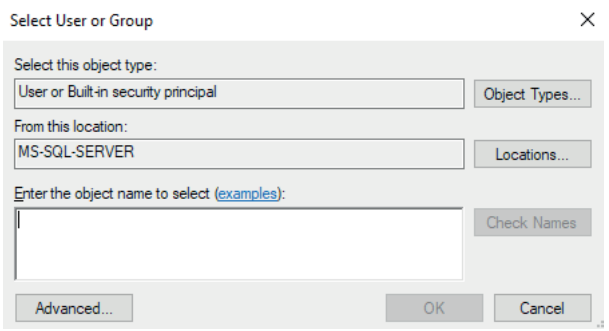
Podrazumevani korisnici baze su sledeći:



Slika 5. Prikaz osnovnih korisnika za pristup bazi

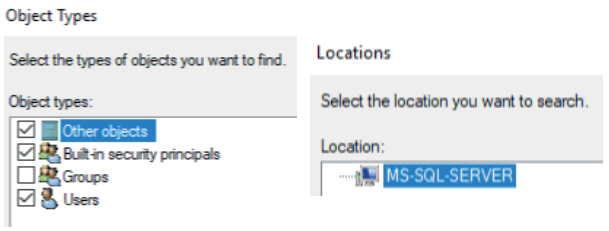
Svakako, najbitniji korisnici baze sa najvišim privilegijama su „sa“ i „Administrator“. Korisnik „sa“ predstavlja System Administratora, tj. administratora SQL Server authentication procesa prijave. Korisnik „Administrator“ predstavlja lokalnog administratora samog servera, tj. administratora Windows authentication procesa prijave.

Podrazumevani korisnici baze često nisu dovoljni za siguran pristup bazi. To znači da je naredni zadatak administratora sistema da definiše nove korisnike ili grupe korisnika koji će imati različite privilegije nad bazom.



Slika 6. Prikaz dodavanja novog korisnika u bazu

Naravno, na administratorima sistema ostaje da izaberu tip i lokaciju željenog naloga ili grupe korisnika kojima želi da dodeli privilegije za pristup nad bazom podataka.

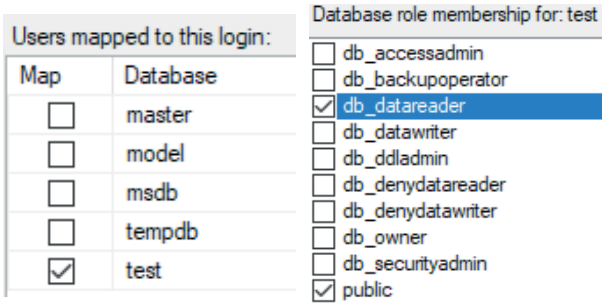


Slika 7. Prikaz odabira tipa objekta korisnika

Slika 8. Prikaz odabira tipa lokacije korisnika

Prilikom dodavanja novog korisnika za pristup bazi potrebno je prvenstveno izabrati način pristupa bazi (Windows authentication mode ili Mixed mode). Preporuka je svakako enforce-ovati password policy-u i password expiration iz razloga što ćemo na ovaj način da tražimo od korisnika da blagovremeno menja pristupne parametre za pristup bazi. Sledeći, najbitniji korak je definisanje uloga samog korisnika nad bazom. Potrebno je obratiti pažnju na ovaj deo i definisati da isključivo administratori sistema mogu da budu okarakterisani kao „sysadmin“ nalozi. Za sve ostale naloge sa manjim nivoom privilegija potrebno je definisati samo ulogu „public“ koja predstavlja način pristupa samoj bazi. Na kraju definisanja privilegija samog korisnika dolazimo do toga da moramo da izvršimo mapiranje samih baza i definisanja tačno određenih pravila koja će novokreirani korisnik moći da izvršava nad samom bazom. Pod terminom mapiranja smatramo dozvolu pristupa samoj bazi koju sve mapirali. Naime, preporuka je da se četiri osnovne baze mapiraju isključivo za administratorske naloge. Što se tiče uloga nad mapiranim bazama taj deo

zavisi od željenog nivoa privilegija novokreiranog korisnika. Obratiti pažnju na to da li sam korisnik ima mogućnost i pisanja i čitanja podataka iz baze.



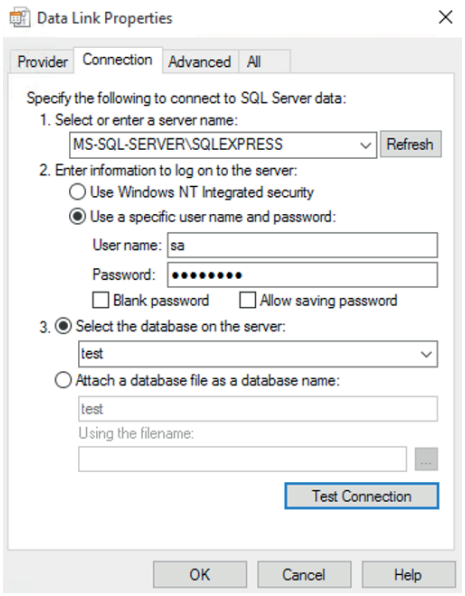
Slika 9. Prikaz mapiranja baza podataka

Slika 10. Prikaz dodeljivanja uloga korisnicima nad bazom

Na ovaj način smo definisali da novokreirani korisnik ima mogućnost samo čitanja nad bazom „test".

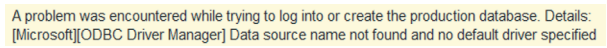
5. KONFIGURACIJA KLIJENTA ZA PRISTUP MICROSOFT SQL SERVER BAZI PODATAKA

U ovom delu rada će biti detaljno objašnjena konfiguracija klijentskog dela aplikacije. Za primer je uzeta virtualna mašina sa instaliranim Microsoft Windows 10 Professional sistemom. Potrebno je napomenuti da konfiguracija klijentskog dela ne zavisi od verzije Microsoft Windows sistema. [6] Prvi i osnovni korak koji je potrebno definisati i prikazati na korisnikom delu jeste testiranje konekcije nakon definisanja *firewall*-a na klijentskoj strani. Naime, kao test je uzet fajl sa ekstenzijom „*.udl*" koji se veoma često koristi za testiranje konekcije između klijentskom i serverskog dela neke aplikacije. Prikaz testirane konekcije je prikazan na slici ispod:



Slika 11. Prikaz testiranja konekcije između korisnika i baze upotrebom .udl fajla

Poslednja, ali ne i najmanje bitna stavka prilikom konfiguracije klijentskog dela jeste konfiguracija ODBC drajvera.



Slika 12. Prikaz zahteva za definisanjem ODBC drajvera

Instalacija ODBC drajvera ima za ulogu da omogući konekciju između Database Management System-a (DBMS) i baze koristeći SQL kao standard za pristupanje podacima. Nakon instalacije drajvera komunikacija između klijenta i servera postaje u potpunosti dozvoljena i veoma sigurna. [7]

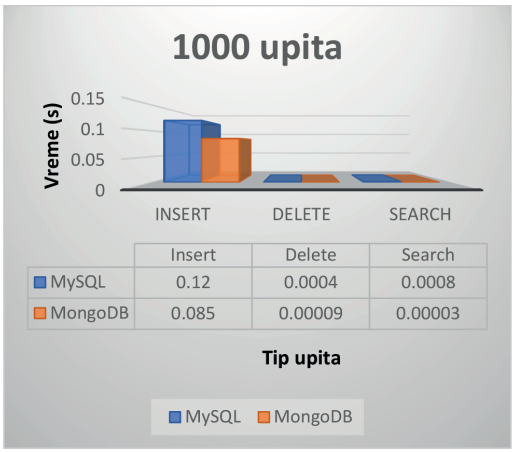
6. ALTERNATIVE MICROSOFT SQL SERVER-A

Porast broja informacija na internetu dovela je do toga da su baze podataka postale toliko kompleksne da se broj servera za skladištenje informacija na globalnom nivou povećao do broja od čitavih 75 miliona. Ovu tvrdnju najbolje objašnjava broj servera koje poseduje Microsoft, a to je 1 milion, odmah iza Microsoft-a nalazi se Google koji poseduje čitavih 900,000 serverskih mašina. Koliko su baze podataka postale kompleksne najbolje

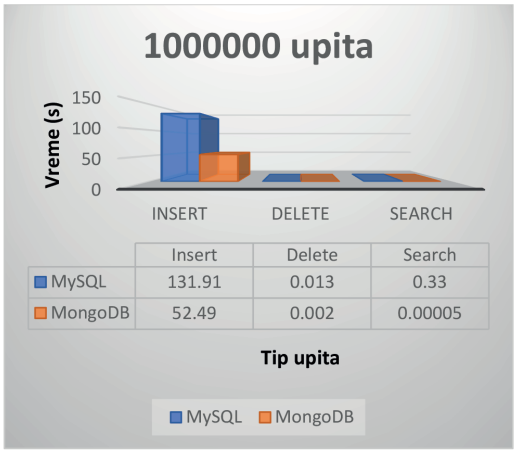
govori činjenica da Google poseduje najveći broj informacija na internetu (engl. *index of internet*), a to je samo 0,004% svih podataka na internetu.

Kada pričamo o alternativama Microsoft SQL Server-a one su mnogobrojne. Svakako, u zavisnosti od tipa podataka koji će biti skladišteni u bazi potrebno je veoma pažljivo izabrati softver za upravljanje bazom. U ovom radu smo naveli tri alternative Microsoft SQL Server-a za koje smatramo da su veliki konkurent Microsoft-ovom rešenju. Prva alternativa jeste MongoDB koja predstavlja ne-relacionu, distribuiranu bazu otvorenog koda. Glava odlika ovog tipa baze predstavlja horizontalna skalabilnost, visoka propusnost i izvršavanje na pristupačnom hardveru. Potrebno je navesti da MongoDB predstavlja jednu od najpoznatijih dokument-orijentisanih baza podataka (NoSQL). Činjenica koja MongoDB čini velikim konkurentom Microsoft-ovog rešenja jeste ta što su drajveri za povezivanje MongoDB baze podataka i klijentskih aplikacija razvijeni za sve veće programske jezike. Ova činjenica svakako omogućava lakšu upotrebu baze podataka i opredeljivanje za MongoDB rešenje. Drugo, ali ništa lošije rešenje predstavlja MySQL. MySQL predstavlja najpopularniji softver za upravljanje bazama podataka na svetu. Važno je napomenuti da je MySQL pod GPL licencom koja omogućava krajnjim korisnicima u potpunosti besplatan softver otvorenog koda. Ovo rešenje predstavlja spregu između SQL i NoSQL baza podataka i čini ih međusobno funkcionalnijim i stabilnijim.

Na slikama ispod su prikazani testovi sa upitima koji su izvršavani nad identičnim podacima sa dve različite baze podataka (SQL i MySQL). Akcenat je stavljen na brzinu dobijanja rezultata iz izvršenih upita.



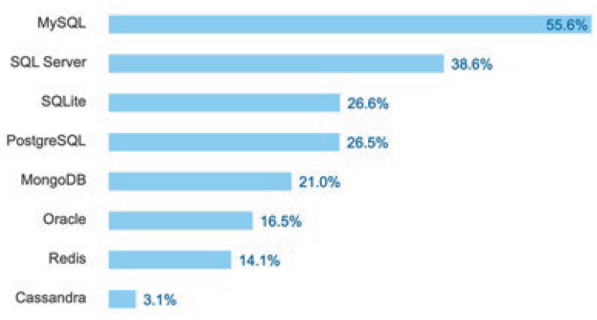
Ilustracija 1. Prikaz razlike u brzini izvršavanja hiljadu upita



Ilustracija 2. Prikaz razlike u brzini izvršavanja milion upita

Na ilustracijama iznad prikazano je vreme izvršavanja istog broja upita nad podacima u dve različite baze, Microsoft SQL i MongoDB. Iz priloženih rezultata može se konstatovati da je vreme izvršavanja upita nad podacima u MongoDB bazi podataka drastično brže. U zavisnosti od tipa upita koji se izvršavaju nad podacima dolazimo do toga da je razlika u brzini čak preko 6000 puta brža. To nam govori da će se milion upita nad MongoDB bazom podataka koji su tipa „*search*" izvršiti čitavih 6677,72 puta brže. Ova činjenica nam govori da je MongoDB baza podataka svakako bolje rešenje za aplikacije čija uloga je pretraživanje velikog broja podataka od strane krajnjih korisnika.

Na ilustraciji ispod je prikazana zastupljenost različitih tipova podataka na tržištu.



Ilustracija 3. Prikaz zastupljenosti različitih tipova podataka na tržištu

7. ZAKLJUČAK

U ovom radu prikazan je pravilna i pre svega bezbedna upotrebu virtualizacije u modernim informacionim datacentar okruženjima. U analiziranom primeru na virtuelnoj mašini je implementiran Microsoft SQL Server koji predstavlja ujedno i studiju slučaja kojom je pokazana pravilna konfiguracije više različitih parametara kako bi se ublažila ranjivost kompletnog sistema do krajnjih granica koje su limitirane i ponekad zavise od ljudskog faktora i administratora sistema.

Praksa je nametnula potrebu za sprovođenjem strogih bezbednosnih politika koje se tiču upravljanja i manipulisanjem podataka u domenu administracije sistema, jer jedino na ovaj način je moguće dostići zadovoljavajuću bezbednost celokupnog sistema.

Ovaj rad je nastao kao rezultat rada i potrebe u sopstvenom radnom okruženju, gde su prikazani stečeno iskustvo i dobri primeri iz prakse, kao i moguće loše strane.

U susret novim izazovima, bezbednost i zaštita informacija su sastavni deo svih tehnoloških rešenja u upotrebi danas, iz tog razloga diskusija na ovu temu će biti nastavljena u budućem radu.

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UPOTREBA ALGORITMA NAIVE BAYES U PROCESU DONOŠENJA POSLOVNIH ODLUKA

Marko Marković[1,*],
Katarina Plećić[1],
Živana Krejić[2],
Biljana Tešić[1]

[1]Fakultet zdravstvenih, pravnih i poslovnih studija Valjevo, Univerzitet Singidunum, Srbija
[2]Fakultet za poslovne studije i pravo, Univerzitet Union, Beograd, Srbija

Rezime:
Postoji značajan broj sistema za pomoć u poslovnom odlučivanju koji kao osnovu koriste Bajesovu teoremu. U ovom radu, prikazuje se jedna od primena ove teoreme korišćenjem algoritma Naive Bayes koji svoju upotrebnu vrednost dokazuje u mnogobrojnim praktičnim primenama upravo zbog jednostavnosti u fazama učenja i klasifikacije, kao i zbog činjenice da se može obučavati na izuzetno malim skupovima podataka i postići prilično veliku brzinu rada u poređenju sa drugim algoritmima mašinskog učenja. U ovom radu, prikazuju se matematičke osnove i način rada algoritma Naive Bayes, uz osvrt na skupove podataka sa kojima se pogodno koristi. Takođe, predstavlja se i praktično softversko rešenje koje su autori razvili za rad sa ovim algoritmom i kao pomoć u donošenju poslovnih odluka.

Ključne reči:
Bajesova teorema, Naive Bayes, poslovno odlučivanje.

1. UVOD

Naive Bayes modeli se često, i sa dosta uspeha, koriste za klasterovanje [1] i klasifikaciju [2]. U mnogim situacijama pokazuju izuzetno dobre karakteristike, a njihova preciznost i vreme učenja se mogu meriti i sa drugim modelima, kao što su Bajesove mreže [3], čiju jednu vrstu zapravo i predstavljaju. Čini ga mešavina komponenti, gde se u okviru svake komponente promenljive smatraju međusobno uslovno nezavisnim. Uz dovoljan broj podataka, može predvideti rešenje sa velikim stepenom preciznosti. Pritom, potreban skup podataka zapravo može biti prilično mali, zbog čega se ovaj algoritam dobro pokazao u situacijama kada ne postoji puno ulaznih podataka.

Algoritam *Naive Bayes*, kao i mnogi drugi sistemi koji koriste rasuđivanje zasnovano na verovatnoći, imaju za temelj Bajesovu teoremu [4]. Ovu teoremu je u XVIII veku razvio engleski matematičar, *Thomas Bayes*. Sam algoritam *Naive Bayes* je prvi put predstavljen tek početkom 1960.-ih godina, a dobio je ime po matematičaru na čijoj teoremi je zasnovan.

Bitno je pomenuti i poreklo naziva algoritma – iako bi neko iz naziva mogao da zaključi da se radi o „naivnom“ algoritmu, zapravo se

Odgovorno lice:
Marko Marković

e-pošta:
mmarkovic@singidunum.ac.rs

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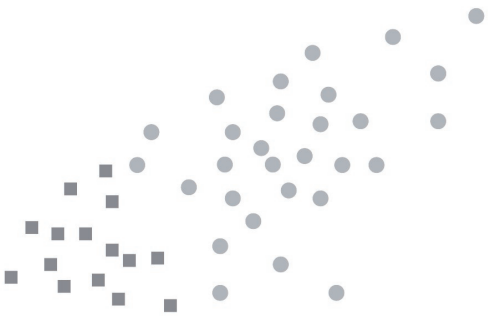
radi o tome da se podrazumeva da su atributi između sebe uslovno nezavisni [5]. I pored toga, u praksi, *Naive Bayes* modeli mogu raditi iznenađujuće dobro, u zavisnosti od prirode verovatnosnog modela, a do sada su svoju veliku upotrebnu vrednost dokazali u nekoliko veoma kompleksnih stvarnih situacija kao što je filtriranje spam poruka ili klasifikacija dokumenata [6]. U literaturi se povremeno ovi modeli nazivaju i "jednostavni Bajes" (*Simple Bayes*) i "nezavisni Bajes" (*Independence Bayes*) modeli.

2. NAČIN RADA ALGORITMA „NAIVE BAYES"

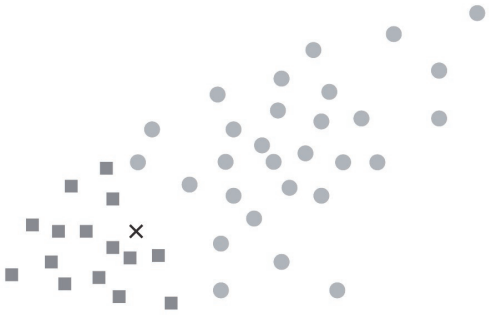
Algoritam Naive Bayes, kao i većina sistema koji koriste rasuđivanje zasnovano na verovatnoći, imaju za temelj Bajesovo pravilo (Bajesovu teoremu).

Kao demonstraciju osnovne ideje klasifikacije pomoću Bajesovog pravila možemo uzeti primer sa slike 1. Početne vrednosti podeljene su u dve kategorije i predstavljene su ili slikom kruga ili slikom kvadrata.

Potrebno je obezbediti da svaka nova vrednost koja se naknadno pojavi (slika 2) bude označena slikom kvadrata ili kruga. Trenutno, nova vrednost predstavljena je znakom X. Postavlja se pitanje na koji način je moguće odrediti u koju kategoriju će biti razvrstana. Jedna mogućnost je da bude označena kao kvadrat iz razloga što se nalazi bliže vrednostima tog tipa. Druga mogućnost je da bude označena kao krug jer je vrednosti koje su tako kategorizovane brojno dvostruko više. Verovatnoće događanja dva navedena scenarija su definisane na osnovu prethodnog iskustva (rasporeda i kategorizacije elemenata) i one se koriste za predviđanje novih ishoda korišćenjem Naive Bayes metoda.



Slika 1. Postojeće vrednosti u skupu podataka



Slika 2. Dodavanje nove vrednosti u postojeći skup podataka

Na osnovu prethodnog primera, može se definisati opšti slučaj Bajesovog pravila u sledećem obliku navedenom u izrazu (1).

$$P(b \mid a) = \frac{P(a \mid b)P(b)}{P(a)} . \quad (1)$$

Zahvaljujući Bajesovom pravilu, možemo izračunati P(b|a) pomoću P(a|b), P(b) i P(a). Iako, površno gledano, to ne izgleda naročito korisno, zapravo u praksi često postoje situacije kada se poznate ove tri vrednosti, a traži se četvrta.

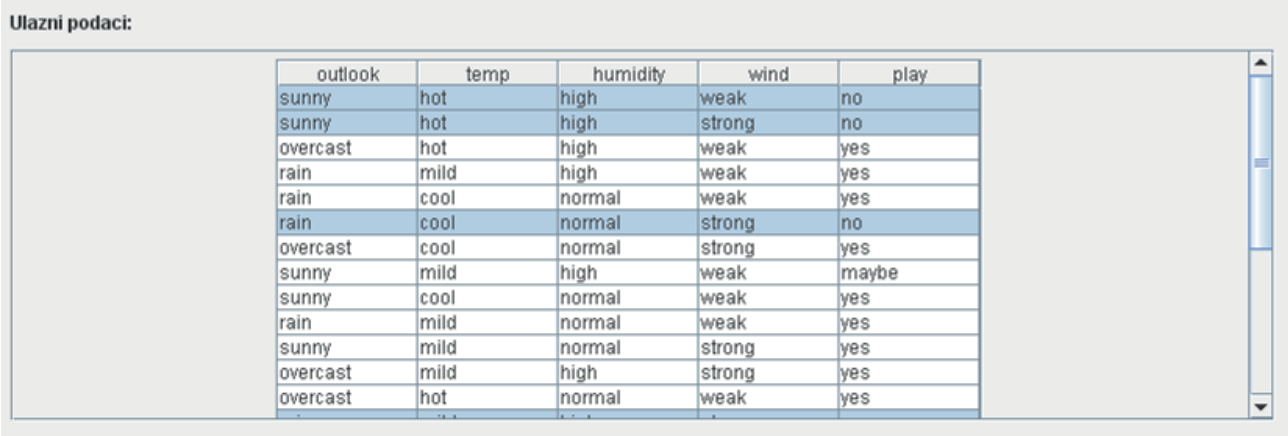
Bitno je pomenuti i poreklo naziva algoritma – iako bi se iz naziva moglo zaključiti da se radi o „naivnom" algoritmu, zapravo se radi o tome da se podrazumeva da su atributi između sebe uslovno nezavisni. Na taj način, svaki atribut doprinosi donošenju krajnje odluke u jednakoj meri i potpuno nezavisno od drugih atributa, što je efikasnije od drugih klasifikatora, gledano iz aspekta broja potrebnih operacija [7]. Zahvaljujući tome, Naive Bayes modeli u praksi mogu raditi iznenađujuće dobro.

S obzirom na navedenu pretpostavku o međusobnoj nezavisnosti atributa, verovatnoća posmatranja konjunkcije $a_1, a_2, \ldots, a_n$ je proizvod verovatnoća pojedinačnih atributa [8][9] kao što prikazuje (2).

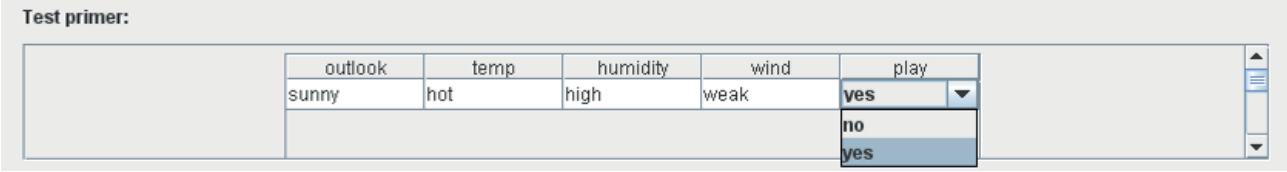
$$P(a_1, a_2, \ldots, a_n \mid v_j) = \prod_i P(a_i \mid v_j) \quad (2)$$

Algoritam *Naive Bayes* koristi ovu tvrdnju kao osnovu svog rada, a ona čini osnovu njegovog funkcionisanja i prikazana je u (3).

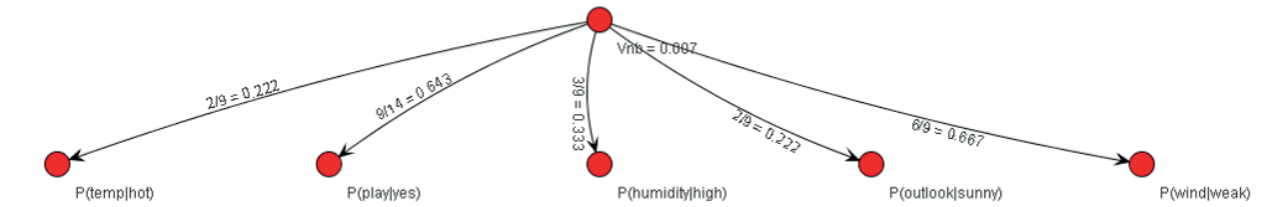
$$v_{NB} = \arg\max_{v_j \in V} P(v_j) \prod_i P(a_i \mid v_j) \quad (3)$$



Slika 3. Označavanje redova u tabeli sa ulaznim podacima



Slika 4. Izbor vrednosti test atributa



Slika 5. Prikaz stabla sa vrednostima uslovnih verovatnoća

Vrednost v_{NB} označava izlaznu vrednost algoritma. V predstavlja konačni skup ulaznih vrednosti, a njeni pojedinačni članovi obeleženi su sa v_j. Svaki primer iz skupa obučavanja predstavljen je kao skup vrednosti atributa (a_1, a_2, ..., a_n). Bitno je naglasiti da je broj različitih $P(a_i|v_j)$ uslova, koji moraju biti procenjeni iz skupa obučavanja, jednak broju različitih vrednosti atributa pomnoženi sa brojem različitih ciljnih vrednosti. [10] Takođe, ulazni skup podataka za algoritam koji se predstavlja u ovom radu mora sadržati diskretne vrednosti. U slučaju potrebe za kontinualnim vrednostima, potrebno je napraviti određene pretpostavke po pitanju distribucije vrednosti, a za tu svrhu se koriste druge varijacije algoritma koje nisu predmet ovog rada (na primer, alogirtam *Gausov Naivni Bajes – Gaussian Naive Bayes*).

Interesantna razlika algoritma Naive Bayes u odnosu na druge algoritme mašinskog učenja (na primer, stablo odlučivanja) je da ne postoji izričita pretraga prostora mogućih hipoteza. Umesto toga, hipoteza se formira bez pretraživanja, prebrojavanjem frekvencija raznih kombinacija podataka u okviru skupa obučavanja. [11]

Ovaj algoritam se pokazuje izuzetno efikasnim u širokoj lepezi primena, posebno zbog svoje jednostavnosti u fazi učenja i klasifikacije [12]. Izuzetno puno se koristi i u

oblasti klasifikacije teksta i slika, što je do sada potvrđeno u mnogim radovima i primerima iz prakse [13, 14]. Njegova važna karakteristika je da se dobro prilagođava i veoma velikim problemima: sa *n* Bulovih atributa, postoji samo *2n+1* parametara. Važno je naglasiti i da nema poteškoća sa nedostajućim podacima i podacima sa šumom. [10]

Čak se i situacije kada postoje nedostajuće vrednosti u ulaznim podacima ili test primerima mogu prilično jednostavno prevazići. Ukoliko u nekom redu sa ulaznim podacim nedostaje određena vrednost, ceo taj red se može ignorisati tokom ciklusa učenja algoritma. Moguće je čak nedostajuću vrednost ignorisati i u test primeru kako ne bi negativno uticala na krajnji rezultat.

Algoritam *Naive Bayes* poseduje i neke negativne strane na koje je potrebno obratiti pažnju prilikom izbora adekvatnog algoritma za potrebe donošenja poslovnih odluka. Upravo jedno od najvažnijih ograničenja predstavlja činjenica da se rad algoritma zasniva na pretpostavci da su atributi između sebe uslovno nezavisni - u realnom životu, gotovo je nemoguće pronaći skup atributa koji su međusobno potpuno nezavisni.

Takođe, ukoliko se u određenoj kategoriji pojavi vrednost koje nije bilo u skupi na kom se algoritam obučavao, biće dodeljena vrednost verovatnoće 0 – obzirom na pretpostavku uslovne nezavisnosti, kada se sve verovatnoće pomnože sa 0 i krajnja vrednost će imati tu vrednost – samim tim algoritam neće moći da napravi predviđanje. Ovaj problem se može dogoditi kada skup na kom se algoritam obučava ne predstavlja u potpunosti reprezentativan uzorak populacije. Postoje i određene tehnike koje se mogu koristiti da se ovakve situacije izbegnu – na primer, *Laplace smoothing*.

3. PRAKTIČNA PRIMENA ALGORITMA NAIVE BAYES

Za potrebe praktične primene algoritma Naive Bayes, autori su razvili softversko rešenje za pomoć u donošenju poslovnih odluka zasnovano na Java platformi. [15, 16] Softver omogućava da se unese proizvoljan ulazni skup podataka, da se iz posebne tabele izaberu test primeri koji se nalaze u odgovarajućim padajućim listama i da se algoritam potom obuči na ulaznom skupu i donese odluku na osnovu test primera. U svakom trenutku, korisnik može kontrolisati rad algoritma tako što će ga pauzirati ili će se kretati napred ili nazad kroz algoritam korak po korak i pratiti međufaze izvršavanja.

Za potrebe rada algoritma *Naive Bayes* može se koristiti bilo koji ulazni skup podataka, a za demostraciju u ovom radu koristi se *play tennis* primer (tabela 1). Ovaj skup podataka se često koristi kao demonstracija rada algoritama poslovnog odlučivanja. Navedeni skup podataka predstavlja vrednosti na osnovu kojih algoritam uči.

Tabela 1. Ulazni skup podataka primera play tennis

outlook	temp	humidity	wind	play
sunny	hot	high	weak	no
sunny	hot	high	strong	no
overcast	hot	high	weak	yes
rain	mild	high	weak	yes
rain	cool	normal	weak	yes
rain	cool	normal	strong	no
overcast	cool	normal	strong	yes
sunny	mild	high	weak	no
sunny	cool	normal	weak	yes
rain	mild	normal	weak	yes
sunny	mild	normal	strong	yes
overcast	mild	high	strong	yes
overcast	hot	normal	weak	yes
rain	mild	high	strong	no

Nakon što se vrednosti ovog primera učitaju u softver, prikazuju se u grafičkom interfejsu programa u tabeli prikazanoj na slici 3. U prikazu su trenutno označeni redovi čiji atributa *play* imaju vrednost *no*. Označene vrednosti se po potrebi mogu promeniti u skladu sa potrebama za lakšim pregledom korisnika koji upotrebljava program.

Nakon unosa ulaznih podataka, potrebno je izabrati vrednosti atributa za test primer koji će se koristiti (slika 4).

Algoritam radi tako što se za određenu kombinaciju atributa (u ovom slučaju vremenskih uslova) obračunava verovatnoća da li će se meč odigrati ili neće. Kao što je prikazano na slici 4, u ovom slučaju je potrebno odrediti verovatnoću da li će se teniski meč igrati, ukoliko je sunčano vreme, visoka temperatura i vlažnost vazduha, a vetar slab. Naravno, moguće je napraviti i bilo koju drugu kombinaciju test parametara.

Nakon pokretanja algoritma, vrši se obračun vrednosti i iscrtava se stablo sa prikazanim vrednostima uslovnih verovatnoća (slika 5).

U listovima stabla, nalaze se vrednosti uslovnih verovatnoća, kao i objašnjenje načina na koji su dobijene, tako da se može samostalno proveriti kako se došlo do određenih vrednosti. U korenu stabla nalazi se tražena verovatnoća da će meč biti odigran, uz zadate vremenske uslove iz test primera.

Slika 6 prikazuje tekstualni izlaz programa pomoću koga se može videti kako algoritam funkcioniše.

```
Korak 1
  P(play|yes) = 9 / 14 = 0.643
Korak 2
  P(outlook|sunny) = 2 / 9 = 0.222
Korak 3
  P(temp|hot) = 2 / 9 = 0.222
Korak 4
  P(humidity|high) = 3 / 9 = 0.333
Korak 5
  P(wind|weak) = 6 / 9 = 0.667
Korak 6
  Pronađeno rešenje
  Vnb = 0.007
```

Slika 6. Tekstualni izlaz algoritma Naive Bayes

Kao što se vidi iz korena stabla i tekstualnog izlaza algoritma, verovatnoća da će se igrati teniski meč je *0.007*. Da bi ova vrednost bila još korisnija, potrebno je izračunati verovatnoću da se pri zadatim vremenskim uslovima teniski meč neće odigrati. Ukoliko se ponovi prethodni postupak i za taj slučaj, dobiće se verovatnoća od *0.027*. Time zaključujemo da je veća verovatnoća da se teniski meč *neće* odigrati.

Od izuzetne važnosti je obratiti dodatnu pažnju na realizaciju procesa obračuna krajnje verovatnoće, a vezano za preciznost brojeva sa pokretnim zarezom. Naime, kada se uslovne verovatnoće (koje su uglavnom veoma mali brojevi) međusobno množe, mogu nastati još manje vrednosti – u tim situacijama postoji mogućnost gubitka preciznosti u računanju, o čemu se tokom razvoja softvera posebno mora voditi računa.

4. ZAKLJUČAK

U oblasti primene inteligentnih sistema u poslovnom odlučivanju postoji veliki broj algoritama koji se mogu koristiti kao pomoć pri donošenju odluka. U okviru ovog rada, cilj je bio da se predstavi Naive Bayes kao jedan od algoritama za koji su autori smatrali da sa jedne strane omogućava brz i efikasan proces učenja i klasifikacije, a da sa druge strane nudi značajnu prednost po pitanju kvaliteta odluka koje predviđa. Ovaj algoritam je i specifičan po tome što poseduje izuzetno veliku brzinu rada. To znači da se u nekim slučajevima verovatnoće mogu izračunavati čak i kod svake promene ulaznih podataka, što je nezamislivo za mnoge druge algoritme mašinskog učenja.

Kada su ulazni podaci takvi da se može održati pretpostavka što višeg stepena uslovne nezavisnosti atributa, mogu se ostvariti i bolji rezultati u odnosu na druge modele, a često i ulazni skupovi podataka na kojima algoritam uči mogu biti manji. Iako postoje i određeni nedostaci, uz adekvatnu pažnju i primenu korektivnih mera, mogući problemi se mogu izbeći. Upravo korišćenjem softvera koji su razvili autori rada, moguće je primeniti *Naive Bayes* algoritam, ali i kroz grafički izlaz programa lako uvideti sve uslovne verovatnoće koje čine krajnji rezultat. Zahvaljujući tome, nastao je alat koji omogućava lako korišćenje algoritma, čak i za one korisnike koji nisu detaljno upućeni u sam princip rada navedenog algoritma.

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INFORMATION SECURITY AND DIGITAL FORENSICS & E-COMMERCE SYSTEMS

ENCHANTMENT OF MAGENTO CMS SECURITY

Nikola Pavlović*,
Marko Šarac,
Saša Adamović,
Miloš Mravik

Singidunum University,
Belgrade, Serbia

Abstract:
Magento is a CMS (Content Management System) platform used to create e-commerce websites and online stores. With it, users can fully manage their online store, display specific products, provide customers with different methods of payment and delivery, as well as many other options. Magento uses an authentication system based on the knowledge of the user name and password. In addition to increasing this problem, there is no mechanism that prevents an attacker from brute forcing passwords. The proposed solution is replacing default Magento authentication with OAuth.

Keywords:
Magento, OAuth, WordPress.

1. INTRODUCTION

E-commerce refers to the buying and selling of goods or services using the internet. One of the most popular CMS platforms for E-commerce is Magento. Magento is open-source platform written in PHP. Thanks to its great scalability, flexibility and optimization Magento has become a tool that is most used by developers, designers and web agencies to create E-commerce websites.

One of the biggest problems of Magento CMS is security. To keep Admin Dashboard and entire back-end secure most of the time just changing admin dashboard and back-end URL is not enough. This is because default Controllers still stays at same URL and anyone can brute force them.

The proposed solution for this problem is to replace default Magento password-based authentication with OAuth and add Captcha to prevent brute forcing open controllers. Furthermore, the generic scheme of the suggested solution and its implementation will be explained.

2. MAGENTO SECURITY

In Hivemind's E-commerce Survey report Magento holds 24.6% after studying 56,793 E-commerce websites inside the Alexa Top 1 Million. It is clear that Magento is the most popular CMS.

Correspondence:
Nikola Pavlović

e-mail:
nikola.pavlovic.141@singimail.rs

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E-commerce websites are attractive targets to hackers because of payment and personal information required to properly use them. A compromised web store can have long-term consequences for both customer and owner. Owner can suffer lawsuits, damage to their reputation, revoked privileges with financial institutions, higher processing fees. Customer can suffer financial loss and identity theft.

Trust plays an important part when one has an online store. To improve Magento security it is important to have latest version of Magento implemented.

As of July of 2018. Google started to force HTTPS. This is very important because no store owners want to get their data being intercepted. It is also one of the key elements in making store compliant with the PCI data security standard and in securing online transactions. SSL certification can be obtained from Let's Encrypt. It will also help in becoming PCI compliant.

The most popular way for hackers to get access to server is that by guessing FTP password. Hosting providers nowadays always recommend using SFTP (Secured File Transfer Protocol) which uses private key for decryption or authenticating a user.

Disabling directory indexing is another way to increase security of Magento site.

E-mails used for Magento store needs to be protected with two-factor authentication and not publicly known.

Magento developers recommend using password with uppercase, numbers and special characters.

Another alternative for security is using static IP addresses and black listing all that shouldn't have access to admin dashboard.

The most popular two factor authentication method is Google Authenticator. With Google Authenticator you also need to know two-factor code. First, install application on your smart phone. In order to add new verification code into your Google Authenticator mobile application, you just need to scan QR code of the desired website (the best way) which you want to add. Each two-factor code changes every 30 seconds meaning every time you access the site this code will be different (the same way when you enter CAPTCHA incorrectly). You can use Google Authenticator only on sites who supports Google Authenticator. This application is most commonly used on sites which primary job is to buy or sell goods online.

3. STATE OF WORDPRESS SECURITY

While Magento is built to be enterprise level E-commerce platform, WordPress is built to be more developer friendly. This comes with community solutions for many security problems.

It is important to mention that Wordpress comes with Captcha support for admin dashboard out of box.

There are many community plugins [1] that improve Wordpress security but most important is iThemes Security.

iThemes Security (formerly Better WP Security) adds two factor authentification using Google Authenticator. Out of box generate stronger passwords and adds expiration date so users can be forced to update them. All users actions are logged. Forces usage of SSL. Prevents brute force attacks by banning hosts and users with too many invalid login attempts. Detects and blocks numerous attacks to your filesystem and database.

Magento is ideal for building online business and sales. On the other hand WordPress revolves around marketing and digital publishing. However, WordPress can become a robust online store with the help of plugins such as WooCommerce. Big companies choose Magento as default platform for online sales while smaller WordPress (WooCommerce).

4. STATE OF THE ART

Authors [2] suggest using the OAuth to separate the role of the Client from the resource owner. In OAuth, the client request access to resources owned by the resource owner and is issued a different set of credentials than those of the resource owner. The client obtains access token by the authorization server and then uses is to access the protected resources hosted by the resource owner. Authors also suggest using OAuth because it defines four roles: resource owner, an entity capable of granting access to a protected resource, resource server, the server hosting protected resource, client, an application making request to protected resources and authorization server, the server issuing access tokens.

In the paper [3] the authors researched some of the most popular web security exploits such as SQL injection and XSS. Their suggestion to improve Web Application security is to avoid unsafe APIs, always sanitize user inputs, apply strong cryptography and security protocols. One of the most important suggestion is to follow the principle of least privilege.

Authors [4] review existing CAPTCHA schemes to protect various Web services. Authors explains that text-based CAPTCHAs have become sufficiently hard for humans to solve and thus their usability has decreased at least for an ordinary user. Often ordinary users fail to solve hard text-based CAPTCHAs in their first attempt. Also breaking CAPTCHA challenge is difficult and it is hard to find 100% success rate. Authors have implied that several CAPTCHA implementations have been broken and provided to be inefficient. With the requirement to make web more user-friendly new CAPTCHA techniques are designed. They require less server processing and offer improved security control against bots.

The popularity of content management software (CMS) is growing vastly. The authors of the paper [5] have implemented tool SAISAN to conduct examination of the 176 WordPress websites. From their research 32% of the WordPress websites are on version 4.7.0 or 4.7.1 and have content injection vulnerability.

Millions of users use Google to log in to websites supporting OAuth 2.0 or OpenID Connect. The authors [6] used OAuthGuard to survey 1000 most popular websites that supports Google-sign in. From the research they have concluded that of the 137 sites in our study that employ Google Sign-in, 69 were found to suffer from at least one serious vulnerability

Authors [7] did analysis of the OAuth 2.0. The aim of their security analysis is establishing strong authorization, authentication and session integrity guarantees. They have covered authorization code grant, implicit grant, resource owner password credentials grant, and the client credentials grant. Four security breaks have been discovered. Authors have proposed solutions to patch security exploits.

5. MAGENTO SECURITY GENERAL GUIDE

The aim of this chapter is to describe simply main aspects that must be considered when securing Magento E-commerce platform.

Security testing is a major means for assuring software security [8]. Most popular way to test security exploits in Magento is by using online tool Magereport.

This web application will generate key that must be placed in content of the website. After placing the key scanner can be run and report for missing patches and possible vulnerabilities will be generated. Magereport do passive checks in read only mode. Also, Magereport tells only what is wrong, not how to exploit it.

Before starting with best practices to improve security of Magento CMS, latest security patches must be applied. Magento patches must be applied in order. Applying them out of order can break Magento since they are directly changing core code.

Magento patches can be downloaded from Magento Security Center as it is only verified source.

Most popular practice is to change path for the admin panel. In most cases access to admin panel can be granted by visiting “example.com/admin”. To prevent this, it is possible to change “/admin” to desired word or code. To change path, open “/app/etc/local.xml”, find <![CDATA[admin]]> and replace admin with desired word or code.

Set correct permissions on Magento Core files. Core Magento and directory files should be set to read only, including “app/etc/local.xml” files.

Setting access permissions for the various files in the Magento application is one of the most important security measures that should be applied in a production environment. Setting proper permissions cuts down the potential damage that an attacker might cause through some vulnerability or exploit in the system. It is also advisable to set privileges for reading and execution as shown below:

```
find . -type f -exec chmod 400 {} \;
find . -type d -exec chmod 500 {} \;
find var/ -type f -exec chmod 600 {} \;
find media/ -type f -exec chmod 600 {} \;
find var/ -type d -exec chmod 700 {} \;
find media/ -type d -exec chmod 700 {} \;
```

Another most popular way to protect Magento administrator dashboard is limiting number of allowed IP addresses that can access it. This can be achieved by changing “.htaccess” file. The following example would redirect to the main Magento address all requests received by the Apache server from any IP other than 192.168.56.102 when the URL contains the string “admin”.

```
<IfModule mod_rewrite.c>
   RewriteEngine On
   RewriteCond %{REMOTE_ADDR}
!^192\.168\.56\.102
    RewriteCond %{THE_REQUEST} ^.*
(admin).* [NC]
    RewriteRule (.*) /
</IfModule>
```

On nginx servers following example can be applied:

```
# nginx configuration

location / {
  if ($remote_addr !~
“^192\.168\.56\.102”){
    rewrite ^(.*)$ / ;
  }
}
```

6. PROPOSED SOLUTION

In this chapter, a developed solution will be presented from theory to practical implementation. Our solution has two different ways of implementation. First is adding CAPTCHA to admin dashboard login form to prevent password guessing.



Figure 1. Adding CAPTCHA to admin login form

Using CAPTCHA is great from client-side point of view, but it is not perfect. To further improve security of store account lockdown is added. Account lockdown is very effective deterrent against brute force attacks. Account lockdown functionality is independent of the client side completely.

Since it is unrealistic for a human to send two or more requests within one second, adding limit the frequency of accepted connections is another techique to futher improve security and performance of Magento store. Next command can be added to iptables to disable multiple accepting multiple requests:

```
iptables -I INPUT -p tcp --dport 22 -i eth0
-m state --state NEW -m recent --set

iptables -I INPUT -p tcp --dport 22 -i eth0
-m state --state NEW -m recent --update
--seconds 60 --hitcount 4 -j DROP
```

Second implementation of the proposed solution is using two step authentification and OAuth 2.0 for Web Server Applications. OAuth 2.0 is the industry-standard protocol for authorization. Every E-commerce store owner uses Google mail and has Google account. Since Google account security natively supports two step authentication using phone number or another mail, adding this to Magento store is most secure approach.

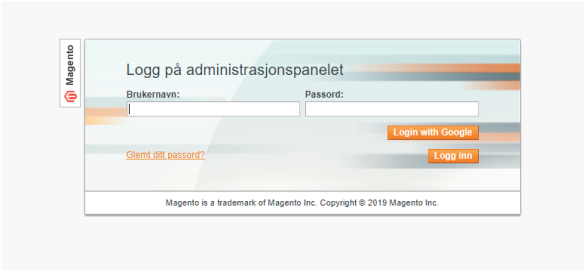


Figure 2. Using Google OAuth 2.0 to sign up

The next chapter will present the implementation of the proposed solution. The solution itself is developed PHP programming language in Zend Framework.

7. REALISATION OF THE GIVEN SOLUTION

In this chapter, the realisation of the given idea will be shown. On figure 3 is displayed how Magento store authenticate user based on his credentials using OAuth 2.0 Google API.

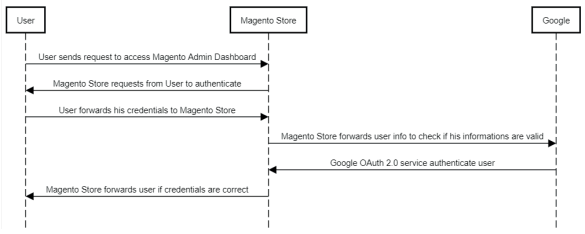


Figure 3. Authentication using OAuth 2.0

When user access Admin Login form Magento will request from him to authenticate. To successfully authenticate user will forward his Google account credentials to Magento store. After getting user credentials Magento will request from Google Authorization Service if user is valid. If user is valid Google Authorization Service will respond with user information. Our

solution uses domain name as check if user is valid after getting information from Google Authorization Service. This feature can be improved further by using full email address. We're using domain name since most E-commerce owners have custom domain and they want that all their employees have access to Magento Admin dashboard. Application Id and Shared secret is what links Magento Store with Google OAuth 2.0 API.

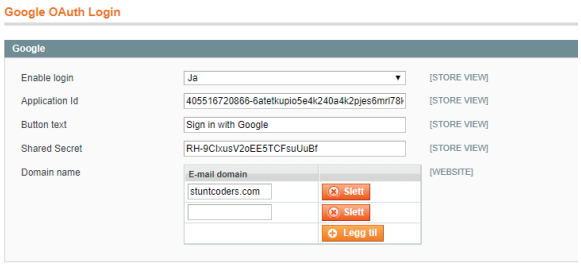


Figure 4. Configuration for OAuth 2.0

On figure 4. Is displayed configuration for OAuth 2.0. To successfully use OAuth 2.0 on Magento Application id generated from Google OAuth API. Application Id is shared to public. On the other hand, Shared Secret must be protected and never shared to public since it is used by Google OAuth 2.0 API as verification key.

On figure 5 is displayed how Magento store authenticate user based on his credentials and Captcha guess.

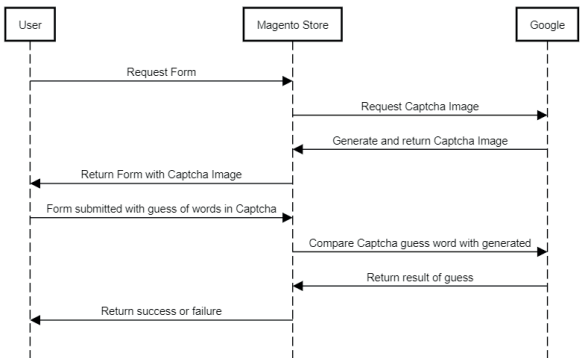


Figure 5. Authentication using Captcha

When user visits Admin dashboard login page Magento will require from him to authenticate. By using Captcha on this form, we have added one additional step before serving Admin Login Form. Before generating HTML and displaying it to user, Magento will send request to Google Captcha API to generate challenge for user. After challenge is generated Google Captcha API will respond to Magento with challenge. After getting challenge Magento will display Form to user. After user guess challenge and submit form. Magento will forward challenge result to Google Captcha API. Google will compare result with generated and respond to Magento. Magento will then then validate username and password if Google response to challenge is positive.

8. CONCLUSION

The goal of this paper is to enchantment of Magento CMS security. By using OAuth 2.0 and Captcha we have removed possible password guessing, SQL injection and XSS attacks. Proposed solution has improved Magento performance since authentication is moved to third trusted party, in our case Google Authorization Server. By removing need to type email and password to access Magento Admin dashboard client experience is drastically improved. Also, by removing need to have hard guessed password to access store Administrator will never have to worry about losing access to store or being locked out of it.

By using Captcha, we have overcome Magento biggest problem of password guessing. This solution as well have improved Magento performance and decreased load on MySQL database since all the work is done by Google Authorization Server.

The implemented solution must be based on the trusted third party, i.e. on the authentication server. The benefit of this authentication method is to achieve high level security of user credentials. The disadvantages are if the authentication server is not active, Magento Admin dashboard is inaccessible, due to the inability of the Administrator to successfully authenticate.

It is important to mention that using OAuth 2.0 is only secure if the authorization code is not used more then once. If it is used more than once server must deny and revoke all previously issued tokens based on that authorization code. Also access token should never be passed as URI parameter.

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PENETRATION TESTING AND VULNERABILITY ASSESSMENT: INTRODUCTION, PHASES, TOOLS AND METHODS

Kristina Božić,
Nikola Penevski,
Saša Adamović*

Singidunum University,
Belgrade, Serbia

Abstract:
Penetration testing is the practice of testing a computer system, network or web application to find security vulnerabilities by using a diverse variety of tools and methods. This work is a brief overview of the phases, including reconnaissance or information gathering, scanning, vulnerability analysis, exploitation, and reporting, along with some of the basic tools and methods of penetration testing. It's fundamental, for every penetration tester, to be familiar with these concepts in order to successfully execute a full testing process and forge good reports.

Keywords:
Penetration Testing, Vulnerabilities, Security Testing, Vulnerability Assessment, Exploits.

1. INTRODUCTION

With the ever growing connectivity of things through the internet, security is becoming one of the most important parts of information systems. Businesses tend to protect their information assets by complying with the mandated security regulations and following best practices in order to reduce the risks that they might face. In an attempt to solve the security problem and comply with the mandated security regulations, security experts have developed various security assurance methods including proof of correctness, layered design, software engineering environments and penetration testing.

Penetration testing is a comprehensive method to test the complete, integrated, operational, and trusted computing base that consists of hardware, software and people. The objective is to test real-time systems, find any potential vulnerabilities, and take measures to improve the overall security of the system.

Penetration testing differs from security testing. The latter demonstrates the correct behavior of the system's security controls while penetration testing determines the difficulty for someone to evade an organization's security controls and gain unauthorized access to its information and information systems.

Correspondence:
Saša Adamović

e-mail:
sadamovic@singidunum.ac.rs

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Experts have developed various tools and methods with the aim to provide a better, more efficient and dynamic examination. This paper provides an overview by going through phases, tools and methods used in penetration testing.

2. BACKGROUND

Penetration Testing

Penetration Testing can be defined as "is an authorized simulated cyber attack on a computer system, performed to evaluate the security of the system".[1] Process of penetration testing, or for short pen testing, is performed by trained security experts called ethical hackers. The purpose of these tests is to find the security vulnerabilities that the software may contain.

The Nation Institute of Standards and Technology (NIST) defines penetration testing as: "a specialized type of assessment conducted on information systems or individual system components to identify vulnerabilities that could be exploited by adversaries".[2]

Some of the best Penetration Testing Companies in recent years are Security Assessment, Security Audit Systems and Hacklabs.[3]

Phases of Penetration Testing

The process of penetration testing is consisted of five phases:

1. Reconnaissance – in the first step, a tester must gather basic information of a targeted system, such as the correct domain of web server, are there any sub-domains connected to this domain, is there any firewall, relevant IP addresses and so on. The information gathered here is used later on in the testing, which makes this step very important.
2. Scanning – in this step the use of technical tools is needed to further the attacker's knowledge of the system. By doing that we can gain information about what type of services are running on the server and what is the version of the given server. Additional information can be identification of the port that this service is running, and which Operating System is used on the system.
3. Gaining Access/Discover Vulnerability – in this step a tester must use the information gathered from the previous two phases in order to successfully penetrate the targeted system.
4. Maintaining Access/Exploitation – after successfully compromising a system, tester's goal is to breach all types of securities and gain remote access to the system. If the rules of engagement permit this, a tester ensures that he will be able to maintain access for further examination or penetration of the targeted system.
5. Covering Tracks/Report Generation – the attacker must not leave any trace of compromising the system. This includes returning the system to a state that it was in before the attack by clearing logs and resetting security parameters. In the case of report generation, a tester would write a full report of the Penetration test and give insight on how to increase the overall security of the system.[4]

Penetration Testing methods and benefits

Methods used in penetration testing are:

1. External testing which targets the assets of a company that are available on the internet
2. Internal testing allows a tester to access an application behind the firewall to simulate an attack by a malicious insider
3. Blind testing where a tester only knows the name of the target
4. Double Blind testing means that the security personnel of a targeted company has no knowledge about the arranged simulated attack
5. Targeted testing where both the tester and security personnel of the targeted company work together to provide a security team with real-time feedback from a hacker's perspective.

Benefits of Penetration Testing are:

1. Discovery of publicly available information that has vulnerabilities which can harm the system
2. Managing the unnecessary ports and services open to external access despite the fact that they are not being used
3. Identifying poorly configured systems that allow easy exploitation by a malicious attacker, or poor patch management processes.
4. Finding weak passwords on the system
5. Inadequate or a complete lack of antivirus software
6. Penetration Testing gives company clear recommendations on how to improve their security and maintain their system.

Vulnerability Assessment

Vulnerability Assessment is the process of defining, identifying, classifying and prioritizing vulnerabilities in computer systems, application and network infrastructures and providing the organization doing the assessment with the necessary knowledge, awareness and risk background to understand the threats to its environment and react appropriately.[5] Vulnerability Assessment is important because it provides a company with information on the security risks and weaknesses in their systems, and helps them to better understand their security flaws and overall risk of a faulty system.

A vulnerability assessment includes penetration testing components used to identify vulnerabilities in the company's personnel, and discover processes that might not be detectable with network or system scans. Some types of vulnerability assessment scans are listed below:

1. Network-based scans, used to identify network security attacks
2. Host-based scans, used to discover vulnerabilities in servers or other network hosts.
3. Wireless network scans usually used to identify rogue access points, or just validate that the company's network is securely configured
4. Application scans, used in website testing to discover potential software vulnerabilities
5. Database scans, used to determine weak points in a database in order to prevent malicious attacks



Figure 1. Phases of Penetration Testing

3. PENETRATION TESTING AND VULNERABILITY ASSESSMENT MOST USED TOOLS

Penetration testing is method used to find the vulnerabilities that exist in the system. These tests simulate various types of attacks on the targeted system using variety of tools. Some of those tools and basics of their usage will be reviewed in this work.

Nmap

Network mapper, or for short Nmap, is a free and open source tool which can be used for initial scanning of systems or networks. This tool is always used in the first phase of penetration testing because of its utilities. Most useful Nmap utilities are gaining insight of a targeted network, including the discovery of hosts available on that network, operating systems running on them and port discovery. Nmap is also suitable for scanning both large and small networks.

Some basic Nmap scanning examples which can be used in enumeration are listed below:

nmap -sP 10.0.0.0/24 – this ping scans the network and makes a list of machines that respond to it

nmap -p 1-65535 -sV -sS target – this is a full TCP port scan along with service version detection

nmap -v -sS -A target – this command prints verbose output, runs stealth tcp syn scan with OS and version detection

nmap -v -p 1-65535 -sV -O -sS target – this prints verbose output, runs a stealthy syn scan, OS and version detection with a full port range scan

Shodan

Shodan represents a search engine and can be used for finding specific devices and their types. Most common searches are for webcams, cisco and netgear devices.

Shodan search engine works by scanning the entire Internet and then parse the banners returned by scanned devices. When the search is over, the information received by shodan search will be most likely about web servers and their versions, as well as anonymous FTP servers if they exist in a particular location, and the information about the model of the device.

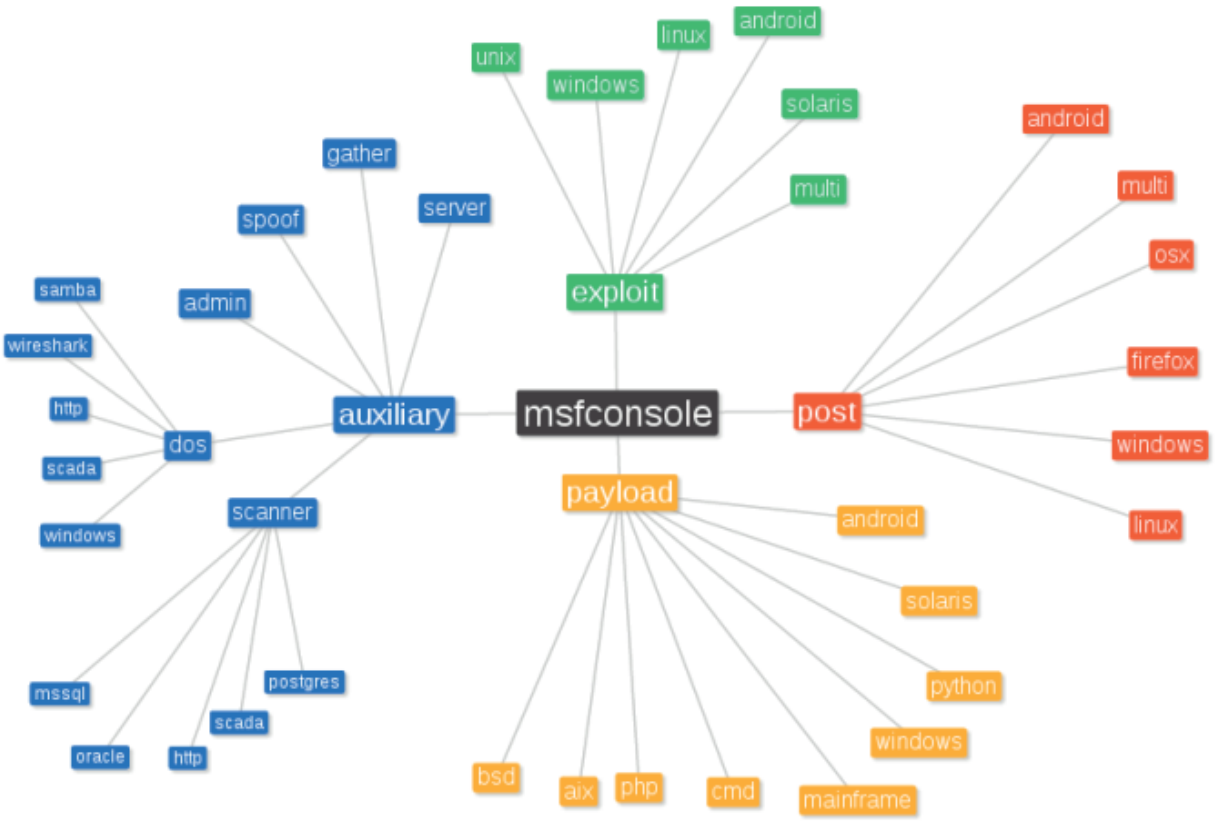


Figure 2. Metasploit Framework Modules

The use of Shodan search engine will most likely increase even more for security research around the Internet of things.

Burp Suite

Burp Suite is a platform for performing security testing of web applications. It's a tool that supports the entire testing process, from initial mapping and analysis of an application's attack surface, through to finding and exploiting security vulnerabilities.[6]

Some of the essential manual tools that are provided by Burp Suite are listed down below:

1. It allows a manual tester to intercept all requests and responses between the browser and the target application, even with HTTPS in use.
2. It allows the following commands: view, edit or drop individual messages in order to manipulate components of the application.
3. The fine-grained interception rules can be configured in order to control precisely which messages are going to be intercepted
4. The Repeater tool allows to manually edit and reissue individual requests
5. It captures detailed attack results, with all relevant information about each request and response presented in table form. Information obtained with Burp Suite are most likely to be the payload values, HTTP status code, response timers or cookies.[7]

Metasploit

Metasploit is a platform which includes Metasploit Framework and some of the commercial counterparts, and it allows finding, exploiting and validating vulnerabilities.

Metasploit Framework is an open source project which provides the infrastructure, content and tools for performing penetration tests. Anti-forensics andadvanced evasion tools are also offered, and some of them are built into the Metasploit Framework.

A module, which is a core component of the Metasploit Framework, is a piece of software that can perform

a specific action, for example scanning or exploiting. Every task done in Metasploit Framework is defined within a module. The following module types are the ones that are available on Metasploit Framework and contain a brief explanation of each:

1. Exploit - an exploit module executes a sequence of commands which then target a specific vulnerability found in a system or application.
2. Auxiliary - auxiliary modules include scanners, fuzzers, and denial of service attacks.
3. Post-Exploitation - a post-exploitation module allows additional information gathering, but it can be used to gain further access to an exploited target system.
4. Payload – an executable code that runs after an exploit successfully compromised a system and performs malicious actions written by the attacker.
5. NOP generator - NOP generator produces a series of random bytes that you can use to bypass standard IDS and IPS NOP sled signatures. [8]

Wireshark

Wireshark is a network packet analysis tool (also known as a network sniffer) which allows packets to be captured in real time while displaying them in a human readable format. Wireshark is a passive tool that only records network traffic without sending it. This means that if used on the network Wireshark cannot be detected by other parties. This tool is open source and is compatible with both UNIX and Windows and many other operating systems. It uses a graphical user interface which sets it apart from different packet analyzers such as tcpdump which with Wireshark shares many characteristics.

The information captured with Wireshark can be viewed through a GUI or the TTY mode TShark Utility. Wireshark is mostly used for troubleshooting network problems, for examining security problems, verifying network applications and debugging protocol implementations.

Wireshark allows for recording of network activity in different formats such as XML, PostScript, CSV or plain text so that the traffic can be analysed afterwards. It can record traffic directly from the internet via the network adapter, PPP/HDLC, ATM, Bluetooth, USB (natively supported on UNIX), Token Ring, etc. New protocols can be scrutinized within Wireshark by adding or creating plugin. Wireshark is capable of capturing compressed files and decompressing them on the fly further making it easier to analyse the data. It's also capable of capturing and playing VoIP in real time. Data can be collected from many protocols supported by Wireshark some of which include IPsec, ISAKMP, SSL/TLS, WEP, and WPA/WPA2. For an easier management of data and a more intuitive analysis Wireshark offers filters and coloring rules can be applied to different types of packets. Traffic recorded through Wireshark can be replayed to offer a repeatable controlled environment.

4. CONCLUSION

Penetration testing is a very effective method used to analyze security of a system. In testing, a variety of tools can be used to test different parts of a system and write a full report on one system's weaknesses. Some of the tools which are mostly used by pen testers are listed in this work, along with their basic usage and explanation. The most important thing for making a successful penetration test consists of following all the phases discussed above and keeping a clean record of all the information that were gathered during the process. The testers can choose from black box, white box and gray box types of testing, which depends on the amount of information available to testers. They can also choose which method to use, like from the internal or external testing among others, depending on the specific objectives that need to be achieved.

This paper describes and encloses all the basic knowledge needed for the beginning of penetration testing process, phases that the tester goes through with the goal of creating a detailed report that helps companies fix vulnerabilities, increase security and ensure safety of one company's data.

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FACTORS AFFECTING RFID SUBCUTANEOUS MICROCHIPS USAGE

Svetlana Čičević[1],
Andreja Samčović[1, *],
Magdalena Dragović[2]

[1]Faculty of Transport and Traffic Engineering,
University of Belgrade,
Belgrade, Serbia
[2]Faculty of Civil Engineering,
University of Belgrade,
Belgrade, Serbia

Abstract:
Microchips are used for many years for different purposes. Nevertheless, recently applications of radio frequency identification technology have been progressed tremendously with the potential to permeate throughout society as valuable tool for enabling automatic identification and management. However, they are perceived as threats at several levels that impede its implementation. Most of the research discusses the adoption of Radio Frequency Identification (RFID) devices from the provider's point of view. Thus, it would be of interest to examine the factors of RFID subcutaneous microchip (RFID-SM) usage, adoption and diffusion by individuals from various perspectives, particularly in developing countries. Knowledge upon the factors that drive RFID adoption is a crucial step in creating the policies required for its successful implementation. This quantitative, descriptive study investigated whether young people in Serbia would be willing to use subcutaneous microchip. Preliminary findings indicate that positive attitudes prevail for the perceived usefulness and ease of use, while suspicions of confidentiality and privacy are strong, and what is most surprising none of the respondents showed willingness to use microchip implants for everyday home activities. Since the process of individual users' acceptance of technology is very complex, the full range of variables should be investigated from broader perspective.

Keywords:
subcutaneous microchip, implant, acceptance of technology, adoption, privacy concerns.

1. INTRODUCTION

RFID is a wireless proximity communication method, which can be used as a standalone technology or it can be complementary to existing technologies [1]. Radio Frequency Identification (RFID) involves systems and technologies that transmit and automatically identify objects and people based on radio waves [2]. RFID is one of the key technologies that build up the Internet of Things, a pervasive network environment. RFID plays a fundamental role in the so-called digital factory or 4.0 Industry, aiming to increase the level of automatization of industrial processes. For many industries, RFID is not only a new alternative to existing tracking methods but is also a solution for a range of previously cost-prohibitive innovations in internal control and supply chain coordination [3]. RFID

Correspondence:
Andreja Samčović

e-mail:
andrej@sf.bg.ac.rs

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usually consists of tags, readers and middleware. RFID operates similarly on a barcode that stores serial numbers for identifying products and related information on a microchip [4]. However, unlike a barcode, RFID offers the advantage of allowing the tracking without the line of sight. Ultra high-frequency (UHF) RFID technology is selected over the most extended near-field communication (NFC) and high-frequency (HF) RFID technology to minimize hardware infrastructure. In particular, UHF RFID also makes the coverage/reading area conformation easier by using different kinds of antennas. Information is stored in a database, which is accessed from end-user mobile devices (tablets, smartphones) where the position and status of the assets to be tracked are displayed [5]. This allows for better time management and better human resource utilization.

This paper is structured as follows. After the introduction some important applications of considered RFID technology are mentioned and described. The Technology Acceptance Model is presented in the next section, because we used that model in our study. The corresponding methodology and obtained results are shown in the following section. Before the conclusion we discussed our results.

Applications of RFID technology

Embedded radio-frequency identification, sensor technologies, biomedical devices and a new breed of nanotechnologies are now being commercialized within a variety of contexts and use cases. RFID is present in a wide variety of applications. These applications include access control procedures, supply management, and protection against theft. There is a rapid increase in the use of RFID systems in the transport sector (toll collection), as well as in supply chain management infrastructures [6], logistic, automotive industry, livestock production [7], food production and public sector [8]. RFID has potential applications across a wide range of sectors and activities such as defense, agriculture, culture and other domains. Both industry and governments are strong promoters of RFID technology.

RFID microchip is used in shops, passports, proximity cards, ignition keys, contactless credit-cards, smart bracelets, smart finger rings, smart watches, etc. [9]. Additionally, RFID technology is starting to penetrate the medical and healthcare sector (in palliative care, home care and preventive care applications, including telehomecare applications) [10], enabling locating elderly or children in the case of their uncontrolled departure from home (Alzheimer's disease, kidnapping). RFID system is also used in hospitals for tracing the distribution of medicines, equipment, healing procedures, patient movements, but in these cases the RFID labels were attached or fixed to observed item [11]. In the year 2012 first results of wirelessly controlled drug delivery microchip testing were published [12]. The use of microchips also brings some risks such as safety of device, privacy of patients' records and coercion to consent to the implantation of the devices. Additional, there is a social and ethical risk.

However, like any wireless technology, including cell phones, wireless networks and Bluetooth connections, RFID devices provide remote readability. In theory, any technology that relies on radio frequency (RF) is inherently insecure. As a result, businesses and legislative bodies continuously seek ways to understand and lock down wireless security issues.

There are a massive number of devices with sensors that track and record different aspects of your life, with the goal of aggregating the data for the user to peruse (Fig 1). There are, of course, drawbacks to measuring multiple bodily functions with different devices. It has been pointed out that some devices are occasionally cumbersome, can interfere with everyday tasks, and even make the users even more aware of their bodily limitations - all of which can cause frustrations [13,14,15,16]. Natural user interfaces (NUI) is another field which shows promising relevance to the studies in quantified self [17] by transferring some of the functionality from the devices themselves onto in-home surfaces.

Some issues arise with implanting people with microchips though. Issues include, being able to track a person's previous and current location, their purchasing habits, legal and privacy concerns, as well as hacking their personal and financial information. There are potential health problems as well. For example, non-ionizing radiation from microwave radio frequency and magnetic fields could cause various health issues. A potential benefit could include storing a person's complete medical history, or at the bare minimal the drugs that they are taking or are allergic to [18]. Some health issues include adverse tissue reaction, migration of implanted transponder, electromagnetic interference, electrical hazards, and magnetic resonance imaging incompatibility [19]. There are legal and legislative issues as well dealing with RFID technology. Even though the scanner that reads the sensor has to be close to the body to read the chip, there still is the possibility of identity

theft. Parts of the problem are security, confidentiality and data integrity. There is a need for more laws dealing with RFID to protect privacy.

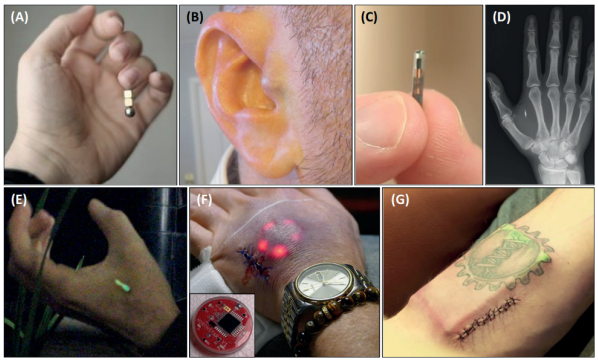


Fig. 1. Subdermal implants: (A) A neodymium magnet in a finger. (B) Magnets in the tragus of an ear. (C) A RFID tag. (D) RFID tags implanted in the webbing between the metacarpal bones of the index finger and thumb, positioned parallel to the index metacarpal. (E) Tritium lighting implants. (F) LEDs in hand. (G) Continual temperature sensor in forearm. Source: [20]

Concern is growing that RFID systems have the potential to be used as tools for surveillance, which could very much undermine the dignity and autonomy of employees. Recent studies have shown that the RFID technology is safe enough to be used for personal identification and some attempts were made to use RFID subcutaneous microchip implants (RFID-SM) [21,22,23]. The number of people willing to get chipped has increased since the technology's commercial arrival in 2002, despite the fact that adoption rates have been very low. Nevertheless, some researchers still explore the potential negative impact of enforced micro-chipping [24], while others look for highly positive effects of RFID implants.

2. TECHNOLOGY ACCEPTANCE MODEL (TAM)

Since its introduction almost three decades ago, by [25,26], TAM has become one of the most frequently used models used to explain behavioral intention, in general, and technology system acceptance, in particular [27].

Of the suite of theories that explain technology acceptance, TAM appears the most popular. It explains IT usage as a function of a four-stage process:

- External variables (user training) influences use beliefs about using the system;
- User beliefs influence their attitudes about using a system;
- User attitudes influence their intentions to use a system;
- The user intentions determine level of usage of the system [28].

It provides the framework to measure users' perceptions and intentions to use technology within and across organizations. Through research TAM has been empirically proven to be a robust model for understanding end-user adoption of technology and for examining the acceptance of new and developing technology by users with different characteristics in different organizations. The flexibility of TAM to be extended and modified to take into account other relevant factors makes it a powerful framework [29].

TAM comprises core variables of user motivation (i.e., perceived ease of use, perceived usefulness, and attitudes toward technology) and outcome variables (i.e., behavioral intentions, technology use). Of these variables, perceived usefulness (PU) and perceived ease of use (PEU) are considered key variables that directly or indirectly explain the outcomes [27]. Overall, perceived ease of use and perceived usefulness, the most important factors in the TAM, refer to the degrees to which a person believes that using technology would be free from effort (PEU) and that using technology would enhance their job or task performance (PU).

In the Technology Acceptance Model 2 (TAM 2) [30], TAM is extended by including additional key determinants of perceived usefulness and usage intention constructs. They aimed to determine the antecedents of external factors that affect perceived usefulness. These external factors are divided into two groups as social influence processes (subjective norm, voluntariness and imagination) and cognitive instrumental processes (job relevance, output quality, result demonstrability and perceived ease of use). Perceived ease of use and perceived usefulness positively affect the attitudes toward an information system; and further, positively affect the individuals' intentions to use and the acceptance of the information system. In addition, perceived ease of use positively affects the perceived usefulness, and both of perceived ease of use and perceived usefulness are influenced by external variable. Shroff et al. [31] reported that by manipulating these two determinants, system developers can have better control over users' beliefs about the

system and so can predict their behavioral intention and actual usage of the system. Some authors found significant direct relations between perceived usefulness and behavioral intention [32,33], others did not [34,35].

A variety of TAM models exist, with or without external variables, with or without direct effects of certain variables on outcome variables. In the literature, many studies mentioned the relationship among trust, perceived risks and behavioral intention [36]. The perception of trust in any relationship will elevate the perception of security. Generally, people feel unsafe or insecure in unpredictable situations. Trust plays a crucial role in reducing consumer perception of the risk of vulnerability [37]. In other words, people will feel safer about any particular product or transaction if they trust their partners or providers [38].

Despite its prominence, the existing body of research does not draw a clear picture about specific relations within the TAM. Whereas some studies confirmed the hypothesized relations fully, others did not [39,40]. This finding is further substantiated by significant variation of TAM relations across studies and samples from multiple occupations and domains, thus consequently calls for a systematic synthesis [41,42]. Finally, Ajibade [43] argues that the TAM model was more appropriate for individual use and acceptance of technology rather than in a corporate or institutional application that requires integration of information technology.

Studies from psychology research have widely stated that an individual's demographic and personality characteristics are important predictors, having moderating effects on Information Technology (IT) adoption [6,44]. IT adoption researches have confirmed the importance of the role of users when it comes to adopting new information systems [45]. Younger people are more prone to adopt new technologies. Bearing in mind the above mentioned, our study was conducted in order to examine the readiness to adopt RFID-SM by focusing on the individual users' point of view. The subjects in this research were undergraduate students because they represent the largest group of potential RFID-SM users.

3. METHODOLOGY

Data collection

The study was performed as a web survey used to collect data about attitudes toward RFID-SM usage in Serbia. Online survey was conducted using a convenience sample of 100 respondents. The participants were students enrolled in Traffic Psychology courses offered at the Faculty of Transport and Traffic Engineering. The sample consists of 56% of women and 44% of men. The average age of the respondents is 24.5.

Measures

Questionnaire on adoption of RFID systems and subcutaneous microchips were used. The students' attitudes towards various aspects of RFID-SM usage were investigated. The questionnaire items were proposed based on the literature review, relying primarily on extended Technology Acceptance Model (TAM). In addition to the three original components of TAM (Perceived Usefulness, Perceived Ease of Use, and Behavioral Intentions to Use), two external variables (Health Concerns and Perceived Trust) were also included. PU (Perceived Usefulness) has seven items which are in accordance with items proposed by [46] in the original TAM model. Five of them were adopted from [1], and two additional items on storing information about organ donation and a general statement on saving lives in different medical conditions were added from [47].

PEU (Perceived Ease of Use) and PT (Perceived Trust) items were adopted based on [48] and [49], respectively. PT (Perceived Trust) refers to an individual's trust that the state, banks and healthcare systems will be able to ensure security and protection of human rights in the fields of identification, tracking and archiving of personal data, financial transactions, and patient data on treatments and organ donation. Items composing HC (Health Concern) construct which possible threats of RFID-SM usage were found based on extensive literature review of medical research papers [46,50,51]. The component HC refers to four possible threats of RFID-SM usage: the possibility of movement in the body, effect on emotional behavior, health threats due to possible allergies, and health threats because of impacts on the nervous system. The items of output variable BIU (Behavioral Intentions to Use) are adapted from [45]. BIU reflects four different possible types of the RFID-SM usage (healthcare purposes, for identification purposes, for shopping and payment, and for everyday home usage). BIU items were measured as dichotomous variables. Furthermore, manifest variable PP (Painful Procedure) was included.

Items of HC, PT, and PEU, as well as the last item of PU, were measured on a 5-point Likert-type scale

of agreement ("strongly disagree" to "strongly agree"), while the first six items of PU were measured on a 5-point scale of acceptability ("very bad idea" to "very good idea"), while the items of BIU were measured as dichotomous variable (yes/no).

4. RESULTS

Descriptive statistics were calculated for 23 measured items as well as for five dimensions. The means of items are measured on the 5-point scale ranged from 1.72 to 5.00. Standard deviations of all items are in the range from 0.32 to 1.68, indicating a fairly narrow spread of scores around the means. The means of three components are 4.2 for PU, 4.58 for PEU, and 4.88 for PP, which indicate that although the majority of respondents considered the implantation procedure to be very painful (Fig. 2), their estimates for perceived usefulness and perceived ease of use were very high, in other words, they rated RFID microchips usage as effortless and enhancing. The mean of HC is equal to 3.21, which indicates that the respondents are not quite sure if the consequences of microchips usage could have harmful effects on their health. The mean of PT is equal to 2.83, which indicates that the average perceived trust on security issues assured by state, banks, and healthcare system is rather low (Fig. 3).

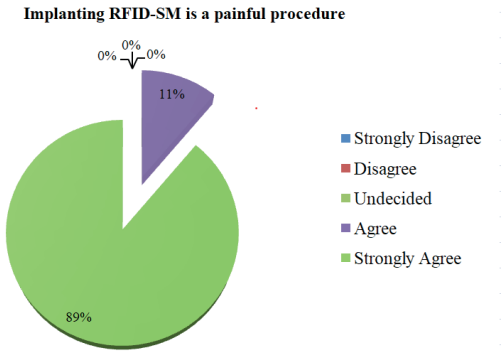


Fig. 2. Attitude toward implantation procedure

On average, respondents agree mostly with the statement that subcutaneous microchips cannot be stolen (high-security protection). Also, they are convinced that subcutaneous microchips have very high life-saving potential (M = 4.89). Likewise, they show a high degree of agreement with the statement that subcutaneous microchips can integrate multiple functions at the same time, as well as for storing medical information for accident or emergency situations (M = 4.78, for both statements). Students highly rated the feature that microchips are always available (M = 4.61). The features of monitoring the health of the user (M = 4.55) and for warning about potential health problems or complications (M = 4.27) received high ratings, too.

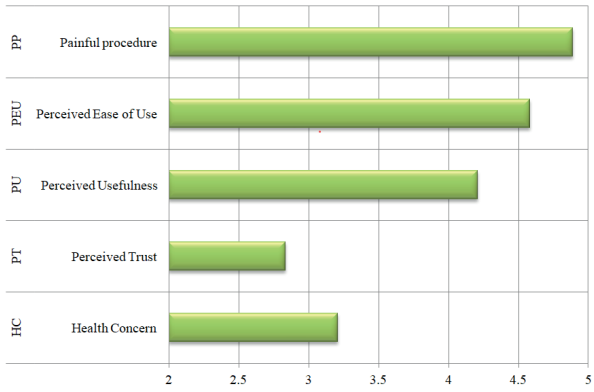


Fig. 3. Readiness to adopt RFID subcutaneous microchip

If we examine the four items of HC closely, we can see that respondents are worried due to treats of possible allergies (M = 3.78), and an impact on emotional behavior (M = 3.27). On the other hand, they are less concerned due to possibility of microchip movements in their bodies (M = 2.94) and with respect to the effects on the nervous system (M = 2.78). The respondents declare that they do not trust that the banks (M = 1.72), the state (M = 3.00) and healthcare system (M = 3.78) can provide the appropriate level of safety and security related to RFID-SM usage (Fig. 1). Obviously, the banks deserve the lowest level of trust among the respondents. When it comes to individual's intention of the RFID usage and a willingness to adopt the RFID microchip implants, the highest proportion of the respondents would primarily consider using the RFID-SM for healthcare purposes (56%), rather than for personal identification (33%).

If they could be assured that Global Positioning System (GPS) and tracking were not possible 37% would be ready to use RFID microchip implants. What is very interesting and surprising is that none of the respondents would use microchip implants for everyday home tasks (unlocking house or apartment, car, computer, mobile phone, etc.) (Table I).

Table 1. Behavioral Intentions to Use RFID subcutaneous microchip

Would you insert a subcutaneous microchip:	YES	NO
for healthcare purposes (identification, storage of medical data, information on organ donation, etc.)?	56	44
for identification purposes (ID card, passport, driving licence, etc.)?	33	67
for everyday home usage (unlocking house or apartment, car, computer, mobile phone, etc.)?	0	100
if you were assured that GPS positioning and tracking were not possible?	37	63

5. DISCUSSION AND CONCLUSIONS

The aim of the study was to research the attitudes of potential RFID-SM users. Nevertheless, concerns among potential users about privacy issues, personal data security, and implants' impact on health are evident. Our study indicates that a lack of trust presents a significant obstacle for adoption. Obviously, more research must be done to prove the reliability and harmlessness of RFIDSM and its technical possibilities.

This article presents preliminary and partial results of the survey conducted in Serbia, therefore, further research needs to include the results of the surveys gathered in other European countries to establish whether similarities in the attitudes toward RFID-SM adoption exists.

Currently, the only comparison can be done with the findings of the [23,47]. While similar values were obtained for HC and PT dimensions, the PEU and PU dimensions in our sample show much higher mean values. These differences can be attributed to age differences between the two samples. Thus, the sample that includes only undergraduate students limits the generalization of the study. However, a student sample is the appropriate context because students represent an important segment of future users. The new research design should take special care to include more representative sample of older people, who have no internet access or experience with new technologies.

According to [52,53] TAM has proven to be a useful theoretical model in helping to understand and explain usage behavior in technology acceptance.

Though, limitations of research that rely on TAM to date still remain the involvement of students and self-reports. They revealed that although TAM is useful, it has to be integrated into a broader model which would include variables related to both human and social change processes.

Nowadays, there are various technologies which can be used by any individual without having any technology competence. Although these devices minimize technology competencies, the variables predicting acceptance of people for using these devices may also show variety. In the future, technology will continue to change and as users we will also continue to adapt ourselves and learn how to cope with the new features of upcoming technologies. During this process, investigating personal variables that affect this adaptation process will be still important. Therefore, the study of technological innovation acceptance requires psychological models and theories to explain and rationalize whether users benefit from new devices [29].

The instrument used in the current research to assess students' opinions is based on the self reported design. Another opportunity for future work is to extend the survey to address objective measures of actual system usage.

There is ample concern, even among engineers, that the RFID chip's unique numerical code, though encrypted, may be discovered or copied, placing the owner at risk of identity theft, which could result in the fabricated identity being almost undetectable [24]. Uberveillance (or the omnipresent surveillance) can be, to a certain extent, circumvented with the development of specified social, legal and engineering advances.

As Li [55] suggests in order to utilize the full advantages of RFID and at the same time to keep the threats as small as possible, it will be a matter of implementing the principles of modern data protection laws, data economy and the most rapid possible anonymization of personal referenced data in RFID systems early in the design process and in market introduction.

ACKNOWLEDGMENT

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USE OF SOCIAL MEDIA IN COMMUNICATION STRATEGIES OF PREMIER LEAGUE FOOTBALL CLUBS

Maja Obradović[1,*],
Slavko Alčaković[1],
Daria Vyugina[2],
Sandra Tasevski[1]

[1]Singidunum University,
Belgrade, Serbia
[2]Lomonosov Moscow State University,
Moscow, Russia

Abstract:
Development of internet and new technologies leads to big changes in communications. Every sport organization is in search for the most efficient communication channel. In order to find the most efficient communication channel with the lowest cost, sport organizations have recognized the importance of social media networks in communication strategies. Being that social media networks can be considered as a source of information for customers, this article considers social media networks as one of the main tools used in sports branding and communication strategies due to its communicative, broadcasting, organizational and interactive potential. As a network with the higher number of active users, Facebook was the main network which has been analyzed. Using the example of Premier League football clubs, the authors analyzed the content of the most popular official Facebook pages dedicated to the English football clubs and tries to identify the key conditions for successful social media campaign. Results show that the top Premier League clubs are usually using four content formats combined with nine content types.

Keywords:
sports social media, digital consumption, sports branding, communication strategies in sports.

1. INTRODUCTION

In the world where there are 3.5 billion football fans -EU, Africa, Asia, America [1] one professional league stands out. The Premier league (UK football league) with projected revenue of 4.5 billion pounds in 2017-2018 season [2] marks the number one sport in professional football. None of the football clubs or organizations involved in the business of sport can forget the fundamental aim of every sport marketing activity: "satisfaction of every right consumer need with sports product or services that offer benefits better than all other competitors whilst making the maximum profit. [3].

A sport brand is no longer just a name or a symbol, colour, but a product of communication between the producer and the consumer, in the images, values and other characteristics that the audience of the stakeholders sees behind the brand. The image component of the brand allows to form the necessary projection of these values as a recognizable, value aspect of the brand in the mass consciousness.

Correspondence:
Maja Obradović

e-mail:
mobradovic@singidunum.ac.rs

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To reach sport fans, marketers are focusing their efforts on anything that brings them closer to the action and discussion. Sport organizations have been searching for more efficient channels to reach consumers with the lowest possible cost and the highest possible efficiency. [4] For industry of that size, challenge is to build a strong relation with every sport fan.

There are some main ideas that might support the communication strategy of any sports club brand in the digital world [5]. First of all, any sport brand seeking success should create newsbreak and interesting stories, provide the audience with a dramatic act, provoke emotional empathy, and make them participate in the main events. Secondly, it is important to involve new sponsorship in the process, educate the loyalty of the sponsors, and create an associative relationship between brands to make beneficial profit on the sports events. Also, due to the development of the digital technologies it becomes easier to organize and enlighten media and social projects, and control feedback of the audience, as far as interact with it actively.

A sport business needs to communicate with its customers (fans) in order to ensure that existing (and new) customers are aware of the sport, team or player, hold positive attitudes, have extensive and appropriate knowledge of the sport offering, and provide a source of revenue. [3] One of the best ways for the companies or sport organizations to meet their relationship marketing goals is using the benefits of the social media [6]. Social media is being used more frequently by sports organizations and athletes as a tool for communication. It allows consumers to interact on several levels. It permits interaction from consumers to consumers (between fans) and consumers to organizations. These interactions can develop into consumer experience. Social media could be seen as initial interaction with the purpose of transforming into a strong relationship.

Today, sport organizations are realizing the benefits of social media and they are seeking ways to most effectively use them as part of their overall marketing, communication, and brand-management strategies. [7] According to [8] there are many dimensions to relationship marketing, however social media provides the opportunity to focus on two out of three core components: communication and interaction. For those two purposes, most marketers recommend the most used social media platforms - Facebook, Instagram, Twitter. Facebook as the biggest media platform with over 2 billion monthly active users [9] will be the main focus of this article.

Most of the football clubs have recognized efficiency of social networks in communication strategies. Kuzma, Bell and Logue compared communication strategies of European football in four leagues. Overall, the research statistics showed that most teams do have some social media presence. In terms of official presence, Twitter was the surprise social network to have the widest spread usage, as every team bar one used it to communicate with fans. Facebook usage was also good, but there were four teams in the European leagues that did not have an official Facebook page. [10]

The media consumers are no longer passive users; their interaction with the information and content is quite active due to the newest technologies and access to the digital media gadgets. Due to opportunities of the multimedia technologies brand consumers can influence content, ad campaigns and events. Social media websites in this case can be introduced as the main instruments successful interaction. In addition, the establishment of a dialogue with the public is driven through the social media profile to explain its position on various sports, financial and legal issues. [11]

For sport fans, two screen experience has become crucial for their engagement, with the 76% of fans who watched sports on one screen, had the second screen active [12] allowing them to have a stronger relationship with their sports organizations. A second screen is a second electronic device used by television viewers to connect to a program they're watching. The thing about second screen is to make TV more interactive for viewers and create buzz on social media about program/event. [13] Mostly, second screen is the mobile screen. According to SecondSync, fully 60% of the interactions around primetime programming take place during the broadcast. This is especially true of new status updates, or Posts, which tend to cluster within the live window. Reactions to those posts, such as likes and comments, have a longer tail. In aggregate, for the 10 different broadcasts included in the SecondSync study, Facebook users produced 9.9 million relevant posts and comments versus 5.1 million tweets. [14]

Facebook is an online social network launched in 2004. According to Statista, in the third quarter of 2017, Facebook had 2.07 billion monthly active users. [15] Mission of the Facebook is "bringing the world closer together" [16] The goal of the network is to connect and share information. Past research has shown that Facebook is used to provide information, post pictures and videos and promote upcoming events. Facebook's mission is to give a people the power to build a community

and to connect and bring together people from different parts of the world in one place. By using Facebook, football clubs are attempting to take advantage of its capabilities, by keeping consumers aware and connected to the brand.

Current literature shows that there is no specific number of posts per day which will bring the best results. That depends of characteristics of fans/followers on Facebook. According to Social Bakers and their research, there is no exact ideal number, but there is a range. Typically, if you post fewer than 2 posts a week, you will not engage your audience enough for them to maintain a social connection with you, and you will lose engagement. If you post more than 2 per day (as a brand) you will typically lose engagement. [17] Additional research by Track Social says that when a brand posts twice a day, those posts only receive 57% of the likes and 78% of the comments per post. The drop-off continues as more posts are made in the day. [18]

Marketers agree that frequency of posting, time of posting and content itself are the most important elements of good communication strategy and interaction on social media.

The significance of this study is finding the right type of content which has ability to engage sport fans through social media.

2. METHODOLOGY

In order to answer which content has most success in communication strategies, conducted research analyzed Premier League clubs and their online communication channels. The research included monitoring of Facebook profiles of Premier League football clubs. Data was analyzed in April 2017, including weekends when clubs were the most active on social networks. Observation included analysis of twenty clubs of Premier League and identified five clubs with the higher number of fans. All data were collected from official Facebook profiles.

Research and results were divided in three categories: Type of content, Content format and Frequency of posting on Facebook.

Content is a compilation of information, ideas, and messages that are translated into some kind of written, visual, or audible format for others to consume. [19] Type of content defines a category of published posts and what are posts about. Usually posts are published in link, photo or video format. Frequency of posting is showing a number of posts which are published in some period of time.

3. RESULTS AND DISCUSSION

Results of conducted research are showing a way of using social media as a marketing tool in sport industry through the type of content which has been posted and has engaged the most fans.

Table 1. Number of Facebook fans - top 5 premier league clubs

No	Team	Facebook
1	Manchester United	73.018.132
2	Chelsea	47.789.562
3	Arsenal	37.854.441
4	Liverpool	29.751.065
5	Manchester City	23.656.473

According to Table 1, from data which has been collected from official football club profiles on social networks, Manchester United, Chelsea and Arsenal are clubs with the higher number of likes/ fans on Facebook.

First category which has been analyzed was content. In the period of observation, entire content which has been posted was sorted in nine categories. Categories were formed to give a complete insight in online communication strategies of football clubs with their fans. Categories were formed depending on what they are talking about- is it about game, interesting information or promotion activities and sponsorship which is not directly connected with football.

Content which has been posted was analyzed and grouped in nine categories:

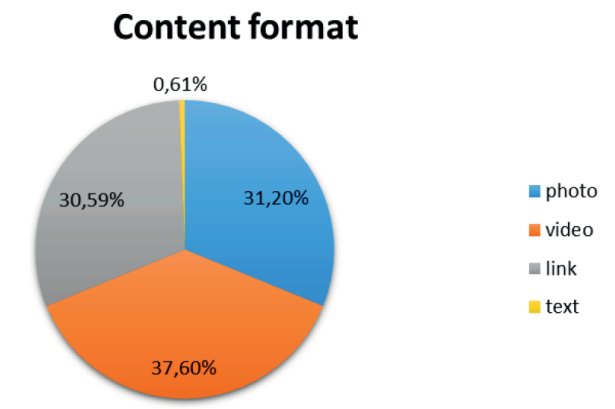
1. Game announcements
2. About game (new/live info)- team members on field, changes and injuries, scored goals
3. The best moments (from the game)- the most attractive moves, goals, score
4. Players and coach announcements/ interviews
5. Behind the scene- players on training, arrivals to stadium, hanging out and stories from the locker room
6. Interesting facts/info about players and club- past event reminders in history of club, player birthdays and interesting statistics
7. Fan support- arrivals to stadium and cheer/support
8. Promotion activities which are not directly connected with football- charity events and ceremony
9. Sponsors and partner promotions

According to Table 2. Manchester United gives the most attention to content categorized as Game announcement and Players and coach announcements/ interviews. These two categories together make about 50% of all Facebook posts in period of observation. Type of content with the lowest percentage in all Facebook posts categories are Sponsors and partner promotions and Promotion activities which are not directly connected with football. Chelsea has no posts from the last-mentioned categories.

Announcements which are directly connected to game- live info, the best moments and game announcements are necessarily/ required part of communication strategies for all clubs and they make a 1/3 of all posts. On the other side, on the day when there is no game on, posts like. Behind the scene and Players & coach announcements/ interviews had a lead role.

Interesting is that even the game is the main attraction of clubs, only 1/3 announcements are directly connected with them, and even 50% or over 60% of posts are related to atmosphere, club activities and they don't need to necessarily be connected to the game. This could be explained with the fact that the games are playing only once or twice a week but clubs are interested in everyday communication and interaction with their fans.

In addition to everything mentioned above also it should pay attention to format of content. Content was categorized in four types- photo, video, link and text.

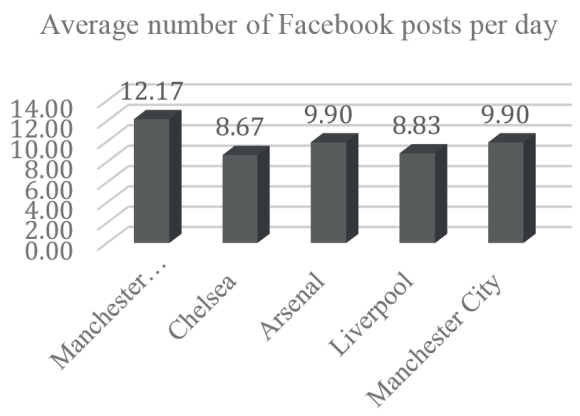


Graph 1. Content format posted on Facebook

According to research results, video is taking lead as type of content format with almost 38%. Posts with photo and link are almost equally distributed (around 31%). Link means any post with link which redirect to another web page. Most often, that redirect leads consumer directly to official football club website. This can be interpreted as an attempt of clubs to increase number of unique visits to the official site, which includes links to their online stores, as well as links to sponsors.

Table 2. Facebook content analysis

Content type/category	Manchester United	Chelsea	Arsenal	Liverpool	Manchester City
Game announcements	20,71%	8,70%	6,86%	11,28%	15,79%
About game (new/live info)	8,08%	10,14%	5,88%	6,77%	7,89%
The best moments (from the game)	8,59%	5,80%	13,73%	12,03%	10,53%
Players and coach announcements/ interviews	29,29%	23,19%	29,41%	28,57%	19,30%
Behind the scene	6,57%	11,59%	7,84%	8,27%	9,65%
Interesting facts/info about players and club	19,19%	39,13%	29,41%	24,06%	29,82%
Fan support	1,52%	1,45%	1,96%	3,76%	4,39%
Promotion activities which are not directly connected with football	4,04%	0%	0,98%	2,26%	0,88%
Sponsors and partner promotions	2,02%	0%	3,92%	3,01%	1,75%



Graph 2. Review of the average number of published Facebook posts per day

Graph 1 shows the average number of Facebook posts per day in observed period for top five clubs. Manchester United has around 12, 17 posts, Manchester city and Arsenal has almost equal number of posts (9,90), and Chelsea and Liverpool have no posts so often (8,67). Analyzed Facebook pages of football clubs are popular and followed from people all over the world, so they have published posts in different time of day, according to different time zones of fans.

4. CONCLUSION

Social media might be effectively used in communication strategies and developing of the sports brands due to several reasons that were indicated in this article. Multimedia content makes the experience of the audience more diversified and complete; as one of the main informational sources for all the media consumers today, it creates the sports agenda. Also, it opens up new ways to reach new sponsors that might not be found in the "offline"; and becomes the easiest and the fastest way to interact with the audience, to deliver content personally.

The paper presented analysis of Facebook pages and content which has been posted on official profiles of Premier League clubs. After the conducted research and interpreted results authors come to conclusion that a carefully created communication strategy is very important when it comes to communication with followers / fans on social networks.

The most popular social media network among the researched is Manchester United Facebook page. It happens due to several facts that are not caused by the historical popularity of this football club. Its online success depends on the highest number of posts created and published every day, the type and variety of content, mostly dedicated to the club, its games, players and coaches - a kind of closer look at the team, its everyday life and history that creates the uniqueness of this club as a famous sports brand.

As a result, according to the previous research, the most important managerial implication suggests that number of fans (i.e., brand reach) is the most important social media indicator because it is correlated with several other indicators (i.e., brand growth and engagement). Therefore, leading brands in sports industry should as their primary goal strive towards maximizing fan base. [4].

Also, when it comes to frequency of communicating with fans through the social media networks, clubs need to have in mind that they need to continue with everyday interaction. Crucial is to communicate continuously, every day, not just on days when club is playing a game. Social media profiles created by clubs should be the source of information for fans about events important for club. Also, it need to be considered that content needs to be focused on game results, success of the team, but also on players individually, the history of the team and interesting facts about club and team- as a content with the higher interaction (according to research).

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ISAM INTEGRACIJA SA FACEBOOK PLATFORMOM KAO PROVAJDEROM IDENTITETA PREKO OPENID CONNECT PROTOKOLA

Bojan Bucalo*,
Jovana Samardžija,
Saša Adamović

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

IBM Security Access Manager (*ISAM*) je *web access* rešenje koje omogućava autentifikaciju, autorizaciju, upravljanje sigurnošću kao i centralizaciju resursa. *IBM Security Access Manager* poseduje modul federacije kako bi saradničke kompanije mogle da pruže međusobno siguran pristup različitim aplikacijama. Korišćenjem federacije, dobija se sigurna, bešavna prijava stranoj aplikaciji, čime se izbegava potreba za višestrukim korisničkim nalozima. Po definiciji, federacija je veza u kojoj obe strane prihvataju korišćenje istog tehničkog standarda pri tom omogućavajući obostrani pristup resursima i podacima. Sastoji se od više provajdera servisa kao i od jednog provajdera identiteta. *Facebook platforma* kao jedan od najvećih provajdera identitetima na svetu je kompatibilna i omogućava vezu, odnosno poverenje prema ISAM rešenju.

Ključne reči:

Web Access, ISAM, Federacija, Facebook platforma, OAuth 2.0, OpenID Connect.

1. IBM SECURITY ACCESS MANAGER

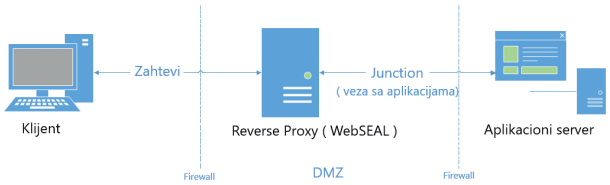
IBM Security Access Manager (ISAM) je *web access* rešenje koje pomaže da se pojednostavi pristup korisnika dok se bezbednije usvajaju *web*, *IOT (Internet Of Things)* i *cloud* tehnologije. Usled svoje fleksibilnosti može se koristiti u lokalnom, virtuelnom i hardverskom okruženju ili se pak može koristiti i u kontejnerima sa *Docker* platforme. *ISAM* pomaže da uspostavimo ravnotežu između upotrebljivosti i bezbednosti kroz korišćenje pristupa zasnovanog na jednostrukoj prijavi, riziku, integrisane kontrole pristupa, federacije identiteta kao i mobilne više faktorske autentifikacije.

Uspostavljanje upravljanja i kontrole sa *IBM SAM* rešenjem i njegov proces bi slikovito izgledao ovako:

Odgovorno lice:
Bojan Bucalo

e-pošta:
bojan.bucalo.15@singimail.rs

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Slika 1. ISAM arhitektura

2. FEDERACIJA

Federacija kao veza u kojoj obe strane prihvataju korišćenje istog tehničkog standarda pri tom omogućavajući obostrani pristup resursima i podacima takođe pruža mogućnost korišćenja mnogih funkcija kao što su: [1]

- *Federated single sign-on (SSO)* za korisnike višestrukih aplikacija
- Podrška za SAML 2.0, WS-Federacija *(Web Service Federation)*, kao i OAuth 2.0 odnosno *OpenID Connect* protokol za pristup putem federacije
- Prethodno integrisana rešenja federacije putem konektora za popularne *cloud* aplikacije

Federacija je grupa mrežnih ili računarskih provajdera koji se dogovaraju o standardima rada uz obostranu korist. Termin se može koristiti za opisivanje međusobnog funkcionisanja dve različite, formalno nepovezane, telekomunikacione mreže koje mogu imati različite unutrašnje strukture. Da bi dve strane bile u federaciji neophodno je da komunikacija između dveju mreža bude moguća i stabilna.

3. OAUTH 2.0

OAuth2.0 je protokol industrijskog standarda za autorizaciju. Nasledio je i u potpunosti zamenio svog prethodnika koji je nastao 2006. godine. Prvi put se pojavio kao verzija OAuth1.0 2006. godine kada je rađen kao OpenID rešenje za *Twitter*. Nakon nekoliko godina prvi put je i objavljen kao standard 2010. godine da bi samo dve godine kasnije objavljena i verzija OAuth2.0.

OAuth2.0 je poseban po svojim specifičnim procesom autorizacije za veb aplikacije kao i desktop, mobilne pa čak i *IOT* uređaje.[2] Koristi se kao način da se korisnicima interneta omogući pristup veb stranicama odnosno njihovim veb aplikacijama kao i informacijama sa sistema bez delegiranja lozinke. Velike kompanije kao što su *Facebook, Amazon, Google, Twitter, Microsoft* kako bi proširili mogućnosti svojim korisnicima da pomoću svojih naloga pristupaju stranim aplikacijama (aplikacijama koje nisu vezane za njihove servise) su ga uvrstile kao svoju uslugu. Zasnovan je na SOAP odnosno REST protokolu razmene poruka. Predstavljanje toka informacija u jednom OAuth procesu bi izgledalo ovako.

Komunikacija između klijenta i autorizacionog servera:

Traži dozvolu

- K=>AS “Ćao, treba mi pristup tvojoj aplikaciji ” (Autorizacioni zahtev) PK

Traži identifikaciju (korisničko ime i lozinku) i šalje nekakav izazov (npr. otp,…)

- AS=>K “Predstavi se, ko si ti ?” (Autorizacija, Dozvoljeno) PK

Identifikuje se i rešava izazov i dostavlja ga AS

- K=>AS “Ja sam k.i.:client lozi:client, evo otp (Autorizacija, Dozvoljeno) ZK

Obezbeđuje *access token*

- AS=>K “OK, možeš pristupiti aplikaciji” (*Access Token*) ZK

Koristi *token* da pi pristupio resursu

- K=>RS “Pita za korišćenje resursa” (*Access Token*) PK

Identifikuj *token* i dozvoli korišćenje resursa

- RS=>K “Vraća resurs” (Zaštićeni resursi) PK

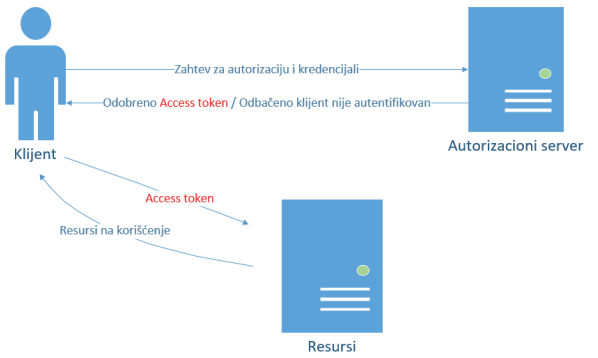
K = Klijent

AS = Autorizacijoni Server

ZK= Zadnji kanal

PK= Prednji kanal

Dva kanala se koriste da bi se povećala sigurnost. Grafički prikazano to bi izgledalo ovako:



Slika 2. Proces OAuth protokola

4. SOAP I REST PROTOKOL

SOAP je protokol koji u sebi sadrži niz važnih pravila i uz pomoć njih postiže nivo standardizacije, dok za razliku od njega REST protokol ima složeniju arhitekturu i fleksibilniji je po tom pitanju. Ujedno SOAP i REST imaju dobro predefinisana pravila koja im omogućavaju uspešnu razmenu informacija. Kada nekad u životu postavimo sebi pitanje: "Kako da pristupimo veb servisima?" odgovor bi bio prost korišćenjem Simple Object Access Protocol (SOAP) ili pak korišćenjem Representational State Transfer (REST).

Upoređivanje SOAP sa REST protokolom

Prednosti SOAP protokola:

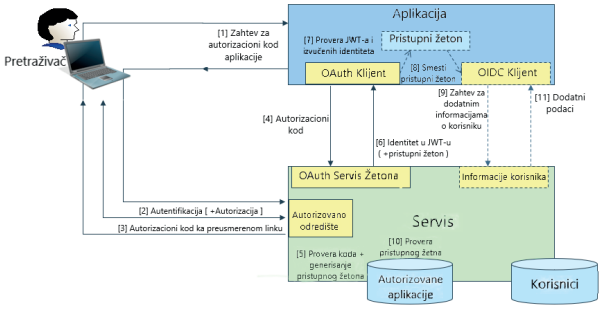
- Nezavisnost jezika, platforme i transporta (REST zahteva upotrebu HTTP-a)
- Dobro funkcioniše u distribuiranim poslovnim okruženjima (ko REST-a se pretpostavlja direktna komunikacija od tačke do tačke)
- Standardizovan
- Ugrađeno rukovanje greškama
- Kada se koristi sa specifičnim jezičnim proizvodima postoji automatizacija

Prednosti REST protokola:

- Nisu potrebni skupi alati za interakciju sa veb uslugama
- Jednostavniji je za korišćenje samim tim se i brže uči
- Efikasnost (SOAP zahteva upotrebu XML za sve poruke, dok REST može da koristi i poruke u manjim formatima)
- Brzina (nema zahtevnih obrada)
- Izuzetno blizu veb tehnologijama u filozofiji dizajna

5. OPENID CONNECT

OpenID Connect je protokol koji u svojoj osnovi zasnovan na OAuth 2.0 protokolu s tim što je dodato par modifikacija odnosno novina. Glavna novina jeste ta da je na postojeći OAuth protokol dodat takozvani *identity layer* ili drugačije rečeno omogućeno je da klijenti verifikuju identitet krajnjeg korisnika na osnovu autentifikacije izvršene od strane autorizacionog servera kao i da dobiju osnovne informacije o krajnjem korisniku i sve to zasnovano na REST protokolu. Ako ste upoznati sa SAML protokolom, OpenID Connect struktura je izuzetno slična osim što OpenID Connect koristi REST odnosno JSON format dok SAML protokol koristi isključivo XML tip poruke.



Slika 3. Proces OpenID Connect protokola [3]

6. FACEBOOK

Facebook je društvena mreža nastala 2004. godine koja svojim korisnicima iz godine u godinu pruža sve više usluga i mogućnosti, pa tako i servise *Facebook* platforma i *Facebook Connect* koje će nama poslužiti za ovaj slučaj.

Facebook platforma

Facebook platforma je platforma društvene mreže *Facebook* koja pruža skup usluga, servisa, alata i proizvoda kao spoljno lice programerima koji za svoje aplikacije žele da pristupaju *Facebook* podacima. Nastala je 2010. godine, i do sad se razvila toliko da pruža programerima širok asortiman interfejsa i alata za olakšan rad. Neki od tih alata su "social graph", "Log In with Facebook", … Iz pogleda programera *Facebook* platforma se ponaša kao treće lice od poverenja, koje omogućava dodatne opcije i olakšice. Ovaj princip je jako koristan i programeri se često odlučuju za njega pogotovo oni koji se bave veb programiranjem. Povezivanjem svoje veb aplikacije sa *Facebook* platformom omogućuju svojim korisnicima prijavu na njihov sajt bez pravljenja dodatnog naloga, jedino što treba da imaju je *Facebook* nalog i moći će da pristupe toj aplikaciji.[4]

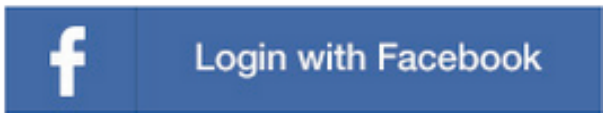
Facebook Connect

Facebook Connect još poznatiji i kao *Log in with Facebook* je skup *API*-ja koji za programere pružaju

uslugu autentifikacije sa *Facebook*-om i da njihovi korisnici mogu da se povežu i podele sa *Facebook* prijateljima. Kao takav *Facebook Connect* pruža da *Facebook* korisnici mogu da se prijave na spoljne veb aplikacije, aplikacija, mobilnih uređaja i sistema i ujedno svoje bitisanje na istim mogu ažurirati odnosno objavljivati na svojim *Facebook* profilima, deliti sa svojim prijateljima kao i pratiti statistike svojih aktivnosti.[5]

7. INTEGRACIJA FACEBOOK-A SA ISAM REŠENJEM

IBM Security Access Manager kao samostalni proizvod može da vrši usluge provajdera identitetima i u standardnim okruženjima to i radi. Međutim u velikom broju okruženja i platformi klijenti prilikom zahteva za ISAM rešenje koji će da štiti njihove aplikacije, traže da provajder identiteta bude neki spoljašnji provajder (*third-party provider*). Najčešće su to *Google, Facebook, Outlook, Linked In*, … U našem slučaju imamo neku javno dostupnu stranu koja je socijalnog karaktera tako da nam je najpovoljnija opcija bila da taj spoljašnji provajder identiteta bude baš *Facebook*. Sigurno ste negde videli ovaj vid obezbeđivanja identiteta za prijavu.



Slika 4. Dugme za korišćenje Facebook-a kao provajdera [6]

Ljudi se često odlučuju prilikom svoje prijave na veb stranice da im Facebook bude provajder naloga jer nemaju vremena da naprave nalog baš za tu stranicu i posao koji žele da obave na toj stranici ne istiskuje toliko vremena ili jednostavno žele trenutno korišćenje te veb stranice i ne žele da prave trajne naloge a kad već imaju Facebook nalog to im dođe kao odličan izbor koji radije koriste. Takođe u poslovnom okruženju ponekad je lakše da korisnik pristupi nekom veb servisu preko spoljašnjeg naloga, naročito ako je u tom okruženju na određeno vreme i nema potrebe da se zavodi u internu bazu firme koja iznajmljuje njegove usluge, pogotovo ako rešenje kao što je ISAM koje zavodi svaki vid autentifikacije koji prođe ili pokuša da prođe do servisa. S obzirom da je ISAM dobio unapređenje i od verzije ISAM 9.0.4.0 postupak konfiguracije opcije *relying party* koja omogućava da usled federacije ISAM-a sa drugim provajderom identiteta razgraniči uloge u toj istoj federaciji, odnosno ko će da bude provajder identiteta a ko strana koja će da pruža usluge. Postupak konfiguracije nakon nadogradnje je svrstan u par koraka:

- Preduslovi
- *"Relying party"* federacija
- Mapiranje atributa
- Usklađivanje *Facebook Connect* – ISAM
- Otkrivanje federacije *reverse Proxy*-ju

Preduslovi

Pre bilo kakve integracije neophodno je pripremiti ISAM okruženje. Tačnije neophodno je da imamo standardno ISAM okruženje koje podrazumeva:

- Instaliranu verziju ISAM rešenja koja je verzije ISAM 9.0.4.0 ili novije
- Na ISAM okruženju konfigurisan *WebSEAL reverse Proxy* sa osnovnim podešavanjima i
- Aktivan federacioni modul u okviru ISAM okruženja

"Relying party" federacija

Nakon što smo obezbedili sve preduslove za ovu integraciju krenućemo na konfigurisanje federacije odnosno modula u ISAM okruženju koji će nam omogućiti ovu integraciju ISAM rešenja sa *Facebook* platformom. Potrebno je napraviti federaciju koja će imati protokol *OpenID Connect Relying Party*. Takođe je neophodno da kažemo prilikom autorizacije odnosno procesa OpenID Connect protokola kome će se obraćati klijent za autorizaciju odnosno da kažemo da će ISAM sa svojim internim protokolom vršiti autorizaciju. Uz to je za početak neophodno i definisati kakav će povratni zahtev biti kao i na koji način će se mapiranje atributa izvršiti.

Mapiranje atributa

Što se mapiranja atributa tiče generalno za ISAM okruženje, prilikom bilo kakve veze odnosno integracije, mapiranje atributa se vrši uz pomoć takozvanih pravila mapiranja (*mapping rule*). Čemu služe? Pravila mapiranja služe da kažemo ISAM okruženju koje atribute treba da očekuje, odnosno koji atributi sa strane ISAM-ovog skladišta korisnika odgovaraju atributima aplikacije sa kojom se vrši integracija. Recimo u aplikaciji kao što je

Facebook polje „korisničko ime" se vodi kao "*username*" a u ISAM okruženju odnosno njegovom skladištu korisnika isto to polje se zavodi kao "uid". Tako da je neophodno da mi prilikom veze ISAM-a i *Facebook* aplikacije kažemo preko pravila mapiranja da atribut "uid" iz ISAM-a ustvari odgovara atributu "username" iz *Facebook* aplikacije.

Usklađivanje Facebook Connect – ISAM

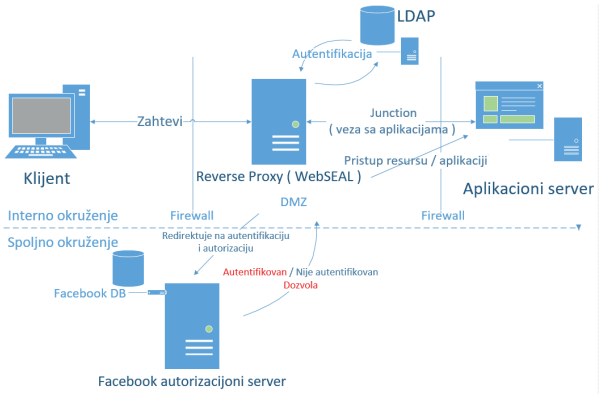
Usklađivanje dva sistema, dve aplikacije, platforme kada pričamo o federaciji, odnosi se na način na koji će ta dva okruženja da se upoznaju, odnosno steknu uzajamno poverenje. Kada pričamo o ISAM rešenju i sa strane samog ISAM-a da bi se steklo uzajamno poverenje sa drugom veb aplikacijom neophodno je da se ispune dva uslova:

- Da ISAM sadrži SSL sertifikate o postojećoj veb aplikaciji ako je zahtevana sigurna veza između ISAM-a i te veb aplikacije i
- Da se federaciji samim tim i ISAM-u proslede takozvani „kredencijali klijenta" koji zapravo predstavljaju identifikaciju klijent aplikacije na internetu.

Otkrivanje federacije reverse Proxy-ju

Nakon što smo završili i imamo do kraja, pravilno konfigurisanu federaciju neophodno je da se takva federacija upozna, odnosno kaže "reverse Proxy-ju" da u nju ima puno poverenje. Nakon tog koraka imamo sigurnu federaciju ISAM-a sa nekom veb aplikacijom u kome će ISAM kao takav pružati dodatnu mogućnost pored zaštite aplikacije i omogućavanja pristupa svojim internim korisnicima, omogućavati i siguran pristup spoljašnjih korisnika putem svojih *Facebook* naloga.

Usled ovako podešenog okruženja, dobili smo jedan siguran i poverljiv sistem zaštite sa mogućnošću proširenja opsega korisnika. U glavnini, proces tog okruženja bi izgledao ovako.



Slika 5. Proces federacije ISAM-a sa Facebook-om

8. ZAKLJUČAK

Ako pričamo o nekom poslovnom okruženju, firme uglavnom žele da veliki deo informacija koje protiču kroz nju budu tajna, samim tim ovakav vid integracije im baš i ne odgovara i uvek gledaju kako bi tako neki pristup učinili internim i zatvorenim. Ali pošto živimo u dinamičnom okruženju i tržište se jako brzo menja i raste kao i to da je zahtevnije i očekuje kvalitetnu uslugu za kratak period, nastala su ovakva okruženja i samo postojanje federacije kao procesa integracije je tu da olakša proširenje i ubrza pristup željenim informacijama i uslugama. Svakako ćemo se složiti da ubacivanje treće strane od poverenja nije najsrećnije rešenje i u velikom broju slučajeva se izbegava ali uslovi kao što su ovi zahtevaju ovakav vid integracije. IBM kao korporacija stoji iza svog proizvoda i garantuje sigurnost i integritet samog SAM proizvoda kao i u spoljnu, proširenu(*federated*) verziju istog. Ovaj vid usluge je pogodan za ovakva okruženja de je potrebno izvršiti kratkoročnu ili trenutnu uslugu. Takođe sa druge strane imamo *Facebook* kao jednu veliku i pouzdanu korporaciju sa preko 2.3 milijarde aktivnih korisnika koja pruža kvalitetnu uslugu na jako zavidnom nivou. Ovakav vid federacije i rešenja bi mogao da ima veliku primenu u nekim internim sistemima u pogledu rasterećivanja sopstvenih sistema, možda čak i širenja firmi i korisnika u različitim delovima sveta. Na taj način bi moglo da se izvrši sigurno spajanje i razmena informacija nevezano od mesta grananja i rasta poslovanja.

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LIČNO APLIKATIVNO REŠENJE ZA IŠČITAVANJE EXIF TIPA METAPODATKA IZ JPEG FORMATA FOTOGRAFIJE, NJIHOVA ULOGA I PRIMENA U POLJU DIGITALNE FORENZIKE

Đorđe Todić*,
Petar Jakić,
Uroš Arnaut,
Aleksa Ćuk

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

U ovom radu je opisano jedno rešenje alata za iščitavanje metapodataka iz fotografija formata JPEG. Aplikacija je razvijena u programskom jeziku JAVA kao GUI rešenje. Osnovna prednost u odnosu na ostala dostupna rešenja je u činjenici da je ovo desktop aplikacija, za razliku od većine koje su razvijane kao internet aplikacije. Dodatno, zbog svojih karakteristika, aplikacija omogućava brže dobijanje informacija kao i mogućnost poređenja exif tipa metapodatka između dve fotografije. Samim tim dobijene informacije imaju veliki značaj u polju digitalne forenzike pružajući mogućnost otkrivanja velikog broja relevantnih informacija o prethodno navedenom vidu digitalnog podatka. Jedan od glavnih pokretača za izradu ovog projekta jeste pokušaj da se suzbije vid verbalnog uznemiravanja koji je zastupljen putem raznih društvenih aplikacija, kao i to u kojoj meri bi se moglo dokazati izvorno poreklo digitalnog sadržaja. Aplikacija može naći primenu i u tehničkom smislu a to je analiza parametara fotografije. Analiza parametara pruža pomoć u usavršavanju tehnike fotografisanja i uviđenju grešaka prilikom setovanja uređaja.

Ključne reči:

Exif, Java, Jpeg, metapodaci, digitalna forenzika.

1. UVOD

Metapodaci predstavljaju “podatke o podacima”, u ovom slučaju dodatne informacije o fotografiji koja je sačuvana u jpeg formatu.[1]

U digitalnom smislu to su podaci koji dodatno opisuju, objašnjavaju i omogućavaju lakše upravljanje resursima. Neki od metapodaka su automatski generisani od uređaja koji je kreirao fotografiju. Takođe postoji način za njihovo ručno dodavanje ili menjanje uz pomoć adekvatnih softvera kao što su GIMP ili Adobe Photoshop. Zastupljeni su i primeri gde se metapodaci mogu dodatno ubaciti i putem samog uređaja, jedan od primera je digitalna kamera. Metapodaci takođe mogu pomoći u vidu zaštite intelektualne svojine. Mora postojati svest o tome da kao što postoji način da se nešto naknadno utisne kao dodatna informacija o fotografiji, isto tako postoji i način da se to ukloni ili izmeni. Metapodaci se mogu definisati u tri glavne kategorije. Tehničke metapodatke, opisne metapodatke i administrativne metapodatke. Ono čime se primarno bavi pomenuta aplikacija jeste analiza tehničkih metapodataka, kao

Odgovorno lice:
Đorđe Todić

e-pošta:
djole.toda@gmail.com

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tipova podataka koji su „fabrički“ utisnuti u fotografiju. Kao primer se navodi informacija o proizvođaču, modelu uređaja, vremenu i datumu kreiranja fotografije, u određenim slučajevima i GPS lokaciji. Iščitavanje metapodataka može biti otežano raznim tehnikama kompresovanja podataka koji su zastupljeni na društvenim mrežama. U predstojećem delu rada biće opisano nesto više o tagovima exif tipa metapodatka, u kojoj meri se kompresuje digitalni sadržaj putem društvenih mreža, u kojim situacijama možemo ili ne možemo iskoristiti exif tip metapodatka kako bi dokazali poreklo testiranog sadržaja, analiza sličnih aplikacija kao i sama struktura i funkcionisanje pomenute aplikacije.

2. GUBITAK METAPODATAKA SLANJEM DIGITALNOG SADRŽAJA PUTEM DRUŠTVENIH MREŽA

Facebook

Facebook koristi „zlib“ tip kompresovanja čiji je kod javno dostupan na „github“ sajtu. [2]

Na prvi pogled, po pitanju kvaliteta, ne mogu se uvideti razlike između originalne i fotografije poslate putem facebook društvene mreže.Kad su u pitanju metapodaci „zlib“ briše sve informacije o poslatoj fotografiji. Ne postoji razlika u tome da li je fotografija preuzeta(download) ili direktno sačuvana(Save As).

Na osnovu ovih rezultata, poreklo poslate fotografije je nemoguće dokazati.

Jedini uspešan način u ovom vidu testiranja jeste taj kada je slika, koja je poslata, prethodno arhivirana u neku od tipova arhiva(zip, rar, itd.). Tada „zlib“ ne pristupa dodatnom kompresovanju poslatog sadržaja i metapodaci se, nakon ekstraktovanja arhive, mogli iščitati.

Gmail

Prilikom prosleđivanja fotografije putem Gmail aplikacije dobija se veća količina upotrebljivih metapodataka. Jedna od glavnih jeste podatak o „proizvođaču“ uređaja preko koga je nastala fotografija, dok su detalji o modelu, lokaciji, vremenu i datumu izgubljeni. Samim tim ako je uznemirujući sadržaj prosleđen putem gmail-a i posedujemo uređaj optuženog, možemo uporediti da li odgovara proizvođaču uređaja koji on poseduje, što nam može pružiti pomak u daljoj istrazi.

Apple Imessage

Aplikacija koja podržava razmenu poruka putem interneta na svim apple uređajima od verzije „IOS 5“ i „OS X Mountain Lion“ verzije.

Prilikom istraživanja fotografije poslate sa jednog uređaja na drugi dolazi se do ohrabrujućih informacija.Gubitak metapodataka nije zabeležen.Samim tim se mogu posedovati dokazi o tačnom tipu i modelu uređaja, datumu i vremenu nastanka fotografije kao i podatke o tome gde je nastala fotografija, ukoliko je u tom trenutku bila uključena opcija lokaciranja (GPRS) na datom uređaju.

Viber i WhatsApp

Aplikacije funkcionišu po sličnom principu kao Facebook što prouzrokuje iste rezultate. Brišu se sve informacije o poslatoj fotografiji.

3. EXIF

Šta je Exif

Exif metapodaci su zapis koji prikazuje podatke digitalnih SLR(*Single-line reflex*) fotoaparata koje se koriste za snimanje određene fotografije. Ovi podaci se snimaju u stvarnu datoteku slike.

Svaka fotografija ima svoje jedinstvene podatke. Exif podaci prikazuju informacije o fotografiji, kao što su model kamere, ekspozicija, otvor blende, ISO, koji je režim kamere bio korišćen, da li je ili nije aktiviran blic, i dr.[3]

Exif specifikacija

Specifikacija Exif slikovne datoteke propisuje metod snimanja slikovnih podataka u datotekama i navodi sledeće stavke:

- Struktura datoteka sa slikovnim podacima,
- Oznake koje koristi ovaj standard i
- Definisanje i upravljanje verzijama formata.

Karakteristike specifikacije Exif slikovnih datoteka uključuju sledeće.

Format snimanja datoteka je zasnovan na postojećim formatima. kompresovane datoteke se snimaju kao

JPEG (ISO / IEC 10918-1iv) sa umetnutim segmentima markera aplikacije (APP1 i APP2). Nekompresovane datoteke se snimaju u TIFF Rev. 6.0v format. Upotreba postojećih formata znači da datoteke snimljene pomoću DSC(digital still camera) ili srodnog sistema mogu biti direktno pročitane od strane komercijalne aplikacije, i omogućava korišćenje funkcija za pregled i manipulisanje slikama.

Informacije o srodnim atributima za kompresovane i nekompresovane datoteke čuvaju se u formatu informacija o oznakama definisano u TIFF Rev. 6.0. Informacije koje su specifične za sistem kamere i nisu definisane u TIFF-u čuvaju se u privatnim oznakama registrovan za Exif. Specifikacija Exif fajla takođe određuje metod za snimanje sličica. Razlog za korišćenje TIFF Rev. 6.0 formata oznaka u kompresovanoj datoteci APP1 segment je da olakša razmenu atributa podataka između Exif kompresovanih i nekompresovanih datoteka.

Kompresovane datoteke mogu snimati proširene podatke koji prelaze 64 kilobajta tako što ga dele više APP2 segmenta. APP2 segment se koristi prilikom snimanja FlashPix[vi] ekstenzija.

Značajka Exif slikovnih datoteka je njihova kompatibilnost sa standardnim formatima u širokoj upotrebi danas, omogućavajući im da se koriste na personalnim računarima i drugim informacionim sistemima. Namera je da se promoviše široka upotreba digitalne fotografije kamere.[4]

Tagovi – IFD structure

IFD (image file directory) koji se koristi u ovom standardu sastoji se od 2-bajtnog broja, 12-bajtnih polja kompatibilnosti, i 4-bajtni pomeraj na sledeći IFD, u skladu sa TIFF Rev. 6.0.

Svaka od 12-bajtnih kompatibilnosti polja se sastoji od sledećih četiri elementa.

- Bytes 0-1 Tag
- Bites 2-3 Tip
- Bites 4-7 Brojač(*count*)
- Bites 8-11 Value Offset

Tag

Svakoj oznaci se dodeljuje jedinstveni 2-bajtni broj za identifikaciju polja. Oznaka brojeva u Exif nultog IFD i 1. IFD isti su kao brojevi TIFF oznaka.

Tip

Sledeći tipovi se koriste u Exif-u:

- 1 = BITE je 8-bitni nepotpisani ceo broj,
- 2 = ASCII je 8-bitni bajt koji sadrži jedan 7-bitni ASCII kod. Završni bajt se završava sa NULL,
- 3 = SHORT je 16-bitni (2-bajtni) nepotpisani ceo broj,
- 4 = LONG je 32-bitni (4-bajt) nepotpisani ceo broj,
- 5 = RATIONAL - Prvi LONG je numerator, a drugi LONG izražava imenilac,
- 7 = UNDEFINED je 8-bitni bajt koji može uzeti bilo koju vrednost u zavisnosti od definicije polja,
- 9 = SLONG je 32-bitni (4-bajtni) potpisani celobrojni (dvokomplementna notacija),
- 10 = SRATIONAL 2 SLONGs. Prvi SLONG je numerator, a drugi SLONG je imenilac.

Vrednost

Broj vrednosti. Treba pažljivo napomenuti da brojanje nije suma bajtova. U slučaju jedne vrednosti od SHORT (16 bita), na primer, broj je ‘1’ iako je dva bajta.[4]

Vrednost pomaka

Ovaj tag beleži pomak od početka TIFF zaglavlja do pozicije u kojoj je snimljena sama vrednost. U slučajevima kada se vrednost uklapa u 4 bajta, sama vrednost se beleži. Ako je vrednost manja od 4 bajta, vrednost je u 4-bajtnoj oblasti počevši sa leve strane, tj, sa donjeg kraja zone odstupanja bajta. Na primer, u velikom endian format, ako je tip KRATKO, a vrednost 1, on se snima kao 00010000.H.

Obratite pažnju da kompatibilnost polja mora biti zabeležena u nizu počevši od najmanjeg broja oznake. Nema odredba u vezi sa redosledom ili pozicijom snimanja vrednosti oznake.[4]

3. POREĐENJE POSTOJEĆIH APLIKACIJA I IMPLEMENTACIJA SOPSTVENOG REŠENJA

Postoje različita rešenja za iščitavanje exif tipa metapodatka iz JPEG formata slika i upoređivanja istog sa

dve ili više različitih slika, što je svrha rada aplikacije opisane u radu. Neke od postojećih softvera su Internet rešenja u vidu online aplikacija, druga rešenja su gotove desktop aplikacije otvorenog i zatvorenog koda. Svaka od njih ima svoje prednosti i mane.

Internet aplikacije

Prednosti Internet rešenja ogledaju se u dostupnosti i brzini dobijanja povratnih informacija. Za verifikaciju slike je dovoljno da posedujete na Vašem računaru one slike koje želite da proverite, da posedujete Internet pretraživač i konekciju na Internet.

Internet aplikacije mogu da budu rešene u vidu vebsajtova, korišćenjem različitih tehnologija kao što su PHP, .NET, JavaScript, itd. Najčešća rešenja su korišćenjem JavaScript jezika u kombinaciji sa HTML-om za prikaz stranica. Takve stranice prikazuju formu u kojoj imate mogućnost da izaberete fotografiju iz Vašeg računara i pročitate njen sadržaj metapodataka i dobijete tabelarni prikaz istih.

U takvoj aplikaciji u samo nekoliko klikova dolazite do željenih rezultata. Problem kod ovakvih aplikacija se javlja kod poverljivosti. Ne možete da verujete drugoj strani da neće kompromitovati Vaše podatke ili ih sačuvati za sebe radi svojih daljih istraživanja. Postoji mogućnost da će sve što postavite (eng. Upload) na takvom vebsajtu biti iskorišćeno u neke druge svrhe.

Desktop aplikacije

Bolja rešenja su desktop aplikacije, kod kojih lokalno možete uporediti slike i iščitati podatke bez konekcije na Internet. Međutim, idalje postoji verovatnoća da je osoba ili kompanija, koja Vam je dostavila svoje rešenje, ostavila sebi mogućnost da dobije podatke iz aplikacije sa Vašeg računara (eng. Backdoor). To može da bude prilikom prve sledeće konekcije na Internet iako aplikacija ne radi.

Desktop aplikacije (otvorenog i zatvorenog koda) nude iste ili proširene mogućnosti u odnosu na Internet rešenja. Nude veću sigurnost, u odnosu na prethodno opisane, iz razloga što veće ili manje korporacije nude svoje usluge i stoje iza njih. Takva rešenja su uglavnom u Java i C# programskim jezicima. Ti jezici nude pregršt biblioteka koje nude različite funkcionalnosti.

Kod gore navedenih rešenja takođe postoji mogućnost neprikazivanja određenih delova metapodataka koji su Vama neophodni za upoređivanje, to se ogleda kroz neefikasnost i nepouzdanost. Dodatni nedostaci se mogu ispoljiti u nemogućnosti ostvarivanja konekcije na Internet, što predstavlja nepouzdanost, jer se ne možete osloniti na takve informacione sisteme. Šta više, jedna od najvećih opasnosti je prikupljanje Vaših podataka, i njihovim skladištenjem u bazama podataka.

Nezvanično, korporacije mogu da plate programerima da ostave ulaz u Vašu aplikaciju kako bi prikupljale podatke i kasnije ih koristile protiv Vas ili u svrhu istraživanja za sopstvene potrebe.

Implementacija i pojašnjenje sopstvenog rešenja

Iz prethodno navedenih razloga, možda je najbolje rešenje razvijanje sopstvenog informacionog sistema koji će obavljati sve potrebne funkcionalnosti. Prednost ovakvog rešenja je što u svakom trenutku poznato koji podaci će biti pročitani, na koji način, koje biblioteke će se koristiti, koji tipovi fotografija su podržani, troškovi su izrade i održavanja smanjeni, itd.

Kao što je prethodno opisano u radu, napravili smo aplikaciju koja će učitavati dve slike sa računara i raditi njihovo poredjenje na osnovu metapodataka. Kada aplikacija uporedi slike, možemo da zaključimo da li su nastale na istom uredjaju, lokaciji, itd.

Uzmimo za primer da imate neke slike za koje se ne sećate gde su nastale i da li su iz istog perioda ili iz istog mesta. U softveru ćete izabrati slike za koje želite da dobijete informacije, kada ste to uradili, videćete da postoji opcija za otpakivanje metapodataka. To je prvi korak koji je potrebno uraditi. Sledeći korak je da izvršimo poređenje ovih podataka, koje je glavni cilj ovog rešenja.

Da bi aplikacija mogla da čita meta podatke korišćena su biblioteke :

- com.drew.imaging.ImageMetadataReader;
- com.drew.metadata.Directory;
- com.drew.metadata.Metadata;
- com.drew.metadata.Tag;

Jedan od jednostavniji načina da se čitaju meta podaci je preko „ImageMetadataReader“, koji koristi „FileTypeDetector“ kako bi odredio koji metod dekodiranja će biti najbolji da se iskoristi. Ova biblioteka dobija metapodatke iz svih podržanih formata datoteka, uključujući JPEG, RAW (NEF / CRv / CR2) i TIFF.

Ako se zna tačan tip određenog fajla, moguće je koristiti specifičan „MetadataReader“ koji će biti namenjen takvom tipu podatka (JpegMetadataReader za JPEG datoteke, ili

TiffMetadataReader za TIFF i RAW datoteke), s tim da takvi namenski čitači ne nude mnogo bolje performanse.

Objekat meta podataka sadrži nula ili više objekata direktorijuma (eng. Directory) i sadrže nula ili više „Tag“ objekata. Oznake sadrže vrednosti koje predstavljaju metapodatke za izvornu sliku.

Da bi fajl mogao da se otvori u aplikaciji, korišćene su biblioteke:

- java.io.File;
- javax.swing.JFileChooser;

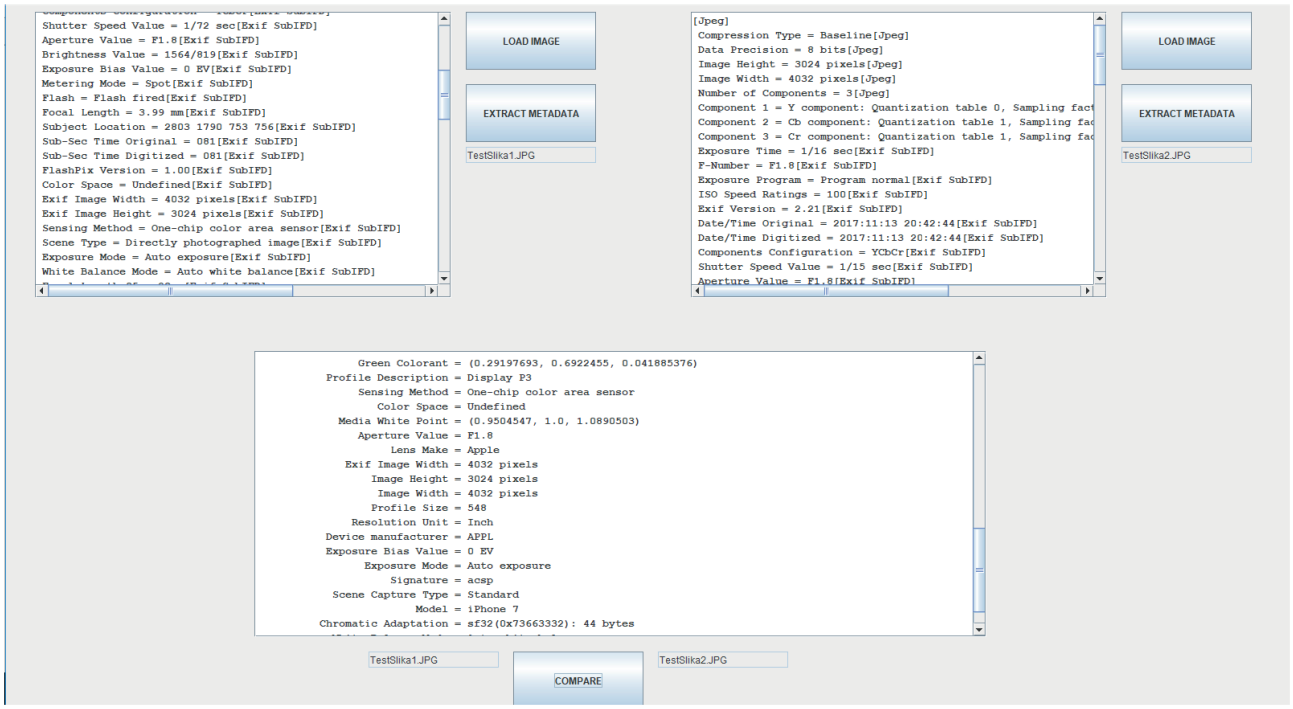
Java klasa javax.swing.JOptionPane ima mogućnosti za kreiranje prozora za dijalog, koji se može pojaviti na radnoj površini računara (na ekranu) da bi se od korisnika zatražio unos poruke ili za prikazivanje poruke korisniku. Na slici 1 se može primetiti da je kreiran korisnički interfejs koji ima za cilj jednostavniju interakciju između klijenta i računara. [5, 6]

Grafički interfejs od klijenta zahteva unos slike, čije ime ispisuje u labeli namenjenoj za čuvanje imena slike. Dugme „Extract metadata“ je jedna od dve namene ovog softvera i nudi prikaz meta podataka slike unutar okvira namenjenog za ispis teksta, taj okvir ima predefinisane dimenzije sa mogućnošću pomeranja sadržaja po x i y osi. Druga namena aplikacije je upoređivanje sadržaja dve slike, upoređeni sadržaj se prikazuje kao tekst na dnu grafičkog interfejsa sa mogućnošću pomeranja sadržaja po x i y osi.

Biblioteka java.util.HashMap je takođe korišćena u aplikaciji. Heš mapa je deo Java biblioteka od verzije 1.2. Ona obezbeđuje osnovnu implementaciju „Map“ interfejsa Jave. Ova biblioteka interno koristi listu veza da čuva podatke u parovima koji su poznatiji kao ključ-vrednost, što znači da biste pristupili vrednostima, morate znati ključ. HashMap koristi tehniku pretvaranja velikog Stringa u mali String koji predstavlja isti niz. Kraća vrednost pomaže u indeksiranju i bržem pretraživanju.[7, 8]

Za rad softvera su korišćene i druge biblioteke koje doprinose pouzdanijem i bržem radu, ali neće biti opisane u ovom radu. Ovakvo rešenje problema iščitavanja exif tipa metapodatka iz slika doprinosi bržem, efikasnijem i pouzdanijem radu. Prednosti su mogućnost rada u „offline“ režimu, odnosno da aplikacija ne mora da radi isključivo zahtevajući Internet konekciju. To doprinosi zaštiti podataka u smislu da ćemo biti sigurni da neće doći do kompromitovanja istih od strane trećeg lica. Dodatni vid zaštite bi bio da se aplikacija koristi na zasebnom računaru koji ne bi imao pristup internetu i služio bi isključivo za namene ovog softvera.

Još jedna od prednosti ogleda se u brzini rada. Jednostavnost grafičkog interfejsa omogućava korisniku da u samo nekoliko klikova iščita podatke i uporedi ih.



Slika 1. Slika prozora aplikacije za učitavanje i poređenje metapodataka

4. ZAKLJUČAK

U poslednjih par godina došlo je do velike ekspanzije društvenih mreža kao primarnog sredstva za komuniciranje među ljudima. Sa druge strane, sa sve većom upotrebom javlja se i pretnja za verbalnim nasiljem putem istih. Najveći problem je usklađivanje prava na privatnost i prava na dostupnost informacijama, pošto postoji potreba za kontrolom i praćenjem toka svih informacija, ali i pravo pojedinca na privatnost. Nivo anonimnosti koji počinioci mogu imati je visok jer oni mogu da izvrše napad, obrišu nalog i negiraju krivicu. Razmatrana aplikacija se može usavršavati u smeru otkrivanja eventualnih promena u samoj fotografiji, prikazivanju stepena tih promena, kao i pokušaju dovođenja svih metapodataka na početno stanje.Integritet digitalnog dokaza mora biti sačuvan ukoliko treba biti prezentovan na sudu, samim tim se radi na daljem razvoju deskop aplikacije i licenciranju iste.

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RAZVOJ JAVA POSLOVNE APLIKACIJE SA IMPLEMENTIRANIM KRIPTOGRAFSKIM SERVISIMA

Marina Savić

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Predmet ovog rada je realizacija Java desktop aplikacije pomoću koje se vodi evidencija podataka o žrtvama nasilja. Obzirom da se ovde radi o naročito osetljivim podacima a čijom se i samom obradom zadire duboko u privatnost građana, potrebno je primeniti posebne mere zaštite zbog čega smo se odlučili da podaci budu šifrovani. U ovom radu biće predstavljeni mehanizmi koji osiguravaju integritet i tajnost podataka. Dat je pregled osnovnih pojmova u kriptografiji. Predstavljene su prednosti i nedostaci. Opisani su simetrični šifarski sistemi koji su sastavni deo aplikacije a koji obezbeđuju tajnost, zatim njihovi režimi rada, heš funkcije koje obezbeđuju integritet kao i pregled predloženog rešenja. Ujedno su opisani ostvareni rezultati kao i predlog za budući rad.

Ključne reči:

java aplikacija, šifrovanje, aes, privatnost, integritet.

1. UVOD

Digitalna komunikacija uključuje upotrebu računara i samim tim čuvanje velikih količina digitalnih informacija. U današnje vreme, raspolaganje informacijama može da predstavlja političku ili vojnu prednost, pa samim tim imamo i informaciju kao oružje.

Sa razvojem informacionih tehnologija raste i mogućnost zloupotreba informacija koje se tim putem prenose, što zahteva viši stepen zaštite. U ovom radu, rizici su svedeni na minimum, odnosno sistem je bezbedan do te mere da ne postoji ekonomska opravdanost za izvođenje napada.

Digitalna komunikacija neizostavno uključuje upotrebu računara, prenos i čuvanje digitalnih podataka ali i njihovu zaštitu kao i zaštitu informacionih sistema, uređaja i mreža.

2. SIMETRIČNI ŠIFARSKI SISTEMI

Simetrični šifarski sistemi [1] su najstariji oblik kriptografije. Za proces šifrovanja potrebno je znati algoritam i tajni ključ. Nekada su se algoritmi čuvali u tajnosti, ali se pokazalo da to ne doprinosi sigurnosti.

Odgovorno lice:
Marina Savić

e-pošta:
marina.savic.14@singimail.rs

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Sigurnost simetričnih algoritama zavisi od sigurnosti algoritma i dužine njegovog ključa. Simetrični šifarski sistemi predstavljaju sisteme šifrovanja tajnim ključem pri čemu je ključ za šifrovanje identičan ključu za dešifrovanje.

Karakterišu se relativno velikom brzinom rada i jednostavnom implementacijom. Međutim pored tih prednosti, postoje i nedostaci. Kao nedostatak javlja se distribucija ključa što se uspešno rešava upotrebom asimetrične kriptografije koja je i nastala kao odgovor na problem distribucije tajnih simetričnih ključeva gde postoje postoje perfektni i računarski protokoli koje možemo da upotrebimo za sigurnu razmenu ključa.

U slučaju perfektnih protokola postoji problem u nedostatku autentifikacije te je potrebno upotrebiti neki od algoritama za obezbeđenje servisa autentifikacije na primer RSA algoritam. U drugom slučaju, to su računarski protokoli zasnovani na DH (Difi Helman) i to različite verzije i implementacije kao i RSA protokolu.

3. IMPLEMENTACIJA ALGORITAMA ZA ŠIFROVANJE

U zavisnosti od operacija koje se izvršavaju nad otvorenim tekstom, algoritmi za šifrovanje mogu biti efikasniji kao softversko ili kao hardversko rešenje.

Prednosti softverske realizacije su:

- prenosivost,
- fleksibilnost,
- jednostavnost korišćenja i nadogradnje uz male izmene i bez velikih troškova,

dok se za vojne primene hardverska rešenja koriste kao glavni vid realizacije.

AES se pokazao jednako dobar za implementaciju u obe varijante. U algoritmu do danas, nisu pronađeni nesigurni ključevi kao kod DES (*eng. Data Encryption Standard*) algoritma, koristi se u mnogim protokolima i tehnologijama za prenos podataka kao što je zaštita bežičnih mreža WPA2, zatim SSH ili IPsec, kao i kod Voice-over-IP tehnologije a u Sjedinjenim Američkim Državama ga koriste za šifrovanje dokumenata koji zahtevaju najviši nivo zaštite, pa su to razlozi zašto smo se odlučili za implementaciju AES kriptografskog algoritma.

Iako AES algoritam nije osetljiv na napade korišćenjem linearne i diferencijalne kriptoanalize, sumnja se da je osetljiv na algebarske napade.

Ukoliko je potrebno obezbediti integritet ali ne i tajnost podataka, jedan od glavnih kriptoloških alata koji garantuje integritet je heš funkcija. Ukoliko je potrebno osigurati i tajnost, onda to kombinujemo sa šifrovanjem. U ovom radu bilo je potrebno obezbediti i integritet i tajnost podataka.

Da bi se obezbedilo da krajnji korisnici što manje osećaju prisustvo kriptografskih rešenja ovo rešenje primenjuje „Client-side encryption" tehniku - kriptografsku tehniku šifrovanja podataka na strani pošiljaoca, pre nego što se podaci pošalju na server, na takav način da korisnici ne moraju da imaju predznanje o kriptografiji a da im sa druge strane upotreba aplikacije ne otežava posao, niti se značajno menjaju vremenski resursi kod izvršavanja poslovnih procesa.

Razvili smo sopstveno rešenje u kome su ključevi za šifrovanje na strani klijenta da bismo obezbedili da neovlašćene osobe imaju pristup našim poverljivim podacima a istovremeno je lako za korišćenje.

Kako pouzdanost aplikacije ne zavisi od nje same, već i od uslova u kojima ona funkcioniše [3], ovo rešenje podrazumeva sledeće uslove:

- Veoma je važno ograničiti pristup sistemu poput zaključavanja prostorija i opreme;
- Objekti ograničenja fizičkog pristupa su serveri, sama aplikacija, njene biblioteke i slično.

4. APLIKACIJA ZA EVIDENCIJU PODATAKA O ŽRTVAMA NASILJA I BEZBEDNOSNI ZAHTEVI

Perspektiva sistema

Prva verzija sistema ima za cilj da automatizuje procese koji se često odvijaju u Centru za žrtve nasilja i da omogući jednostavnije vođenje evidencije o žrtvama nasilja pri čemu se mora voditi računa o Zakonu o zaštiti podataka o ličnosti [7]. U narednim verzijama se planira uvođenje sistema za bezbedan pristup web aplikaciji.

Karakteristike sistema

Centar ima potrebe da beleži podatke o žrtvama nasilja, bilo da su to žene ili deca. Prilikom poziva Centra, žrtva svojom voljom ostavlja podatke koje ona želi. Detaljnom analizom, došlo se do zaključka da su sledeći podaci oni koji se u većini slučajeva ostavljaju volonterima putem fiksnog telefona koji nema i ne sme da ima identifikaciju poziva. To su:

- Ime i prezime;
- Radno mesto;
- Datum javljanja;
- JMBG;
- Kontakt telefon;
- Email;
- Mesto boravka;
- Da li je policija obaveštena ili nije, da li ima nameru da obavesti policiju ili volonter nema tu informaciju;
- Da li je razlog ostajanja u zajednici sa nasilnikom novac, osuda okoline, deca ili volonter nema tu informaciju ;
- Da li je vrsta nasilja socijalno, psihičko, ekonomsko ili volonter nema tu informaciju;
- Broj dece jedno, više, nema decu ili volonter nema tu informaciju;
- Da li se žrtva javlja prvi put ili je već zvala;
- Da li je potrebno obezbediti savetovanje, pravnu pomoć ili volonter nema tu informaciju;
- Kratak opis ukoliko je potreban komentar volontera a u vezi sa tim pozivom.

Dodatno a bez zahteva korisnika, uvesti neki ID za svaku žrtvu, a vreme i datum poziva automatski ubaciti. Ta dva polja nije moguće izmeniti ni kao volonter (običan korisnik) ni kao administrator (super user).

Volonter (običan korisnik) – je svaki korisnik koji sa svojim korisničkim imenom i lozinkom pristupi sistemu ali mu je pristup ograničen. Običan korisnik ima pravo da dodaje žrtvu u bazu podataka ali ne i da vrši izmenu ili briše žrtvu iz baze. Nema pravo na štampu niti na uvoz/izvoz podataka u Excel formatu. Ima pravo da koristi biblioteku u kojoj se nalaze PDF fajlovi radi lakše komunikacije sa žrtvom u smislu: članovi zakona, mere bezbednosti i slično.

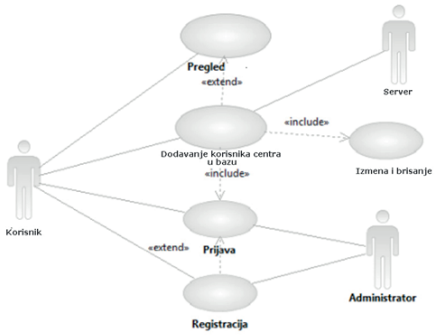
Administrator (super user) – je samo onaj korisnik koji ima sva prava pristupa sistemu. Sve funkcije su omogućene.

Radno okruženje

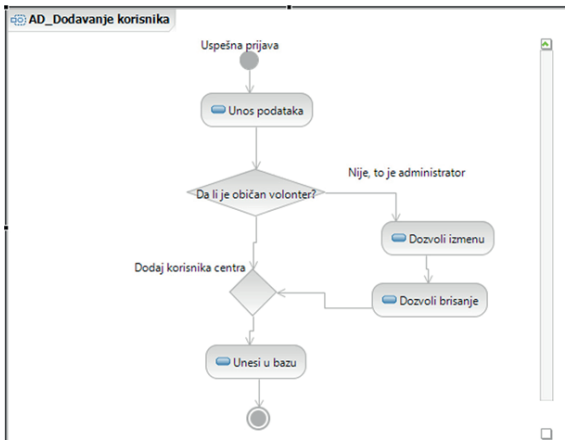
Softver će biti realizovan kao desktop aplikacija, koji ima lokalnu bazu ali ima i mogućnost povezivanja na server baze podataka, te za njegovo korišćenje nije neophodan računar koji ima pristup Internetu. Implementacija će se zasnivati na Java programskom jeziku [2] uz korišćenje NetBeans razvojnog okruženja. Za projektovanje šeme baze podataka koristiće se JDBC za lokalnu a MySql za server baze podataka.

Specifikacija dizajna

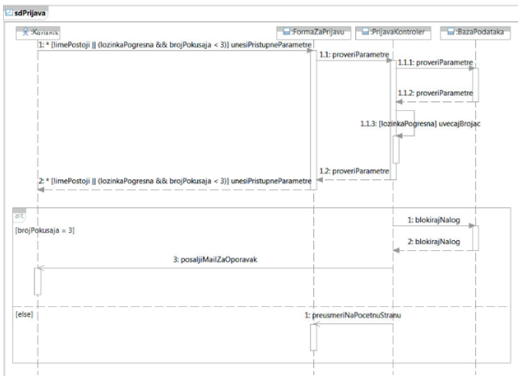
Ovo poglavlje ima za cilj da opiše slučajeve korišćenja sistema uz priložene dijagrame. Dijagram klasa prikazuje klase kojima će biti modelirani podaci, dok dijagrami sekvence, aktivnosti i komunikacije služe da detaljno prikažu tok kontrole ključnih funkcija sistema.



Dijagram 1. Use case dijagram



Dijagram 2. Dijagram aktivnosti Dodaj korisnika



Dijagram 3. Dijagram sekvence Prijava

5. REALIZACIJA PREDLOŽENOG REŠENJA

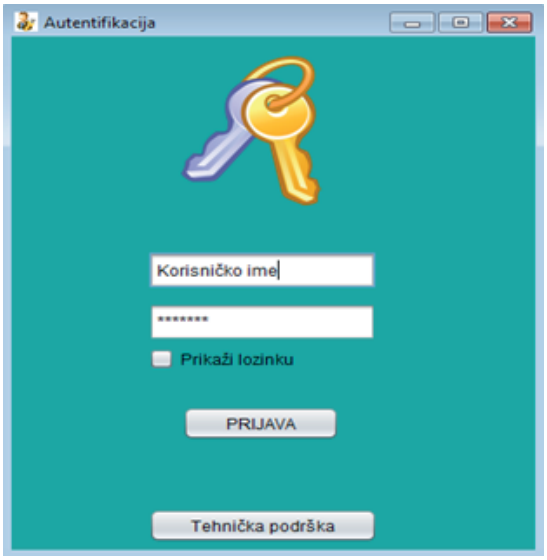
Aplikacija ima serversku i klijentsku stranu. Sam izgled aplikacije prikazan je na slikama ispod.

Nakon pokretanja aplikacije, prikazaće se sledeći prozor koji je prikazan na slici 1. U ovom delu aplikacije, korisnik mora da izabere da li se prijavljuje kao običan korisnik (zaposleni, volonter) ili kao administrator sistema [6].



Slika 1. Prozor nakon pokretanja aplikacije

Nakon izabranog naloga za prijavu, korisnik se prijavljuje sa svojim pristupnim parametrima.

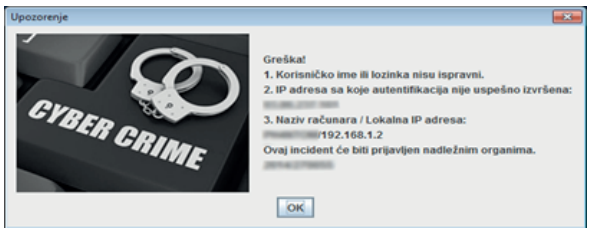


Slika 2. Autentifikacija korisnika

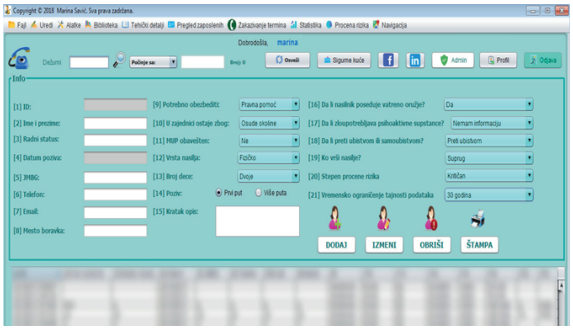
Broj pokušaja logovanja je ograničen. Izgled prozora zavisi od izabranog naloga. Pritiskom na dugme prijava, izvršiće se provera da li u bazi postoji korisnik sa zadatim parametrima, pri čemu će se uporediti heš (SHA3-256) lozinke korisnika, što je opisano pod 4.1 Autentifikacija korisnika.

Ukoliko korisnik poslednji put unese pogrešno korisničko ime i/ili lozinku, kao rezultat pojaviće se prozor o upozorenju nakon čega se informacija o grešci šalje na email adresu administratora.

Svaki pristupni log u mejlu sadrži informacije o korisniku koji je pristupio bazi podataka, datumu i vremenu pristupa i IP adresi (javnoj i lokalnoj) sa koje je pokušan pristup ili se pristupilo bazi podataka.



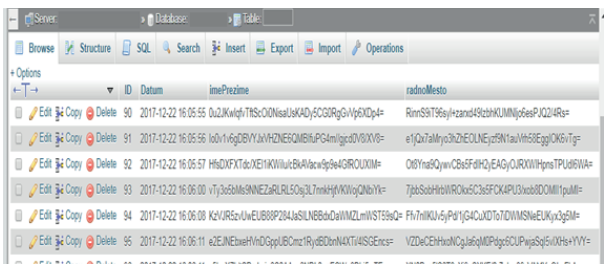
Slika 3. Neuspešna autentifikacija



Slika 4. Glavni panel

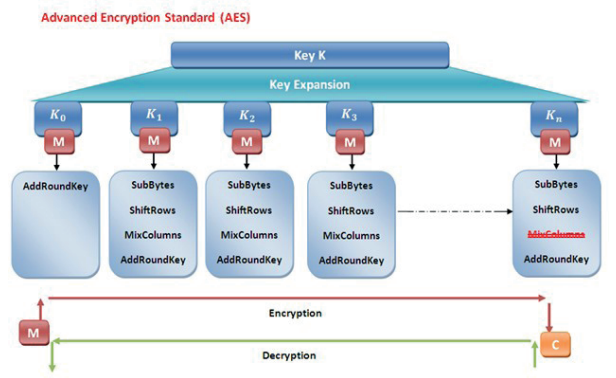
Na klijentskoj strani, nakon unošenja podataka, pritiskom na dugme dodaj, prvo se vrši šifovanje koje je u daljem tekstu opisano i tek nakon šifrovanja podaci se šalju na server baze podataka. U našem slučaju korišćena je MySQL baza podataka.

Nakon dodavanja podataka u bazu, oni će izgledati kao što je prikazano na slici 5.



Slika 5. Šifrat u bazi

U ovom radu kombinovali smo AES sa SHA-256 heš funkcijom. Postoje različiti mogući napadi na heš funkcije, a naročito ako se uoči da heš funkcija ima slab efekat lavine, odnosno da male promene na ulazu izazivaju male promene na izlazu.



Slika 6 AES Scenario [9]

Autentifikacija korisnika

Iako je SHA2 i dalje bezbedan, u ovom radu a za potrebe hešovanja korisničkih lozinki pomoću kojih se vrši prijava korisnika na aplikaciju, koristili smo SHA3 standard [5].

Lozinke su hešovane sa SHA3 (eng. Secure Hash Algorithm 3) algoritmom sa 256 izlazom, koji je odobren od strane Nacionalnog Instituta za Standarde i Tehnologiju i pogodan je za zaštitu od napada preko bočnih kanala (eng. Side-channel attack).

Osim korisnika koji se nalaze u bazi podataka, postoje nalozi koji omogućavaju korišćenje programa u slučaju da nema Internet konekcije. U samom kodu nalaze se korisnička imena, međutim, za korisničke lozinke urađena je provera heš vrednosti sa SHA-3 algoritmom pa ih nije moguće kompromitovati.

Iz tog razloga, nismo kreirali String nego se vrši direktna konverzija iz karaktera u bajtove. Kreirali smo objekat klase *CharBuffer* koji sadrži karaktere lozinke. Uz pomoć *encode* metoda *Charset* klase, pretvorili smo karaktere lozinke u niz bajtova po UTF kodnoj stranici i sačuvali ga u objekat klase *ByteBuffer*.

Nakon toga, niz bajtova lozinke smo provukli kroz *Digest* metod klase *Digest256,* čime smo dobili heš lozinke. Međutim, samim unošenjem lozinki prilikom prijave na sistem, one ipak ostaju na nekoliko mesta.

Zato smo na kraju, prepisali sve memorijske lokacije gde se čuvala lozinka u originalnom obliku – nulama. Nakon te operacije, originalne lozinke više neće biti u memoriji. Nakon uspešne autentifikacije, korisnik se preusmerava na glavni panel.

```
public static byte[] hesujLozinku(char[] lozinka)
{
CharBuffer cb = CharBuffer.wrap(lozinka);
ByteBuffer bb = Charset.forName("UTF8").encode(cb);
byte[] hesovanaLozinka = new SHA3.Digest256().digest(bb.array());
Arrays.fill(lozinka, '\u0000');
Arrays.fill(cb.array(), '\u0000');
Arrays.fill(bb.array(), (byte) 0);return hesovanaLozinka;
}
```

Base64 encoding

Base64 Encoding koristimo kada postoji potreba za kodiranje binarnih podataka koji moraju da se čuvaju i prenose preko medija koji su dizajnirani da se bave tekstualnim podacima. Isto tako koristićemo ga da osiguramo da su podaci ostali netaknuti, bez izmena u toku transporta.

AES

U ovom radu implementacija u Java programskom jeziku je urađena je uz pomoć paketa Bouncy Castle provajdera [4], čiji JAR fajl sadrži kriptografski API.

Implementiran je AES (eng. *Advanced Encryption Standard*) algoritam, sa 128bit-nom dužinom ključa, u CBC (*eng. Cipher-block chaining*) režimu rada koji se koristi za ulančavanje blokova šifrata koristeći .PKCS#5 (eng. *Public Key Cryptography Standards*) kao dopunu.

Inicijalni vektor

Prvi blok šifrata nema svog prethodnika pa se iz tog razloga uvodi Inicijalni vektor (IV) koji se koristi za generisanje prvog bloka šifrata. IV bi trebao da bude generisan na čisto slučajan način. Dužina IV je uvek

jednaka dužini bloka date šifre što znači da je za AES uvek 128bita ili 16bajtova. Inicijalni vektor ne zavisi od dužine ključa i ne mora da bude tajna.

PKCS#5

Metod dopunjavanja (*eng. Padding*) koristi se nad porukama bilo kojih dužina. Razlika između metoda PKCS verzije 5 (PKCS#5) i metoda PKCS verzije 7 (PKCS#7) je u veličina bloka. Za PKCS#5 veličina bloka je 8-bita, dok je kod PKCS#7 između 1 i 255-bitova. Vrednost nula označava da ne postoji dopuna.

Obzirom da je PKCS#5 podskup PKCS#7, podatke šifrovane pomoću PKCS#5 moguće je dešifrovati sa PKCS#7 ali ukoliko su podaci šifrovani pomoću PKCS#7 neće biti moguće dešifrovati ih sa PKCS#5.

Kriptografska so

Kriptografska so - u kriptografiji, so (*eng. salt*) je nasumičan podatak koji se koristi kao dodatni ulaz u jednosmernu funkciju koja „hešira" podatke ili lozinku. Primarna funkcija soli je odbrana od napada rečnikom i „dugine tabele". So se koristi za zaštitu lozinki u bazama dodavanjem soli na lozinku pre heširanja.

Međutim, ona ne može da nas zaštiti od uobičajenih lozinki ili od onih koje je lako pogoditi. So ne mora da bude tajna a mi smo je generisali preko SecureRandom klase i ima 8 bajtova tj. 64bita.

Skladište i upravljanje ključevima za šifrovanje

Za potrebe generisanja ključeva i njihovog skladištenja, napisali smo pomoćni program koji će nam omogućiti da kreiramo skladište i generišemo ključ. Klasa SecretKey generiše ključ za zadati algoritam.

Klasa KeyStore je klasa u Javi, kroz koju pristupamo skladištu ključeva iz programa. Koristili smo KeyGenerator i prosledili mu kao argument String AES kako bi nam generisao 128-bitni ključ. Prilikom svakog šifrovanja i dešifrovanja, ključ će se čitati iz skladišta ključeva.

Baza podataka

Iz bezbednosnih razloga, aplikacija opisana u ovom radu, ima lokalnu bazu koja je šifrovana i nije potreban pristup Internetu.

Da bi se omogućila jedna centralizovana baza podataka kao i da bi kreirali sigurnosnu rezervnu kopiju baze podataka u slučaju gubitka, oštećenja ili uništenja računarske opreme, sekundarni server može da preuzme aktivnost primarnog, pa je u ovom radu aplikacija povezana na MySQL (*eng. My Structured Query Language*) server baze podataka.

6. PREDNOSTI I NEDOSTACI ŠIFROVANJA

Šifrovanje podataka je neophodno tamo gde je zahtevan visok stepen zaštite. Međutim, šifrovanje i dešifrovanje podataka prouzrokovaće neku degradaciju performansi jer algoritmi moraju da ispoštuju niz matematičkih zahteva. Iz tih razloga, veoma je bitno razmotriti koje podatke treba šifrovati.

Male celobrojne vrednosti (*eng. integer*) kao i *boolean* vrednosti nisu pogodne za šifrovanje jer se mogu zaključiti sa velikom verovatnoćom. Dodatno opterećenje je šifrovanje indeksiranih polja kao i pregled šifrovanih podataka koji zahtevaju dešifrovanje.

U nekim slučajevima, indeksiranje i pretraživanje mogu da se obave nad šifrovanim podacima a da to ne utiče na performanse. To bi zahtevalo da i termini pretrage budu šifrovani.

7. ZAKLJUČAK

Obzirom da poverenje korisnika i partnera predstavlja osnovu celokupnog poslovanja, podaci moraju biti zaštićeni u svakom momentu, ne samo na serveru baze podataka nego i na putu do istog.

Uvođenje kriptoloških mera zaštite rezultira padom performansi sistema, a koliki će biti pad performansi zavisi od količine podataka koje šifrujemo i dešifrujemo kao i od samog algoritma koji smo implementirali. Ova aplikacija namenjena je organizaciji kojoj je potreban visok stepen zaštite podataka.

Sva pitanja u vezi sa bezbednošću šifrovanih podataka treba da se postave u smislu koliko vremena i koliko će koštati napadača da pronađe ključ. Dužina ključa je kompromis između performansi i sigurnosti.

Zbog toga, dužinu ključa treba odabrati tek kada se odluči koje je vreme zaštite koje je potrebno i koliko će koštati nasilno pronalaženje tajnog ključa.

U nekim vojnim okolnostima, dovoljna je zaštita na nekoliko sati ili dana – nakon toga, rat ili misija su završeni i informacija je nezanimljiva i bezvredna. U nekim drugim slučajevima, ceo životni vek možda neće biti dovoljan.

Trenutno nema dokaza da AES ima bilo kakve slabosti, moguća je jedino iscrpna pretraga, odnosno napad grubom silom. Pravilno implementiran AES-128 [8] će verovatno zaštititi podatke na 50 do 60 godina od budžeta od million dolara a od individualnih budžeta, zaštita će potrajati najmanje još dodatnih 10 godina.

8. PREDLOG ZA BUDUĆI RAD

Potrebno je dodati podršku za promenu ključa, da bi onemogućili kriptoanalitičke metode koje se zasnivaju na posedovanju velike količine šifrata koji je nastao upotrebom istog ključa.

Tu se sada javlja i problem čuvanja tih ključeva ali na takav način da je siguran a opet dostupan za legitimnu upotrebu.

ZAHVALNOST

Zahvaljujem se kolegi Marku Laziću na savetima i pomoći prilikom realizacije eksperimentalnog dela rada.

Najveću zahvalnost dugujem svojim roditeljima i sestri na velikoj podršci i nesebičnoj pomoći koju su mi pružali svih ovih godina. Ovaj rad posvećujem njima.

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STRATEGIJSKO UPRAVLJANJE RESURSIMA PRIVREDNOG DRUŠTVA: KOMPARATIVNA ANALIZA SISTEMA ZA PLANIRANJE POSLOVNIH RESURSA (ERP) I RAČUNOVODSTVENIH INFORMACIONIH SISTEMA (RIS)

Maja Gligorić*,
Tamara Kokić,
Ana Obradović,
Dušan Borovčanin

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Stalan i veoma brz razvoj informacionih i komunikacionih tehnologija, kao i turbulentno poslovno okruženje uslovile su promene u industrijskim granama. Od privrednih društava se zahteva stalno prilagođavanje i usavršavanje, jer samo ona koja su spremna za promene mogu biti označene kao konkurentne na tržištu rada. Sa druge strane, česta je situacija da privredna društva nestaju sa tržišta jer nisu sposobna da se menjaju ili prilagođavaju tržišnim uslovima. Međutim, visoki troškovi i poteškoće pri implementaciji poslovnih rešenja mogu itekako da utiču na dalji tok rada i uspešnost privrednog subjekta. U vezi sa tim, od privrednih društava očekuje se pažljiv odabir adekvatnog informacionog sistema uzimajući u obzir zahteve koje diktira njegovo poslovanje. Ovim radom je obuhvaćena komparativna analiza prednosti i nedostataka najzastupljenijih računovodstvenih informacionih sistema i sistema za planiranje poslovnih resursa na teritoriji Republike Srbije. Takođe, komparativnom analizom je definisana upotrebljivost informacionih sistema uzimajući u obzir veličinu privrednog društva.

Ključne reči:

računovodstveni informacioni sistemi, ERP rešenja, strategijsko upravljanje, informacione tehnologije, savremeno poslovno okruženje.

1. UVOD

Problem savremenog poslovanja privrednih društava, kako na teritoriji Republike Srbije tako i u drugim zemljama, je brza i česta promena trendova u poslovanju. U vezi sa tim, od privrednih društava zahteva se usvajanje specifičnih poslovnih modela, odnosno savremenih tehnika i metoda koje su fokusirane na dugoročni uspeh [1]. Globalizacija i takozvana nova ekonomija zasnivaju se na stalnim promenama i sve većoj upotrebi informacionih i komunikacionih tehnologija u poslovanju privrednih subjekata [2]. Tehnološka znanja i tehnički pronalasci promenili su poslovni ambijent, jer su pravovremenost i brzina osnovne karakteristike savremenog načina poslovanja. Važno je istaći da je računovodstveni informacioni sistem (skraćeno RIS) samo jedan od segmenata savremenog poslovnog sistema. Razvoj poslovanja privrednih društava u savremenom okruženju zasniva se na primeni različitih menadžment tehnika i softverskih rešenja koji utiču na razvoj konkurentnosti, fleksibilnosti, inovativnosti, kao i na unapređivanju znanja zaposlenih unutar

Odgovorno lice:
Maja Gligorić

e-pošta:
mgligoric@singidunum.ac.rs

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privrednog društva, a posebno višeg rukovodstva [3]. U procesu planiranja i formulisanja strategije menadžment privrednog društva uvek polazi od raspoloživih resursa, uzimajući u obzir i resurse koje kompanija nedovoljno koristi. Na ovaj način obezbeđuje se efikasna i efektivna upotreba resursa privrednog društva i time se postiže pravovremeno reagovanje na promene u okruženju.

Kako bi privredna društva išla u korak sa vremenom, zadatak menadžmenta privrednog društva je implementacija određenog poslovnog rešenja ili sistema koji bi omogućio adekvatno upravljanje poslovnim procesima, odnosno što efikasnije korišćenje dostupnih resursa kompanije. Samim tim, korišćenjem nove tehnologije unutar privrednog društva menjaju se ciljevi i planovi kompanije, radne vrednosti, raspoloživi kadrovi, kao i sama organizaciona struktura društva. Brzo reagovanje u procesu donošenja poslovnih odluka predstavlja osnovni uslov za opstanak privrednog društva na tržištu rada. Ujedno, od samog menadžmenta privrednog društva zavisi da li su isti spremni za inovativna odlučivanja na osnovu kojih će društvu obezbediti bolju tržišnu poziciju [4].

2. STRATEGIJSKO UPRAVLJANJE

Strategijsko upravljanje predstavlja proces pomoću kojeg se donose i sprovode strategijske odluke koje omogućavaju privrednom društvu ostvarivanje željenog položaja na tržištu. Cilj strategijskog planiranja je da obezbedi sklad između sadašnje i planirane tržišne pozicije i načina dostizanja željenog cilja. Postoje dve faze u procesu strategijskog upravljanja, i to strategijsko planiranje i implementacija strategije. U prvoj fazi se vrši formulisanje same strategije poslovanja koja je orijentisana na tržišni rast i razvoj privrednog društva. Shodno tome, neophodna je spremnost menadžmenta za implementaciju i primenu informaciono–komunikacionih tehnologija. U drugoj fazi vrši se preduzimanje odgovarajućih akcija na osnovu tačno utvrđene strategije [5]. Menadžment privrednog društva, od koga zavisi inovativnost i rad same kompanije predstavlja najvažniju kariku u procesu uvođenja novih sistem pomoću kojih se vrši strategijsko upravljanje resursima privrednog društva. Zapravo, menadžment označava efektivno i efikasno upravljanje aktivnostima koje su vezane za posao koji ljudi treba da obave pojedinačno ili uz pomoć drugih ljudi [6].

3. RAČUNOVODSTVENI INFORMACIONI SISTEM I SISTEM ZA PLANIRANJE POSLOVNIH RESURSA

Razvoj i primena informaciono–komunikacionih tehnologija uslovile su nastanak savremenog poslovnog ambijenta. Primena elektronskog poslovanja je iz korena promenila način poslovanja, te je postalo neophodno redefinisanje poslovnih procesa unutar poslovnih sistema, a u skladu sa njima i informacionih potreba. Računovodstveni informacioni sistemi predstavljaju formalne procedure kojima se vrši prikupljanje podataka, koje se zatim obrađuju u informacije, i kao takve se dostavljaju korisnicima. Osnovni uslov za rad i opstanak privrednog društva na tržištu predstavlja efikasno korišćenje računovodstvenog informacionog sistema. Međutim, ukoliko privredna društva za cilj imaju automatizaciju i integraciju poslovnih aktivnosti i poslovnih procesa unutar društva neophodno je korišćenje integrisanog poslovnog rešenja, odnosno ***Enterprise Resource Planning (ERP).*** Osnovni cilj primene integrisanog poslovnog rešenja je pomoć privrednom društvu u uštedi resursa, ali i u efikasnosti poslovanja [7].

4. RAČUNOVODSTVENI INFORMACIONI SISTEMI

Uspešno poslovanje privrednih društava obuhvata adekvatnu primenu i upotrebu računovodstvenih informacionih sistemi koji direktno utiču na obradu finansijskih i nefinansijskih transakcija unutar istog. Implementacija i upotreba računovodstvenih informacionih sistema predstavlja neophodan segment savremenog poslovanja za privredna društva, koji dodatno pojednostavljuje svakodnevne poslovne transakcije. U daljem tekstu predstavićemo prednosti i nedostatke računovodstvenih informacionih sistema koji su najzastupljeniji na teritoriji Republike Srbije.

Lidder MRS

Privredno društvo New Dimension osnovano je 1992. godine sa idejom razvoja i kreiranja adekvatnog softverskog rešenja. Lidder predstavlja monolitni računovodstveni softver koji omogućava efikasan rad korišćenjem raznovrsnih i jednostavnih softverskih alata. Računovodstveni softver Lidder prevashodno je namenjen malim i srednjim privrednim društvima koja posluju u dinamičnom okruženju sa većim brojem

komitenata. Računovodstveni servisi koriste Lidder u cilju vođenja dvojnog knjigovodstva, u proseku za oko 30 malih ili srednjih privrednih društava po jednom serveru. Najveću funkcionalnost postiže primenom u privrednim društvima koja generišu oko 10.000 dokumenata i 10.000 artikala godišnje i rade sa oko 1000 aktivnih komitenata.

Računovodstveni softver Lidder prilagođen je korisnicima različitih obima poslovanja i sastoji se od sledećih tehničkih verzija:

- ENT je ENTerprise verzija Liddera;
- PRO je PROfessional verzija Liddera;
- STD je STanDard verzija Liddera;
- START je STanDard verzija Liddera koja ne može imati terminale;
- EDUCA je START verzija Liddera koja je besplatna, ali sa nekim dodatnim ograničenjima.

Benefit korišćenja ovog savremenog softverskog rešenja ogleda se u mogućnosti sveobuhvatnog vođenja knjigovodstva i knjiženja svih poslovnih promena uključujući i računovodstveno planiranje i analizu, računovodstvenu kontrolu i reviziju koja se zasniva na poštovanju računovodstvene teorije i prakse [8].

Mali poslovni program 2 - MPP2

Mali poslovni program 2 (u daljem tekstu MPP2) predstavlja savremeni računovodstveni softver koji omogućava sveobuhvatnu evidenciju poslovnih transakcija, nadzor i kontrolu poslovanja privrednih subjekata. MPP2 je druga generacija računovodstvenog softvera organizacije Privredni Savetnik, zastupljen na tržištu Republike Srbije od 2010. godine. Korisnici imaju mogućnost da se opredele za pojedinačne segmente koji su im neophodni za svakodnevno obavljanje poslovnih aktivnosti. MPP2 poseduje osnovni, standardni i napredni nivo funkcionalnosti, sastoji se od 11 softverskih modula koji se odnose na različite segmente poslovanja. Navedeni nivoi pružaju mogućnost korišćenja određenih funkcija softvera. Osnovni nivo omogućava funkcije koje su potrebne malim privrednim društvima u svakodnevnom poslovanju. Standardni nivo predstavlja unapređenu verziju funkcija osnovnog nivoa, dok napredni nivo pruža kompletno izveštavanje i kontrolu celokupnog poslovanja [9].

5. SISTEMI ZA PLANIRANJE POSLOVNIH RESURSA (ENTERPRISE RESOURCE PLANNING)

Sistemi za planiranje poslovnih resursa spajaju i obrađuju informacije koje su zasnovane na praćenju procesa unutar privrednog društva, na osnovu čega se postiže potpuna upotrebljivost raspoloživih resursa privrednog društva. S obzirom da sistemi za planiranje poslovnih resursa predstavljaju veoma kompleksna i skupa rešenja za vođenje poslovanja, u daljem tekstu predstavićemo njihove prednosti i nedostatke.

SAP

SAP je svetski lider, odnosno treći najveći nezavisni proizvođač softvera na svetu u poslovnim aplikacijama po kriterijumu prihoda od softvera i usluga vezanih uz softver. Takođe, kompanija SAP predstavlja najveće evropsko softversko privredno društvo čiji programi olakšavaju strategijsko upravljanje resursima kompanije i nude sistem za planiranje poslovnih procesa (***Enterprise Resource Planning*** – u daljem tekstu ***ERP***). Kompanija SAP je na tržištu započela kao proizvođač ERP softvera, a danas predstavlja vodeću kompaniju za ponudu ERP rešenja. SAP ERP rešenje koristi se od strane 50.000 korisnika širom sveta, koji podržava procese u 25 industrijskih grana, u upotrebi je na čak 37 jezika i u 45 lokalizovanih varijanti [10].

Sistem za planiranje poslovnih resursa, odnosno ***ERP*** rešenje je softverski paket koji predstavlja skup alata i procesa za upravljanje poslovnim aktivnostima. Spomenuti sistemi omogućavaju kompanijama trenutno reagovanje na tržišne promene zahvaljujući razvrstavanju podataka, poslovnih objekata i procesa kojima se upravlja u realnom vremenu [11]. ERP sistemi su postali veoma važni za procese poslovanja kompanija širom sveta, jer su im omogućili da pojednostave svoje poslovanje, kao i da iskoriste i integrišu proces poslovnih podataka. ERP rešenja su razvijena kako bi ispunila poslovne zahteve kompanije u celini, i kao takva u sebi sadrže iskustvo i veštine preuzete iz kompanija, kao i od prethodnih korisnika. Takođe, da bi kompanije uspešno implementirale ERP projekte, neophodno je da izaberu ERP sistem koji može biti usklađen sa potrebama kompanije [12]. Osnovna i najvažnija karakteristika ERP sistema je integrisano planiranje i kontrola svih značajnih resursa posmatranog poslovnog sistema. Odnosno, pomenuti sistem omogućava povezivanje svih delova

(sektora) poslovanja u jedan jedinstveni integrisani sistem, pomoću kojeg se odvija stalna komunikacija, kao i deljenje informacija iz iste baze podataka. ERP sistem omogućava jednostavnije obavljanje poslova uz smanjenje papirologije i povećanje produktivnosti [13].

Jako je važno napomenuti da kompanija SAP nudi softverska rešenja za privredna društva svih veličina. U vezi sa tim, *SAP Business Suite* predstavlja integrisanu poslovnu aplikaciju koja se koristi u različitim industrijskim granama, za privredna društva koja zapošljavaju od 100 do 500 radnika. Sa druge strane, osnovna ponuda kompanije SAP sastoji se od *SAP Business All-in-One* i *SAP Business One* poslovnog softvera. Poslovno rešenje *SAP Business All-in-One* namenjen je malim i srednjim privrednim društvima koje zapošljavaju do 2.500 radnika, dok je *SAP Business One* kreiran za mala privredna društva koja zapošljavaju manje od 100 radnika [14], [10].

Pantheon

Razvoj novih tehnologija uslovio je korišćenje informacionih sistema za uspešno upravljanje privrednim društvima. Još jedan predstavnik ERP poslovno-informacionih sistema je Pantheon, kreiran od strane kompanije Datalab. Privredno društvo Datalab osnovano je 1997. godine sa sedištem u Sloveniji i trenutno broji 56.089 prodatih licenci. Pantheon je pre svega namenjen privrednim društvima koja ostvaruju brz rast i razvoj na tržištu i povećava funkcionalnost i stabilnost kompletnog poslovnog sistema. U fokusu njihovog poslovanja je kreiranje odgovarajućih informacionih sistema za vođenje malih, srednjih i velikih privrednih društava. Sistem je prilagođen za rad zaposlenih u okviru različitih sektora (rukovodstvo, računovodstvo, nabavka, prodaja itd.). Stoga, Datalab je razvio nekoliko Pantheon softverskih sistema za unapređenje poslovanja, i to: Pantheon - Small Business, Pantheon – Enterprise, Pantheon – Accounting, Pantheon – Retail, Pantheon – Manufacture, Pantheon – Public service, Pantheon – Specific Solutions [15].

6. PREDNOSTI SISTEMA ZA PLANIRANJE POSLOVNIH RESURSA I RAČUNOVODSTVENIH INFORMACIONIH SISTEMA

U tabeli br. 1 biće predstavljena komparativna analiza prednosti sistema za planiranje poslovnih resursa i računovodstvenih informacionih sistema [8], [9], [10], [15].

Tabela 1. Komparativna analiza prednosti sistema za planiranje poslovnih resursa i računovodstvenih informacionih sistema

PREDNOSTI SISTEMA ZA PLANIRANJE POSLOVNIH RESURSA	
SAP	**PANTHEON**
» Povećava konkurentnost pomoću brzih, integrisanih i pre svega fleksibilnih procesa » Modernizuje poslovne procese » Ušteda vremena potrebna za lansiranje na tržište » Obezbeđivanje mobilne, Cloud i in-memory tehnologije » Kontrola kvaliteta » Razvoj proizvoda i procesa proizvodnje » Unapređenje poslovnih procesa » Smanjenje zaliha gotovih proizvoda, poluproizvoda i nedovršene proizvodnje	» Prilagođava se potrebama klijenata » Unapređenje poslovnih procesa » Objedinjuje administraciju i operativne procedure » Minimiziranje nastanka grešaka » Izuzetno visok povraćaj na investiciju » Kompletna integrisana mrežna rešenja » Povećanje produktivnosti » Poboljšana komunikacija i razmena informacija sa stejkholderima
PREDNOSTI RAČUNOVODSTVENIH INFORMACIONIH SISTEMA	
LIDDER	**MPP2**
» Cena softvera » Jednostavna implementacija » Nivo/obim podrške » Jednostavna upotreba » Efikasnost i brzina početka rada » Obuhvatnost kompletnog poslovanja privrednog društva » Usklađenost sa zakonskim propisima » Profesionalni alat za vođenje poslovanja koji radi uvek nezavisno od interneta » Koristi uvedenog sistema su vidljive u kraćem vremenskom periodu	» Usklađenost sa zakonskim propisima » Fleksibilnost i otvorenost » Modularnost » Elektronska komunikacija » Korišćenje i tehnička podrška » Mogućnost preuzimanja podataka iz drugog softvera » Koristi uvedenog sistema su vidljive u kraćem vremenskom periodu

7. NEDOSTACI SISTEMA ZA PLANIRARANJE POSLOVNIH RESURSA I RAČUNOVODSTVENIH INFORMACIONIH SISTEMA

Pogrešno je razmišljanje menadžmenta privrednog društva da će uvođenje određenog informacionog rešenja u poslovni sistem preko noći poboljšati poslovne procese privrednog društva. Međutim, od odabira određenog sistema zavisi kako će se isti uklopiti sa strategijom, poslovnom kulturom i strukturom privrednog društva. U vezi sa tim, u daljem tekstu navedeni su osnovni nedostaci informacionih sistema [8], [9], [10], [15]:

- Visoka cena softvera;
- Visoki troškovi infrastrukture;
- Visoki troškovi uvođenja i implementacije softvera;
- Visoki troškovi za integraciju i testiranje;
- Visoki troškovi i obimna obuka kadrova;
- Visoki troškovi održavanja sistema;
- Teška integracija sa ostalim poslovnim rešenjima;
- Reorganizacija postojećih poslovnih aktivnosti i procesa;
- Veliki broj softverskih rešenja ne radi ukoliko nema internet konekcije;
- Ugrožena bezbednost podataka;
- Često javljanje grešaka;
- Koristi uvedenog sistema nisu odmah vidljive.

Svako privredno društvo ima svojstven način poslovanja na tržištu rada, pa u vezi sa tim svaki pojedinačni privredni sistem ima različite zahteve od svog informacionog sistema. Uvođenjem pogodnog računovodstvenog ili ERP sistema rukovodstvo privrednog društva može uticati na unapređenje svojih performansi, tržišne konkurentnosti i uspešnosti poslovanja [16]. Za privredno društvo je itekako važno uvođenje sveobuhvatnog i jedinstvenog informacionog sistema, jer od istog zavisi poslovanje privrednog društva. Od veličine i obima poslovanja privrednog subjekta zavisi izbor odgovarajućeg softverskog rešenja. U skladu sa pomenutim, privredna društva moraju jasno da definišu potrebna rešenja za svoju organizaciju, jer na primer ERP sistemi imaju veliki broj modula čije dodavanje može uticati na povećanje angažovanja i troškova. Da bi privredno društvo uvelo i implementiralo određeni informacioni sistem potrebna je adekvatna infrastruktura koja iziskuje visoke troškove. Za uspešno uvođenje sistema neophodna je stručna podrška prilikom projektovanja, odnosno dizajna projekta implementacije, programiranja, nadzora, obuke korisnika za rad, kao i njegovog kasnijeg održavanja [17]. Implementacija računovodstvenog informacionog sistema ili ERP rešenja zahteva detaljno finansijsko planiranje, kao i izradu budžeta, koja je relativno dugog trajanja. Konsalting predstavlja sastavnu savetodavnu uslugu u procesu uvođenja i implementacije određenog sistema od strane eksternih stručnjaka softverske kuće koje uglavnom svoje usluge naplaćuju po radnom satu. Osnovni problem sa kojim se menadžment privrednog društva često susreće su koristi uvedenog sistema koje nisu odmah vidljive, već je potrebno vreme za prilagođavanje konkretnim potrebama društva.

8. ZAKLJUČNA RAZMATRANJA

Tehničko – tehnološki razvoj i globalizacija uslovili su promenu rada u svakodnevnom poslovanju privrednih društava. U savremenom društvu korišćenje informacionih tehnologija omogućava izvršenje radnih procesa brže, efikasnije i kvalitetnije. Privredno društvo koje poseduje adekvatne resurse, nastoji da iste sačuva i unapredi. Da bi se pomenuto postiglo, u organizaciji moraju postojati određene strategije za razvoj istih. Zadatak menadžmenta privrednog društva je da motiviše zaposlene u procesu ispunjenja zajedničkih ciljeva i vrednosti. Takođe, od menadžera se zahteva i donošenje poslovnih odluka na osnovu pravovremenih i tačnih informacija. U savremenim uslovima rada, privredna društva na raspolaganju imaju veliki broj alata za operativno i strategijsko upravljanje. Jedan od alata za strategijsko upravljanje resursima društva predstavljaju računovodstveni informacioni sistemi i ERP rešenja koja se koriste za optimizaciju i automatizaciju poslovnih procesa, a koji su neophodni za postizanje ciljeva privrednog društva.

Na osnovu izvršene komparativne analize najzastupljenijih softverskih rešenja na teritoriji Republike Srbije definisani su informacioni sistemi koji imaju veću/manju upotrebljivost u privrednim društvima. U zavisnosti od veličine privrednog društva, koja je uslovljena brojem zaposlenih, imovinom, ostvarenim rezultatom poslovanja, određuje se vrsta informacionog sistema koji će se implementirati unutar poslovnog sistema. U vezi sa tim, pomenuta softverska rešenja poput Lidder-a i MPP2 koriste se za mikro, mala i srednja privredna društva zbog ograničenih funkcionalnih mogućnosti. Sa druge strane, softversko rešenje SAP i Pantheon predstavljaju sisteme koji omogućavaju sveobuhvatno planiranje poslovnih resursa posebno kreirane za srednje i velike poslovne

sisteme. Komparativnom analizom ustanovljeno je da su benefiti primene računovodstvenih informacionih sistema i ERP rešenja daleko značajnija u odnosu na njihove nedostatke. Glavni problem implementacije i uvođenja novog softverskog rešenja predstavljaju visoki početni troškovi, koji se mogu kvantitativno izraziti. Takođe, problem predstavljaju i koristi uvedenog sistema koje nisu odmah kvantitativno i kvalitativno merljive. Međutim, nakon određenog perioda adaptacije i prilagođavanja uvedenog softverskog rešenja potrebama privrednog društva postiže se efikasnija i efektivnija upotreba postojećih i neiskorišćenih resursa. Samim tim, izvršene promene poboljšaće buduće poslovanje kroz procese planiranja, dostizanje kratkoročnih i dugoročnih planova, kao i buduće investicije privrednog društva.

ZAHVALNOST

Rad je deo projekta ”Organizaciona i informaciona podrška sistemu upravljanja kvalitetom kao ključni faktor u povećanju konkurentnosti naših kompanija i njihovom bržem ulasku na svetsko i EU tržište”, br. 179001, u vremenskom trajanju od 2011–2019, finansiran iz sredstava Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije.

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ELECTRICAL ENERGY MARKETS AND ENGINEERING EDUCATION & ADVANCED ENGINEERING SYSTEMS

CONTROLLABLE LOAD FOR A MICROGRID TESTBED

John Konstantaras*,
Ilias Billas,
Eleftherios Tsambasis

Energy Systems Laboratory, National & Kapodistrian University of Athens, Athens, Greece

Abstract:
Microgrids are a building block of the smart grid facilitating the renewable energy sources penetration and customer involvement in demand side management. As the transition from the conventional to the smart grid progresses, the need for appropriate tools for development and testing increases as well. In this work we propose a design for a controllable load to be used with a microgrid testbed used to study stability, sizing and power quality aspects of microgrids. The smart load consists of commonly used loads controlled by a programmable logic controller to emulate actual load curves of a university building. It has been tested for a period of over a year using an existing autonomous microgrid that consists of photovoltaic panels and batteries. The results demonstrate its capability to emulate successfully actual load curves and its potential in microgrid testing.

Keywords:
smart load, hybrid microgrid, storage, load curve emulator.

1. INTRODUCTION

As the shift towards the smart grid [1] progresses, and the technology for renewable energy source (RES) integration improves, microgrids are viewed as an essential building block of the grid at the distribution level. The microgrid is a small-scale electrical power localized system which operates in grid-connected or island mode, may connect to the grid at the Point of Common Coupling (PCC), uses distributed energy resources (DERs), with or without storage, and serves local loads. Microgrids are expected to facilitate RES penetration, improve the grid's stability, resilience and quality of service and enable customer involvement in demand side management technologies [2,3].

A hybrid microgrid consists of various types of DERs, renewable or conventional [4]. DERs may be controllable, e.g. a fuel cell or a generator, or uncontrolled, e.g. PV panels or wind turbines. Hybrid microgrids with storage seem to be the most promising candidate for the emerging paradigm of the smart grid with high RES penetration. However, the storage technology lags behind the microgrid requirements for safety, cycle life, energy density, and cost [2].

Correspondence:
John Konstantaras

e-mail:
john.konstantaras@teiste.gr

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Microgrid testbeds can be used to experimentally test cases related to efficiency, optimal sizing and control, quality of service and resilience. To address these problems a controllable load is necessary to emulate the consumption profile of an entity, be it a user, a group of users or a microgrid. In the literature the term smart or controllable load usually refers to devices that can be controlled by a SCADA [5] or a building management system, such as thermostats [6] or "smart plugs". In this work, we use the term to describe a load that can emulate any given consumption profile.

The proposed controllable load presented is powered by a hybrid autonomous microgrid that serves as a testbed for the study of aspects of optimal microgrid design [7] and demand side management [8]. It is designed to emulate the actual load curve of a University building for various days of the year, scaled down to the capacity of an existing microgrid consisting of photovoltaic panels (PVs) and lead-acid batteries (Fig.1).

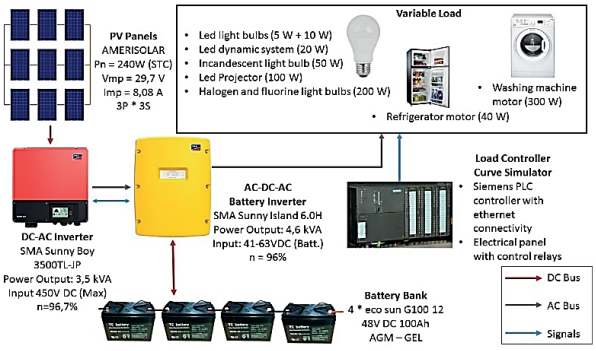


Fig. 1. The microgrid testbed with the controllable load

In the following section we discuss the requirements for the controllable load as dictated by the microgrid and the load studied. In section III, the system design and implementation is presented and section IV presents and discusses the test results.

2. SYSTEM REQUIREMENTS

The microgrid that will serve the controllable load is installed at the Euripus campus of the National and Kapodistrian University of Athens (NKUA) in Evia, Greece. The load curves emulated are those of the main University building. The daily profile varies significantly with the day of the week and the time of the year. The highest consumption is observed during exam weeks in January and June, which are also months of very low and very high temperatures, respectively, while the lowest consumption, which can be as low as one-third of the maximum value, is observed on weekends, holidays and vacation periods, regardless of the season. The minimum, average and maximum power is 2.00kW, 147.13kW and 529.40kW respectively while the minimum, average and maximum daily electricity consumption is 1434.00kWh, 3531.16kWh and 8086.40kWh respectively.

The area is characterized by strong solar irradiance, with Global Horizontal Irradiance, GHI = 1682kWh/m2 per year, and PV expected electricity output, PVout = 1495kWh/kWp but has a negligible wind field, less than 300W/m^2 with velocities less than 5km/h.

Due to the low wind power capacity, the microgrid relies almost entirely on solar power, featuring 2160Wp PVs and 400Ah battery storage. A 400W WT and a 3kW generator are also installed but they haven't been used in the tests discussed in this work. The microgrid has the capability for grid-tied operation but the results reported here have been obtained in island mode operation. The generation and storage systems are controlled by a commercial AC/DC/AC inverter with rated output power of 4.6kVA and efficiency rating over 95%.

Sensors, connected to the controller/inverter unit, measure the DC current generated by the PVs, the temperature of air, PV panels and batteries, the wind velocity and the adjacent radiation on the PV panels.

Typical load curves that reflect the characteristic operation of a university building at different times of the year have been selected from available hourly data of the main university building. As is the case with university buildings, the power consumption is a function of the weather conditions as well as the day of the week or period of operation. For example, the average and peak load of an exam day in June may be three times as much of an equally hot August day during the vacation period. In this work, to prove the flexibility and scalability of the proposed controllable load, we show the results obtained for 4 types of curves reflecting the average hourly consumption of 4 months: January, April, July and October. The data granularity necessary for the controllable load was set to 30 minutes. To double the granularity of the available data, interpolation method was used between existing data points. Given that the peak load is over 500kW, the load curves were scaled down by a factor of 0.0035 to match the generation capacity of the microgrid (Fig. 2).

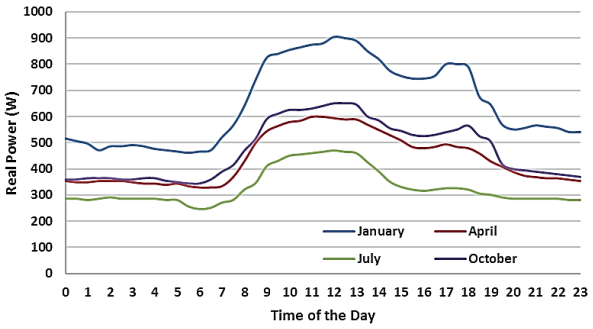


Fig. 2. The four load curves to be emulated by the controllable load correspond to the average hourly consumption of January, April, July and October scaled down by a factor 0.0035

The month of January requires the highest amount of electrical energy because of the lighting and heating needs as well as the long hours of operation, reflected especially in the afternoon peak. This load curve will test the boundaries of the microgrid's operation as it corresponds to a month of relatively low solar irradiance and low expected generation.

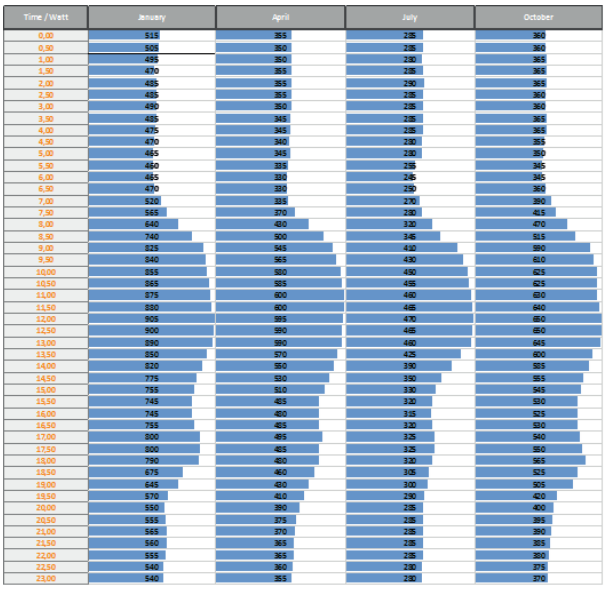
The April load curve corresponds to medium consumption with a smooth differential consumption profile which reflects the mild weather of the season, the longer days, and the typical class attendance. This is a less demanding curve for the microgrid to serve.

The July load curve is a low consumption curve since for the biggest part of it there are no classes due to summer holidays. July is also a month of high solar irradiance and very long days, so the generation is expected to be in the highest levels. This curve will also allow the study of the effect of the high temperatures recorded on location during the summer, which are expected to challenge the system.

The load curve of the month of October is similar to that of April with the exception of the shorter duration of days which reflects in the secondary peak observed in the evening hours. The solar irradiance is also lower, not only because of the earth's location with respect to the sun but also because of the rainy weather in that season.

The next step was to set the requirements for the distinct actual loads that will be used to emulate the scaled down load curves. First, we determine the base load of each curve and then use combinations of eight different devices to obtain the remaining (variable) load. The load is assumed to be constant for each 30-minute interval, the minimum allowed variation is 5kW and its actual (scaled down) value is rounded to the nearest permissible value.

The 30-minute interval values of each one of the four load curves are shown in Fig. 3.



Time / Watt	January	April	July	October
0,00	515	355	285	360
0,50	505	350	285	360
1,00	495	350	280	365
1,50	470	355	285	365
2,00	485	355	290	365
2,50	485	355	285	360
3,00	490	350	285	360
3,50	485	345	285	365
4,00	475	345	285	365
4,50	470	340	280	365
5,00	465	345	280	360
5,50	460	335	285	365
6,00	465	330	285	345
6,50	470	330	290	360
7,00	520	335	270	390
7,50	565	370	280	415
8,00	640	430	320	470
8,50	740	500	345	515
9,00	825	545	400	590
9,50	840	565	430	610
10,00	855	580	450	625
10,50	865	585	455	625
11,00	875	600	460	630
11,50	880	600	465	640
12,00	905	595	470	650
12,50	900	590	465	650
13,00	890	590	460	645
13,50	850	570	425	600
14,00	820	550	390	585
14,50	775	530	390	555
15,00	755	510	330	545
15,50	745	485	320	530
16,00	745	480	315	525
16,50	755	485	320	530
17,00	800	495	325	540
17,50	800	485	325	550
18,00	790	480	320	565
18,50	675	460	305	525
19,00	645	430	300	505
19,50	570	410	290	420
20,00	550	390	285	400
20,50	555	375	285	395
21,00	565	370	285	390
21,50	560	365	285	385
22,00	555	365	285	380
22,50	540	360	280	375
23,00	540	355	280	370

Fig. 3. The four load curves emulated by the controllable load correspond to the average consumption of January, April, July and October

3. EXPERIMENTAL SETUP

The base load of each month was emulated by a purely resistive load of 445W, 320W, 240W and 325W for January, April, July, and August respectively. The variable part of the load was constructed by washing machine and refrigerator motors and various types of light bulbs. More specifically, we used a refrigerator adjustable motor set to 40 Watt using an auxiliary resistor, a washing machine motor regulated to 300 Watt with controllable speed using a transformer and a resistor, 5W and 10W led lighting, dynamic 20W led lighting, a 50W incandescent light bulb, a 100W led video projector, and 200W halogen and fluorescent light bulbs. The selection of loads was such as to allow the study of power quality problems not discussed in this work.

The variable load is controlled by relays driven by a 240W, 24Vdc Siemens S7-300 PLC with a (312-1AE14-0AB0) CPU, 16 digital 24Vdc inputs (321-1BH02-0AA0) and 16 digital 24Vdc outputs (322-1BH01-0AA0) (Fig. 4).

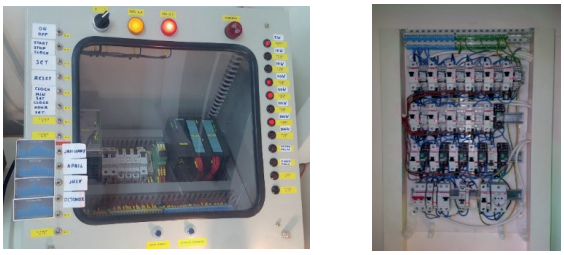


Fig. 4. The PLC and distribution panel of the system

The PLC is programmed to read the desired load for every 30-minute interval for a given month, calculate the appropriate combination of loads and activate / deactivate loads accordingly. Indicator lights inform the user of which loads are active at each given time, and the power supply from the microgrid inverter. The system also allows for an external power supply, e.g. the grid, which is not implemented in the current configuration. All results shown here have been obtained using the power generated by the RES microgrid in off grid mode.

4. RESULTS AND DISCUSSION

An Efergy® smart meter and a SIMEAS P power analyzer were used to monitor the consumption of the system. Several tests were performed for each load curve at different days under various weather conditions. For each test, the batteries were fully charged before turning on the load.

To test the impact of weather conditions, all four curves were tested under different weather conditions. For tests run during the winter season when the hours of daylight and solar irradiance are less and cloudy and rainy days are more often, the January and October curves had the highest number of "blackouts" especially during the night. The productivity of electrical power from the panels was less than in the spring period and the batteries couldn't supply the load during the nighttime. The July curve fared better because of the low energy demand and energy increments. However, for tests run during the spring season, the number of failures was the smallest for all curves, as the sunny hours were more and the weather was better. The summer tests verified our expectations for lower PV performance and higher losses due to the high temperatures.

Figure 5 shows curves obtained from the smart meter interface for cases that the microgrid failed to supply the load even when the base load was decreased to 50W to facilitate its operation during the winter nights. The top graph shows the results of a test run on a December day, a day with low solar irradiance, using the summer curve which corresponds to the lightest load. The system runs out of power during the early hours of the morning, restarts at 07.00, after sunrise, and runs smoothly for the rest of the day. The bottom graph of Fig. 5 shows the results of a test run on a February day, which is a day of relatively low solar irradiance, using the medium consumption spring curve. The microgrid shuts down shortly after 22.00 and unsuccessfully attempts to restart three times until early in the afternoon.

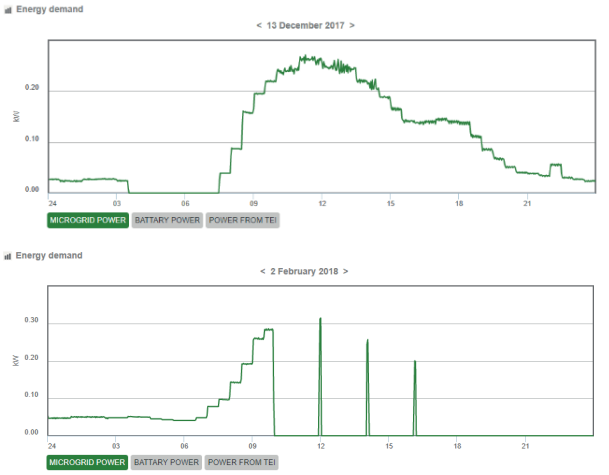


Fig. 5: Failure to supply the load

In Figure 6, the consumption of the controllable load is compared against the actual average load data for each month, for successfully completed tests where the energy supplied by the PVs and the batteries met successfully the demand of the load.

The performance of the controllable load is limited by the power granularity of 5W i.e. the smallest load and the time granularity of 30-minute interval chosen.

Another problem faced during the tests run for more than a year, was the deterioration of the battery performance due to the repeatable discharging and recharging. Optimal battery sizing and performance is an important issue that all autonomous microgrids must address to curtail replacement costs. During the winter season, solar power cannot meet the load requirements and it is necessary to have alternative supplementary energy sources such as wind turbines, if the winds in the region allow it, controllable sources, such as fuel cells or microturbines, or sources with predictable performance, such as tidal generators [9,10].

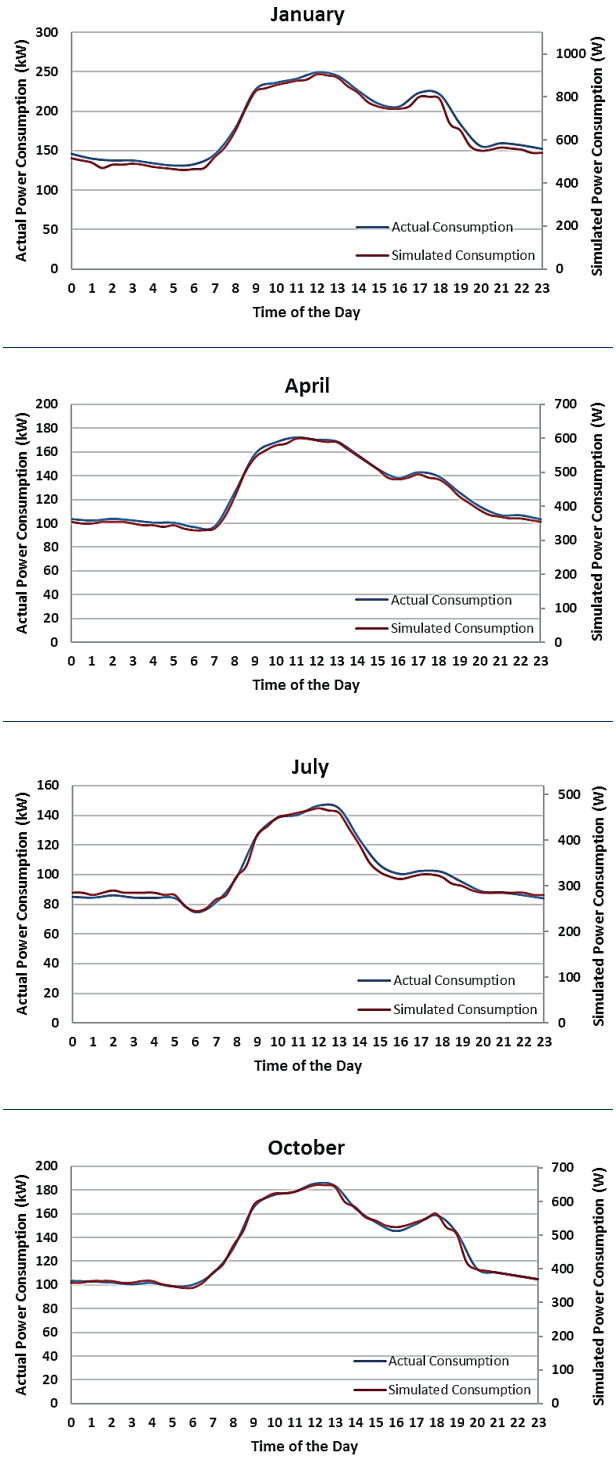


Fig. 6. Comparison between actual (hourly averages) and emulated load curves.

In figure 7 the relative error between the actual load curve and the simulated load curve for each month is shown. The study of the simulation errors is important as it verifies the produced simulation results but at the same time enables us to expose the witnesses of the system and proceed with the necessary upgrades.

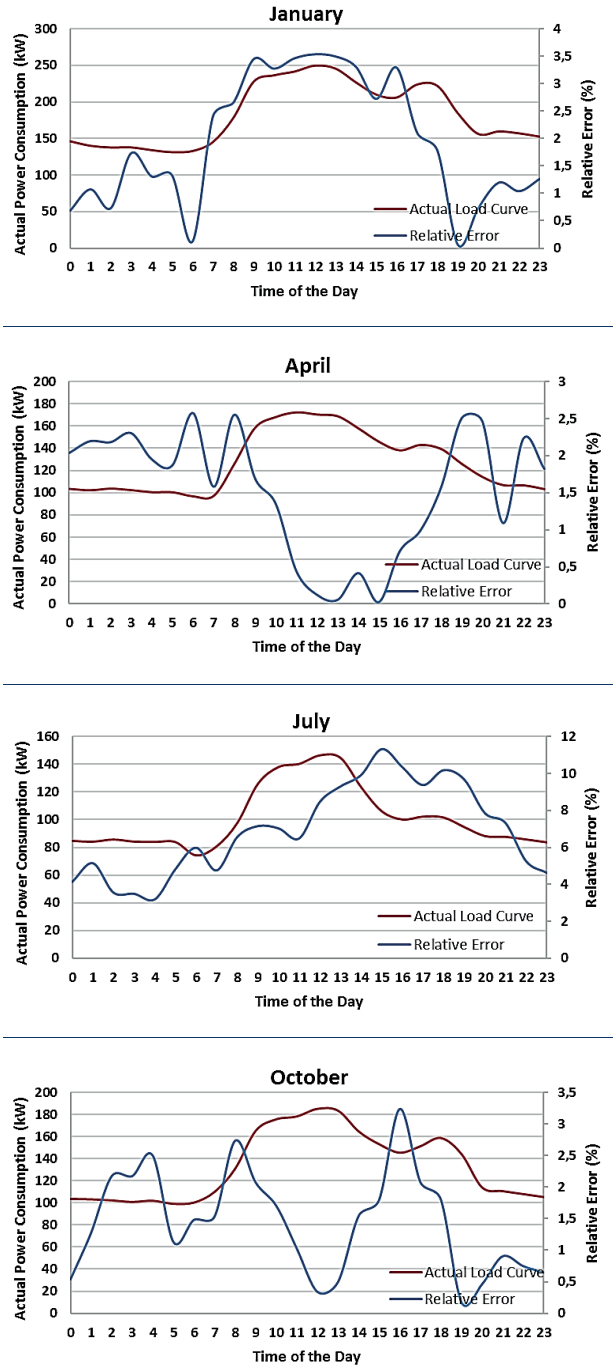


Fig. 7. Comparison between actual (hourly averages) and relative error with the emulated load curves.

For the load curve of January, the relative error between the actual and simulated curve is at an average of 1.95%. The maximum error is 3.54% and appears when the load curve is at its daily peak. One the other hand when power consumption decreases so does the relative error which has a minimum value of 0.06%.

The simulation of the April load curve features the lowest average error indicating that the chosen load

values have the best fit for this load profile. The average error is 1.53%. The maximum error is 2.58% and appears twice in the 24-hour period, at times when the differential load, eg the difference between two consecutive hourly loads, is highest. Greater load granularity would help the system compose a better fitted load for these times of the day and thus lower error would be exhibited. The lowest error value observed is 0.02% and occurs at times when the load is high.

The simulation of the July curve results in the highest error between actual and simulated values. The average error for this curve is 6.90% with 11.30% and 3.18% maximum and minimum values, respectively. The actual load curve for this month exhibits the lowest load among the load curves studied. From the results it is clear that greater load granularity with the addition of smaller loads will be required to better emulate such light load curves. Currently, the lightest load used in the controllable load setup described is 5W. To better fit the scaled down July curve, loads of 2W or even 1W need to be used.

The month of October has many similarities to the month of April. The average error is 1.44% with maximum and minimum values of 3.23% and 0.17%, respectively. The error curve has no correlation to the load curve in terms of minimum and maximum values and it can be attributed to the load granularity used in these tests.

5. CONCLUSIONS

The controllable "smart" load presented in this work is designed based on requirements obtained from actual load curves to be served by a specific microgrid testbed. It is scalable and low cost as it requires commonly used loads and relays and low processing power. It will be used to study various microgrid configurations, control strategies and power quality issues.

The time and power granularities used are acceptable for studying the above-mentioned cases. In cases where the highest and lowest load curves vary greatly, better load granularity should be used to keep the error values low. Should lower errors be required, the granularity can be easily increased with the use of complimentary loads. Furthermore, the addition of smaller loads on the system would have a positive effect when power quality issues are studied.

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ACQUISITION OF EMG SIGNAL USING PIC18F87K22 MICROCONTROLLER

Nemanja Peruničić,
Đorđe Novaković*

Faculty of Technical Sciences,
University of Novi Sad,
Novi Sad, Serbia

Abstract:
Purpose of this paper is to give an insight into the basics of gathering and processing of bio-potentials of our muscles. First, we address the laws and principles on which process of measuring is based upon; namely we examine what is measured, and how? Afterwards there is a detailed description of the measuring system – in our case it is a PIC18F87K22 microcontroller based system with a specially designed click-board on it. Firmware which controls the system behavior is written in mikroC development environment. Finally, the measurement results are acquainted in the .log format and presented by MATLAB program.

Keywords:
EMG, biceps, PIC, UART, mikroC.

1. INTRODUCTION

Information from our environment is gathered by sensory receptors, who process them to the brain. Brain sends a response, put into action by actuators (smooth and skeletal muscles). Nerves represent pathways that connect mentioned entireties; impulses that cause depolarization of muscle cells are transmitted along them. Depolarization occurs when an outside energy causes the regrouping of negative and positive ions, in and out of a muscle cell, via electrical gradient (and supported by diffusion gradient) – this causes chemical reactions, which in turn cause mechanical work. Works of many cells are combined into muscle contraction.

Intensity of contraction is proportional to intensity of the measured signal, and it depends on the number of impulses brought by the nerves. Empirical connection between the frequency of impulses f(t) (given in pps – pulse per second) and intensity of contraction p(t) (non-dimensional) is

$$p(t) = e^{(f(t)-B)/A} \tag{1}$$

And the model for EMG signal is given from [1]

$$e(n) = w(n) + \sum_{r=1}^{N} p(r) \times h(n-r) \tag{2}$$

Correspondence:
Đorđe Novaković

e-mail:
djordjenovakovic@uns.ac.rs

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Where h(n-r) is screening function; it's used to separate individual components from the intensity, and w(n) is additive white Gaussian noise. Digital electronic circuits are used for signal analysis so discrete time is introduced. Intensity p(n) is actually a result of superposition of impulses from individual motor units (group of muscle cells innervated by single nerve), that number N+M inside of a muscle, and differ in number and width of its cells. Not all motor units will become activated with arbitrary contraction (M), because of their different thresholds.

Although the number of pps can be measured with electroneurography device, and models exist for w(n), it is impossible to calculate A and B with great accuracy. Therefore e(t) is measured directly.

2. BASICS OF ELECTROMYOGRAPHY

Electromyography (EMG) is a method for measuring electrical activity of skeletal muscles for diagnostic purposes, or monitoring during therapy for inflammations, injuries and muscle atrophy. It can be used for clinical purposes or scientific research; where the first one will, generally, have higher standards. EMG is usually non-invasive, but it can be – if needle-electrodes are used. Stimulating electrodes can be used in a combination with measuring ones, for testing nerve conductivity.

Measurment ranges

The muscles will generate different signals, plus we have the obvious differences between individuals – but, as far as humans go EMG frequency range is from 10 to 10000 Hz, and amplitude from 0.05 to 5 mV.

In this paper we are considering the use of scientific research non-invasive EMG, set to give valid results for signals up to 500 Hz from left biceps. Frequency limitation isn't a problem since higher frequency components sometime don't exist, or are negligible.

Surface measuring electrodes

Electrodes for gathering physiological signals (EMG, amongst others) are meant for multiple usage, and made from silver of great purity coated with a thin layer of silver-chloride (Ag/AgCl). They are shaped like a disk, 10 mm diameter, and are located inside a plastic isolation package. Each electrode actually consists of two parts, meant to be joint like a button. Part that lays in is connected to a self-adhesive pillow. One-channel bipolar measurement is used, i.e. we are measuring the voltage between the pair of active electrodes, whilst the third one (called Driven Right Leg) is positioned anywhere on the body. It doesn't matter which one is used as DRL, they are identical. Everything given about the electrodes is according to [2]. Fig. 1 gives an example of the electrode placement.

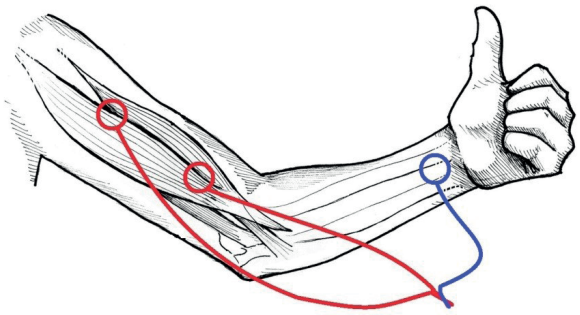


Fig. 1. Electrode placement

Components of EMG system

Signal from the electrodes must be amplified at least 10000 times, plus we have to worry about unwanted signals coming from other parts of the body, or from external electro-magnetic fields. High-pass filter is used for eliminating unwanted signals, and low-pass filter for movement artifacts and offsets from the amplifier. DRL electrode eliminates common voltage from instrumentation amplifier. Parasitic capacitance and inductance are eliminated with twisted and armored cables, respectively.

Since it is commonly used with other devices, ground loop can become a problem. Protection circuit protects both patient and the device from high voltages and electrostatic discharge. All technical solutions mentioned above are found in [3]. Fig. 2 shows the elements that every EMG must have.

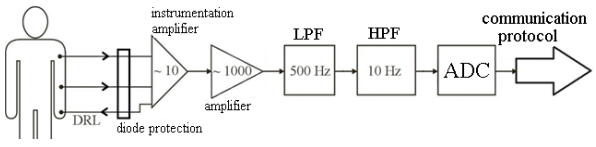


Fig. 2. Principal block scheme

3. MICROCONTROLLER MODULE

Microcontroller is a digitally integrated electronic circuit for independent real-time control of devices and processes, comprising: microprocessor, memory, digital and analog inputs / outputs, oscillators, timers, counters, converters, comparators, communication interfaces, etc. The chip itself is embedded on a development board, rich in various indicators and connectors, with multiple applications.

All microcontrollers are distinguished by the use of interrupt routines - interrupt, which begins when the pre-set conditions are met (the program constantly checks them), and the operations that were executed until that moment are put on hold. Programmable Intelligent Computer (PIC) is one of the types of microcontrollers; division is done according to architecture, method of instruction and application. Click-boards are specially designed integrated circuits designed for a specific job, which connect to a microcontroller through a 16-pin set – mikroBUS socket. The PIC18F87K22 microcontroller, together with the click-board EMG click, plays the role of an EMG device.

The Central Processing Unit (CPU; microprocessor) is the main part of any microcontroller. His role is to receive instructions, process them and hire other units as needed. It consists of

- Instruction decoder – converts binary code into program commands.
- Arithmetic-logical unit (ALU) – performs mathematical and logical operations over data.
- Accumulator – register containing the data that ALU is currently working on.
- Status register – contains additional information about the numbers in the accumulator (e.g. are they positive).

Storage is shared depending on what we store

- Read Only Memory (ROM) – for the code, the size of several tens of kB. In particular, Flash ROM with floating gate transistors is used, which can keep logical state without power supply.
- Random Access Memory (RAM) – for data; whether it's the end results or in-between, the size of a few kB. It's made of general purpose registers (for data values and addresses) and special registers (such as status register).

Input and output pins are registers that connect the microcontroller to the environment. Whether it will be analogue or digital is predefined in their purpose, and the user determines who will receive or send signals (information about this is recorded in the TRIS special register). Oscillator is a piezoelectric crystal with a resonant frequency set (in our case 16 MHz), which gives a working clock to the rest of the circuit. The timer counts the impulses from the oscillator, but since each instruction needs four oscillations, the timer is incremented once for every 0.25 μs (reciprocal value of ¼ of 16 MHz). When the timer's registry is full, it comes to an interrupt – and some time has passed. The counter counts the impulses of the input signals (e.g. objects on the production line, detected with industrial sensors).

Connecting the elements

It is clear that there must be a system of communication between parts of the microcontroller. PICs have a Harvard architecture, which uses two physically separate buses; for data transmission and memory addresses where they are located, or need to be. Bus can be of different size, and we can perform parallel operations, speeding up the work of the entire system. Fig. 4 gives an example of communication.

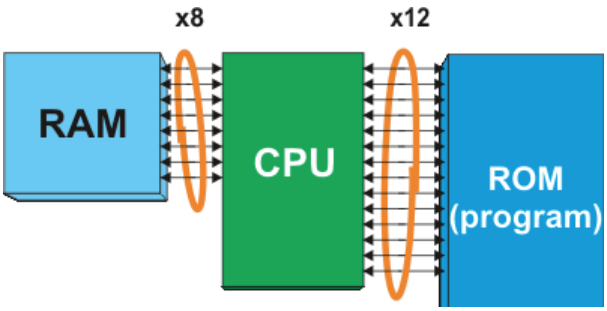


Fig. 3. Harvard architecture

Through the highway, the data is sent by bit; starting from e.g. the one with the highest weight factor, i.e. information is sent in full through one bus. We call this approach Serial Communication, but it is further divided according to the number of connections between the two elements. The best-known example is the Universal Serial Bus (USB), through which computer and microcontroller share information. For the communication between microcontroller and EMG click Universal Asynchronous Receiver-Transmitter (UART) protocol is used. Asynchronous means that the clock is not given

by the synchronization oscillator, but the transmitter and receiver have a predefined common speed (expressed in bps – bits per second). The morphology of the UART code is given in Fig. 5.

- Start bit; always 0 – tells the receiver to turn on its own internal clock; to go and follow what comes to him.
- Data is often sent in 8-bit format; LSB comes first.
- The parity bit can be added as a check of the correct reading of the receiver. It has two modes: even parity and odd parity – depending on whether we want a even or an odd number of counted logical ones 1 (in the code word in front of it) to give logic 1 in parity.
- Stop bit; always 1 – there can be more than one.

With the microcontroller used here, the maximum transmission speed is 10^6 bps. UART transfers digitized EMG from click to microcontroller; because everything is happening in real time, we would have a problem using low speeds since the data simply would not be all sent. The lower bound for the transmission speed should be significantly above the top for the frequency that our bumpers come from. If the sampling frequency was 10 kHz – values would be taken on every 100 μs. If the UART speed is, for example, generally known 9600 bps - we see that 104.2 μs is needed to transfer one bit, i.e. 1042 μs for one byte. A/D converters of less than 8-bits are not used in these applications; PIC18F87K22 contains a 12-bit ADC. We get that for every sample, for every 100 μs, we need 12 bits, and we have only 8 bits available at every 1042 μs. So 8 bits need to be transferred for the maximum of 66 μs.

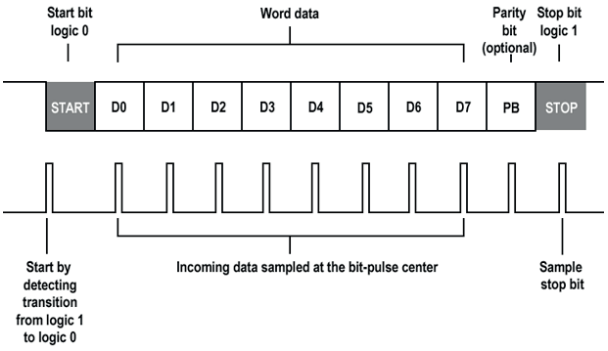


Fig. 4. UART code word

$$Baud\ rate = 8 \times \left(1 \div 0.000066\right) = 121212.1\ bps \quad (3)$$

The first higher value defined with UART standard should be chosen.

Click-board

The EMG click serves for single-channel collection of electrical signals from motor neurons of skeletal muscles. It is placed on one of the microcontrollers mikroBUS sockets, and uses six of the sixteen possible pins (see Fig. 5) – two are for the mass and UART, and one for the power supply (5 V) and an analog EMG signal.

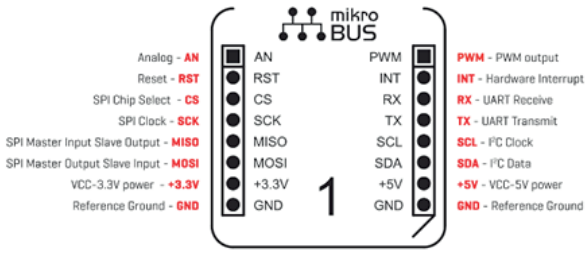


Fig. 5. MikroBUS standard

Before digitization, analog signal must be amplified and filtered – electronic circuits with operational amplifiers are used for that purpose. The electrode signal is run to, from first to last: preamplifier (instrumentation amplifier), HP filter, amplifier, HP filter, LP filter, AN pin of the microbus. All pins are located within the MCP609 amplifier chip. HP filters are passive and first order, and used because it would be technologically more costly to make one to equally weaken the signal. The LP filter is of the third order – the second row active is serial connected to the first order passive.

The DRL circuit takes a signal from the input of the preamplifier and takes it through two inverters, the other being the HP filter. Two-way zener diode (against high voltage) and diode pairs (against electrostatic discharge) are used as protection for the measuring channel and the DRL electrode. Apart from the amplifier, the MAX6106 chip is also used to form a reference mass for the entire circuit; in this case it is 2,048 V. This moves the base line of the EMG signal up from zero – otherwise negative values would be cut off. In case range of enhanced EMG needs to be adjusted to another type of microcontroller, with a different input range of A/D converter, a jumper and potentiometer (within MAX6106) move the reference mass.

4. FIRMWARE AND SOFTWARE

MikroC is a software environment for managing PIC microcontrollers with C programming language. The user has at his disposal (among other things) a number-type converter, several structures for hierarchical navigation within the project, an expandable library with a note on the applied functions and a helpful algorithm for clarifying the errors. The essence of the code (the algorithm for solving this particular problem) is written within the main function "void main ()", and other functions are defined out of it, but called within. Common example for that would be the interrupt routine. The body of the function is defined with curly brackets, and the variables that do not belong to each are automatically global. Fig. 6 shows the entire code needed to activate the necessary components in our system for acquiring and transferring bioelectric signals. For some parts of the code, the theoretical knowledge is necessary

```
bit flag;
void interrupt() {
  if (INTCON.TMR0IF) {
    INTCON.TMR0IF = 0;
    TMR0H        = 0xF9;
    TMR0L        = 0xBF;
    flag = 1;
    }
  }
static void initMain(){
  T0CON        = 0x88;
  TMR0H        = 0xF9;
  TMR0L        = 0xBF;
  GIE_bit      = 1;
  TMR0IE_bit   = 1;

  UART1_Init(115200);
}
```

```
void main(){
  float suma;
  char txt[30];
  unsigned short i;
  initMain();
  while(1){
    suma = 0;
    for(i=0;i<5;i++){
      while(!flag);
      flag = 0;
      suma += ADC_Read(0);
    }
    sprintf(txt,"%.2f",suma/4096.0);
    UART1_Write_Text(txt);
    UART1_Write_Text("\r\n");
  }
}
```

Fig. 6. Complete mikroC code

- Since the EMG frequency up to 500 Hz is considered, the Nyquist criterion states that the signal should be sampled with at least 2500 Hz. Based on this and the logic shown in formula (3), a Baud rate greater than 30303 bps is required (we used 115200).
- For 2500 Hz gives a time interval of 0.4 ms. PICs timer is incremented at every 0.25 μs – divide the time interval with it and it's shown that 1600 increments are needed in order to say with certainty that 0.4 ms have passed. Conclusion: values must be taken after every 1600 countdown – i.e. interrupt must appear.
- The timer register has 16 bits; it counts from 0 to 65535 – in the end an interrupt will automatically occur – it is a hypothetical bit that is out of the counting frame (modeled with a flag), when the registry itself is set to 16 zeros. Therefore, we introduce that every counting cycle starts 1600 increments before the end – hexadecimal variables TMR0H and TMR0L tell us that counting ranges from 63935.
- Assuming that the noise has Gaussian distribution; mentioned in [4], it can be filtered by arithmetic mean. Therefore, when calling an interrupt, a loop is given – every five consecutive values will be averaged. Five are taken for one more reason: when reading the values from the A/D converter we get them in the voltage quants, and they need to be displayed in volts. The conversion is done by multiplying with 5 V (supply voltage) and dividing by 4096 (2^{12}); two fives cancel each other out. Later, when the signal is being processed on a computer, the time axis must be multiplied by 5, in order to be scaled properly.

Signal display

UART is compatible with many third-party programs for recording registered values. The files obtained in this way are in the .log format that can be entered in a spreadsheet like Microsoft Excel. From there they can be loaded into MATLAB. Fig. 7 shows us an example of EMG signal.

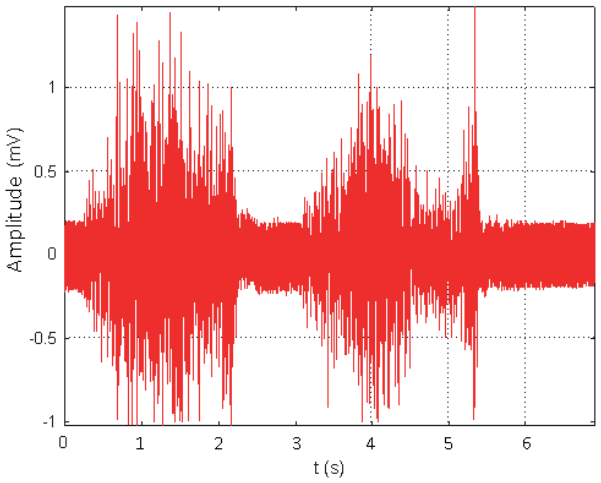


Fig. 7. EMG signal

The respondent performed three rapid biceps contractions; without complete relaxation between the second and third one. Because the muscles are tightened even in a state of complete rest, values will exist at all times. Due to the elevation of the base signal line, a one-way component is hidden within the EMG – it was removed by subtracting its mathematical approximation from the entire signal. Also, 1 % of the highest values in the signal were taken as a result of the pulse noise, and were deleted by direct and inverse vector sorting.

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BSC CURRICULA MEASUREMENT AND CONTROL ENGINEERING AT FACULTY OF TECHNICAL SCIENCES, UNIVERSITY OF NOVI SAD

Zoran Mitrović*,
Platon Sovilj,
Bojan Vujičić,
Đorđe Novaković,
Marjan Urekar

Faculty of Technical Sciences,
University of Novi Sad,
Novi Sad, Serbia

Abstract:
In ELEMEND project, BSc Curricula Measurement and Control Engineering at Faculty of Technical Sciences, University of Novi Sad, is one of the programmes which should be transformed and modernized in order to achieve the ELEMEND project goals. This paper presents the review of this studying programme, from perspective of programme structure, programme objectives, programme goals, graduate competencies and curriculum.

Keywords:
technical sciences, education, measurement, control, engineering.

1. INTRODUCTION

Faculty of Technical Sciences originates from the Faculty of Mechanical Engineering which was established by the Decree of the National Assembly of People's Republic of Serbia on 18th May 1960 as a Faculty of Mechanical Engineering in Novi Sad and it was a constituent part of the University of Belgrade. After the founding of the University of Novi Sad on 28th June 1960, the Faculty along with six previously established faculties in Vojvodina was regarded as a part of the University of Novi Sad.

In the first period of its development the Faculty provided educational activities for three different profiles of mechanical engineering. In 1971 electrical and civil engineering studies were founded. Establishment of the Department of Electrical Engineering as well as the Department of Civil Engineering brought about the change of its name into the Faculty of Technical Sciences on 22nd April 1974. In 1979/80 academic year started the studies in the area of traffic engineering, and in 1996/97 the first generation of students of architectural engineering was enrolled.

In academic year 1999/2000 several different studies for the new professional profile were introduced: Industrial Engineering and Engineering Management (the first generation of students of Industrial Engineering was enrolled in 1969, but within the Department of Mechanical Engineering), Graphic Engineering and Design, and Environmental Engineering. Study programme for Postal Services and Telecommunications were introduced at the Department for Traffic Engineering in 1999/2000.

Correspondence:
Zoran Mitrović

e-mail:
zoranmit@uns.ac.rs

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Interdisciplinary studies of Mechatronics were established in 2002/03 academic year. In 2006/07 academic year the first generation of students of specialist academic studies was enrolled at the Faculty (according to the Law on Higher Education) and the studies of Geodesy and Geomatics engineering were introduced into the educational activities of the Faculty in 2007/08 academic year.

Furthermore, in 2009/2010 the studies of Safety at Work were established at the Department of Environmental Engineering as well as the undergraduate professional programme at the Department of Power Engineering – Renewable Energy Sources. In 2011/2012 academic year the following studies were established: Risk and Fire Protection Management, Animation in Engineering as well as undergraduate professional studies Software and Information Technology at the Faculty Department in Inđija; the same study programme was also introduced at the Faculty Department in Loznica in 2012/2013 academic year.

In 2013/2014 academic year the following study programmes will be established: Biomedical Engineering, Measurement and Control, Clean Energy Technologies, Stage Architecture, Engineering and Design, Electric Power Software Engineering, Software Engineering and Information Technology in Novi Sad as well as at the Faculty Department in Loznica and undergraduate professional studies within the study programme of Electronics and Telecommunication.

Master studies are organized at all study programmes after finishing undergraduate academic studies as well as at study programmes: Mathematics in Engineering; Energy Management; Logistic Engineering, Digital Technology, Design and Production of Architecture and Urban Planning, Industrial Engineering - Advanced Engineering Technology, Industrial Engineering - Development and Product Lifecycle Management, Planning and Management of Regional Development as well as Treatment and Water Protection (TEMPUS programme) which rounds off the educational activities of the Faculty.

Faculty of Technical Sciences offers a very prominent educational profile for prospective engineers, which ranks it among the most developed institutions in the field of technology in our country.

The study programme Measurement and Control Engineering has been created on the basis of modern scientific knowledge in the field of Electrical and Computer Engineering, modeled after similar study programmes at the leading universities in the world and in accordance with the Bologna recommendations and technology strategy development of AP Vojvodina and Serbia. Lectures within the undergraduate academic studies last 4 years and a graduate thesis is planned for the eighth semester. Students who successfully complete this study programme obtain a diploma in Electrical and Computer Engineering with the title of the study programme Measurement and Control Engineering, as well as information on particular competences that the students obtain during their studies.

The current state and, especially, trends in the development of electrical and computer engineering, especially in the field of measurement and control, form the basis for defining the structure and content of the study programme. For that reason a number of subjects at the lower years of study is defined in such a way to provide the necessary general and theoretical knowledge, as well as basic skills that lead the student to practical application of gained knowledge. Good balance between knowledge and skills at lower years provides good base for subjects at higher years, which are devoted primarily to specialized courses which are aimed at providing professional and applied knowledge in the narrow fields of interest.

Acquired knowledge and skills enable graduate students to successfully answer to the demands of the market and knowledge-based economy in the field of modern electrical and computer engineering. Particular knowledge and skills in fields of measurement and control engineering provide students after completing the programme to easily adapt to the industrial process in the field of measurement and control without additional courses in the company. At the same time, graduate students from this programme have good basic knowledge for higher levels of education on study programmes that follow this or similar programmes.

Lectures in professionally applied and scientific-professional subjects are carried out by teachers from the Department of the Power, Electronics and Telecommunications Engineering, which is responsible for the study programme, and Department of Computing and Control Engineering at the Faculty of Technical Sciences in Novi Sad.

Lectures in theoretical-methodological and academic-general educational subjects are carried out by teachers from other departments of the Faculty of Technical Sciences. The practical part of the lectures is carried out in modern and well equipped laboratories in which students are trained to solve practical engineering problems.

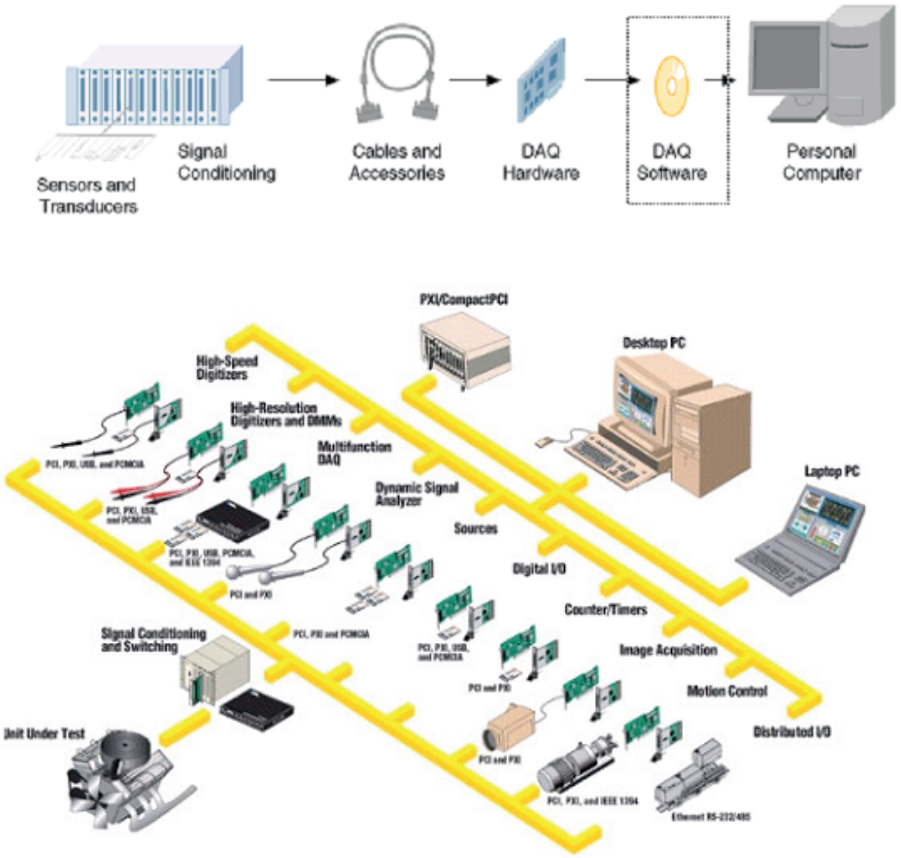


Fig. 1. Typical modules of a measurement and control system, which are the topics in BSc Curricula Measurement and Control Engineering at Faculty of Technical Sciences, University of Novi Sad.

2. PROGRAMME STRUCTURE

The outcomes of the learning process include knowledge, skills and competences which enable students to apply acquired knowledge to the problems arising in engineering practice, to use expert literature and to enable students to continue their studies, if they choose so. Students of this programme have obligatory and elective courses.

Elective courses are chosen from a list of suggested courses. An elective course can be replaced with one of the courses taught at the Faculty of Technical Sciences or the University of Novi Sad with the consent of the head of the study programme.

Courses are carried out in the form of lectures and practice. At lectures, while using the appropriate modern didactic-methodological methods, students become familiar with the course subject matter and are offered explanations that help them understand it more easily.

At practice classes, complementing the lectures, students solve specific engineering problems and are given examples which further illustrate the course matter. The practice classes can be auditory, computer or laboratory practice. Consultations also present an important segment of knowledge transfer.

A large number of laboratory practice in the professional subjects provides students to acquire practical knowledge needed to continue the career, as well as through joint work on the project and acquire the knowledge and skills that are not strictly professional, such as group work, project management, managing a group of people and so on. Number of the students per group depends on the character of practice.

Student obligations may comprise of research papers, homework assignments, as well as smaller professional project assignments. Every activity of the student during the teaching process is evaluated and graded in accordance with the rules established at the Faculty level. The number of obtained credits is represented by the unique methodology and it reflects student load.

3. PROGRAMME OBJECTIVES

The goal of the study programme is to educate students for the profession of an engineer of electrical and computer engineering-Bachelor in accordance with the economy needs, knowledge based economy and society at large. The study programme Measurement and Control Engineering is designed to provide acquisition of competencies necessary for the graduated engineer of electrical and computer engineering.

An important role of all teachers in this study programme is to educate top engineers ready for active involvement in the regional development and responsible for the maintenance of the high-tech and research potential of Vojvodina and Serbia in the field of electrical and computer engineering. The objective of the study programme is fully in accordance with the main objectives and goals of the Faculty of Technical Sciences and is in line with the high educational standards proposed by our educational system.

Also, the realization of this study programme educates engineers of electrical and computer engineering who possess knowledge necessary for the labour market in Serbia, the region and beyond.

4. PROGRAMME GOALS

The objectives of the study programme can be classified in the following categories: Technical knowledge: Acquiring the necessary knowledge in the field of electrical and computer engineering combined with the knowledge of mathematics, physics and selected social studies.

The programme ensures the in-depth knowledge in measurement suystems, automatic control and power drives. Practical knowledge: The focus of this program is placed on practical knowledge in identifying technical issues, terms of project requirements and formulating a plan for the implementation and resolution of technical problems using skills and knowledge in various areas.

Engineers who complete their studies in this program of study will be competent in the design and development of complex measurement and regulation systems and their component parts, and will be trained for later master's and doctoral studies and monitoring of rapid technological development in the field of electrical engineering and computer science. Communicative skills and team work.

Acquiring the necessary knowledge and skill in at least one world language with the ability to present one's results to the professional and wider audience as well as developing the team work skills. Subjects in the field of project management will provide ability of critical thinking, understanding the importance of preparation, leadership roles in the team, and each participant for the timely completion of the project.

Preparation for further studies: One of the specific objectives of the study programme is the development of students' awareness of the necessity for permanent education and advancement in the field of electrical and computer engineering. Acquiring the necessary knowledge which will enable the continuation of student's education at graduate, specialization or doctoral level.

5. GRADUATES` COMPETENCIES

After completing the study programme, students will be competent for the development, engineering, design and application of modern complex systems and their parts in the field of electrical engineering, especially in measurement and control systems that include wide area from measurement of electrical and nonelectrical quantities, data processing, automation and control to control of power drives.

Electrical and computer engineers who have completed Computing and Control Engineering study programme have the competence to solve real life problems in practice as well as to continue education if they decide to do so. Their competences include, primarily, critical thinking, the ability to analyze a problem, synthesize a solution, predict the behaviour of the chosen solution with the clear idea of the advantages and disadvantages of the chosen solution.

Students who successfully complete the study programme in the field of measurement and control engineering will be able to:

- understand and apply fundamental knowledge in electrical engineering.
- apply knowledge in mathematics, physics and engineering disciplines.
- design systems, components and processes based on the provided specifications.
- use engineering approach and modern software tools in engineering practice.
- design and carry out engineering experiments and afterwards analyze and interpret obtained data.
- understand, notice, formulate and solve engineering problems.

- advance their knowledge and follow technological development.
- work in a team composed of experts in different fields.
- understand professional and ethical responsibility of electrical and computer engineers.
- communicate efficiently.
- understand impact of engineering solutions on society and environment.
- accept the need and actively participate in life long education.

6. CURRICULUM

The curriculum of the undergraduate academic studies Measurement and Control Engineering is designed to satisfy objectives of the study programme. In the structure of the study programme there are academicgeneral education, theoretic-methodological, scientific-professional and professional-applicative courses. In order to meet individual preferences of students, study programme curriculum contains elective courses as well, through which student obtain particular competences within the elected modules. All courses last one semester and are worth certain number of ECTS credits, where one credit corresponds to approximately 30 hours of student activity.

The order of course lectures in the study programme is such that the knowledge required for the following courses is gained through previously attended courses. In order to successfully complete this study programme, students must collect at least 240 ECTS credits. Curriculum includes description of each course which contains the name of the course, the type of the course, the year and semester of the studies, the number of ECTS credits, the name of the lecturer, the course objective with the expected outcome, the knowledge and competences the student will acquire, the prerequisites for taking the course, the course content, the recommended literature, the methods of lecturing, the knowledge tests and evaluation and other relevant data.

Professional practice lasting 45 hours is an integral part of this curriculum and it is realized in adequate scientific-research institutions, innovative organizations, companies, public institutions, etc. Students complete their studies by writing the graduate thesis which consists of theoretical-methodological preparations necessary for complete understanding of the field, writing and defense of the graduate thesis.

To perform a study programme, the adequate human, spatial, technical and technological, library and other resources suitable to the study programme features and predicted students' number are to be provided. Lectures are held in amphitheatres, classroomas and specialized computer or measurement laboratories (between 12 and 20 work places) which are equipped with contemporary equipment where students experimentally prove and deepen the matter taught in lectures. Library is within the Faculty of Technical Sciences building, and has enough bibliographic units which are relevant for this study programme. All courses within the study programme are accompanied by adequate textbook literature, teaching aids and props available for normal teching process.

The quality control of the study programme is performed regularly and systematically through selfevaluation and external quality control. At the Faculty of Technical Sciences there is a perennial postitive practice of interviewing students through questionnaire. The quality control of the study programme is perfomed through following activities: (a) interviewing students by questionnaire at the end of the lectures for the given course, (b) interviewing graduated students by questionnaire about study programme quality and logistic support to the studies at the diploma awarding ceremony, (c) interviewing students by questionnaire about evaluation of logistic support to the studies at the certification of the study year, (d) interviewing students by questionnaire when enrolling to the year of study. Students assess study programme of the previously completed school year, (e) interviewing lecturing and non-lecturing staff by questionnaire about quality of the study programme and logistic support to the studies.

ACKNOWLEDGMENT

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QUALITY OF SERVICE OF WSN AS DETERMINATE FACTOR OF SUSTAINABLE AUTONOMOUS BEEKEEPING SYSTEM

Nadezda Kunicina[1,*],
Anatolijs Zabasta[1],
Rasa Bruzgiene[2],
Lina Narbutaite[2],
Antons Patlins[1]

[1]Faculty of Power and Electrical Engineering,
Institute of Industrial Electronics and
Electrical Engineering,
Riga Technical University,
Riga, Latvia
[2]Kaunas University of Technology,
Kaunas, Lithuania

Abstract:
The modern autonomous beekeeping system developed in this research is the real example of Internet of Things technologies (IoT) in the beekeeping sector. It performs a bee colony control without interfering with its processes, while optimizing frequency of the apiary inspection. The system helps to analyze data correlation with video, meteo data, mass changes in time as well as interpretation of nest temperature, humidity and linking to local geographic and biological conditions. It allows a beekeeper to request and receive key data indicators. The Quality of Service of Wireless Sensor Networks is a determinative factor of a resilient Autonomous Beekeeping System. This research explores the problems associated with vulnerability of Wireless Sensor Network with the special focus on the weather conditions impact on the signal transmitting quality in WSN. The study of the impact of weather conditions on the signal strength in outdoor wireless sensor networks, testing the reliability of data transmission, alerting services performance degradation in different weather conditions was implemented in this research based on the WSN testing results.

Keywords:
wireless sensor networks - WSN, Quality of service (QoS), vulnerability, MQTT, autonomous beekeeping system.

1. INTRODUCTION

Nowadays a beekeeping is based largely on manual work that requires regular visits to bee apiaries for monitoring bee hives. However, physical inspection interferes bees' life and causes stress that negatively affects the productivity of all product lines. It is very important to find opportunities for remote monitoring of bee hive' profitability, flying activities, bee colony moods and bees' family health status. By implementing the autonomous beekeeping, the hives conditions can be tracked remotely, e.g. whether the inside temperature is critical, if the family is missing feed, therefore the critical deviations can be detected and prevented in time.

The project "Autonomous Beekeeping" was initiated by the Riga Technical University, Latvian Internet Association and two beekeeper farmers in the beginning of 2018. The project is funded by the European Agricultural Fund for Rural Development Program 2014-2020 Cooperation: Support new products, methods, processes and technologies.

Correspondence:
Nadezda Kunicina

e-mail:
nadezda.kunicina@rtu.lv

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The proposed solution is the real example of Internet of Things technologies (IoT) implementation in the beekeeping sector. It will perform bee apiary control (individual bee colonies and at the apex level) without interfering its processes, while optimizing frequency of the apiary inspection. The system will help to analyze data correlation with video, meteo data, mass changes in time as well as interpretation of a nest temperature, humidity with the linking to local geographic and biological conditions. It will allow a beekeeper to request and receive key data indicators. At the second stage of the project, the use of alternative energy sources (solar) for power supply will increase the application possibilities of the system at variety of geographical locations.

During a summer season beekeepers are forced to reallocate a bee apiary several time pursuing better conditions for harvesting of honey products. This fact sets requirements to the autonomous beekeeping system: a wireless network, which ensures data collection from sensors, has to be easy and fast setup, independent from an electricity supply, reliable, safe and independent of weather conditions (rain, fog, froze, etc.)

The goal of the research is to test the quality and reliability of the WSN network, which is used for a bee hives monitoring system. This research explores the problems associated with vulnerability of the WSN, with a special focus on the weather conditions impact on the signal transmitting quality. The study of impact of weather conditions on the signal strength in outdoor WSN, testing reliability of data transition, alerting a service performance degradation, the data transmitting joint concept in different weather conditions was implemented in this research, based on the WSN testing results.

2. HOW WEATHER AFFECTS WIRELESS SIGNAL

The paper [1] analyzed the potential impact of rain, fog, wind and temperature deviations on the performance of a network equipment of wireless networks. Gathering information about network throughput, error rates etc. on a daily basis it was revealed that "different weather phenomena affect the wireless links in a variety of ways". Their experiment showed that wind storms cause movements in the antenna and consequently make the antenna skew. Moreover, it was proved that high temperature causes the output waveform to distort that results in errors in the packet processors in the routers.

Previous studies have shown that absorption, scattering, and refraction of microelectromagnetic waves by atmospheric gases and precipitation is an important limiting factor in transmission distances in wireless communications. In fact, rain, fog, and clouds become a significant source of attenuation when wireless networks operate using the microwave spectrum [2].

Quality of service (QoS) provisioning in communications systems entails a deep understanding of the delay performance. The delay in wireless networks is strongly affected by the traffic arrival process and the service process, which in turn depends on the medium access protocol and the signal-to-interference-plus-noise ratio (SINR) distribution. The paper [3] characterizes the conditional distribution of the service process given the point process in Poisson bipolar networks. The researchers analyzed the delay performance under statistical queueing constraints using the effective capacity formulation. They identified the impact of QoS requirements, network geometry and link distance on the delay performance.

The research [4] investigated a metering solution based on the modular principle for inter-system communication paradigm using selectable interface modules (IEEE 802.3, ISM radio interface, GSM/GPRS). They focused at EMI electromagnetic interference impact at the proposed solution, which should be applied to the control of different critical infrastructure networks (water distribution and district heating networks, electricity network, etc.) using adapted modules. Therefore, the developed metering systems has to be able to operate under diverse conditions: outdoor installation, indoor industrial installations; under electromagnetic pollution, temperature, humidity, rain impact, etc.

The most common formula for estimating the absorption due to rain, according to which: $A = aR^b$, where absorption is measured in decibels per kilometer, rain intensity is measured in millimeters per hour, and parameters a and b depend on the size distribution of the droplets and on the frequency. Moreover, the absorption also depends on the polarization of the electromagnetic wave. For certain values of a and b, the absorption depends on the intensity of rain, R. The main concern is about the periods of time during which the intensity of rain exceeds a certain threshold. It all depends on the climate zone. There are tables developed by the International Telecommunications Union (ITU), where the Earth is divided into 15 climatic zones depending on precipitation. According to the tables R, values are exceeded for different periods of time during the year. This information can be used to determine the availability of a radio channel [5].

The fog affects similar to rain due to much more smaller droplets. The impact of fog to a wireless signal reception depends on a frequency range used for operating. Below 2 GHz it's not a huge factor, but above that number fog can seriously scatter the signal. If we talk about cell signal, some of the latest 4G LTE bands operate at those frequencies.

Ice crystals are far less dense than liquid water, especially in snowflake form, so they don't have nearly the same effect on signal propagation. But very heavy snow may still refract radio waves, reducing signal strength.

The high frequency wavelengths used by phones don't travel well through *water, b*ecause water conducts electricity that can reflect radio waves. Water vapor absorbs the energy of radio signals, and turns them into heat. Basically, water blocks the radio signal between the tower and mobile phone. There is no or few obstructions to radio signals traveling across bodies of water, however, cool water temperatures can create surface inversions that trap a layer of cool air close to the surface. Both factors together may mean you'll experience longer than usual reception ranges between two points separated by a body of water.

The impact of *hail* on the quality of services depends on the size and density of the hail in question. Ice has less dense than water, and hail does not tend to fall as thickly as rain, so its refraction of cell signal will be less. The huge charge of a *lightning bolt* can cause electrical interference, and can damage antennas, power sources, and other transmission equipment. *Wind* alone does not interfere with radio signals, but the weather conditions associated with it can do it. Wind can damage exposed cell towers, power lines, and the electrical equipment associated with them.

The dense biomass of a forest contains a ton of water, so the *trunks and leaves of trees* combine can reflect and absorb radio signals. In a deciduous forest, you may get better signal reception in winter than in summer, due to the trees shedding their leaves, opening up space for radio transmissions to pass through [6].

The sustainability issues of autonomous beekeeping have been considered in [7, 8, 9] with the research focus on bees behavior in different environment condition. In our research we put emphasis on the development of a reliable monitoring system, which is resilient against changing weather conditions.

3. AUTONOMOUS BEEKEEPING SYSTEM

Wireless Sensor Networks (WSN) are widely used for implementation of Internet of Things (IoT) concept at the different areas of application. The validation of reliability of data transmission can be implemented by alerting a service performance degradation. The data transmitting in different weather conditions have been tested because, it is an important part of the whole Autonomous beekeeping system.

The wireless sensor networks operating outdoors usually are exposed to changing weather conditions, which may cause severe degradation of a system performance. The main impact at the quality on WSN is assessed by Quality of Delivery (QoD) parameters. QoD can be characterized by error recovery procedures, packet loss, retransmission process, data processing, flow control, and integrity of data. The metrics used to link quality estimation in WSNs are RSSI (Received Signal Strength Indicator), PRR (Packet Reception Ratio), SNR (Signal to Noise Ratio), and LQI (Link Quality Indicator). The quality and reliability of WSN network was tested as a part of bee hives monitoring system (see Fig. 1. – sensors and video cameras and Fig. 2 – meteostation and autonomous energy supply).

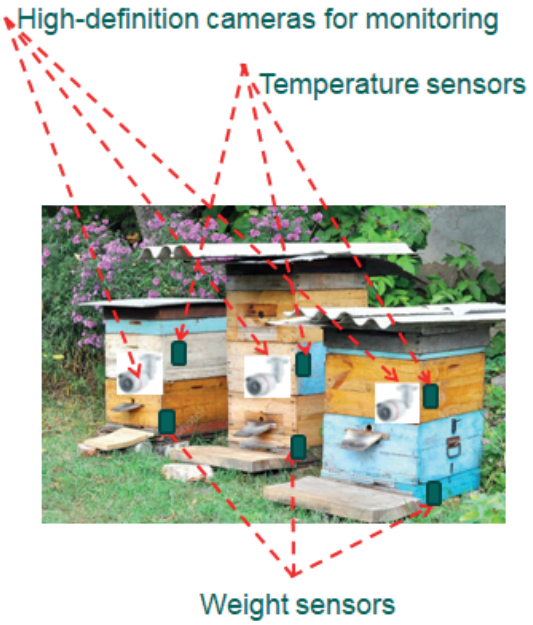


Fig. 1. Sensors and video cameras installation at bee hives

At the project "Autonomous beekeeping", the Riga Technical University in cooperation with two beekeeper farmers and Internet Association has created a unique autonomous beekeeping technology, based on IoT approach, used to monitor bee gardens remotely.

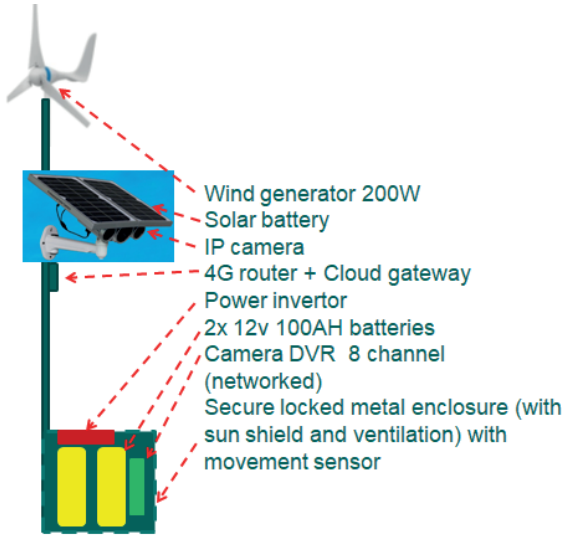


Fig. 2. Autonomous energy supply for smart monitoring

We tested separate elements of the "Autonomous Beekeeping" system installed at five bee hives in really field conditions – Riga Botanic Garden. During testing, the weight of bee hives, as well as the temperature sensors, which measure temperature ambient temperature and the temperature inside of the beehives, were monitored. Fig. 3 depicts the autonomous beekeeping systems organization scheme.

Electrical power consumption of both common and individual elements of the equipment (Fig.2) was measured and monitored at the first stage. However, now we can only theoretically calculate productivity of PV elements for autonomous power supply, since the power consumption after launching of additional measurement equipment and weather stations at the next phase can be predicted based on equipment suppliers' information.

The beehive monitoring system deployed a Node-RED [8] as a gateway concentrator for wiring together hardware devices (temperature, weight, humidity sensors), APIs and online services. At the heart of Node-RED is a visual editor allowing complex data flows to be wired together with only a little coding skills. Node-RED main functionality is to decode and to route MQTT smart metering data to further service orchestration or use in external services as monitoring system or external clients (see Fig. 3).

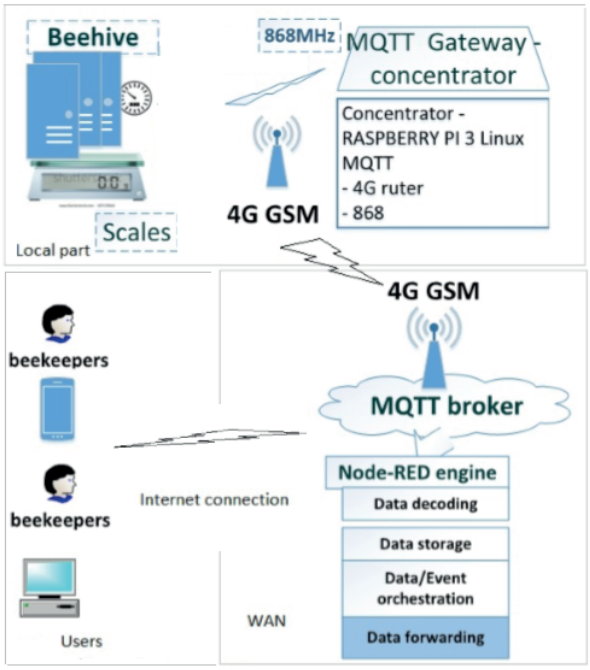


Fig. 3. Test bed layout: beehive monitoring system

The 4 G highly reliable and secure LTE router with I/O, GNSS and RS232/RS485 for professional applications was used for communication between gateway-concentrator and MQTT broker. Router delivers high performance, mission-critical cellular communication and GPS location capabilities. RUT955 is equipped with connectivity redundancy through dual SIM failover. An external LTE omnidirectional antenna connectors makes it possible to attach desired antennas and to easily find the best signal location. Radio chip - semtech sx1231H, SMA antenna, data encryption standard AES-128 is used.

There are 3 surface sensors-transmitters for measuring of temperature inside of a hive in 3 different locations, in the center and sides (Fig. 4) and 1 sensor outside the stack (Fig. 5) to get the outdoor air temperature are used for one beehive. The weight of each hive is measured by specially designed weight platform (Fig. 4) and are sent by a sensor-transmitter to the concentrator without processing.



Fig. 4. Measuring of temperature inside hive

The measurements from sensor-transmitters are transmitted to concentrator from sensors using ISM range signal. For example, weight sensor 1C3003AE0030 transmits data via radio gateway-concentrator. The application MAC CoolTerm has been used to process signals and create tables with data, in the output of data transmitting.



Fig. 5. Outdoor temperature measurement

The message (telegram) looks, for example: 01.01 00:04:40 42 0B 1C3003AE0030 0337 002580. The telegram shows the time, which started from synchronization of time in format mmhhmm.ss. RSSI LENSN03 (telegram counter), 37 (battery level) and at the end 002580 is a data read out from the balance 25b0 hex2dec9640) related the weights with 10kg load (55d0hex2dec21968). The hive weight is calculated in specific measurements, sing the output data from the sensor - transmitter.

The temperature sensor-transmitters transfers data to the server-broker every 15 minutes; the weight sensor transmits data to the server every 5 minutes. All data collected on the MQTT broker are displayed in graphical form. The users interpret data in graphics and as "dashboard" form, based on their own experience and understanding of ongoing processes in the hive.

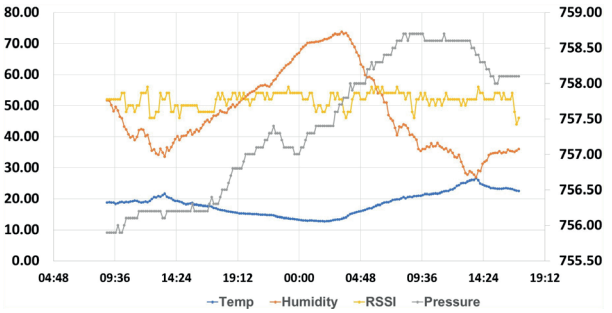


Fig. 6. Environment factor and RSSI Correlation

The weather impact on the tested system was assessed, by comparison RSSI data and the weather conditions data from the Weather monitoring system of Botanical garden in Riga. Environment factor and RSSI correlation during the summer period was analyzed. The weather impact, measured during summer period, was used as a reference for evaluation of Quality of Delivery (QoD). A snapshot of changing weather conditions is presented at Fig. 6.

The actual topology of WSN was defined based on the energy consumption level of nodes, distances between bee hives location points, and weather conditions at defined geographical location in order to assure reacquired level of Quality of Delivery (QoD). It is noticed that the largest impact at the RSSI data is provided by humidity changes, but less impact – by temperature and pressure variations. However, the system showed fair sustainability, due to RSSI data deviation happened within the normal range.

In order to process and interpret results a prototype of MQTT broker and the data collection and transmission system was tested as a part of autonomous beehives system. We deployed a Node-RED as an orchestration tool for wiring together hardware devices, APIs and online services. For further data processing,

monitoring and interpretation an Emoncms code base is used. Emoncms represents measurement data as a dashboard and as the charts. The print screens show the temperature inside and outside of beehives, and deviations of beehives weight (see Fig.7).

It was noticed that the bees maintain a constant ecosystem within +/- 0.5^{0}C at the center of the beehive. The absolute mean value is 34.8^{0}C that really differs from the classical assumption.

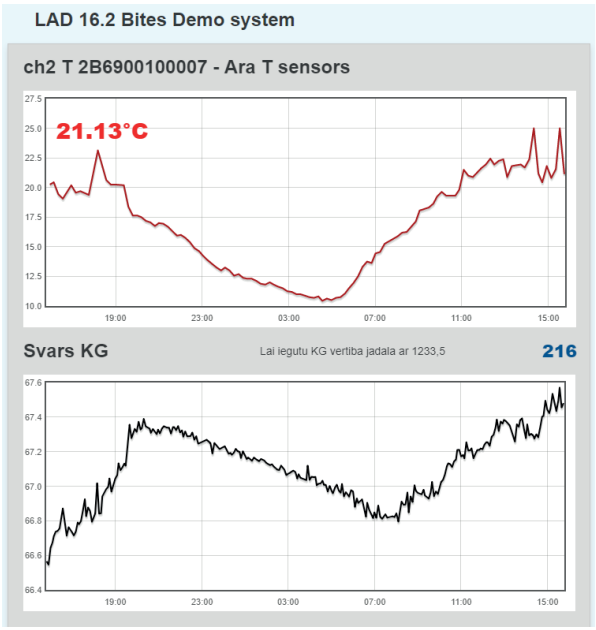


Fig. 7. Web based interface of on-line published monitoring results. Measurements of the temperature inside and outside of beehives, and weight deviations

4. CONCLUSIONS

Development of autonomous beekeeping system is still in progress, since the project team implemented the first stage of the project. Recent achievement of IoT provide good opportunities for Implementation of IoT principles in autonomous beekeeping for creation reliable system, which is resilient to the weather conditions.

The offered autonomous beekeeping system applies sensors that provide useful data on hive status (internal and ambient temperature, humidity, weight of the hives). Such sensors provide important data to the users, so they can evaluate the hive and take further action.

3G technology is used to transmit the sensor data from the hive to the user's phone or computer, because it provides stable, secure and relatively fast data transfer. Furthermore, availability of GSM connection in all parts of Latvia promotes its application at autonomous beekeeping system.

Meteo-data were used to evaluate correlation between measured weather parameters and deviation of the parameters, which characterize QoS of WSN. The assessment of data quality, based on experimental data was done. The quality and reliability of WSN network was tested using bee hives system's monitoring tools.

It has been concluded that the described intelligent beehives system can be improved with additional sensors and various actuators. At the second stage of the project video monitoring system will be introduced as a part of the system. Additional research is planned in order to ensure autonomous energy supply, so it is necessary to evaluate consumption of energy and opportunity to apply alternative energy sources, such wind and photovoltaic elements.

The developed solution could be considered as TRL 5 level, however, for the future commercial use, the data reliability is recognized as one of the critical points. The measurement accuracy and data quality from the testing network are in a line with the initial forecasts. The frequent reading of weight data opens the way for analyzing ongoing steps at a more detailed level than originally anticipated. The use of intelligent bee hives system increases bee productivity beekeepers work easier.

ACKNOWLEDGMENT

This article is based upon the COST Action CA15127 "Resilient communication services protecting end user applications from disaster-based failures - RECODIS" supported by COST (European Cooperation in Science and Technology) and the project "Autonomous Beekeeping" that is funded by the European Agricultural Fund for Rural Development Program, 2014-2020, Cooperation: Support new products, methods, processes and technologies.

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ENABLING TECHNOLOGY IN THREE PRIMARY 5G SERVICES

Zoran Bojković*,
Dragorad Milovanović,
Vladan Pantović

University of Belgrade,
Belgrade, Serbia

Abstract:
This paper presents enabling technology in three primary 5G services, Internet of Things (IoT), ultra-reliable low- latency communication and mobile broadband multimedia. Starting from the fact that 5G massive connectivity has a huge influence - from infrastructure to business models, characteristics of IoT applications within significant parameters are reviewed together with Massive and Critical IoT services. Secondly, ultra-reliable low-latency services are invoked. The fundamental tradeoffs in terms of reliability-latency-throughput are outlined. Finally, mobile broadband, which is oriented to the service in human user access to multimedia content, concludes this presentation.

Keywords:
massive and critical IoT, ultra-reliable low-latency communication, enhanced mobile broadband.

1. INTRODUCTION

The coming fifth generation (5G) era has a huge influence on both the personal broadband mobile communications and the industry utilizations. According to the timetable defined in International Union (ITU), the proposals for 5G systems are to be submitted in 2019, and they will then be evaluated to make final IMT-2020 specifications by the end of 2020. The evolution is based on certain evaluation criteria including Key Performance Indicators (KPIs). The different usage scenarios of the 5G will set different profiles for the KPIs. For example, the key new factors brought by the 5G systems such as mm-Wave and 5G New Radio highly impact those KPIs. The exploratory phase is winding down as the 5G standardization phase already started in 2016. Standards are expected to be approved by ITU during the 2019-2020 timeframe and to become operational in the early 2020's. This way, 5G technology will become the key driving force behind the shift towards digitalization in all industries and a more intelligent, connected world. This has brought challenges to radio access and other networks. Technology and spectrum innovations have to meet divergent requirements within an integrated unified 5G standard framework [1].

Correspondence:
Zoran Bojković

e-mail:
z.bojkovic@yahoo.com

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The NGMN Alliance defines the following requirements that a 5G standard should fulfill such as: data rates of 100 Mbps for metropolitan areas, 1 Gbps simultaneously to many users on the same office floor, several hundreds of thousands of simultaneous connections for sensors, significantly enhanced efficiency compared to 4G, improved coverage, enhanced signaling efficiency, significantly reduced latency compared to Long Term Evaluation (LTE). LTE comes with OFDM-based air interface and all-IP network to provide many improvements. The demand for mobile data continues to grow, while LTE-Advanced and LTE-Advanced Pro promise higher technologies such as: carrier aggregation, coordinated multipoint, enhanced multi-antenna capabilities, relaying and improved inter-cell interference coordination for not only LTE cells, but also small cells and HetNets.

It is imperative that both the academia and industry participate in 5G technology roadmap activity for future networks and massive connectivity. As for participants, they are allowed to realize crucial benefits characterized by: optimized investment strategies for research and development, enabling visibility into future technology trends, focusing of efforts toward future solutions so that benefits are maximized for the industry, solutions that can be implemented in collaborative environments as well as in a competitive domain, exploring unique innovations to provide potential solutions, providing valuable input for the formulation of standards.

In order to study 5G enabling technology and primary services, this paper is structured as follows. After presenting technology enhancements, IoT as a key service together with the impact on 5G is outlined. Next, 5G ultra reliable and low-latency communication services are emphasized. The final part is devoted to the implementation of 5G mobile broadband technology in multimedia services.

2. TECHNOLOGY ENHANCEMENTS

In order to avoid misconceptions about 5G technology, a collaboration between experts in academia, the industry as well as standard development organizations becomes an obligation. The goal is to identify challenges for technologies, paving the way for providing wireless communications with massive connectivity, tactile Internet, quality of service and network slicing. On the other hand, 5G is called to produce a complete revolution in the way users can access content and services in their general daily activities, such as: ultra-high system capacity, massive device connectivity, ultra-low latency, low-cost devices and diverse service types. To satisfy these requirements, enhanced technologies are necessary: massive MIMO, mm-Wave, ultra-dense networks, non-orthogonal multiple-access (NOMA).

Massive MIMO requires the simultaneous processing of signals from many antenna chains and computational operations. MIMO is considered to be one of the key technologies in 5G systems due to its advantages of improving both the received signals-to-noise ratio (SNR) and the bandwidth efficiency. Massive MIMO is capable of substantially increasing both the capacity as well as the energy efficiency [2]. Recent advances on system-algorithm-hardware co-design have led to extremely energy-efficient implementations.

WiFi systems are the most widely deployed wireless technologies. There are actually very sophisticated systems that were created to satisfy difficult and challenging requirements. For example, they operate in unlicensed bands with very severe emission limitations. Also, they need to provide high data rates because they compete with wired LAN-using technologies that link the Ethernet with super-fast rates. Furthermore, in some scenarios, WiFi systems are deployed in a somewhat dispersed manner, without strong centralized control. Thus, challenges of interference and resource sharing arise. Different types of traffic might need different adjustments to meet the Quality of Service (QoS), which could generate additional challenges from the resource sharing and interference management perspectives. These other technical challenges have been handled over the years through a variety of solutions and approaches. Examples of such creative solutions include the various coordination functions at the MAC layer spread spectrum, OFDM, etc. to handle challenging constraints at the physical layer while trying to achieve high data rates.

Dense HetNets are one of the 5G technologies capable of significantly improving the network capacity. The core idea of HetNets is essentially to move the low power Base Stations (BSs) closer to the users in order to form small cells [3]. The basic idea of massive MIMO-assisted HetNets is to install hundreds or thousands of antennas at the macro BSs for offering an unprecedented level of spatial degree of freedom, while using a single antenna at the densely positioned small cell BSs.

The fundamental concept of NOMA (Non-Orthogonal Multiple Access) facilitates supporting multiple users in the power domain. NOMA uses a new dimension to perform multiplexing within one of the time-frequency domains. In fact, NOMA can be regarded as a technique that has the promising potential of facilitating

integration with the existing legacy solutions [4]. One of the main challenges of NOMA is the compatibility with other technologies towards 5G and beyond. Several key directions have been identified: ultra-densification, massive MIMO arrangements, full duplex solutions, cloud-based Radio Access Networks (RANs), mm Wave communications, Device-to-Device (D2D) and Machine-to-Machine (M2M) communications, energy harvesting, virtualization and softwarization.

The 5G will support a wide range of features and use cases, going well beyond current cellular networks. Increased capacity to support Enhanced Mobile Broadband (eMBB) services is a key driver for 5G. Service eMBB is targeting high data rates, such as seamless data access both indoors and outdoors, high-resolution multimedia streaming in high mobility scenarios. 5G is also required to support Ultra Reliable Low-Latency Communications (uRLLC) and Massive Machine Type Communications (mMTC). uRLLC are defined as applications that have stringent latency and reliability requirements (vehicular communications and control network industry), while mMTC is the basis for connectivity in the Internet of Things (IoT) including infrastructure management, environment monitoring, and healthcare. The basic characteristics of mMTC, uRLLC and eMBB service categories are presented in Table 1.

Table 1. Basic characteristics of mMTC, uRLLC and eMBB primary service categories

Category	mMTC	uRLLC	eMBB
Main motivation	Increase the number of support devices and support low-cost devices	Reduce end-to-end latency and increase robustness of data transmission	Increase spectral efficiency and increase peak throughput
Key requirements	$1x10^6$ devices/km^2 100x energy efficiency	10ms end-to-end latency (0.5ms physical-layer) BLER<10^{-5} within 1ms	20x peak throughput, 100x area throughput, 5x spectral efficiency
Packet size	100x bytes	10-100 of bytes	>>100 bytes
Physical-layer solutions	Non-orthogonal multiple access, overloaded data transmission, active user-detection	Instant access, errorless data transmission	Massive antennas, mmWave band-aggregation, and new waveforms
Applications	Logging, metering, lodging, tagging, and measuring	Tactile Internet, remote control, self-car driving, augment reality, industrial automation	Virtual reality, real-time security, 3D image, and 4K video streaming

3. PRIMARY 5G SERVICE CATEGORIES

The use case scenarios for the 5G mobile wireless networks involve IoT, ultra-reliable and low-delay communication as well as multimedia broadband services.

IoT massive connectivity

One of the primary goals of 5G wireless networking is the integration of heterogeneous access technologies that facilitate the connectivity of physical or virtual things with the Internet. IoT enables data communication between heterogeneous devices with modest or no personal intervention. The goal of IoT is to move towards more autonomous, scalable, connected and location-independent infrastructure. IoT presents service management with more challenging issues. IoT applications can be divided into two major categories: Massive IoT and Critical IoT applications. Massive applications have specific requirements of extended coverage area and high scalability, low-energy consumption and low-cost user equipment [5]. Examples of Critical IoT applications include healthcare systems, traffic and industrial control, Smart Grid. Also, lower latency for acceptable end-user experience as well as higher availability and reliability are desirable [6]. IoT applications have varying requirements in diverse domains: smart home, smart city, intelligent transportation system, data reliability in the industrial IoT. An outline of the differences in requirements is presented in Table 2. The characteristics are the application domain, tolerable delay, reporting intervals, and data rate.

Design engineers can easily find which one of the offered alternatives is best suited for current IoT use case. Key design requirements support massive devices, extended coverage, network cost, long battery life, compactness and data reliability, security and privacy. For example, the total cost of devices should be as low as possible to support massive deployment. It implies the reduction in the device complexity and production cost. Also, the total cost of network connectivity should be kept at a minimum in massive IoT deployment. Most IoT devices operate for a long-term period without any human intervention. Thus, the energy efficient design of hardware and software is required. In the case of massive IoT connectivity, extended coverage design is also important. The location and the end user's identity should not be accessible to the public.

Table 2. Short overview of IoT technical parameters

Application	Tolerable delay	Update frequency	Data rate
Structural health	30 min	10 min	low
Waste management	30 min	1 hour	low
Video surveillance	seconds	real-time	high
Air quality monitoring	5 min	30 min	low
Monitoring and supervision	seconds or millisec-onds	seconds	low
Closed loop control	millisec-onds	millisec-onds	low
Interlocking and control	millisec-onds	millisec-onds	low
Patient's health delivery and monitoring	low (seconds)	1 report per hour/day	high
Real-time emer-gency response and remote diag-nostics	low (seconds)	requires ad-hoc emergency communi-cation	high
Real-time man-agement of infor-mation in supply chain	low (seconds)	1 report per hour/day	high

While massive IoT systems require improved system coverage and reduced terminal cost, critical IoT has small data packets and delay-intolerant communication. As the 5G system is characterized by a high degree of heterogeneity using services, device classes, deployment types, environments and mobility levels, key enablers for these activities are based on: software-defined networking, network function virtualization, cognitive radio, scalability, network management and mobility.

Technology Software Defined Networking (SDN) separates the data and control planes, centralizes network control and allows programmability of the network by external applications [7]. In that way, reconfiguration is provided as a dynamic, flexible and automatic method. The most important issues involve avoiding a collapse of the network and guaranteeing that QoS. Technology Network Function Virtualization (NFV) is highly complementary to SDH. The main idea behind NFV is to virtualize a set of network functions implemented into software packages which are now available for the configuration of some services provided by the network. Both solutions (SDN and NFV) can be combined to achieve optimal performance for management of critical and massive IoT applications [8].

Technology Cognitive Radio (CR) utilizes the limited licensed spectrum resources in order to support new service requirements in 5G mobile networks for IoT applications. The CR operates in the best available channel using dynamic spectrum access techniques. This kind of technology provides the detection of users present in the spectrum sensing. Next, it identifies the available free spectrum, based on spectrum management, spectrum sharing and spectrum mobility.

By introducing new heterogeneous devices, applications and functions are based on scalability. For scale efficiency, optimization of the massive deployment of IoT has to be provided [9]. This way, network capacity becomes scalable to accommodate as many connected devices as possible. Efficient network management solutions provide monitoring, remote control and maintenance concerning network equipment, services and devices. The management functions in the IoT carry out remote tasks across a heterogeneous interconnected network. Such a system enables diagnostics in IoT devices and real-time control. This way, the cost of operation will be managed in terms of resource constrained networks. Network coverage remains an open research issue for effective deployment scenarios, since most of the massive and critical IoT users are mobile. As a result of user mobility, connected devices undergo service interruptions. This is the reason why an efficient mobility management mechanism is needed to control the connected devices in IoT networks.

Ultra realiable low-latency services

The use case scenario for the 5G mobile wireless networks involves eMBB human users accessing multimedia content, Massive Machine Type Communications (mMTC), a large number of connected devices, as well as uRLLC with the most stringent requirements. In this case, reliability is the probability that latency will not overstep the pre-determined deadline in data transmission. As for latency, it is defined as the delay of data packet measured in the same layer at the transmitter and at the receiver [10]. Simultaneous requirements for reliability, latency and throughput in a wireless system are demanding. The improvement in throughput and reliability cause the degradation in terms of latency. At the same time, the latency is increased due to an error control mechanism which implies some overhead. The diagram of reliability vs. latency in wireless communication is shown in Figure 1.

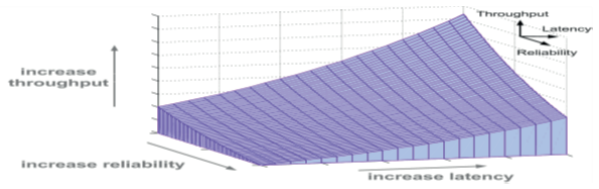


Fig. 1. The diagram of reliability vs. latency in a wireless communication

The *effective bandwidth* function is the minimum service rate assuming prescribed latency requirements in a tradeoff of throughput vs. latency. The *effective capacity* is the maximum constant data rate that a given service supports assuming the delay constraints [11].

The total latency in the 5G system is contributed by user plane and control plane. The user plane latency is measured in transmission and reception of a packet at the corresponding network layers. The control plane latency represents the transition time from an idle state to an active state when user equipment establishes a radio resource control connection.

It is necessary to transmit an uRLLC data packet as soon as it is received at the node / base station on the Downlink (DL) or generated by the User Equipment (UE) on the Uplink (UL). Autonomous transmission is also one of the solutions, where UE transmits on pre-defined uplink resources without the need for an explicit grant from the node. The uRLLC challenges cover not only the physical layer but also all aspects of the 5G system design.

Mobile broadband technology

5G wireless networks are a combination of different, advanced technologies designed to support Gbps data rates, massive capacity and connectivity as well as widely different network deployment scenarios. Significantly lower end-to-end latencies and higher connectivity reliability are needed in real-time applications with Quality of Experience (QoE) guarantees. Also, the reduction of energy consumption by orders of magnitude is required [12].

Mobile broadband is a significant multimedia delivery platform. Thus, it is important to study technical operational and regulatory issues. Considering current and future requirements and constraints, it is important to research feasible and beneficial use cases and usage platforms. A point-to-multipoint interface Multimedia Broadcast Multicast Service (MBMS) is specified to provide efficient delivery of broadcasting services in the core and the radio access networks. The service defines transmission via Single-Frequency Network (SFN) configurations for a broadband transmission across multiple calls. Examples of applications are mobile TV and radio broadcasting, live streaming video services, as well as file delivery and emerging alerts.

The work on adding broadcast/multicast support to 3G networks began in 2002 when 3GPP created a work item in GSM/UMTS and CDMA2000. Requirements are defined for the optimization of the distribution of video traffic (3GPP TS25.992 MBMS UTRAN/GERAN *Requirements*, Oct. 2003). To support Ultra-HDTV, Realize 14 upgraded media codecs and formats to values specified for broadcast television. HDR (High Dynamic Range) format support was added in Release 15 for improvement in MBMS services.

Higher picture quality is a general trend for all services and devices. Service providers seek to deliver as high a quality as possible, despite the growing associated costs and the issues related to network capacity. TV picture quality technical parameters are spatial resolution (the number of pixels in a picture), temporal resolution (the number of picture frames per second), color gamut (the range of colors that can be displayed) and dynamic range (the span between minimum and maximum brightness). The combination of parameters is standardized in order to ensure interoperability. The picture formats that indicate progressively higher quality are SDTV, HDTV and UHDTV. Examples of multimedia services include on-demand, time shifted, interactive and personalized services, multi-screen and multi-view

services and cross-platform services. In order to enable eMBB in mission critical low-latency video applications via cost-efficient RANs for 5G Phase 2, the focus is on mm-Wave access/backhauling with MEC (Mobile Edge Computing) in uHSLLC service [13].

4. CONCLUSION

Looking back at the evolution of technology, there is a separation of 10 years from one generation of mobile system to the next, both if one takes as a reference point the first trials, the first deployment, the mass market uptake or even its obsoletes. Based on this, we will have real mass market adoption of 5G around 2025. However, for the future 6G technology development, the forecast could be based on the law of accelerated returns stating that evolution is accelerating and what used to take 10 years will take 7 years, and then just 5 years, and so on. Collaboration between experts in academia, the industry and standard development organizations has become an obligation.

The goal of this paper is to study primary service categories in typical 5G use cases. Special interest is given to IoT connectivity technology, starting from the point that massive machine type communication requires a significant network capacity increase. As mobile wireless systems also address uRLLC, it is a challenging technological task to reduce the latency, while simultaneously providing certain levels of reliability. In order to enable eMBB services in mission critical low-latency video applications, a new class Ultra-High-Speed Low-Latency Communication (uHSLLC) service is introduced. The corresponding architecture should include software-defined networking and network function virtualization to accommodate diverse use cases in an acceptable cost-efficient manner.

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THE POSSIBILITY OF ELECTROMYOGRAPHY MEASURING AS THE ANSWER TO BREATH HOLDING

Mirko Ostojić,
Milan Milosavljević*

Singidunum University,
Belgrade, Serbia

Abstract:

There is an inherent connection between nervous system and muscle activity during breathing process. Both muscle fiber activation and the propagation of nerve impulses are electrical in its nature, whilst many cognitive functions could be measured by EEG signals. So the logical assumption might be that different breathing patterns, initially spotted by the minute volume changing, could be seen by change in electrophysiology of muscle activity – electromyogram (EMG). This pioneer multidisciplinary investigation has been concentrated on the most passive breathing activity, the prolonged breath holding. The safe and comfort method of physiological breath holding method has been applied. Having in mind number of anatomic and physiological characteristics of human body the two regions for non-invasive EMG measuring had been proposed– the neck and the region of solar plexus. The first test was done by 30 healthy volunteers, the students of sport science. The clear electrophysiology activity in these two regions has been proved. The measured respirational, ECG and two EMG signals has been shown that the sample rate of 200 Hz is quite enough. This opens the new possibilities for further experiments to be performed by enlarged number of electropoligraphical signals simultaneously taken. Whilst approaching to the point of physiological answer of the breath holding, the concerning increase of both average power and power spectral density had been spotted, especially in the regions of delta and theta.

Keywords:
electrocardiogram, respirational signal, the muscle activity, average power, the power spectral density.

1. INTRODUCTION

The main respirational center of the human body is situated in *Medulla oblongata* [1] where four functional parts could be discerned (Fig. 1). For our purposes the two of them are more important for our study. The first part is called *Pneumotaxic center* (*PTC*). It can be spotted at the top of Fig.1 and it controls both the depth and the frequency of breathing. The direct result of its effect is measured clinically by the minute ventilation (*MV*)[1]. The second part is the *Ventral breathing center* and it mainly controls the inspirium. The common characteristic for both of

1 the product of number of inspirium/expirium per minute, as well as the breathing depth.

Correspondence:
Milan Milosavljević

e-mail:
mmilosavljevic@singidunum.ac.rs

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these regions is that they are most sensitive[2] to the afflux of carbon-dioxide concentration [2], PCO_2, inducing enlarge of minute ventilation afterwards. This influence could be seen both by the bigger depth of every breath as well as the enlarged number of breaths per minute. The enlarged product of breathing volume and the number of breaths per minute is always reaction to the higher value of the PCO_2.

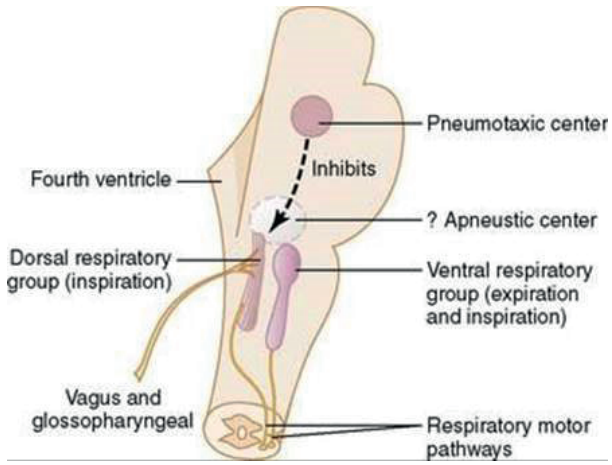


Fig. 1. Respirational centres

The innervation of certain muscle groups is of electrical type, while the true movement nature of myofibrils is contractile [3], what practically means that every single muscle perform action by its contraction. As the answer to the constant influx of PCO_2, *PTC* sends more and more electrical impulses in fixed time frame inducing the increase electrical density in a muscle region, so the following sequence of events could be spotted [4]:

1. The breath holding induces the linear increase of PCO_2.
2. *PTC* reacts to the increase of PCO_2 by the increase of efferent [3] neurons triggering frequency.
3. The different regions of respirational muscles have been aroused what would induce the process of inspirium during normal, spontaneous breathing.
4. After certain period, the triggering neuron frequency is so enlarged that the subject feels on the *'bump'* sensation either in neck or in solar plexus region. This sense requires some practice to be properly recognized. In this phase, it is still possible to maintain willful holding of breath.
5. At certain moment, the innervation series of impulses is so dense that willful holding of breath becomes impossible, leading to a forced inspirium.[4] Ganong labels this moment as the *cutoff point* [4]. The difference between cutoff point and the 'bump' time is non-linear in its nature and the only connection is the subject's ability to hold the breath.

The primal aim of this work has been the identification of possibility of measuring the electromyogram (*EMG*) changes on certain muscle regions during certain variability of the breathing pattern. In order to even touch this problem, it was necessary beforehand to prove the insight of continues, measurable electrical activity [5] between two points on the outer skin surface.

If the answer to the above question would be positive, the second step might be the investigation of the general *EMG* dynamics. This includes not only the changes in average power of consecutive signals, but also their frequency range. The latter result would give the answer to the necessary sample rate frequency. With lower frequency it would be possible to measure more signals simultaneously on the same equipment. Practically this would give the answer the question if we can even tackle measuring full *EEG*-cap at the same moment with measuring *EMG* and *ECG* signals.

The current clinical standard of measuring *EMG* is slightly invasive method, inserting electrode needles to the both ends of a locomotor muscle [6, 7]. It shows the spectral dynamics of maximum 450 *Hz* [8, 9]. If we include the muscle activation during the acquisition period, this process becomes even more complex. Since we had wanted to include only surface, non-invasive, skin electrodes, the frequency dynamics would be the last question to this research.

2. PROCEDURE

The thirty young, healthy students of National faculty of sport were beforehand learnt to the procedure of breath holding after spontaneous exhalation, as well to

2 The influence of the oxygen concentration on these centres is about 10 times less [1]. Also there are other gases involved, but all their influence is of minor importance to the influence of the concentration of carbon-dioxide.

3 also called motor neurons – are the nerves responsible for carrying signals away from the central nervous system in order to initiate an action.

4 this theoretical maximum period of breath holding is called *maximal pause*, MP.

the recognition of physiological muscle activity answer as to a prolonged breath holding.[5] The typical setup is shown at Fig. 2.



Fig. 2. Electrode setup at *Neurofax* equipment.

In order to perform the data acquisition for our purposes we have had the Japanese apparatus *Kohden's Neurofax* including very professional, educated personnel. This multichannel equipment supports measuring a large scale of electropoligraphical signals:

- the complete *EEG* cap, with sixteen channels and two pairs of grounding electrodes,
- *ECG* according to Einthoven,
- respirational signal on the nose tip, with simple task to measure the breathing airflow.
- largest palette of bipolar *EMG* electrodes, whilst we used the best possible surface *Au*-electrodes.
- *HD*-camera built-in to this system so the complete process of data acquisition had been simultaneously recorded.
- light hand *built-in* switch, for the event labeling – it was hold in subject's left hand, so he could mark the events of interest.

After the successful data acquisition, for the purposes of this study we used the four signals out (Fig. 3): *ECG, EMG* signals of neck and solar plexus regions, as well one *RESP* signal on the nose tip as the airflow controller.

The neck signal had been measured at the ends of *Sternocleidomastoids* muscle[6], while two points of solar plexus region were situated on *sternum's* right side at the beginning and end of first sub rib arch. We wished to reduce the influence of the heart muscle wherever we could, so that is the reason why we measured the right side of the sub rib arch.

The whole recording procedure is non-invasive, lasts less than five minutes and *Neurofax* equipment corroborates the ethical standards of Serbian Medical Society.

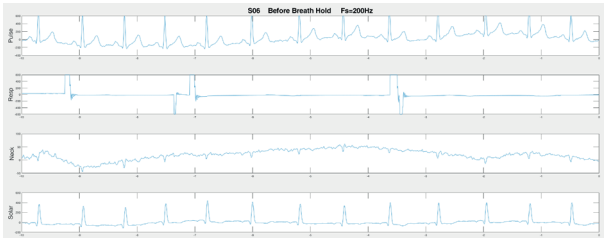


Fig. 3. The time domain of the recorded signals.

3. RESULTS

After the recording of 30 volunteers we got 30 raw time signals. After removing the artefacts, we extracted four groups of signals, according to the natural time sequence:

- natural state, without any activity, before the commencing of breath holding;
- the phase just after the beginning of breath holding;
- the state before the physiological answer to prolonged breath holding, and we call it *before* '*bump*';
- the last, continual phase just *after* '*bump*' with the relaxation period.

Wherever it was possible we obtained up to 10 seconds of continuous signal absent of any artefacts. The heart artefacts weren't treated and that will be explained latter in this work.

At this point we got thirty groups of four signals: normal state (before breath hold), phase after commencing the experiment, the last phase before the 'bump', and the relaxing state after the 'bump'. It was total of 120 signals. Each of them is labeled in form S_{xy} with corresponding phase.

Full *EEG*-cap and the *RESP* recorded signals are out of the scope of this work.

Fig. 3 clearly shows *ECG, RESP* and two *EMG* signals of the neck and solar region. The typical, healthy

5 The given time is labeled on West as **CP**- *control pause*, while Russian term is контрольная пауза (КП)

6 this strong neck muscles has also the important role during the inspirium [1].

behavior of *ECG* can be noted, while signal *RESP* accurately indicates the air flow during both inspirium and expirium.

At the first outlook at *EMG* signals it is easy to spot the influence of *ECG*, especially in the solar region since the proximity of heart muscle. This influence had been minimized by the slightly original method of signal analysis [10].

The first analysis we performed was the change of signal's average power in the time domain (Fig. 4). *Neurofax* equipment records the signals in μV of every single sample on the unit resistance. The current power can be get in μW by simple powering this value [11].

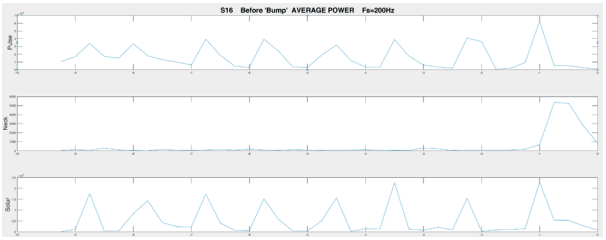


Fig. 4. The signal's average power in time.

In order to get smooth line of these changes we had used the well-known procedure of overlapping regions of digital signals analysis [12]. The correspondent programs for analysis has been attached with all given concrete values. Here we emphasize that the signal width is equal of 2 *s* since the main disruptive signal is *ECG*. In the case of sample frequency of 200 *Hz*, the concrete value of 400 samples had been taken, with overlapping region of 50 samples. In the case of sample rate of 2 *kHz* the proportional 10 times values have been adjusted.

The serious influx of power has been spotted just before the 'bump' in all cases, mainly in neck region, but not exclusively! Fig. 5 shows the period just before the 'bump' at the volunteer number 24. We can spot the reaction in solar plexus region, and practically no reaction in the neck region. The signal propagation of signal till conscious reactions corroborates modern researches and it goes from 0.2 *s* [13] till 1.42 *s* [14][7].

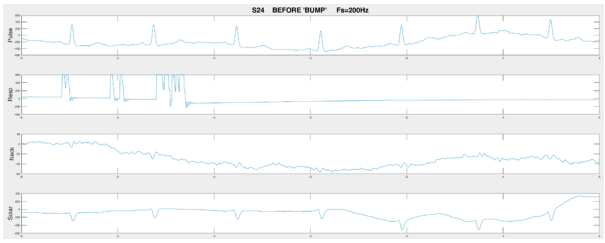


Fig. 5. The reaction in solar plexus region.

The most of the results show the reaction in the neck region versus solar one, but the power afflux was from two to even seven times in corresponding areas without any exception.

We have already mentioned that the breath holding is possible to prolong even certain time after the physiological answer [15], what was expected to happen during our experiment. We may spot at Fig. 6 a typical case where the volunteer was holding his breath additional four seconds after the event. Later, all such cases had been verbally confirmed, commenting the lack of trust in their own feelings[8]. Fig. 6 clearly shows the reactions in both regions. The effect happened in solar regions approximately 4 *s* before the event, and the neck region reaction is about 2 *s*.

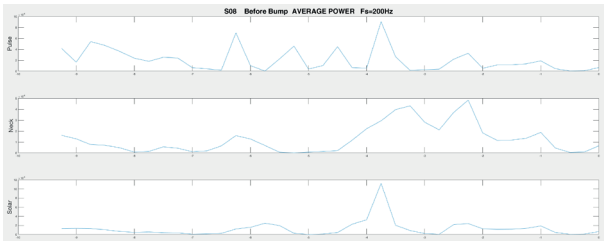


Fig. 6. Prolonged breath holding after the time of physiological answer.

After the positive answer to the first two question of our research, the possibility of getting the quality signals and the serious notice of average power changing of *EMG* signals we commenced the spectral analysis without filtering low frequency components. The reason for this procedure was to spot the possible changes, not the exact values.

Computing the power spectral density [16] of *EMG* signals it had been determined that the given spectra

7 The researchers include different cumulative periods. The full propagation may include the sum of the following steps: time of the sense reaction to the stimulus (visual, auditory, sensual), signal propagation from the sense cells to the brain, time of the reaction of cortex, and the time of pulse propagation from cortex by motor neuron.

8 Here the sport spirit of our volunteers is inevitable. Sport is designed in its core for pushing forward personal limits.

visibly doesn't exceed the value of 70 *Hz*. From the practical point of view, the important conclusion is that over of 95% power spectrum power is situated in the region 0-40 *Hz*. This fact proves that the sample rate of 200 *Hz* is quite enough for this type of research, according to Nyquist [17].

The first insight at Fig. 7 shows the well-known, strong low frequency component that must originate from the heart activity (signals up to 1 *Hz ULF* spectrum). In this region can be spotted regularly high dynamics, while certain signals show also the distinct dynamism in the region of about 13 *Hz*, corresponding to the center of standard *alpha* wave range.



Fig. 7. The power spectral density of the both *EMG* signals of typical volunteer. Blue lines depicts solar region, while red lines the neck area. The four periods are situated from the top to down. It is clearly visible the influx of power of neck signal in the phase of physiological answer. It can be also spotted that the fourth phase equalize its state as it was before the breath holding.

While observing the lower frequency at the Fig. 7, and especially the *ULF* part of the spectrum the few characteristic can be underlined:

1. Before the breath holding and at the commencing the procedure the *PSD* in solar region is almost one order of magnitude above than the corresponding one in the neck area.
2. During the propagation of the experiment that ratio has been significantly reduced.
3. The neck area has the *PSD* afflux during the *'bump'* and in most cases it becomes even higher than the temporary value of the solar region. This effect was present at all volunteers, regardless the mentioned results of the average power.
4. At the end of experiment, we have the exact picture as of the beginning of experiment – the values have been set up to their initial values promptly, without any exceptions.

4. CONCLUSION

Our study confirms the possibility of non-invasive measuring *EMG* signals in the precisely defined solar and neck region without any ambiguities. During the lack of breathing activity, the dynamic of these signals is very similar to *EEG*, also of non-invasive type, so the frequency does not exceed 100 *Hz*. It is necessary to underline that the surface, skin electrodes were applied. It is bold assumption that this must lead to the loss of some spectral components.

Completely all volunteers show the significant afflux of mean power value just before the physiological answer to breath holding. This value is of two to seven times higher than in the normal state. The additional peculiarity of this research shows that five of total number of 30 volunteers shows higher values in solar plexus region, so 16,67%, while the neck region may remain total intact, showing no any changes. This is why we suggest measuring both of the regions simultaneously in future researches of this kind.

The significant changes of *PSD* dynamics could be noticed during the progress of breath holding, and afterwards setting to their initial values quickly with the normalization of breathing pattern. This dynamism is most obvious in the region delta and theta, as well around the exact frequency of 13 *Hz*.

This robust multidisciplinary study presented the results that different biological phenomenon exports to the region of modern electrotechnics, so opening the new possibilities for the series of new experiments in order to establish the standards for electrical constants respirational signals, instead of only existing mechanical and chemical data of breathing parameters. This transition includes not only non-invasive results acquisition, but enables the full space freedom of the human body research, *in vivo*, measuring the current breathing parameters in the scale from severely sick patients to the top sportsmen [5].

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DONOŠENJE ODLUKA O INVESTIRANJU U OBNOVLJIVE IZVORE ENERGIJE – MULTIDISCIPLINARNI PRISTUP

Bojana Vasić*,
Olga Mirković Isaeva,
Mirjana Radovanović

Fakultet za studije bezbednosti,
Univerzitet Educons,
Sremska Kamenica, Srbija

Rezime:

Dobijanje energije iz obnovljivih izvora je proklamovano kao način za rešenje problema energetske zavisnosti i klimatskih promena. Činjenica jeste da sagorevanje fosilnih goriva imaju za posledicu klimatske promene, aero zagađenje i generalno negativno utiču na životnu sredinu. Iz tog razloga nakon 2000. godine, politika razvoja većine država u velikoj meri predviđa investicije u OIE. Ne postoji tačna evidencija o uspešnosti i koristi od investiranja u OIE, ali postoje primeri da su se određeni projekti ispostavili kao neisplativi ili ih je bilo nemoguće realizovati. Zbog važnosti za kreiranje ekonomske, energetske i socijalne politike bitno je realno proceniti prihvatljivost investiranja i eksploatacije OIE. Predmet ovog rada je definisanje procedure za donošenje odluka o investiranju u OIE pri čemu odluka o implementaciji projekta treba da se zasniva na multidisciplinarnom pristupu. Procedura prikazana u radu obuhvata procenu ekoloških, socijalnih, ekonomskih, tehnoloških i geopolitičkih uticaja, kao i usklađenost sa zakonskim propisima. U svetu u kojem i dalje raste potreba za konvencionalnim energentima, velika ulaganja u OIE pokazala su se u pojedinim situacijama kao problematične, što je imalo za posledicu nezadovoljstvo građana i gubitak poverenja kreatore politike u ovoj oblasti. Na kraju rad daje prikaz predloga za unapređenje i realnu procenu opravdanosti ulaganja u OIE.

Ključne reči:
investiranje, projekat, OIE, alati za podršku odlučivanja, indikatori.

1. UVOD

Izbor između različitih investicionih projekata u energetskom sektoru je vrlo težak zadatak koji uključuje više zainteresovanih strana, suprotstavljene prioritete sa posebnim težinama i različite scenarije. Ovo gledište intenzivirano je u protekle dve deceniji sa podizanjem svesti o zaštiti životne sredine, usled velike zavisnosti od uvoza nafte i gasa, kao i zbog pojave alternativnih izvora energije iz obnovljivih izvora. Eksploatacija obnovljivih izvora energije (OIE) dobila je ogroman značaj, pre svega zbog svoje ekološke prihvatljivosti, obezbeđivanja energetske bezbednosti i ekonomskog razvoja svake zemlje.

Složenost energetskog planiranja i energetskih projekata čini višekriterijumsku analizu vrednim alatom u procesu donošenja odluka. Odluka o implementaciji projekta obnovljivih izvora energije treba da se zasniva

Odgovorno lice:
Bojana Vasić

e-pošta:
bvasic01@gmail.com

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na njenom: ekološkom, socijalnom, ekonomskom, tehnološkom i geopolitičkom uticaju. Socijalno prihvatanje ovih projekata može se pretvoriti u oprezan rizik za eksploataciju obnovljive energije. Razumevanje procesa u okviru kojeg se može odobriti socijalna dozvola za projekt obnovljive energije je veoma značajan.

Odluka "GO" ili "NO-GO" za projekat obnovljivih izvora energije je vitalni zadatak. Kako bi se ilustrovano pokazalo kako se projekti obnovljive energije mogu oceniti sa stanovišta održivosti, izgrađena su dva hipotetička scenarija Prvi scenario je scenario „NO-GO": projekat nije održiv zbog značajnih ekoloških, socijalnih, ekonomskih, tehnoloških i geopolitičkih negativnih uticaja. U ovom slučaju, društvena dozvola za rad neće biti odobrena od strane zainteresovanih strana; važne promene su potrebne u ovom slučaju pre ponovnog ocenjivanja projekta. Drugi scenario je "GO" scenario: prioriteti zainteresovanih strana su takvi da se projekat može smatrati održivim i društvena dozvola za rad može biti podržana od strane zainteresovanih strana.

2. INDIKATORI

Nadmetanje oko prirodnih resursa može dovesti do, pojačanog ili održivog nasilja; Sukob oko prirodnih resursa je često deo, i pogoršava, veću borbu oko političkih, ekonomskih, kulturnih ili verskih pitanja u društvu (Američki institut za mir 2007). Upravljanje sistemima prirodnih resursa obično uključuje sukobe; Ponašanje zainteresovanih strana, koje bi mogle biti voljne da doprinesu poboljšanjima i postignu situaciju u kojoj svi dobijaju ("win-win"), ponekad rezultira lošijim uslovima za sve strane [1]. Podele i konflikti vrlo su vidljive u projektima OIE. Održivo rešenje za iskorišćenje OIE trebalo bi barem prilagoditi zaštiti životne sredine, dostupnosti resursa, socijalnom blagostanju i ekonomskoj održivosti sistema [2]. Posebne procedure treba primeniti pre instaliranja postrojenja za obnovljivu energiju, posebno u zemljama sa komplikovanim administrativnim i zakonodavnim sistemom [1].

Energetski projekti praćeni sofisticiranim tehnologijama i obećavaju pristupačnu električnu energiju čak imaju tendenciju da propadnu mnogo puta, zbog neznanja ili ne uzimanja u obzir važnost društvenih faktora. Da bi svaki energetski projekat bio efikasan i uspešan, posebno kada se razmatra u regijama u razvoju, potrebno je pronaći sinergiju uzimajući u obzir različite scenarije s višestrukim pokazateljima. Socijalni faktori igraju ključnu ulogu u projektima elektrifikacije u ruralnim razvojnim područjima.

Da bi se smanjio rizik realizacije projekta OIE potrebno je analizirati što veći broj indikatora. Kada je broj korišćenih indikatora mali, indeks energetske sigurnosti je vrlo osetljiv na promene bilo kog pokazatelja. Promena nivoa indikatora može prouzrokovati velike oscilacije indeksa i to može dovesti u pitanje stabilnost indeksa. Nasuprot tome, kada se koristi veliki broj indikatora, promene u pojedinim indikatorima mogu biti isključene većinom nepromenljivih indikatora. U literaturi se čini da se široko prihvaćena praksa koristi reprezentativnim skupom indikatora koji mogu proizvesti širok pregled situacije energetske sigurnosti. Ovo obezbeđuje ravnotežu između stabilnosti i osetljivosti indeksa. Ukupan broj od 10 do 25 indikatora je najoptimalnije, jer se to pretvara u prosečnu težinu u rasponu od 4% do 10% za svaki indikator (pod pretpostavkom da se svim indikatorima dodeljuje jednaka težina) [3]. U praksi, odgovarajući ili "idealan" broj će zavisiti, između ostalih faktora, od obima i složenosti studije, kao na primer da li su podindeksi izgrađeni na vrhu ukupnog indeksa energetske sigurnosti.

Kada su u pitanju izabrani indikatori, obično imaju različite jedinice i nalaze se na različitim nivoima. U toj situaciji, veoma je teško uporediti ih ili ih agregirati, zbog čega moraju biti transformisani. Ove transformacije se obično obavljaju pomoću jedne od tri metode: Minimum – maksimum, udaljenosti do reference i standardizacije.

Za potrebe ove analize odabrano je pet kompleksnih indikatora: ekološki, ekonomski, socijalni, tehnološki i geopolitički.

Ekološki indikator

Ekološki indikator sačinjen je od tri indikatora:

- Potrošnja energije (kW energije potrošene po hektaru)
- Emisije gasova staklene bašte (kg CO2 po kWh proizvedene energije)
- Proizvedeni otpad (po kW proizvedene energije).

*Ekon*omski indikator

Ekonomski indikator čine tri indikatora:

- Prosečan broj ljudi koji su direktno zaposleni
- Ukupan promet
- Povećanje prosečnog godišnjeg prihoda na tom području

Socijalni indikator

Socijalni indikator čine dva indikatora:

- Broj izgubljenih radnih dana na 100 zaposlenih u ekvivalentu punog radnog vremena (FTE)
- Regionalno zadovoljstvo životom / blagostanje (rangiranje koje se daje kao podindeks OECD-ovog Regionalnog indeksa blagostanja)

OECD-ov regionalni alat za dobrobit pruža informacije o tome na kom se mestu regioni nalaze analizirajući 11 aspekata koji su važni u životima ljudi: radna mesta, prihod, obrazovanje, zdravlje, građansko angažovanje, sigurnost, pristup ljudima, stanovanje, zajednica i zadovoljstvo životom.

Tehnološki indikator

Ovaj indeks sačinjen je od jednog indeksa:

- Rangiranje indeksa tehnologije (podindeks Indeksa globalne kreativnosti Instituta Martin Prosperiti, Univerzitet u Torontu, Kanada)
- GCI je široko zasnovana mera naprednog ekonomskog rasta i održivog prosperiteta zasnovanog na 3T ekonomskog razvoja - talenta, tehnologije i tolerancije. Ona ocenjuje i rangira 139 zemalja širom sveta na svaku od ovih dimenzija i na našu sveukupnu meru kreativnosti i prosperiteta.

Geopolitički indikator

Ovaj indikator obuhvata indikator koji se odnosi na:

- Političku stabilnost u zemlji i odsustvo nasilja / terorizma

Ovo je indikator koji je uključen u Svetske indikatore upravljanja (WGI -World Bank's Worldwide Governance Indicators). Predstavlja skup podataka o istraživanju koji sumira stavove o kvalitetu upravljanja preko velikog broja ispitanika iz preduzeća, građana i stručnjaka u industrijskim zemljama i zemljama u razvoju. Ovi podaci su prikupljeni iz brojnih istraživačkih instituta, istraživačkih centara, nevladinih organizacija, međunarodnih organizacija i firmi iz privatnog sektora. WGI ne odražavaju zvanične stavove Svetske banke, njenih izvršnih direktora ili zemalja koje predstavljaju.

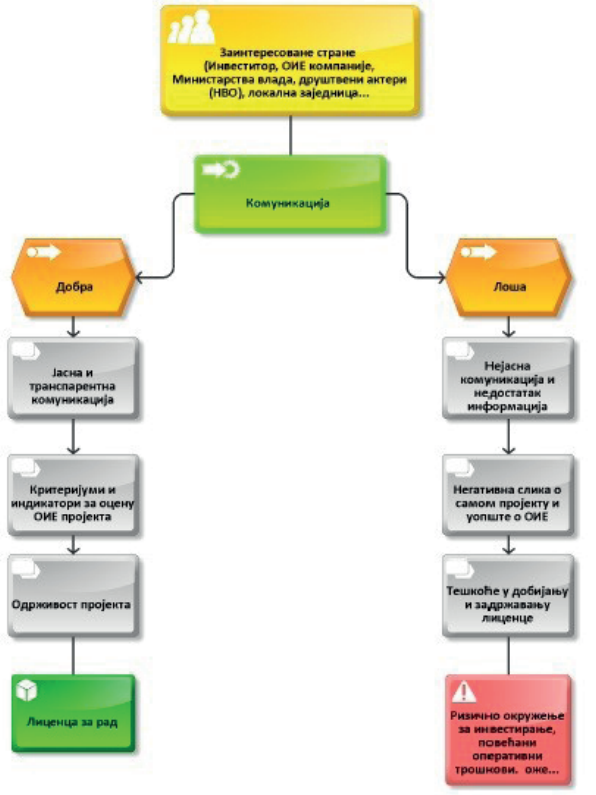
3. PROCEDURA ZA DONOŠENJE ODLUKA O INVESTIRANJU U PROJEKTE OIE

Model koji se koristi zasniva se na multikriterijumskoj analizi odluka i teoriji korisnosti više atributa. Alati za podršku odlučivanju uključuju različite indikatore održivosti jer se oni mogu primeniti na projekte obnovljive energije. Ovaj alat postaje popularan i najpogodniji je u oblasti energetskog planiranja zbog fleksibilnosti koju donosi donosiocima odluka da donose odluke dok istovremeno razmatraju sve kriterijume i ciljeve. Problemi višekriterijumske analize obično se sastoje od pet komponenti koje se odnose na: ciljeve, preference donosioca odluka, alternative, kriterijume i rezultate. Primenom teorije korisnosti više atributa, pokrivene su inherentne karakteristitke, što dovodi do razmatranja manjeg broja alternativa i stoga evaluacija postaje teška jer prioriteti postaju teži [3]. Konačni rezultat se određuje upoređivanjem različitih alternativa u odnosu na svaki od razmatranih atributa. I pored velike složenosti, primenom alata korisnosti više atributa istovremeno se izračunava redosled prioriteta za sve alternative, a da se pri tome uzima u obzir bilo koja razlika u bilo kom kriterijumu. Istovremeno, ukoliko dođe do promene vrednosti usled bilo kakvog uticaja, dinamički se ažurira.

Usklađenost sa zakonskim propisima ne može biti jedini preduslov u slučaju ovakvih projekata; društvo, kao i lokalne zajednice su se pokazale kao dosta sumnjičave kada se radi o projektima obnovljivih izvora energije, a nedostatak vere u kreatore politike stalno je podvrgnut novim procenama. Zainteresovane strane pored investitora, vlade, ministartstva, mogu biti i društveni akteri, NVO, lokalna zajednica i svako ko želi da se informiše o samom projektu, s toga je njihova transparentnost od ključnog značaja. Zainteresovane strane odobravaju dozvolu za rad projektu OIE kada smatraju da su njihove vrednosti / prioriteta i vrednosti kompanije investitora usklađene [1]. Kao rezultat toga, dozvola za rad ne predstavlja stalni ugovor, već dinamičan društveni ugovor koji zavisi od dinamičkih promena prioriteta višestrukih aktera; ona je dinamična zato što se percepcije aktera mogu menjati tokom vremena iz različitih razloga [4]; takođe se može ukinuti, i zbog toga je nikada ne treba uzeti zdravo za gotovo [5]. Potrebna je prilagodljivost za složeno upravljanje koje je povezano sa očuvanjem i održivim poslovanjem [6].

Kao što se može videti na Slici 1. kvalitet komunikacije između svih zainteresovanih strana je od ključne važnosti. Kada je projekat u fazi razvoja interesi zainteresovanih strana su pod stalnom transformacijom, pa

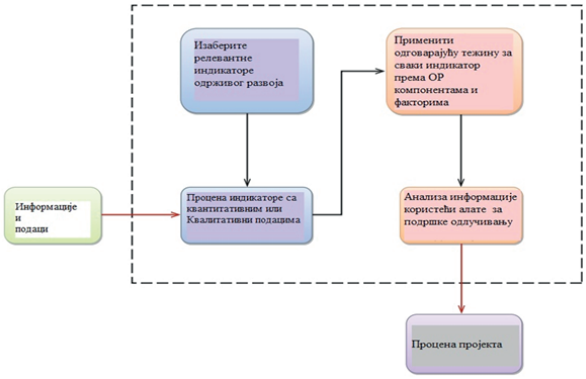
prilagodljivost zahteva njihovo stalno praćenje. U ovom kontinuiranom "procesu praćenja", donosioci odluka mogu utvrditi svoje odluke u okviru "GO-NO-GO" okvira, prilagoditi svoju politiku u skladu sa interesima zainteresovanih strana i proceniti projekat.



Slika 1. Modifikovani proces koji može odobriti održivu eksploataciju obnovljivih izvora energije

Nejasna, netransparentna, loša komunikacija može stvoriti značajne negativne implikacije za prihvatanje OIE projekta od stane zainteresovanih strana, najčešće društvenih aktera i lokalne zajednice, što je kritično za projekat OIE jer se javljaju oblici rizika / nesigurnosti sa ozbiljnim neželjenim efektima [7]. Ovi rizici mogu biti povezani sa kašnjenjima projekta i / ili otkazivanjem zbog društvenih previranja, vandalizma ili povećanih operativnih troškova [8]. Ovi rizici mogu biti tehnološki, ekološki, socijalni, ekonomski ili geopolitički. Kad informacije nisu jasno i transparentno podeljene, kompanija za obnovljive izvore energije možda neće moći da dobije upotrebnu dozvolu, što se odnosi na nivo prihvatanja ili odobrenja od strane lokalnih zajednica i zainteresovanih strana u preduzećima za obnovljivu energiju i njihovom poslovanju.

Dobra, jasna i transparentna komunikacija, dovodi do donošenja odluka kroz pregovarački proces između zainteresovanih strana. Uz pomoć alata za podršku odlučivanja, multikriterijumske analize, kao i teorije više atributa analiziraju se kriterijumi i indikatori za ocenu OIE projekta (Slika 2).



Slika 2. Modifikovana primena konceptualnog okvira u slučaju projekata obnovljivih izvora energije na osnovu analize višekriterijumskih odluka i teorije korisnosti više atributa

Pre svake analize, potrebno je prikupiti što više relevantnih podataka i informacija. Nakon izbora odgovarajućih indikatora održivog razvoja, vrši se procena indikatora sa kvantitativnim i kvalitativnim podacima. Koristeći alate za podršku odlučivanja radi se analiza i zahvaljujući dobijenim rezultatima, u vidu kompleksnog indikatora, vrši se procena održivosti projekta.

U ovom slučaju kompleksni (kumulativni) indeks nazvali smo "IRIS". Odluka "GO" ili "NO-GO" zasnovana je na oceni ovog indeksa i prikazana je u tabeli 1.

Tabela 1. "GO" ili "NO-GO" odluka zasnovana na proceni indeksa "ACROPOLIS"

Iris	Odluka	Kategorija (boja koda)	Komentar
Pozitivan	GO	A - zelena	Projekat je prihvaćen.
Negativan	NO-GO	C - crvena	Projekat je odbijen. (zahtevaju se značajne promene pre evaluacije).
Oko nule	Na čekanju	B - narandžasta	Predlažu se mere za ublažavanje uticaja. Projekat ima potencijal da se ponovo proceni.

Pozitivna vrednost ovog indeksa, odlikuje se zelenom bojom koda (kategorija A), što znači da je projekat održiv i projekat je prihvaćen. U slučaju da je vrednost indeksa negativna, boja koda je crvena (kategorija C) i ovakav projekat se odbija. Da bi se ponovo razmatrao, potrebno je napraviti značajne promene na projektu. Ukoliko je vrednost "Acropolis" indeksa oko nula, boja koda je narandžasta i projekat se stavlja na čekanje, što znači da projekat ima potencijal za ponovnu procenu uz manje promene.

Prednost teorije višestrukih atributa leži u sledećem [9]:

- ona objašnjava svaku razliku u bilo kom kriterijumu,
- istovremeno izračunava redosled preferencija svih alternativa, i
- dinamički ažurira promene vrednosti zbog bilo kakvog uticaja.

Nedostaci ove teorije:

- teško je imati precizan doprinos od strane donosioca odluka, i
- rezultat kriterijuma za odlučivanje je neizvestan.

4. ZAKLJUČAK

Model koji je prikazan može da pomogne donosiocima odluka i zainteresovanim stranama da procene projekat OIE i izrade "GO-NO-GO" odluke sa tačke gledišta održivog razvoja. Sa povećanjem složenosti i mnogostrukosti problema energetskog planiranja, pojedinačna optimizacija / analiza nije adekvatna, te je iz tog razloga ovaj model zasnovan na multikriterijumskoj analizi odluka i teoriji korisnosti više atributa. Dokazano je da je donošenje višekriterijumskih odluka jedan od boljih instrumenata za efikasno energetsko planiranje, zato što je u osnovi nastao iz operacionih istraživanja koja uključuju širok spektar metodologija. Ovakva analiza se smatra bitnom strukturom procene za rešavanje ekoloških, socio-ekonomskih, tehničkih i institucionalnih prepreka uključenih u energetsko planiranje. Ova analiza je postala popularna u energetskom planiranju jer omogućava donosiocu odluka da obrati pažnju na sve dostupne kriterijume i donese odgovarajuće odluke po prioritetu. Pošto je savršen dizajn vođen višestrukim dimenzijama, dobar donosilac odluka, u određenim situacijama, može tražiti parametre kao što su tehnički ili ekonomski koji mogu biti kompromitovani.

Model obezbeđuje sposobnost vizuelizacije percepcije o učešću građana i većoj transparentnosti u sveobuhvatnom režimu koji su Ujedinjenim nacijama preporučili u ranijim godinama i kvantifikovali ideju održivog puta, jer je to definisao Nacionalni savet za istraživanje SAD.

Prednosti ovog modela ogleda se u tome što pruža priliku zainteresovanim stranama transparentno, slobodno odlučivanje i demokratsko pregovaranje sa svim zainteresovanim stranama; kvantifikuje i meri stepen održivosti samog projekta; usklađen je sa preduslovom UN za održivi razvoj, koji se odnosi na "... efikasno učešće građana u donošenju odluka i većom demokratijom u međunarodnim donošenjima odluka ... " ; doprinosi sticanju i zadržavanju "društvene dozvole" ; dizajniran je da podrži sve tri faze projekta: pre, tokom i nakon završetka projekta; može da se menja; uključuje kvalitativne i kvantitativne pokazatelje.

Ono što se može smatrati nedostacima ovog modela odnosi se na same podatke. Nema dovoljno dostupnih podataka, a i sama verodostojnost često je pod znakom pitanja.

Treba napomenuti i to da svaki projekat OIE ima jedinstvene karakteristike. Indikativni rezultati su pokazali da predstavljeni model može dati rezultate koji se sastoje od prioriteta zainteresovanih strana i relativno dobro prosuđivanje.

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PRIMENA METODE KONTROLISANOG EKSPERIMENTA U ANALIZI PONAŠANJA POTROŠAČA ELEKTRIČNE ENERGIJE

Sanja Filipović[1,*],
Mirjana Radovanović[2]

[1]Univerzitet Singidunum,
Beograd, Srbija
[2]Univerzitet Educons,
Sremska Kamenica, Srbija

Rezime:

Unapređenje energetske efikasnosti u domaćinstvima je jedan od prioriteta Srbije, s obzirom da se električna energija u domaćinstvima neracionalno troši, a domaćinstva imaju dominantno učešće od oko 51% u finalnoj potrošnji električne energije. Kako bi se unapredila energetska efikasnost, neophodno je definisati ključne faktore koji utiču na ponašanje potrošača. Na ponašanje potrošača, pored cenovnih, utiče i čitav niz necenovnih faktora. Polazeći od činjenice da je cena električne energije u Srbiji najniža u Evropi, u ovom radu fokus je na necenovnim faktorima. Cilj ovog istraživanja je da utvrdi da li informisanje domaćinstava o jednostavnim načinima za uštedu električne energije doprinosi promeni njihovog ponašanja. Istraživanje je sprovedeno primenom metode kontrolisanog eksperimenta što je podrazumevalo definisanje eksperimentalne i kontrolne grupe na uzorku od 330 domaćinstava. Istraživanje je pokazalo da u situaciji kada je cena električne energije veoma niska, informacije o uštedi energije nemaju značajan uticaj na promenu ponašanja potrošača.

Ključne reči:

cena električne energije, potrošnja, metod kontrolisanog eksperimenta.

1. UVOD

Evropska unija aktivno promoviše tranziciju energetike na troškovno-efikasnom principu, a sve u cilju da svojim građanima omogući sigurno, pouzdano i održivo snabdevanje energijom. Energetska i klimatska politika Evropske unije za vremenski period do 2030. godine ima jasno definisana tri ključna cilja: a) unapređenje energetske efikasnosti za 20%; b) smanjenje emisije gasova staklene bašte za najmanje 40% u odnosu na nivo emisije iz 1990. godine i c) povećanje učešća obnovljivih izvora energije u ukupnoj potrošnji energije za 30%. U novembru 2016. godine, Evropska komisija je predložila energetski paket (*Clean Energy Package For All Europeans*) kojim se reguliše osam oblasti, gde posebno mesto ima regulacija tržišta električne energije i regulativa vezana za unapređenje energetske efikasnosti.

U ovom radu fokus istraživanja biće isključivo na faktorima koji podstiču efikasno korišćenje električne energije u domaćinstvima. U cilju unapređenja efikasne potrošnje električne energije u domaćinstvima

Odgovorno lice:
Sanja Filipović

e-pošta:
sfilipovic@singidunum.ac.rs

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koriste se razne vrste mera koje se generalno mogu svrstati u grupu finansisjkih mera (npr. subvencije za kupovinu energetski efikasnih kućnih aparata) i nefinansijskih mera koje više imaju informativnu i edukativnu ulogu (npr. edukacija o efikasnoj upotrebi električne energije). Utvrđivanje efekata ovih podsticajnih mera u velikoj meri može doprineti definisanju adekvatne politike unapređenja energetske efikasnosti u domaćinstvima.

Istraživanje uticaja promene cene električne energije na promenu nivoa potrošnje električne energije ima ogroman značaj kako bi se definisala adekvatna politika podsticanja efikasne potršnje. U literaturi se može naći dosta istraživanja koja su se bavila analizom uticaja cena električne energije na promenu nivoa potrošnje električne energije u domaćinstvima [1, 2]. U skladu sa empirijskim rezultatima, opšte je poznato da je električna energija visoko cenovno neelastična, odnosno da će procentualni rast cene električne energije biti praćen manjim procentualnim padom u traženoj količini. Razlog tome je činjenica da je električna energija jedno od osnovnih dobara bez koga se teško može zamisliti savremeno društvo.

Jacobsen [3] tvrdi da, u uslovima kada postoje neiskorišćene mogućnosti za ulaganje, rast cene električne energije za potrošače ne znači gubitak po svaku cenu. Štaviše, potrošači mogu biti na dobitku ukoliko ih rast cene električne energije podstakne da ulažu u energetski efikasne uređaje. Nasuprot tome, ako potrošači reaguju na rast cene električne energije tako što smanjuju potrošnju električne energije, gubitak može biti znatno veći, apstrahujući tako sve koristi od redukovanja eksternalija nastalih potrošnjom električne energije (primer eksternalija može biti emisija CO_2 u slučaju proizvodnje električne energije na bazi fosilnih goriva). Prisustvo anomalija u ponašanju potrošača može dovesti do toga da se potrošači ne ponašaju u skladu sa očekivanjima (npr. nezainteresovanost za štednju električne energije), odnosno da rast cene ne mora nužno značiti i doslednu primenu principa minimizacije troškova [4]. Otuda, finansijski podsticaji bazirani na rastu cena električne energije ne moraju nužno da podstiču investicije u energetski efikasne uređaje u domaćinstvu [5].

Kako je analiza uticaja cene električne energije dosta zastupljena u literaturi, predmet ovog istraživanja biće analiza uticaja necenovnih faktora, a pre svega, uticaja informacija kako se električna energija može efikasno i bez velikih ulaganja uštedeti u domaćinstvima. Istražvanje je sprovedeno u Srbiji na uzorku od 330 domaćinstava i u ovom radu su predstavljeni preliminarni rezultati istraživanja. Dodatni motiv za analizu necenovnih faktora je činjenica da Srbija (gde je terensko istraživanje sprovedeno) ima ubedljivo najnižu cenu električne energije u Evropi.

Cilj istraživanja je da se utvrdi koliki značaj imaju korisne informacije za uštedu električne energije na potrošnju u domaćinstvu. Istraživanje je sprovedeno primenom metode kontrolisanog eksperimenta (*Randomized Control Trials*, RCT). Činjenica da se u ovom istraživanju koristi RCT metod, čini ovo istraživanje jedinstvenim s obzirom da koliko je poznato autorima ovaj metod istraživanja nije korišćen za te svrhe u Srbiji. Inače RCT method se tek odnedavno koristi u svetu za ispitivanje faktora koji utiču na ponašanje potrošača, a njegova primena je bila dominantna u medicinskim naukama i psihologiji.

Drugi bitan naučni doprinos ovog istraživanja se ogleda u činjenici da je ono sprovedeno na uzorku od 330 domaćinstava, što u odnosu na sprovedena istraživanja ove vrste u svetu nije zanemarljiv uzorak. Ranije studije iz ove oblasti su bile bazirane na malim pilot istraživanjima kod kojih je bilo teško odrediti uzročne faktore i generalizovati zaključke [6, 7]. Tek nedavno su sprovedena empirijska istraživanja na relativno većim uzorcima uz primenu RCT metode [8, 9, 10]. Istraživanja su pokazala da cene i informacije, kao i faktori koji utiču na ponašanje potrošača (npr. društvene norme, standardi i obrasci ponašanja) imaju značajan uticaj na potrošnju električne energije u domaćinstvu.

Rad je struktuiran tako da, pored uvoda ima još pet tematski povezanih celina. U drugom delu rada dat je kratak pregled literature, odnosno rezultata relevantnih istraživanja u ovoj oblasti. U trećem delu rada je predstavljena metodologija istraživanja. Četvrti deo rada je posvećen analizi rezultata i diskusiji, dok su u poslednjem zaključnom delu sumirani nalazi istraživanja.

2. PREGLED LITERATURE

Tek nedavno je RCT metod počeo da se koristi u studijama koje imaju za predmet istraživanja očuvanje resursa i tumačenje eksternalija u životnoj sredini. U poslednjih nekoliko godina su sprovedena istraživanja na bazi RCT metode koja imaju za cilj da utvrde efikasnost intervencija (u vidu edukativnih informacija) u na nivo potrošnje električne energije u domaćinstvima. Tako je Allcott u svom istraživanju iz 2011. godine [11] pokazao da pružanje informacija o efikasnim načinima uštede električne energije može smanjiti potrošnju na nivou domaćinstva od 2%. Druga istraživanja [12] su

pokazala da efekti korisnih instrukcija mogu biti najveći u domaćinstvima koja inače imaju visok nivo potrošnje, ali da je bitno koliko se često instrukcije ponavljaju.

U jednom pilot istraživanju iz 2013. godine, Houde [13] je pokazao da prosečna ušteda potrošnje električne energije može biti i 7%, ali pod uslovom da domaćinstva imaju tzv. pametne uređaje koji automatski mere potrošnju u realnom vremenu. Jedno drugo empirijsko istraživanje [14] je pokazalo da će se efekat instrukcija tokom vremena smanjivati tako da će nakon četiri nedelje efekat instrukcija biti gotovo neznatan.

Istraživanje koje su sproveli Allcott i Rogersa [8] pokazalo je da domaćinstva čim prime izveštaj o potrošnji odmah smanjuju svoju potrošnju, ali nedugo zatim ovaj efekat gubi na značaju i domaćinstva se već posle nekoliko nedelja vraćaju prvobitnim navikama i tako završavaju na prvovobitnom nivou potrošnje električne energije.

Upravo ta istraživanja koja su pokazala da se efekat informacije smanjuje s protokom vremena su podstakla istraživanje grupe autora [15] koji su imali za cilj da definišu da li je smanjenje potrošnje energije nastalo kao posledica usvanjanja informacija (tzv. efekat učenja) ili je do smanjenja u potrošnji energije došlo usled toga što su stalno pred sobom imali informaciju o nivou potrošnje (npr. merač koji pokazuje uštede). To istraživanje je pokazalo da je efekat učenja bio dominantniji, ali da je imao opadajući značaj tokom vremena. U skladu sa tim, autori su zaključili da medijske informativne i edukativne kampanje imaju veći efekat od instaliranja raznih merača u domaćinstvima.

Do sada nisu sprovedena neka značajnija istraživanja na većem uzorku koja bi na sistemskom nivou analizirala koliko je bitna učestalost informacija na ponašanje potrošača, niti koliko sama dužina eksperimenta utiče na istrajnost domaćinstava u primeni instrukcija za energetske uštede. Taubinsky [4] je u svom istraživanju pokazao da se istrajnost u primeni instrukcija može podstaći tako što će se instrukcije ponavljati kroz razne medijske kampanje. Do sličnih nalaza su došli Allcott i Rogers [14] koji su ukazali da razni izveštaji o potrošnji imaju samo kratkotrajan efekat.

Svi ti nalazi su dali podsticaj da se sprovede ovo istraživanje u Srbiji bazirano isključivo na širenju korisnih edukativnih informacija o načinima uštede električne energije u domaćinstvu koji ne zahtevaju nikakva dodatna ulaganja. Naravno, pošlo se i od činjenice da domaćinstva u Srbiji generalno ne raspolažu sa meračima za potrošnju električne energije (tzv. brojila koja očitavaju potrošnju svakog kućnog aparata u domaćinstvu).

3. METODOLOGIJA ISTRAŽIVANJA

U ovom istraživanju terenski eksperiment je razvijen u skladu sa karakteristikama nacionalnog tržišta električne energije. Tržište električne energije u Srbiji još nije potpuno liberalizovano i cene električne energije su regulisane. Domaćinstva mogu da biraju između nekoliko registrovanih dobavljača električne energije, ali ipak zbog konkurentne cene domaćinstva se opredeljuju za tržišno dominantnog proizvođača električne energije (javno preduzeće Elektroprivreda Srbije, EPS). U Srbiji ne postoje tzv. pametna brojila, tako da podatke o potrošnji električne energije i dalje beleže operateri koje EPS angažuje. Operateri na mesečnom nivou posećuju domaćinstva i prave evidenciju o potrošnji, na osnovu koje se sastavlja mesečni račun za potrošnju električne energije.

U Srbiji domaćinstva imaju dominantno učešće od 51% u ukupnoj potrošnji električne energije. Potrošnja električne energije u domaćinstvima nije efikasna između ostalog i zbog toga što se električna energija koristi za grejanje. Podaci Eurostata pokazuju da domaćinstava u Srbiji troši gotovo pet puta više električne energije po jedinici bruto domaćeg proizvoda od proseka zemalja članica Evropske unije. Budući da se proizvodnja električne energije u Srbiji uglavnom zasniva na termoelektranama na lignit (termoelektrane čine 73% ukupne proizvodnje električne energije), postoji visok nivo emisije CO_2. Nivo emisije CO_2 po stanovniku je na nivou proseka Evropske unije, ali je emisija po jedinici bruto domaćeg proizvoda u Srbiji skoro šest puta veća.

Vrlo bitna je činjanica da je cena električne energije u Srbiji najniža u Evropi. Poređenja radi, prema podacima Eurostata za kraj prvog polugodišta 2018. godine, prosečna cena električne energije (uključujući poreze i takse) za domaćinstva na nivou Evropske unije je iznosila 20,53 euro centi, dok je cena električne energije za domaćinstvo u Srbiji iznosila 7,05 euro centi.

Imajući u vidu da su cene električne energije u Srbiji najniže u Evropi, preliminarna hipoteza ovog istraživanja bila je da je niska cena električne energije za domaćinstava glavni razlog zašto se električna energija ne koristi racionalno. Polazeći od te pretpostavke, ideja ovog istraživanja je bila da se analizira da li informacije o uštedi energije mogu da promene ponašanje potrošača u Srbiji.

Polazna hipoteza istraživanja je da informacije o uštedi energije predstavljaju efikasno sredstvo za menjanje navika potrošača, odnosno da će korisne informacije uticati na efikasnije ponašanje potrošača i smanjenje

potrošnje električne energije u domaćinstvima. Istraživanje je urađeno sa ciljem da se utvrdi uticaj instrukcija za uštedu energije na potrošnju električne energije u domaćinstvu, odnosno da li korisne informacije mogu da promene navike potrošača u Srbiji.

Uzorak istraživanja se sastojao od 330 domaćinstava sa teritorije Beograda koja imaju slične nivoe prosečne potrošnje električne energije. Da bi se postigla jednaka zastupljenost domaćinstava koja koriste različite metode za zagrevanje, ukupan uzorak je podeljen na tri pod-uzorka:

1. Prvi pod-uzorak čine domaćinstva koja žive u zgradama u kojima postoji daljinski sistem grejana (domaćinstva sa lokaliteta Novi Beograd),
2. Drugi pod-uzorak čine domaćinstva koja žive u manjim i starijim zgradama bez daljinskog grejanja, tako da ova domaćinstva uglavnom koriste električnu energiju za zagrevanje (stari centar Beograda) i
3. Treći pod-uzorak čine domaćinstva koja žive u predgrađu, uglavnom u kućama i koriste različite energetne za zagrevanje životnog prostora (struja, drvo, ugalje, itd.).

Ova podela je važna jer uređaji koji se koriste za zagrevanje na električnu energiju često su najveći potrošači u domaćinstvu i stoga mogu uticati na spremnost domaćinstava da primenjuju instrukcije za uštedu energije. Za svaki pod-uzorak, domaćinstva su nasumično izabrana. Nakon toga, prešlo se u fazu terenskog istraživanja što je podrazumevalo posetu domaćinstava i informisanje o samom istraživanju. Domaćinstva koja su pristala da učestvuju su nasumično podeljena u eksperimentalnu grupu i kontrolnu grupu (50:50).

Kontrolna grupa nije bila izložena "tretmanu" i ova grupa je korišćena za poređenje sa eksperimentalnom grupom. Učesnici u eksperimentalnoj grupi su dobili brošuru sa uputstvima za uštedu energije. Takva intervencija je korišćena kako bi se povećala svest potrošača i ispitalo da li usvajanje novih obrazaca potrošnje ima stvarni uticaj na smanjenje potrošnje. Domaćinstva u eksperimentalnoj grupi trebalo je da usvoje i primene jednostavne instrukcije za uštedu energije date u brošuri. Ta uputstva za uštedu električne energije u domaćinstvima odnosila su se na efikasnije korišćenje aparata za svakodnevnu upotrebu (grejanje, bojler, veš mašina, šporet, frižider i osvetljenje u stanovima). Promenom navika u korišćenju kućnih aparata, moguće su određene uštede. Očekivani uticaj takve intervencije odražava usvajanje i sprovođenje datih uputstava za domaćinstva tokom eksperimenta.

Takav vid intervencija (instrukcija) su koristili i drugi autori. Abrahamse [15] je isto u svom istraživanju koristio instrukcije u vidu informacija o mogućnostima uštede energije za domaćinstva što može dovesti do uštede energije jer su potrošači stekli određena saznanja. Potrošnja potrošača u eksperimentalnoj grupi je poređena sa domaćinstvima u kontrolnoj grupi na mesečnom nivou. Ovakvo poređenje potrošnje električne energije između eksperimentalne i kontrolne grupe omogućava nam da odredimo efekat informacija o promeni ponašanja, a samim tim i potrošnji električne energije.

Istraživanje je sprovedeno tokom tromesečnog perioda i obuhvatio je analizu potrošnje električne energije u periodu februar – april 2018. godine. Primenom eksperimentalne i kontrolne grupe eliminiše se problem sezonskog efekta u potrošnji.

4. REZULTATI I DISKUSIJA

Na početku istraživanja, polazna pretpostavka je bila da cenovni podsticaji neće biti efikasni u ovom istraživanju zbog činjenice da je cena električne energije u Srbiji najniža u Evropi.

Politika cena električne energije mora se voditi pravilom da cene moraju biti iznad nivoa marginalnih troškova proizvodnje jer u suprotnom cene šalju pogrešne signale što se negativno odražava na nivo potrošnje (neracionalna potrošnja) ili na pogrešne investicione odluke [16]. Formiranje cena u realnom vremenu može da ispravi ovu distorziju, ali efekat cena na ukupnu potrošnju i na investicije u energetski efikasne tehnologije je upitan [17].

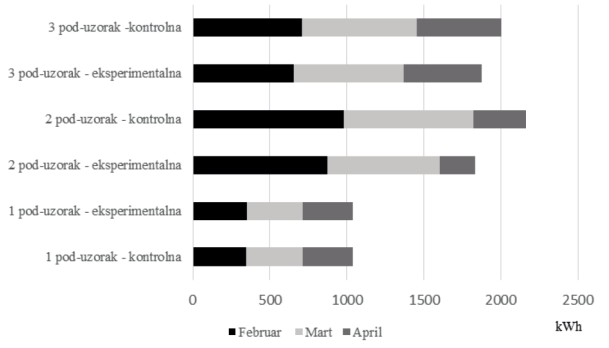
U ovom istraživanju pretpostavljeno je da niska cena električne energije može biti ključni razlog visoke i neefikasne potrošnje električne energije u domaćinstvima. Umesto izbora cena, u ovom istraživanju postavljena je hipoteza istraživanja da informacije o uštedi energije predstavljaju efikasno sredstvo za uticj na energetsko ponašanje domaćinstava u Srbiji i smanjenje potrošnje električne energije.

Međutim, rezultati istraživanja nisu potvrdili ovu hipotezu. Prvi pod-uzorak koji čine domaćinstva koja imaju pristup daljinskom grejanju (ova grupa domaćinstava ima inače najniži nivo potrošnje električne energije) su zabeležila najniži nivo promene potrošnje električne energije između eksperimentalne i kontrolne grupe. U februaru je prosečna potrošnja domaćinstava u eksperimentalnoj grupi i kontrolnoj grupi iznosila 349 kWh, odnosno 345 kWh. U martu je kontrolna grupa zabeležila pad potrošnje (prosečna potrošnja električne energije domaćinstava u eksperimentalnoj grupi bila je 366 kWh u odnosu na

369 kWh u kontrolnoj grupi), dok je u aprilu nivo potrošnje u obe grupe bio na istom nivou (322 kVh).

U drugom pod-uzorku koji čine domaćinstava koja dominantno koriste električnu energiju za grejanje (centar Beograda), prosečna potrošnja električne energije je najveća. Posmatrajući kontrolnu grupu pre početka eksperimenta, prosečna mesečna potrošnja je bila 2,5 puta veća nego u domaćinstvima sa daljinskim grejanjem. U ovom pod-uzorku, eksperimentalna grupa je tokom čitavog eksperimentalnog perioda zabeležila niži nivo potrošnje električne energije nego u kontrolnoj grupi. U februaru je prosečna potrošnja domaćinstava u eksperimentalnoj grupi i kontrolnoj grupi iznosila 872 kWh, odnosno 979 kWh. U martu je zabeležen pad potrošnje električne energije - prosečna potrošnja električne energije u eksperimentalnoj grupi iznosila je 732 kWh, dok je prosečna potrošnja električne energije u kontrolnoj grupi iznosila 842 kWh. U aprilu je nivo potrošnje u eksperimentalnoj grupi iznosio 230 kWh, dok je u kontrolnoj grupi bio 343 kWh.

U trećem pod-uzorku koji čine domaćinstva koja koriste različite izvore energije za grejanje (predgrađe Beograda), eksperimentalna grupa je zabeležila niži nivo potrošnje električne energije od prosečne potrošnje domaćinstava u kontrolnoj grupi tokom celog posmatranog perioda. U februaru je prosečna potrošnja domaćinstava u eksperimentalnoj grupi iznosila 656 kWh, dok je kontrolna grupa imala prosečnu potrošnju električne energije od 710 kWh. U martu je prosečna potrošnja domaćinstava u eksperimentalnoj grupi iznosila 715 kWh i 743 kWh u kontrolnoj grupi. Prosečna potrošnja domaćinstava u eksperimentalnoj grupi i kontrolnoj grupi u aprilu je iznosila 503 kWh, odnosno 550 kWh. Na slici 1. prikazani su rezultati prosečne potrošnje električne energije u obe grupe za tri stratuma tokom posmatranog perioda.



Grafikon 1. Prosečna potrošnja električne energije na nivou uzorka

Izvor: proračun autora.

Ovo istraživanje je pokazalo da se nivo potrošnje električne energije nije značajno razlikovao između kontrolne i eksperimentalne grupe, iako je eksperimentalna grupa dobila instrukcije o tome kako poboljšati energetsku efikasnost u svom domaćinstvu. Pored toga, važno je istaći da se svi članovi eksperimentalne grupe bili kontaktirani telefonom svakog meseca i tom prilikom su bili pitani da li se pridržavaju uputstava. Najveće odstupanje u potrošnji električne energije između eksperimentalne i kontrolne grupe evidentno je u uzorku domaćinstava koja koriste električnu energiju za grejanje (drugi pod-uzorak). Stoga se može zaključiti da je ova grupa domaćinstava bila najviše zainteresovana za smanjenje potrošnje električne energije što je u skladu i sa nalazima drugih autora.

5. ZAKLJUČAK

Istraživanje je pokazalo da u situaciji kada su cene električne energije niske, informacije o uštedama električne energije nemaju veliki uticaj na ponašanje potrošača. Na osnovu analize prosečne potrošnje u kontrolnoj i eksperimentalnoj grupi (sezonski efekat se gubi jer se koristi kontrolna i eksperimentalna grupa) može se videti da nisu prisutna značajnija odstupanja, odnosno potrošači nisu spremni da samo na osnovu informacija o uštedama menjaju svoje navike u potrošnji električne energije.

Pa ipak, terensko istraživanje je pokazalo da domaćinstva u Srbiji još uvek nemaju dovoljno informacija o efikasnim načinima za uštedu električne energije, niti imaju dovoljno znanja o savremenim tehnološkim uređajima koji su troškovno efikasniji u odnosu na tradicionalne uređaje koji se koriste za grejanje u domaćinstvima. Činjenica je da domaćinstva imaju dominantno učešće u strukturi finalne potrošnje električne energije, kao i da velika većina električnu energiju neefikasno koristi. Najveći problem predstavlja praksa da se usled relativno niske cene, električna energija u mnogim domaćinstvima koristi za grejanje. Razlog tome je nerazvijena infrastruktura, odnosno mogućnosti za upotrebu drugih izvora za grejanje (npr. nerazvijen sistem za daljinsko grejanje, nedovoljno razgranata mreža za gasifikaciju, nedostatak podsticaja za uvođenje tehnološki efikasnijih sistema za grejanje u domaćinstvima, itd.). Bolja informisanost i podsticaji domaćinstvima za ulaganja u tehnologije za proizvodnju električne energije na bazi obnovljivih izvora (npr. solarni paneli), mogli bi promenitu tradicionalnu sliku prosečnog potrošača u Srbiji.

Najveće ograničenje ovog istraživanja je bilo da se obezbedi da domaćinstava koja čine eksperimentalnu i kontrolnu grupu, na samom početku, pre nego što se i počne sa eksperimentom, imaju isti nivo potrošnje električne energije. I pored toga što je napravljen uzorak od domaćinstva koja imaju prilično ujednačenu potrošnju na nivou uzorka, gotovo je bilo nemoguće napraviti podelu na eksperimentalnu i kontrolnu grupu tako da nivo potrošnje pre početka istraživanja bude isti. Kako je taj kriterijum bio ispunjen jedino u prvom slučaju (domaćinstva koja imaju daljinsko grejanje), čini se da su ti podaci i najpouzdaniji.

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UPOTREBA FJUČERSA ZA HEDŽOVANJE RIZIKA NA TRŽIŠTU ELEKTRIČNE ENERGIJE

Tatjana Latas[1, *],
Zoran Jeremić[2],

[1]Somborelektro d.o.o.,
Sombor, Srbija
[2]Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Na kretanje cena električne energije na tržištu utiče veliki broj faktora, te je veoma složeno predviđati kretanje tržišnih cena na kratak, a pogotovo duži rok i doneti odluku kada i u kojoj količini nabaviti ili prodati električnu energiju. Predviđanje kretanja cena električne energije stoga predstavlja veliki izazov, jer nosi visoke rizike, što direktno može da utiče na poslovanje kompanija. Ovi rizici se mogu ublažiti primenom adekvatnih hedžing strategija, pa u ovom radu istražujemo mogućnosti smanjenja rizika upotrebom fjučersa na električnu energiju. Ova tema dobija na aktuelnosti i značaju budući da EEX u saradnji sa SEEPEX uvodi fjučerse za srpsko tržište.

Ključne reči:
hedžing, fjučers, EEX, SEEPEX.

1. UVOD

Izlažući se nekontrolisanom riziku od stalnih promena spot cena električne energije, učesnici na tržištu električne energije su često u situaciji da kreiraju gubitke. Kontrolisati i smanjiti tržišne rizike je moguće primenom adekvatnog hedžinga (engl. hedging). U većini slučajeva hedžing tehnike, podrazumevaju upotrebu finansijskih derivata, čija je suštinska uloga da smanje tržišne rizike, te ih učesnici tržišta električne energije sve više koriste.

Razlozi za hedžovanje rizika na tržištu električne enegije mogu biti raznovrsni. Zbog izrazite volatilnosti cena električne energije, cenovni rizik pretstavlja posebnu pretnju za uspeh kompanija, koji se može ublažiti upotrebom robnih derivata za hedžiranje. Upotrebom robnih derivata za hedžiranje korisnici mogu imati višestruke koristi: izbegavanje nepovoljnih cenovnih kretanja, osiguranje sigurne prodaje/nabavke, sigurni dugoročni novčani tokovi [1]

Na tržištu derivata za električnu energiju, za razliku od spot tržišta, ugovaraju se isporuke za duži vremenski period, cene odražavaju buduća očekivanja spot cena, pa su ova tržišta daleko veća po obimu trgovanja, sa relativno niskom volatilnošću.

Odgovorno lice:
Tatjana Latas

e-pošta:
tatjana.latas@somborelektro.rs

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Cene na tržištu derivata se formiraju pod uticajem mnogobrojnih faktora: spot cena (vreme, raspoloživost, sezona, doba dana, operativni troškovi, strani ponuđači) ekonomski rast, situacija na drugim tržištima, posebni događaji (moratorijum na elektrane), politička situacija.

Učesnici tržišta električne energije poput proizvođača, dobavljača, snabdevača, te ostalih učesnika sposobnih za upravljanje rizicima, koriste se različitim finansijskim instrumentima da se zaštite od rizika promena cena: terminskim ugovorima (fjučers i forvard), ugovorima o zameni jedne vrste imovine za drugu (svopovi) i opcijama.

Jedan od najšire primenjenih derivata na tržištu električne energije su fjučersi, koji mogu da budu sklopljeni na berzi ili izvan berze. Učesnici tržišta električne energije najčešće koriste fjučers ugovore da bi se zaštitili od gubitaka zbog stalnih promena spot cena na tržištu električne energije. Da bi se postigao cilj, odnosno da bi se zaštitili od rizika, mora im prethoditi uspešno savladavanje tehnike njihovog korištenja, kao i pravilna primena hedžing metode. U ovom radu dat je paralelan prikaz primene jednostavne i metode dinamičkog hedžiranja fjučers ugovora.

Kupoprodaja električne energije se odvija na berzi ili izvan berze. Na berzama je, zbog strogih pravila zagarantovana likvidnost trgovanja, odnosno tržišni učesnici mogu izvoditi fjučers ugovore samo pod uslovom da otvore račun na kojem će polagati novac, garancije ili hartije od vrednosti za pokrivanje margina u slučaju kad terminske cene električne energije rastu u odnosu na fiksno utvrđenu cenu. U suprotnom, učesnik tržišta na tom računu sakuplja kredite koje će iskoristiti u trenucima ponovnog rasta terminskih cena. Upravo taj mehanizam trgovanja čini berzu likvidnom.

Prilikom sklapanja fjučers ugovora utvrđuje se: ukupna količina električne energije koja treba biti isporučena, cena, mesto isporuke, trajanje isporuke, količina električne energije tokom razdoblja isporuke, te poslednji dan za trgovanje koji pada na datum konačnog ispunjavanja obaveza prema fjučers ugovoru.

Fjučers ugovori imaju minimalni rok dospeća od sat vremena do najviše jedne godine. Fjučers ugovori mogu biti sa fizičkim i finansijskim poravnanjem. Uobičajena je praksa da su ugovori o fizičkoj isporuci električne energije ugovori koji dospevaju u roku jednog sata ili jednog dana, a da ugovori koji dospevaju u roku nedelju ili mesec dana mogu biti i fizički i finansijski, te da se njima trguje putem brokera ili ih učesnici tržišta direktno izvode na tržištima izvan berze.

2. PRIMENA HEDŽING METODA NA FJUČERS UGOVORE

Primenjivati hedžing znači zaštiti se ili osigurati od negativnih pojava, koje se ne moraju dogoditi, ali i ako se dogode dobar hedžing će ih značajno ublažiti. Stoga je primena hedžinga prisutna gotovo svugde i gotovo svakodnevno. Investitori i upravljači portfeljima najčešće koriste hedžing kako bi bili što manje izloženi raznoraznim rizicima. Investitori štite jednu investiciju time što stvaraju drugu investiciju. Hedžiranje podrazumeva istovremeno dve investicije u kojima jedna investicija pokriva ili štiti drugu. Smanjenje rizika uvek podrazumeva i smanjenje potencijalne dobiti, što znači da se hedžiranjem ne stvaraju viškovi dobiti, već se smanjuje potencijalni gubitak. Ako neka investicija koja je hedžirana stvara dobit , onda će dobit od te investicije biti manja nego od investicije koja nije hedžirana i obrnuto, ako investicija koja je hedžirana rezultira gubitkom, tada će taj gubitak, zahvaljujući hedžiranju, biti smanjen ili izbegnut. Imajući u vidu visoku volatilnost cena električne energije, hedžing metode nalaze svoju punu primenu na tržištima električne energije.

Za primenu hedžing metode osnovno je da se utvrdi razlika između spot cene i terminske cene električne energije. Pretpostavka je da se zarada ostvaruje kada vrednosti tih cena konvergiraju. Kao jednostavan primer može se uzeti ugovor sklopljen između prodavaca i kupca na berzi, s unapred određenom cenom električne energije od 50 EUR/MWh, za ugovorenu količinu električne energije od 100 MWh. Zadata transakcija će se obaviti preko berze. Ako je u trenutku ispunjenja ugovornih obaveza cena na berzi 60 EUR/MWh, tada će prodavac dobiti 60 EUR/MWh, ali će razliku od 10 EUR/MWh vratiti kupcu. I obrnuto, kupac će platiti razliku prodavacu ako se dogodi da je u trenutku isporuke cena električne energije na berzi manja od ugovorene. To rezultira anuliranjem dobiti jer obe ugovorne strane, tj. kupac i prodavac, plaćaju električnu energiju po ugovorenoj ceni. Vidljivo je da ugovorna strana koja plaća razliku u ceni električne energije nije iskoristila mogućnost za većom dobiti koju bi ostvarila prema tržišnoj ceni s berze, pošto je prethodno hedžirala svoju poziciju od tržišnog rizika.

Vrednost fjučers ugovora sa fiksnom cenom

Smisao fjučers ugovora je taj da se odredi njegova vrednost u svakom trenutku t do trenutka T kada on

ističe, a u odnosu na kupoprodaju električne energije po fiksno utvrđenoj ceni X po jedinici električne energije. Pretpostavlja se da vrednost fjučers ugovora sve više raste, odnosno sve više pada što se više približava trenutak njegovog isteka. Iz toga proizlazi da je vrednost fjučers ugovora za onu stranu koja plaća električnu energiju po fiksno utvrđenoj ceni X jednaka [2]:

$$V(t, F_{tT})=e^{-r(T-t)}(F_{tT}-X) \quad (1)$$

gde je: r - bezrizična kamata, a $F_{t,T}$ - cena električne energije u trenutku t utvrđena prema fjučers ugovoru. Za stranu koja isporučuje električnu energiju vrednost fjučers ugovora izračunava se na sledeći način:

$$V(t, F_{tT})=e^{-r(T-t)}(X-F_{tT}) \quad (2)$$

Prethodni izrazi dobijeni su na osnovu pretpostavljenog izjednačavanja vrednosti terminske i spot cene u trenutku isteka fjučers ugovora (pretpostavka konvergencije):

$$F_{T,T}=S_T \quad (3)$$

Za dokazivanje ove pretpostavke koristi se metoda dinamičkog hedžiranja (delta hedžing) u određenim trenucima $t0$, $t1$, $t2$, ...,$tn = T$. Uspešni delta hedžing proizlazi iz sledeće jednačine [2]:

$$V(T,F_{TT})+ e^{r(T-t_1)}\delta_0\Delta F_0+ e^{r(T-t_2)}\delta_1\Delta F_1+\ldots+ e^{r(T-t_{i+1})} \delta_i\Delta F_{i....+}\delta_{n-1}\Delta F_{n-1}= e^{r(T-t_0)}V(t_0,F_{t0,T}) \quad (4)$$

gde su:

$$\delta_1= \partial V/\partial F(T_i F_{ti} T) \text{ i } \Delta Fi= F_{ti+1,T} - F_{ti,T} \quad (5)$$

uvrštavajući u prethodne izraze pretpostavku konvergencije dobijamo:

$$(S_T-X)+ e^{r(T-t_1)}\delta_0\Delta F_0+\ldots+\delta_{n-1}\Delta F_{n-1}= (F_{t0,T}-X) \quad (6)$$

koji se odnosi na kupca (primaoca) električne energije,

$$(X-S_T)+ e^{r(T-t_1)}\delta_0\Delta F_0+\ldots+\delta_{n-1}\Delta F_{n-1}= (X-F_{t0,T}) \quad (7)$$

koji se odnosi na prodavaca (isporučioca) električne energije.

Značenje izraza i parametara je sledeće: X - fiksno utvrđena cena električne energije, S_T - spot cena električne energije, $e^{r(T-t1)}\delta_0\Delta F_0 +\ldots + \delta_{n-1}\Delta F_{n-1}$ – obračun margina (marginski račun), $F_{t0,T}$ - cena električne energije u trenutku t_0 prema fjučers ugovoru.

Izrazi pokazuju da je pravilno utvrđena cena električne energije u svakom trenutku valjanosti fjučers ugovora jednaka:

$$X=F_{Tt} \quad (8)$$

Neto sadašnja vrednost ugovora pri ovoj ceni je jednaka nuli. Transparentnost cena jedna je od najvažnijih karakteristika koja čini tržište fjučers ugovora likvidnim. Sposobnost kvalitetne primene hedžing metode predstavlja glavni razlog zašto se obe ugovorne strane mogu i žele dogovoriti oko utvrđivanja cene električne energije po fjučers ugovoru.

Primena hedžing metode kod fjučers ugovora može se prikazati sledećim primerom [2]. Snabdevač električnom energijom u fazi pronalaženja načina kako da snabde svoje potrošače tokom letnjeg perioda, s ciljem da ostvari što veće prihode, polazi od pretpostavke da bi spot cena električne energije u tom razdoblju mogla biti visoka i varijabilna. Da bi se zaštitio od mogućih gubitaka donosi odluku da što je pre moguće utvrdi cenu za taj period u godini, na primer 1. januara. Snabdevač pregovara s dobavljačem električne energije oko utvrđivanja cene električne energije za isporuku u julu posmatrane godine. Na dan 1. januara (datum označen sa t_0) utvrđena cena električne energije je jednaka X=50 EUR/MWh. To znači da su se obe ugovorne strane (snabdevač i dobavljač) dogovorile oko toga da će u julu posmatrane godine dobavljač isporučiti ugovorenu količinu on-peak električne energije u iznosu od 73.600 MWh, koju će snabdevač platiti po fiksno utvrđenoj ceni od X=50 EUR/MWh. Na taj način se snabdevač zaštitio od promena spot cena tokom letnjeg perioda. Međutim, ovakav ugovor je dobavljača električne energije izložio riziku, pa je on odmah počeo primenjivati hedžing, koji će rezultirati različitim strategijama dinamičkog hedžiranja (tabela 1 i 2). Po pravilu on će odmah na terminskom tržištu zauzeti poziciju koja je po veličini ista, a po smeru suprotna od pozicije koju drži na spot tržištu.

Tabela 1. Strategija dinamičkog hedžiranja kod rasta terminskih cena

korak hedžiranja	Datum	Terminska cena EUR/ MWh	Vrednost ugovora (EUR)	Razlika u vrednosti ugovora (EUR)	Delta hedžing (MWh)	Broj ugovora	Račun margina (EUR)	Razlika u računu margina (EUR)
1	1.jan	50	0		71.501,15	97	0	
2	1.feb	55	-359.332,20	-359.332,20	71.866,44	98	358.783,67	358.783,67
3	1.mar	60	-721.979,86	-362.647,65	72.197,99	98	722.742,62	363.958,95
4	1.apr	70	-1.451.336,76	-729.356,90	72.566,84	99	1.451.399,99	728.657,37
5	1.maj	80	-2.187.767,57	-736.430,81	72.925,59	99	2.190.817,42	739.417,43
6	1.jun	90	-2.931.926,20	-744.158,63	73.298,15	100	2.934.372,63	743.555,21
Istek ugovora	26.jun	100	-3.680.000,00	-748.073,80			3.685.487,39	751.114,76

Izvor: Eydeland, A., Volyniec, K., Energy Power and Risk Menagement

Tabela 2. Strategija dinamičkog hedžiranja kod padaterminskih cena

korak hedžiranja	Datum	Terminska cena EUR/ MWh	Vrednost ugovora (EUR)	Razlika u vrednosti ugovora (EUR)	Delta hedžing (MWh)	Broj ugovora	Račun margina (EUR)	Razlika u računu margina (EUR)
1	1.jan	50	0		71.501,15	97	0	
2	1.feb	47	215.599,32	215.599,32	71.866,44	98	-215.270,20	-215.270,20
3	1.mar	43	505.385,90	289.786,58	72.197,99	98	-506.106,33	-290.836,13
4	1.apr	40	725.668,38	220.282,48	72.566,84	99	-726.181,45	-220.075,12
5	1.maj	35	1.093.883,78	368.215,41	72.925,59	99	-1.095.892,55	-369.711,10
6	1.jun	33	1.246.068,63	152.184,85	73.298,15	100	-1.247.963,86	-152.071,31
Istek ugovora	26.jun	27	1.692.800,00	446.731,37			-1.696.521,56	-448.557,70

Izvor: Eydeland, A., Volyniec, K., Energy Power and Risk Menagement

Tabele 1 i 2 prikazuju strategiju dinamičkog hedžiranja snabdevača, gde je fjučers ugovor valjan i to u oba scenarija, kad terminske cene električne energije rastu i kad padaju.

Način računanja vrednosti iz tabele 1 je sledeći:

Vrednost ugovora u 2. koraku hedžiranja:

$V(t, F_{tT})=e^{-r(T-t)}(X-F_{tT}) = e^{-0,06((176-31)/365)}\cdot(50-55)\cdot 73.600=$ -359.332,20 EUR

gde je 6% bezrizična kamata, broj dana između 01.01. i 26.06. je 176, umanjen za 31 dan, što je jednako broju dana između 1. i 2. koraka hedžiranja.

Delta hedžing:

$\delta_2= e^{-r(T-t)} \cdot 73.600=e^{-0,06((176-31)/365)} \cdot 73.600=71.866,44$ MWh

Broj ugovora:

$n= e^{-r(T-t)}\cdot=e^{-0,06((176-31)/365)} =0,976*100=98$

Obračun margina:

$e^{0,06(31/365)} \cdot 0,97\cdot(55-50)\cdot 73.600=358.783,67$ EUR

Na isti način se računaju vrednosti iz tabele 2. Na štetu dobavljača idu terminske cene kojima vrednosti rastu pa će se na kraju juna posmatrane godine on suočiti s gubitkom u iznosu od 3.680.000 eura (u slučaju da spot cena u trenutku isteka fjučers ugovora iznosi 100 EUR/ MWh), jer se obavezao snabdevaču isporučiti električnu energiju po fiksno utvrđenoj ceni od 50 EUR/MWh. Međutim, novac koji je dobavljač položio na svom marginskom računu poništiće taj gubitak. U slučaju kad

terminske cene padaju (tabela 2), dobavljač će zaraditi na isporuci električne energije, te vratiti dug koji je stvorio na marginskom računu. Odnosno, dobavljač će u trenutku isteka fjučers ugovora kupiti električnu energiju po spot ceni od 27 EUR/MWh i isporučiti je snabdevaču po fiksno utvrđenoj ceni od 50 EUR/MWh.

Ako pretpostavimo da je, umesto dinamičnog hedžinga, snabdevač izabrao drugačiju strategiju kako bi se zaštitio od rizika, te da je na početku ugovora kupio fjučerse za punu količinu električne energije koju je bio dužan isporučiti kupcu, u tom slučaju, to bi bilo 73.600 MWh ili 100 fjučers ugovora po ceni od 50 EUR/MWh. Čini se da se dobro zaštio, budući da će po dospeću snabdevač preuzeti isporuku za svoju dugu poziciju fjučersa od 73,600 MVh plaćajući 50 EUR/MWh, a zatim isporučiti električnu energiju kupcu, primajući 50 EUR/MWh. U stvarnosti, ova statička hedžing strategija ima neke rizike kao što je prikazano u Tabeli 3, gde je strategija primenjena na scenario 2 iz tabele 2.

Tabela 3. Statična hedžing metoda primenjenja na scenario 2

korak hedžiranja	Datum	Terminska cena EUR/MWh	Vrednost ugovora (EUR)	Razlika u vrednosti ugovora (EUR)	Delta hedžing (MWh)	Broj ugovora	Račun margina (EUR)	Razlika u računu margina (EUR)
1	1.jan	50	0		71.501,15	100		
2	1.feb	47	215.599,32	215.599,32	71.866,44	100	221.928,04	221.928,04
3	1.mar	43	505.385,90	289.786,58	72.197,99	100	518.710,05	296.782,01
4	1.apr	40	725.668,38	220.282,48	72.566,84	100	743.288,13	224.578,08
5	1.maj	35	1.093.883,78	368.215,41	72.925,59	100	1.116.781,99	373.493,86
6	1.jun	33	1.246.068,63	152.184,85	73.298,15	100	1.270.439,54	153.657,55
Istek ugovora	26.jun	27	1.692.800,00	446.731,37			1.719.089,80	448.650,26

Izvor: Eydeland, A., Volyniec, K., Energy Power and Risk Menagement

Iz tabele se nedvosmisleno može utvrditi da će snabdevač primenjujući ovu strategiju imati deficit od 23,698.57 EUR na isteku ročnosti fjučersa i da neće biti u mogućnosti da pokrije marginu. Razlika koja se pojavila na marginskom računu je akumulirana kamata.

Na početku, vrednost posla je nula. Savršena hedžing strategija samo će sačuvati nultu vrednost pod tržišnim kretanjima. Prema tome, ako snabdevač odluči da se zaštiti, jedini način da se zaštiti je primenom adekvatne hedžing metode.

3. PRIMENA FJUČERS UGOVORA NA EEX

Fjučers ugovor je tipičan za berzu EEX. Osnov za uspostavljanje fjučers ugovora na EEX je isporuka ili prihvatanje isporuke električne energije sa stalnom snagom od 1 MW u maksimalnom naponskom nivou definisanog tržišta u toku vremena isporuke za svaki dan isporuke u periodu isporuke [3]. Na EEX berzi, članovi berze, obavljaju kupovinu / prodaju električne energije tako da odrede cenu u EUR/MWh kao i broj fjučers ugovora kojim žele trgovati. U zavisnosti od porudžbine i faze trgovanja, porudžbine se beleže u knjizi porudžbina. Na EEX-u je moguće trgovati dnevnim, vikend, nedeljnim, mesečnim, kvartalnim, sezonskim (zimska sezona oktobar – mart ili letnja sezona april – septembar) i godišnjim fjučersima. Prema vremenu isporuke (satu u toku dana) fjučersi mogu biti kreirani za bazni, vršni i period van vršnog opterećenja, što je navedeno u samom imenu fjučersa tako da se Base odnosi na bazno opterećenje elektroenergetskog sistema (00-24h svakog dana), Peak na vršno opterećenje EES-a (08-20 svakog dana – radni dan / vikend), a Off-Peak na periode van vršnog opterećenja (00-08 i 20-24 od ponedeljka do petka i 00-24 vikendom). Obim ugovora se računa množenjem broja sati isporuke, tokom perioda isporuke (h) sa konstantnim outputom (MW) navedenim u odgovarajućem ugovoru [3]. Na EEX-u je moguće ugovoriti fjučerse samo sa finansijskim poravnanjem u odnosu na spot cenu za hedžovanu električnu energiju,

gde kupac/prodavac prima razliku između cene fjučersa i spot cene na tržištu kao finansijsku nadoknadu.

Berza EEX zahteva da se odmah nakon zaključenja ugovora, kod klirinše kuće ECC položi sigurnosni depozit kako bi smanjio mogući rizik neizmirenja obaveza. Taj sigurnosni depozit naziva se inicijalna margina i utvrđuje se od strane ECC-a na osnovu veličine ugovora i parametara volatilnosti za ugovor. Inicijalne margine se vraćaju ugovornim stranama, nakon dospelosti fjučers ugovora [1]. Ove margine se računaju u EUR/MWh. Na primer, neka je parametar inicijalnih margina za ugovor tipa Phelix Base Month Futures jednak 2 EUR/MWh, to znači da će u slučaju ugovorene količine električne energije od 720 MWh, ukupne inicijalne margine iznositi: 2 EUR/MWh x 720 MWh = 1.440 EUR.

EEX Power Future ugovori su dizajnirani da služe kao savršeno osiguranje za spot tržište na koje se odnose. Uzimajući aktuelne cene na spot tržištu za fizičku isporuku kao osnovu za finalnu cenu poravnanja, osnovni rizik se izbegava pošto se plaćanja balansiraju između ugovornih strana [4].

Izvođenje fjučers ugovora rezultira utvrđivanjem dnevne dobiti i gubitka. Promene u vrednosti fjučers ugovora utvrđuju se svakodnevno nakon čega sledi formiranje nove cene poravnanja koja je odraz trenutne spot cene na tržištu. Za podmirivanje fjučers pozicija zbog promene dnevnih cena poravnanja koriste se varijacijske margine. Varijacijske margine se računaju na osnovu cena poravnanja, koje se računaju različito za period pre meseca isporuke i za mesec isporuke. Za određivanje cena poravnanja tzv. teoretska cena poravnanja do početka meseca isporuke je presudna knjiga porudžbina (metod zavisi od broja validnih trgovina i porudžbina koje zadovoljavaju posebne zahteve u vezi sa predmetom trgovanja, odnosno izvori informacija za ustanovljenje cena su trgovine, narudžbe, postupak glavnog trgovca (fer vrednosti) i druge informacije), dok je za određivanje cena u toku meseca isporuke, za ustanovljavanje cene poravnanja relevantna spot cena (npr. konačna cena poravnanja za mesečni fjučers se utvrđuje kao srednja vrednost spot tržišnog indeksa za odgovarajući mesec) na odgovarajućem tržištu [5]. Na taj način se eliminiše bazni rizik (bazni rizik se povećava kada raste vremenska razlika između isteka hedža i meseca dospeća [6].

Varijacijske margine računaju se na sledeći način: broj ugovora x ugovorena količina električne energije x (utvrđena cena na današnji dan trgovanja na berzi - utvrđena cena na jučerašnji dan trgovanja na berzi). Pozitivni iznos ove formule znači dobit od preuzete fjučers pozicije, dok negativni iznos predstavlja gubitak zbog napuštanja te iste pozicije [7].

Varijacijska margina za fjučers poziciju, s kojom se ulazi na poslednji dan trgovanja na berzi, računa se na sledeći način: broj ugovora x ugovorena količina električne energije x (utvrđena cena na poslednji dan trgovanja na berzi - terminska cena). I u ovom slučaju pozitivni iznos znači dobit od preuzete pozicije, odnosno negativni iznos je gubitak zbog napuštanja te iste pozicije.

Na primer, snabdevač planira da kupi svakog sata 1 MW električne energije tokom novembra 2018. godine, što znači 30 dana, 24 sata, primenom satnih ugovora. Budući da se cena na spot tržištu ne može predvideti sa sigurnošću, snabdevač se odlučuje da se zaštiti od gubitaka na tržištu, na način da kupi 1 mesečni fjučers za novembar 2018. godine, po ceni od 30 EUR/MWh.Planirani budžet za nabavku električne energije iznosi: 1 MW x 24 sata/dan x 30 dana x 30 EUR/MWh = 21.600 EUR. Snabdevač je započeo s kupovinom električne energije 31. oktobra 2018. godine, što važi za prvi dan trgovanja (tj. 1. novembra), a završio 29. novembra 2018. godine i važi za poslednji dan trgovanja (odnosno 30. novembra). To znači da snabdevač svakih 24 sata daje ponudu po kojoj kupuje 1 MW električne energije svakog sata po određenoj spot ceni. Prosečna cena koju snabdevač postigne trgovanjem na spot tržištu (tabela 5) jednaka je finalnoj ceni poravnanja za fjučers ugovor (tabela 4).

U tabeli 5 se može uočiti da cena poravnanja raste iznad planirane vrednosti od 30 EUR/MWh. Prema proseku, tržišni učesnik uspeva nabavati električnu energiju po ceni od 38,00 EUR/MWh na spot tržištu i zbog toga mu se planirani troškovi uvećavaju za 5.760,00 eura. Varijacijska margina pokriva nedostatak od 5.760,00 eura i dovodi do uravnoteženja računa dobiti i gubitka. To pokazuje da je planirani trošak od ukupno 21.600 eura već utvrđen transakcijom po fjučers ugovoru. Ukupan trošak se u tom smislu sastoji od cene ostvarene na spot tržištu: 720 MWh x 38 EUR/MWh = 27.360, te prihoda ostvarenog na tržištu derivatima: 720 MWh x (30,00 EUR/MWh – 38,00 EUR/MWh) = -5.760,00 EUR.

Kao dodatnu meru obezbeđenja snabdevač je dužan, da nakon zaključenja fjučers ugovora, položi i inicijalnu marginu, koja se vraća po ugovornim stranama po završetku ugovornog perioda (u našem primeru, ako uzmemo da se inicijalna margina zasniva na parametru jednakom 2,00 EUR/MWh, snabdevač bi, preko svoje kliring kuće, morao u inicijalnu marginu položiti: 1 MW x 24 sata/dan x 30 dana x 2,00 EUR/MWh = 1.440 EUR od momenta preuzimanja fjučers pozicije pa sve do 29. novembra 2018. godine kad fjučers ugovor ističe i kada bi mu ta inicijalna margina, opet preko kliring kuće, bila vraćena).

Tabela 4. Plaćanje na EEX na tržištu derivate (fjučers)

	31.10.	01.11.	02.11.	03.11.	...	28.11.	29.11.	30.11.	Ø38
dnevna spot cena (EUR/MWh)	34	34	38	38		42	42		
obim isporuke (MWh)	24	24	24	24		24	24		
kupovna cena na aukciji EUR	-816	-816	-912	-912		-1.008	-1.008		-27.360
varijacijska margina iz fjučersa (EUR)									5.760
rezultat EUR									21.600

Izvor: EEX, EEX/SEEPEX Cooperation

Tabela 5. Ispunjenje na tržišnoj spot aukciji

					01.11.	02.11.	03.11.		28.11.	29.11.	30.11.	rezultat
cena ugovora EUR/MWh	30											
konačna cena poravnanja EUR/MWh	31	33	31	29	30	31	34	...	36			
cena poravnanja EUR/MWh										38		
promena EUR/MWh	+1	+2	-2	-2	+1	+1	+3		+2	+2		+8
obim ugovora MWh	720	720	720	720	720	720	720		720	720		720
pozicija	1	1	1	1	1	1	1		1	1		1
varijacijska margina	+720	+1.440	-+1.440	-+1.440	+720	+720	+720		+1.440	+1.440		+5.760

Izvor: EEX, EEX/SEEPEX Cooperation

Ispunjenje na finansijskom tržištu je izvršeno slanjem cenovno nezavisne ponude koja prihvata sve cene. Na taj način, skoro da nema rizika ispunjenja. Nepovoljna cenovna kretanja su hedžovana putem fjučersa i obrnuto. Ovo zahvaljući tome, da je finalna cena poravnanja fjučersa od 38 EUR prosek svih relevantnih dnevnih spot cena [1]. Naravno, postoje i suprotne situacije od situacije prikazane u tabeli 5, a to je kad prosečna spot cena pada, pa u tom slučaju snabdevač električne energije može nabaviti jeftinije električnu energiju na spot tržištu, nego što je obezbedio fjučers ugovorom. U svakom slučaju, cilj primene hedžing tehnike je zaštita od rizika sa kojim se susreću (ako izuzmemo spekulante na tržištu, koji koriste fjučerse za ostvarivanje profita).

SEEPEX i EEX su započeli saradnju za uvođenje fjučersa za električnu energiju sa finansijskim poravnanjem za srpsko tržište. EEX će uvesti bazne mesečne, kvartalne i godišnje fjučerse za tržište Srbije. Finansijsko poravnanje će se vršiti u odnosu na spot cenu u Srbiji, koje objavljuje SEEPEX. Referentna cena i fizička isporuka biće obezbeđena preko SEEPEX infrastrukture ETS platforme i ECC kliringa [7].

Uvođenje fjučersa električne energije za srpsko tržište na EEX će doprineti daljem razvoju srpskog spot

tržišta električne energije koje se brzo razvija, ali će omogućiti i primenu hedžinga na srpskom tržištu električne energije, gde će svi učesnici na tržištu imati koristi od standardizovanog proizvoda i mogućnost da se zaštite od cenovnih rizika na srpskom tržištu električne energije.

4. ZAKLJUČAK

Upravljanje tržišnim rizicima u trgovanju električnom energijom zahteva primenu adekvatnog hedžinga. Hedžing je kreiran da minimizira izlaganje nepoželjnom poslovnom riziku. Izbor pogrešne strategije hedžiranja može imati negativne posledice umesto pozitivnih.

Kvalitetno predviđanje budućih kretanja cena na bazi tekućih cena i svih faktora rizika koji postoje kod trgovanja električnom energijom, kao i odabir adekvatne hedžing strategije, osnova su uspešne zaštite od tržišnih rzika

S obzirom na činjenicu da se u Srbiji u vrlo bliskoj budućnosti otvara mogućnost hedžovanja cene električne energije, neophodno je intenzivirati sve oblike edukacije o zaštiti od tržišnih rizika, kako zaposlenih u energetskom sektoru, tako i njihovih korisnika (npr. veliki industrijski potrošači)

Daljim razvojem berzanskog trgovanja i uvođenjem fjučersa za srpsko tržiše doći će do povezivanja regionalnih berzi i njihove integracije u evropske berze na kojima je razvijeno trgovanje derivatima, usled čega postoji potreba širenja znanja i istraživanja u Srbiji vezanih za oblast trgovanja derivatima na električnu energiju.

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GRAFIČKA I STRUKTURNA KOMUNIKACIJA AMBALAŽNIH SISTEMA

Srđan Stanojković[1, *],
Dragan Cvetković[2],
Petra Balaban[3]

[1]Beogradska politehnika,
Univerzitet u Beogradu,
Beograd, Srbija
[2]Univerzitet Singidunum,
Beograd, Srbija
[3]Visoka škola strukovnih studija u
Novom Sadu,
Novi Sad, Srbija

Rezime:

Razvojem informaciono komunikacione tehnologije ostvaraju se nove mogućnosti koje utiču na sve sfere rada i života. Ovaj stručni rad ima za cilj, da približi značaj komunikacije savremene ambalaže i korisnika usled pojave novih sistema grafičkog obeležavanja pri procesu pakovanja proizvoda. Novim sistemima i simbolima obeležavanja, poboljšavaju se proizvodnja, praćenje i manipulacija proizvodom što rezultira olakšnim i bezbednim korišćenjem ambalažiranog proizvoda. Time se ispunjava osnovni zahtev kupca: korišćenje bezbednog i kvalitetnog proizvoda. Ambalaža štiti proizvod, štiti okolinu od proizvoda i estetski definiše upakovanu robu. Dodavanjem funkcije komunikacije i uz primenu novih materijala ambalaža postaje "pametna" tj. inteligentna. Komunikacija ambalaže podrazumeva njenu unutrašnju i spoljašnju komponentu u odnosu na ambalažni materijal i pakovanje.

Ključne reči:

Pametna ambalaža, Bar kod, RFID sistem, Hologram, Brajevo pismo.

1. UVOD

Ambalaža je neoblikovan ili oblikovan materijal u kome se roba pakuje i drži da bi se zaštitila, sigurno transportovala i njome se lakše rukovalo. Ambalaža spaja znanje, umetnost, trgovinu i tehnologiju. Njeno prisustvo je integrisano u svakodnevni život potrošača do nivoa podrazumevanog i na taj način pomaže izbor, kupovinu, transport i primenu proizvoda. Kako je glavna funkcija hrane zaštita i održavanje zdravlja potrošača, očekivano je da su se oblici savremene ambalaže javili najpre u domenu zaštite i pakovanja hrane. Pored prehrambene industrije i farmaceutska idustrija aktivno koristi saznanja i vrednosti savremene ambalaže. Materijali koji se koriste u izrade ove ambalaže mogu biti prirodnog, veštačkog ili kombinovanog sastava [1].

Sinergiju direktiva i standarda u proizvodnji savremene ambalaže, omogućavaju savremeni komunikacioni sistemi, ostvarajući stalno poboljšanje kvaliteta. Kako je "stalno poboljšanje" jedan od osnovnih postulata metode poslovanja Potpunog upravljanja kvalitetom (*Total Quality Management, TQM*), možemo reći da način izrade savremene ambalaže teži pristupu poslovanja za koji se zalaže i TQM. ISO standardi služe za uklanjanje "nekvaliteta", tj. nekvalitetnih proizvoda, dok TQM ima

Odgovorno lice:
Srđan Stanojković

e-pošta:
sstanojkovic@politehnika.edu.rs

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zadatak unapređenja kvaliteta iznad očekivanja kupaca i stalno teži ka poboljšanju karakteristika proizvoda [2].

2. OBLICI PAMETNE AMBALAŽE I NJEN DIZAJN

Dizajn je proces vizuelne kreacije i pored lepog on mora da ispuni i praktične potrebe ambalaže, kako bi ona odgovarala datom proizvodu pri njegovom pakovanju. Pored toga što pomaže karakterizaciji robe, ambalaža sa razvojem tehnologije prevazilazi svoju osnovnu ulogu: zaštitu robe od okruženja. Na području razvoja grafičke ambalaže danas su najprisutniji aktivni i inteligentni ambalažni sistemi sa novim materijalima (nanomaterijali) i savremenim sistemima komunakacije, u odnosu na korisnika [2]. Sva proizvedena ambalaža, tj. ambalažni materijali za pakovanje prehrambenih proizvoda, moraju biti usklađeni sa Evropskim direktivama, a način izrade prilagođen zahtevima pripadajućih ISO standarda [3].

Sistemi aktivne i inteligentne ambalaže koja dolazi u dodir sa hranom (pametni sistemi pakovanja)

Neprestan je razvoj novih ambalažnih materijala i tehnika pakovanja, radi zadovoljenja zahteva potrošača. Oni zajedno omogućavaju bolji kvalitet i trajnost proizvoda, atraktivnost, lakše rukovanje, veću zdravstvenu sigurnost i više informacija o proizvodu "na prvi" pogled. Javljau se tzv. pametni sistemi pakovanja. Pametni sistemi pakovanja u ambalažiranju najčešće se koriste kod prehrambenih i farmaceutskih proizvoda. Cilj im je da olakšaju korišćenje proizvoda, očuvaju njegov kvalitet i prenesu dodatne informacije o trenutnom stanju proizvoda. Pametni sisitemi se integrišu i javljaju sa novim tehnologijama u ambalažiranju hrane a poznati su kao:

- aktivno i inteligentno pakovanje,
- pakovanje u modifikovanoj atmosferi (MAP),
- jestivi filmovi i premazi.

U tehničkom smislu ambalaža se proizvodi od ambalažnih materijala. Za izradu jednog ambalažnog oblika često koristimo dva ili više, ista ili različita ambalažna materijala. U tom smislu tradicionalne materijale "kao samostalne" za pakovanje hrane (metal, keramika, staklo, papir, karton), zamenjuju savremeni nanopolimaterijali. Specifične osobine nanomaterijala, kao što su mala specifična težina, niska cena, lako oblikovanje, dobre fizičke ili mehaničke osobine, preporučuju ih kao zamenu za tradicionalne materijale. Za izradu ambalažnih oblika kojima se hrana pakuje najčešće se koristi: polipropilen (PP) i različite gradacije polietilena (HDPE, LDPE), polietilen tereftalat (PET), polistiren (PS) i polivinil hlorid (PVC). Pojam "aktivna i inteligentna ambalaža" prvi puta se pominje na japanskom tržištu sredinom sedamdesetih godina, a sredinom devedesetih i u Evropi i SAD [4,5].

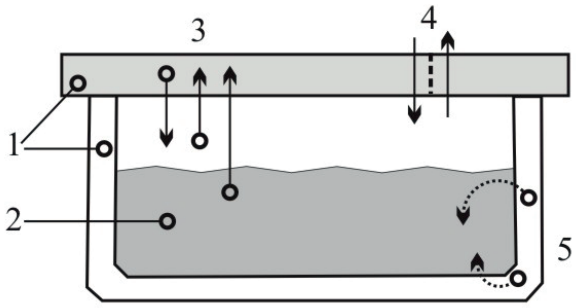
Zakonodavstvo aktivne i inteligentne ambalaže. Najo-psežniji propis za upotrebu polimernih nanokompozitnih materijalia u ambalaži je „Uredba o plastičnim materijalima i predmetima namenjenim za neposredni dodir s hranom", Uredba (EU) br. 10/2011. Ona navodi zahteve o sastojcima plastičnih materijala i predmeta koji dolaze u dodir s hranom. Takođe prikazuje spiskove odobrenih materijala EU koje je dozvoljeno koristiti u proizvodnji plastičnih materija i predmeta koji dolaze u dodir s hranom. Uredba propisuje granice migracija koje određuju maksimalnu količinu sastojaka dozvoljenih za migraciju u hranu [4,5].

Sistemi komunikacije aktivne ambalaže

Pakovanje je tehnološki proces postavljanja proizvoda u ambalažu (ambalažiranje). Tradicionalni način ambalažiranja hrane (tzv. pasivno pakovanje), ima svoja ograničenja u zaštiti proizvoda. Zahtevi za povećanu trajnosti proizvoda, doveli su do razvoja novog aktivnog pakovanja hrane, tzv. aktivne ambalaže. Ona se uglavnom izrađuje od nanomaterijala.

Pojam "aktivna ambalaža" definše specifičan materijal koji dolazi u dodir sa hranom, dok se hrana ambalažira. Njegova posebnost je sadržana u konstrukciji materijala ambalažnog oblika, tako da on otpušta aktivne komponente u upakovanu hranu ili ih apsorbuje iz hrane. Na taj način se produžava rok trajnosti ili se poboljšavaju uslovi u kojima se hrana nalazi, tj. upakovana je. Aktivna ambalaža, u prostoru oko upakovane hrane, stalno menja propusnost zbog koncentracije različitih gasova ili zbog dodataka antimikrobnih supstanci i antioksidansa. Svi oni zajedno održavaju dobar kvalitet proizvoda tokom skladištenja. Takva ambalaža naziva se još i *interaktivna,* budući da dolazi u aktivnu interakciju s hranom.

Na slici 1. grafički je prikazana funkcija aktivne ambalaže.



Slika 1. Šematski prikaz funkcije aktivne ambalaže: 1) presek ambalažnog zida, 2) upakovani proizvod, 3) regulacija atmosfere unutar ambalaže, 4) regulacija propustljivosti ambalaže, 5) razmena aktivnih materija između ambalaže i upakovanog proizvoda čime se čuva kvalitet proizvoda. (modifikovano od strane autora)

Navedeni procesi doprinose produženju veka upotrebe upakovane hrane, tj. utiču na sporije opadanju kvaliteta upakovanog proizvoda. Aktivne komponente mogu biti inkorporirane u različitim oblicima kao što su: kesice, etikete, filmovi ili premazi (slika 1.) [5].

Korišćenjem aktivne ambalaže ciljano se menjaju uslovi oko upakovanog proizvoda, kao i u samom proizvodu a sve radi produženje dozvoljenog vremena njegovog lagerovanja. Svoju funkciju aktivna prehrambena ambalaža ostvaruje inte-grisanjem aktivnih supstanci i novim načinom primene ambalažnih polimernih materijala. U makromolekule polimera površinskog sloja ambalaže, ugrade se odgovarajuće funkcionalne grupe ili se u jedan sloj višeslojne polimerne folije integrišu niskomolekularne supstance (željenih osobina). Njih gradivni polimer može da otpušta kontrolisanom brzinom ili da na njih veže neke supstance koje otpušta upakovani proizvod.

Aktivna ambalaža pored barijernih svojstava u stanju je da kontrolisano otpušta ili da veže (tj. dozira) različite elemente i supstance. Tako može otpuštati: konzervanse, etanol, sorbate, , antioksidante ili antimikrobne supstance. Drugačija funkcija ove ambalaže jeste da recimo spreči ulazak kiseonika, a da omogućava izlazak CO_2 (primer: ventil vrećice) [5].

Sistemi komunikacije inteligentne ambalaže

Inteligentna prehrambena ambalaža je sistem koji prati stanje upakovane namirnice i daje informaciju o određenim parametrima kvaliteta tokom transporta i skladištenja [6,7].

Dok aktivna prehrambena ambalaža održava ispravnost i kvalitet upakovanog sadržaja svojstvima svog materijala, inteligentntna prehrambena ambalaža nadzire i prikazuje ispravnost zadatih referenci koje čine upakovanu hranu kvalitetnom i ispravnom za primenu. Sistem aktivne ambalaže dolazi u dodir sa hranom ukazuje na stanje upakovanog proizvoda i prikazuje te informacije potrošaču, na sugestivan način. Značaj ovakvog načina pakovanja je mogućnost efikasne kontrole proizvoda. Proizvođač (ili prodavac) lako prati put od pakovanja proizvoda do upotrebe, brzo registruje eventualne nedostatke u rukovanju, kontaminaciju ili neadekvatno skladištenje. Kupac dobija široki spektar informacija o proizvodu, putem senzora i indikatora. U odnosu na lokaciju indikatora, senzora i simbola koje koristi, inteligentnu ambalažu razlikujemo kao: inteligentnu ambalažu opremljenu indikatorima i senzorima ili inteligentnu ambalažu kao nosioca grafičkih podataka za komunikaciju [6,7].

Sistem indikatora i senzora inteligentne ambalaže

Inteligentna ambalaža sa indikatorima. Ova vrsta ambalaže na sebi ili u sebi ima indikatore koji ukazuju na razne promene unutar pakovanja. Indikatori mogu biti unutrašnji (indikatori gasova, svežine, propustljivosti, loma, boje) ili spoljašni (indikatori temperature, vremena). Rad indikatora se temelji na mehaničkim, hemijskim, elektrohemijskim, enzimskim ili mikrobiološkim promenama. Najčešće se manifestoju nekom vidljivom promenom na ambalaži kao što je mehanička deformacija, nastajanje ili promena boje [6,7].

Inteligentna ambalaža sa senzorima. Senzor je uređaj koji se koristi za otkrivanje, lociranje i merenje energije ili materije čime se obezbeđuje signal za merenje fizičkih ili hemijskih osobina na koje reaguje uređaj. Senzori mogu biti: senzori promene gasa, biosenzori ili bežični senzori [6,7].

Inteligentna ambalaža kao nosilac grafičkih podataka komunikacije

Simboli na ambalaži služe za komunikaciju kroz upozoravanje i informisanje korisnika. Oni upućuju na način rukovanja proizvodom (i ambalažom), način čuvanja, način manipulacije i sve češće ukazuju i na način pripremanja ili korišćenja sadržaja. Pokazalo se da je povećanje kvaliteta pakovanja i poboljšanje uslova čuvanja proizvoda najbolje izvodljivo kombinovanjem više bezbedonosnih i informacionih sistema na ambalaži, kroz specifične sirovine i grafičke simbole. Proizvođač (dizajner) ima zadatak da estetski i funkcionalno postavi

simbole (oznake) na ambalažu tako da budu uočljivi i prilagođeni korporativnoj kulturi proizvoda. Najčešće upotrebljivani simboli i oznake na ambalaži su upozoravajući, bezbedonosni i simboli za označavanje sastava grafičke ambalaže [5,6].

Upozoravajući simboli. Ovi simboli su grafički sugestivni prikazi u konturi pravougaonika koji se odnose na sadržaj ambalaže. Štampaju se uglavnom crnom bojom raznim tehnikama umnožavanja. Najčešći oblici su: Zapaljivo! Lomljivo! Ne kotrljati! Čuvati na suvom itd.

Bezbedonosni simboli. Ovakvi simboli su veći od ostalih simbola čime im se povećava značaj i štampani su u više boja. Ukazuju i upozoravaju potrošače na bezbednost pri korišćenju opasnih i štetnih proizvoda. Primer: Nadražujuće, Štetno, Otrov, ili i znakovi CE (nije štetno), E (tačna količina ili broj proizvoda) itd.

Simboli za označavanje sastava ambalaže. Svrha ovih simbola jeste prikazivanje informacije o satavu ambalažnog materijala, korisnicima i komintentima koji se bave zbrinjavanjem ambalažnog otpada. Ona se sastoji od tri osnovna elementa: *Möbius*-ove petlje (oblika jednako-straničnog trougla), numeričke oznake u centru trougla, a ispod trougla se nalazi skraćenica hemijskog sastava od kojeg je ambalažni materijal sačinjen. Ovaj simbol predstavlja „oblik šifrarnika" o sastavu ambalažnog materijala. On je odštampan ili drugačije inkorporiran na spoljašni vidljivi deo ambalažnog materijala. Ovi simboli se štampaju u raznim bojama i na različitim materijalima.

Ostali simboli. Predsavljaju raznorodna obaveštenja i sugestije o ambalaži na kojoj se nalaze van navedenih grupa. Primer: sama *Möbius*-ova petlja (ona govori o nivou moguće reciklaže), zelena tačka (simbolizuje status ambalaže), ozonski neškodljivo (obaveštava o sastavu gasova u ambalaži), [6,7].

3. OSTALI GRAFIČKI OBLICI KOMUNIKACIJE SAVREMENE AMBALAZE

Bar-kod

Bar-kod (*eng. barcode*) je sistem označavanja proizvoda nizom crnih i belih linija, koje se posebnim uređajima lako prepoznaju. Primenjuje se u procesu identifikacije proizvoda na mestima gde je potrebno brzo prepoznavanje proizvoda (magacini, unutrašnja i spoljna distribucija, supermarketi). Brojevi u bar-kodu su grupisani kao: broj sistema, zaštitni bar, spoljni i srednji bar, fabrički broj, broj proizvoda i samokontrolni broj.

Princip rada bar-kod sistema

Jedan od najčešćih primera korišćenja bar-koda jeste postupk naplate, prilikom indentifikacije proizvoda na blagajni (kasi). Računar uz pomoć čitača bar-koda sâm prepoznaje o kojem se proizvodu radi i iz baze podataka uzima informaciju o ceni i prikazuje vrednost na računu. U isto vreme se u bazi podataka registrije prodaja proizvoda, čime se ažurira uvid u stanje magacina, a radi blagovremene nove porudžbine proizvođaču [7]. Bar-kod predstavlja identifikacioni, ali zaje-dnički broj artikla (ID) u nekoj seriji proizvoda. Taj podatak računar koristi da pronađe specifičnu informaciju dodeljenu toj identifikaciji za seriju. Sam računar ne može čitati bar-kodove već koristi skenirane i na svoj jezik prevedene podatke uz pomoć bar-kod čitača (skenera) [8]. Kada uređaj bar-kod čitača „pređe" preko bar-koda, tamne linije apsorbuju svetlost iz čitača, dok svetli međuprostori reflektuju svetlost. U čitaču je smeštena fotoćelija koja prima reflektovanu svetlost i pretvara je u električni signal. Tako se u čitaču stvaraju: niski električni signal za prazne međuprostore i visoki električni signal za linije. Trajanje električnog signala definišu širok element nasuprot uskom. Nastali signal dekoder u čitaču dekodira u znakove kao podatke i šalje ih računaru kao ključ u uobičajenom formatu podataka. Kao simbol bar-kod se štampa direktno na ambalažu ili direktno na nalepnicu koja se potom postavlja na ambalažu. Štampa bar-kodova se uglavnom radi na bar-kod štampačima koji koriste *Direct Thermal* (DT) i *Thermal Transfer* (TT) tehnologije štampe, mada se koriste druge tehnike štampe kao što su: *ink-džet*, *laserska* ili *offset* štampa. Štampa se pomoću specijalnih programa na papirima, folijama u rolni ili tabaku, koji se kasnije formatiraju i nanose na ambalažu [7].

Osnovni tipovi bar-kodova

Linijski bar-kod

- Numerički kodovi: EAN/UPC, EAN 13, EAN 8, UPC-A
- Alfanumerički kodovi: Kod 39, Kod 128

Dvodimenzionalni bar-kod

- Složeni simboli: Kod 49, SuperCode
- Matrični simboli: Code One, Data Matrix

Alfanumerički kodovi Code 39 i Code 128 su bar-kodovi široke industrijske primene i koriste se za bar-kodiranje najrazličitijih podatka pošto su promenljive dužine. Bar- kodovi EAN 13, EAN 8 i UPC-A su isključivo za numeričko kodiranje fiksne dužine (13, 8 i 12 cifara) i predstavljaju, EAN 13 i EAN 8, evropski

standard i UPC-A, američki standard za označavanje roba i usluga. EAN 13 bar-kod je standardni kod koji pored 12 osnovnih brojeva sadrži i trinaesti broj, kao kontrolni broj. Izračunava se posebnim algoritmom i proverava ispravnu strukturu prethodnih znakova [8].

Primena bar-koda. Kada se bar-kod odštampa (ili nalepi) na ambalažirani prozvod, skener skenira bar-kod, detektuje i beleži tanke linije i razmake bar-koda i dalje *šalje* signal u dekoder. Dekoder prevodi tanke linije i razmake na bar-kodu u odgovarajući električni signal i šalje te podatke u računar u standardnom formatu podataka. Upotreba navedenog načina korišćenja bar-kod sistema prisutna je na svim nivoima manipulacije upakovane robe, na putu proizvođač-korisnik. Standardni bar-kod automatski identifikuje uglavnom vrstu proizvoda i proizvođača, koji čine ključne informacije u komunikaciji između privrednih društava i korisnika. On ne predstavlja pojedinačnu personalizaciju robe [8].

RFID sistem

Kako je informisanost organizacije od suštinskog je značaja za njen opstanak, informacioni sistemi predstavljaju bitan faktor za uspešno poslovanje organizacija. Tehnologija koja ubrzano napreduje i omogućava lakši i brži pristup informacijama jeste RFID.

RFID *(Radio Freqency Identification*) predstavlja sistem za automatsko prikupljanje podataka koji omogućava prihvatanje i prenos podataka u okviru proizvodnih i poslovnih procesa, bežičnim putem pomoću radio talasa [9].

RFID predstavlja sistem za pojedinačnu personalizaciju proizvoda. Njegov transponder nosi identifikator, tj. serijski broj jedinstven samo za "taj proizvod", sa svim informacijama bitnim za proizvod.

Osnovne komponente i princip rada RFID sistema

RFID je tehnologija koja koristi tehniku radio frekventnih signala za automatsku razmenu podataka i identifikaciju. Sastoji se od: računara (ili PLC-a), transpondera (taga), antene, i RFID čitača (kontrolora) [9].

Transponder - tag (transmiter). Transponder je nosač informacija o identifikaciji i ostalim potrebnim podacima proizvoda. On je elektronska komponenta RFID sistema koja se postavlja na objekat koji je potrebno identifikovati i pratiti. Osnovne komponente transpondera su mikročip, antena i kondenzator. Oni su smešteni u otporno kućište ili PCB pločicu (*Printed Circuit Board*) koja se ugrađuje ili lepi na ambalažu. Osnovna svrha RFID transpondera je da fizički inkorporira podatke o predmetu, na sam taj predmet. Svaki RFID tag poseduje neku vrstu kalema ili antene. Transponder može biti u obliku: pametnih etiketa, plastičnih dugmića, diskova, u formi ključeva, privezaka ili kapsula.

Antena. RFID sistem u osnovi radi sa dve odvojene antene, jednom u čitaču, a drugom u tagu. Antena se koristi za pojačavanje signala koji odašilje čitač ka tagu i signala koji tag vraća čitaču, čime se i povećava domet čitanja taga.

RFID čitač. RFID čitač predstavlja statičan ili prenosni uređaj koji aktivira ili prikuplja signale emitovane od tra-nspondera. Uglavnom se sastoji od: napajanja, antene i štampane ploče. Osnovna uloga mu je prijem i slanje RF signala od strane transpondera korišćenjem antene. Naredbe definisane odgovarajućim softverom čitač prima od računara ili PLC-a. U njemu se nalazi upravljačka jedinica koja izvršava primljene naredbe [9].

Princip rada RFID sistema. RFID sistem u mnogome nadmašuje bar-kod system i rasprostranjeniji je kao tehnologija za automatsku identifikaciju. Identifikacija RFID tehnologijom, podrazumeva razmenu radio magnetnih signala niske snage između čitača i elementa, (prenosni medij su radiotalasi). RFID čitač u svom okruženju stvara jako radiofrekventno magnetno polje. Kada se element na objektu približi čitaču i uđe u njegovo polje, „aktivira se" elektronska veza u elementu i pošalje svoj podatak (lični identifikacioni podatk) u obliku radiosignala čitaču. Čitač primi taj signal i prosleđuje ga računaru na obradu. U slučaju da se radi o element-signalu „čitaj - piši", čitač i „zapiše" nove podatke u unutrašnju memoriju elementa [12, 13]. Kapacitet RFID sistema može biti različit u zavisnosti od tipa taga koji se koristi i frekvencije koja je upotrebljena. Domet antene čitača je od 10 cm do 30m. Oblici RFID sistema u odnosu na memoriju mogu biti: niskofrekventni (LF) RFID uređaji dometa očitanja manje od 0,5m; visokofrekventni (HF) uređaji dometom očitavanja 1m; ultra visokofrekventni (UHF) koji očitavaju 4 do 5 m [9].

Upotreba RFID sistema

RFID sistem se koristi za elektronsku personalizaciju amba-laže, u praćenju delova proizvodnog lanca, za elektronsku identifikaciju, razno označavanje proizvoda, magacinsku manipulaciju, praćenje sledljivosti robe ili registrovanje robe u maloprodajnim i velikoprodajim objektima. Primenjuju se i kao bezbedonosni sistemi ili kontrola pristupa, za identifikaciju opreme ili zaštitu vrednosnih predmeta. Antene za RFID sistema se rade uglavnom: sito štampom, vodenim bojama sa različitim

aktivnim supstancama (aluminijum, bakar, polimeri) ili savijanjem žice. Od navedenih načina izrade antena za RFID najčešće se izrađuju tehnikom sito štampe. „Ekološkom tehnologijom" se smatra proizvodnja RF antena, tehnikom savijanja bakarne žice što je slučaj kod RFID oblika s niskom frekvencijom (LF). Takve antene se proizvode za tržište gde cena RFID transpondera nije glavni prioritet pri izradi RFID sistema [9].

Hologram

Holografija, je napredan način prikazivanja slike u tri dimenzije. Ona je metoda stvaranja i reprodukovanja trodime-nzionalnih slika na hologramskoj ploči (hologram) primenom koherentne svetlosti tj. lasera. Hologram**,** definišemo kao trodimenzionalni „nepostojeći svet" koji je ograničen veli-činom hologramske ploče na kojoj je hologram snimljen. Menjanjem ugla posmatranja snimljeni predmet sagledavamo sa različitih strana. Razlika između holograma i fotografije jeste: u jednoj dimenzijii. Fotografije su dvodimenzionalne slike (2D), a holografi trodimenzionalne slike (3D). Jedino se holografijom može vizualnim snimanjem i reprodukcijom snimiti naš trodimenzionalni svet na dvodimenzionalni medijum za snimanje, a potom reprodukovati izvorni "objekt", golim očima kao trodimenzionalnu sliku [10].

Vrste holograma

Na osnovu načina snimanja i rekonstrukcije lika tj. u zavisnosti od strane sa koje referentni zrak obasjava hologram i načina prikazivanja, holografi mogu biti: refleksioni holografi, transmisioni holografi, holografi sa nekoliko slika, multipleksni holografi ili holografi u boji. Najčešće se sreću holografi iz prve dve grupe.

Refleksioni holografi. Kod nastanka ovog hologrma laserski zraci dolaze s različitih strana fotografskog materijala (sa obe strane hologramske ploče). Laser kao izvor koherentne svetlosti dolazi do razdelnika snopa, a on kao polureflektujuća ploča, deli zrak na dva dela: objektni i referentni zrak. Objektni zrak se proširuje pomoću širitelja snopa (ekspandera), reflektuje se sa objekta i projektuje na fotografski materijal. Referentni zrak se isto tako proširuje, reflektuje se ogledalom i obasjava fotografski materijal. Dolazeći sa obe strane hologramske ploče, objektni i referentni zrak se susreću u fotografskom materijalu i stvaraju interferentni uzorak. Da bi se iz hologrma opet rekonstruisala slika, potrebno je ponoviti postupak kakav je upotrebljen pri dobijanju hologrma. Kada se snimljeni hologram osvetli jednakim ravnim referentnim talasom koji pada na njega pod jednakim uglom kao i pri snimanju, svetlo kroz hologram delimično prolazi kao talas nultog reda, a delimično formira talas prvog reda. Jedan talas prvog reda daje realnu sliku objekta, a drugi talas prvog reda daje virtualnu sliku. Obe slike su trodimenzionalne. Realna slika se može snimiti fotografskim postupkom, a virtualna ne može. Slika objekta dobijena reprodukcijom hologrma verna je objektu, iste je veličine kao i objekat. Zavisno od ugla gledanja moguće je videti predmete koji stoje jedan iza drugoga.

Transmisioni holografi. Transmisioni holografi stva-raju sliku transmisijom zraka svetlosti kroz holografski materijal. Kao i kod refleksionih hologrma, koristi se laser kao izvor koherentne svetlosti, ekspanderi i razdelnici zraka. Kada objektni zrak prođe kroz razdelnik snopa, svetlo se reflekuje sa ogledala na objekt i dalje s objekta na fotografski materijal. Referentni zrak se isto reflektuje sa drugog ogledala na fotografski materijal. Na hologramskoj ploči oba zraka zajedno stvaraju interferentni uzorak. U ovom slučaju zraci obasjavaju materijal sa iste strane. Pri čitanju hologrma koristi se rekonstrukcijski zrak, koji je pozicioniran istovetno kao i pri referentnom snimanju. Transmisioni holografi se masovno proizvode jer imaju jeftinije zahteve proizvodnje. Štampani holografi (rezbareni ili *embossed*) su transmisijski holografi sa ogledalom kao (metaliziranom) podlogom [10].

Štampanje hologrma i njegova upotreba

Proces izrade štampanih hologrma sastoji se iz više faza: izrade forme za otiskivanje matrice (izradu master hologrma kao lika objekta, elektro oblikovanje i metaliziranje) i proces utiskivanja na specijalnu foliju. *Hot stamp* folija je sistem koji se sastoji od poliesterskog nosača na kojem se nalazi razdvajajući sloj (najčešće vosak), uskog spektra temperature topljenja. Na taj sloj je naneseno nekoliko slojeva laka koji štiti foliju, ali je to ujedno i sloj u kojem se stvara deformacija pod uticajem povišene temperature i mehaničkog pritiska, tj. medijum na kojem se utiskuje hologram. Metalizirani sloj je najčešće aluminijumski, ređe se koriste hrom ili zlato. Takav sloj služi reflektovanju svetlosti sa površine hologrma. Na metaliziranom sloju se nalazi adhezivni sloj koji treba da osigura vezivanje metalnog i otisnutog sloja za štamparsku podlogu. Principi otiskivanja su ploča o ploču ili valjak o valjak i štampa se na klasičnim knjigovezačkim mašininama za utiskivanje zlatoštampe.

Sigurnosni holografi

Zadatak samolepljivih sigurnosnih hologramskih nalepnica i identifikacionih hologrma jeste obezbeđivanje

auteničnosti i zaštite robe od falsifikovanja. Proizvodni procesi koriste najnovije sigurnosne tehnologije te je veoma otežano falsifikovanje originala i izrada lažnih (proizvoda) zaštitnih holograma. Integracijom sigurnosnih holograma u proizvodni proces organizacija se preporučuje svojim kvalitetom, a oni postaju dominantan način za zaštitu od falsifikovanja. Najčešće vrste sigurnosnih holograma u ambalaži su holograma za utiskivanje folija i holografska sigurnosna traka.

Holografi za vruće utiskivanje folija. Integrišu se na raznim materijalima kao što su papir, karton, plastika, veštačka, tkanina, metal. Koristi se kod svih vrste pakovanja.

Holografska sigurnosna traka. Pruža zaštitu najvišeg nivoa pakovanja. Vidljivi uzorak se odvaja prilikom otvaranja (ili pakovanja proizvoda), tako da se sa trake skida uzorak metalizirane folije, što daje sigurnost originalu. Mikrotekst ili slika u hologramu su čitlivi pod lupom ili mikroskopom. Aktivno se koriste i 2D/3D hologram, *Dot-Matrix* hologram, Flip-flop Hologram itd. U zaštiti proizvoda ambalažom koja garantuje sigurnosti i atentičnosti proizvoda, teži se višenamenskim pristupom gde je prvi korak zaštite upotreba štampanog hologrma: tehnike koja se ne može reprodukovati niti jednom drugom grafičkom tehnikom [10].

Brajevo pismo

Brajevo pismo je sistem čitanja i pisanja namenjen slepim ili slabovidnim osobama. Svako slovo, interpunkcijski znak ili broj ovog pisma svrstani su u sistem sa 6 tačkica (ili 8 tačkica kod digitalnog Brajevog pisma). Postoji više oblika Brajevog pisma, a neki dodatni znakovi razvijeni su za muzičke note, matematičke znakove i rad na računaru. Različiti jezici imaju i različite Brajeve abecede i znakove. Opšti standard (*brajica*) je klasifikovao tačkice brojevima od 1 do 6, smeštenih u dve kolone sa po tri tačkice. Tačkice mogu biti izdignute ili udubljene. Svakom slovu abecede, broju, ili znaku odgovara određena kombinacija, položaj i broj tih reljefnih tačkica, te se «čita» dodirom ruku tj. vrhovima prstiju. I pored raznih tehnoloških pomagala savremenog doba sistem ovog pisma još je nezamenljiv i integriše se na ili u pomagala (Brajev sat, Brajev digitalni *smartwatch*, Brajev *display* itd.) [11].

Štampa Brajevog pisma. Uz pomoć specijalne aplikacije tekst koji će se se štampati Brajevim pismom unosi se u računar skeniranjem ili upisivanjem preko tastature. Skenirati se mogu samo tekstovi koji sadrže isključivo tekst u Brajevom pismu. Unešene podatke računar aplikacijom prilagođava Brajevom pismu i formatu na kojem će se štampati. Kod Brajevog pisma ne postoji mogućnost menjanja veličine slova i razmaka kao ni izgled slova. *Štampa se na specijalnim mašinama i uređajima koji „deformišu materijal*“ u oblike ispupčenih tačkica u okviru sistema Brajevog pisma ili perforišu (buše) mesta tačke. Bira se materijal koji trajno zadržava ovu deformaciju. Ovom tehnikom se može samo "jednostrano štampati". Obostrana *štampa* Brajevog pisma moguća je korišćenjem tehnike termografske *štampe* ili sito*štampe*. Promena visine i oblika ta*čkica moguća je* i pomoću višeslojne digitalne *štampe*. Veličina Brajevog znaka *čini „zamišljeni trougao" dimenzija* 6x10 mm [11].

Korišćenje Brajevog pisma kao zaštite. Samo po sebi ovo pismo ne predstavlja veliku zaštitu. Ono što ovom pismu daje značaj jeste složenost njegove kvalitetne izrade čime se mogućnost falsifikovanja ambalažnog proizvoda obeleženog ovim pismom, svodi na minimum. Brajevo pismo u kombinaciji s još nekim elementima zaštite (hologram, zaštitne *štamparske* boje, mikrotekst itd.) može znatno smanjiti mogućnost falsifikovanja proizvoda. Time se u suštini garantuje kvalitet proizvoda. Brajev zapis se najčešće koristi kod izrade prehrambene ambalaže (celulozne ili plastične) i u farmaceutskoj industriji. Međunarodni standard koji definiše šifre fontova pisma, zvanično "Brajeva slova" i njegovih 256 tačaka tretira kao simbole" [11].

Specijalne vizuelne komunikacije - pametne boje

Zahvaljujući promeni boje indikatora inteligentne amba-laže, kupac prepoznaje kada se hrana počne kvariti zbog: lošeg pakovanja, isteka roka trajanja, mehaničkog oštećenja na ambalaži ili držanja u neadekvatnim uslovima. Ambalažni materijal u dodiru sa proizvodom (preko indikatora), ukazuje na stanje upakovanog proizvoda i daje informaciju o proizvodu "kontrolnom promenom boja". Inteligentna ambalaža može menjati boju kako bi kupac znao koliko je hrana sveža, da li se pokvarila zbog promene temperature pri skladištenju ili da li je kod manipulacije njome došlo do oštećenja pakovanja. Primer: zelena traka na ambalaži će biti pokazatelj "starosti" namirnice, tj. traka će biti zelena u prve tri nedelje (dok je namirnica ispravna), a zatim čim se promeni hemijski sastav namirnice traka postaje crvena, što ukazuje da više nije za konzumiranje. Principi „reagovanja boje" zavise od njenog „zadatka". I u holografiji dodavanje "pametnih boja" predstavlja dodatnu tehnika zaštite ambalažnog proizvoda.

4. ZAKLJUČAK

Osnovni cilj stvaranja i očuvanja kvalitetne savremene ambalaže, jesu poboljšanja u funkciji postizanja i održavanja kvaliteta ambalaže a time i upakovanog sadržaja. Svojom komunikacijom, ambalažni sistemi pakovanje hrane, ambalažu i korisnike objedinjuju u aktivan proces. Često sistemi komunikacije učestvuju i u pripremanju sadžaja pakovanja za njegovo korišćenje.

Sigurnosni aspekt upakovanog sadržaja savremena ambaža ostvaruje zahvaljujući novim sistemima strukturne (indikatori, senzori, simboli) i grafičke komunikacije (bar-kod, hologram, Brajevo pismo, itd). Štampa na sigurnosnim samolepljivim trakama ima veliki uticaj na sigurnosti korišćenja i zaštitu transportne ambalaže. Stepen originalnosti i sigurnosti upakovanog proizvoda garantujue se štampom elektronike (RFID radio frevkventnih identifikacionih čipova, mikro-čipova) ili pametnim bojama. Sa aspekta poslovnosti, navedene aktivnosti pri izradi savremene ambalaže predstavljaju vid poboljšanja. Brajevo pismo, hologram ili bar-kod predstavljaju vrstu verifikacije autentičnosti proizvoda. Opet, svi zajedno čine i komunikacione sisteme savremene ambalaže sa zajedničkim ciljem: stvaranje i očuvanje originalnosti i kvaliteta proizvoda. U različitim delovima procesa izrade grafičkih i strukturnih elemenata grafičke ambalaže preporučuje se primena pripadajućih ISO standarda. Nove aktivnosti sistema komunikacije savremene ambalaže prepoznaju i implementiraju procese i aktivnosti konstantnog poboljšanja zasnovanim na principima TQM-a, čime se zadovoljavaju očekivanja kupaca.

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RENDGENSKA DIFRAKTOMETRIJA PRAHA - XRPD

Vladimir D. Pavkov[1, *],
Gordana M. Bakić[2],
Vesna Maksimović[1],
Branko Matović[1],
Miloš Đukić[2]

[1]Institut za nuklearne nauke "Vinča",
Univerzitet u Beogradu,
Beograd, Srbija.
[2]Univerzitet u Beogradu,
Mašinski fakultet,
Beograd, Srbija

Rezime:

Nauka o materijalima danas predstavlja multidisciplinarnu oblast, gde na osnovu fizičke i hemijske karakterizacije materijala mogu da se definišu njihova svojstva kao i potencijalna primena. U cilju dobijanja finalnog proizvoda zahtevanih karakteristika, neophodno je primeniti savremene eksperimentalne metode za ispitivanje materijala, među kojima značajno mesto zauzima metoda rendgenske difrakcije. Metoda rendgenske difraktometrije praha XRPD predstavlja najjednostavniju, najtačniju, najbržu pa ujedno i najefikasniju metodu za identifikaciju materijala. Ova metoda je nedestruktivna, pa uzorak nakon ispitivanja ostaje sačuvan za dalju analizu. XRPD metodom se mogu lako razlikovati kristalne faze čak i kada imaju isti hemijski sastav. Iako mnoga jedinjenja mogu da imaju istu strukturu, tj. da im dijagram praha bude isti, rendgenska difrakcija sa velikom pouzdanošću indirektno pruža uvid u hemijsku analizu datog jedinjenja. U ovom radu predstavljeni su osnovni pojmovi metode rendgenske difraktometrije praha, njena primena i značaj u ispitivanju različitih materijala kao i identifikacija strukture bazalta pre i nakon termičkog tretmana.

Ključne reči:

Rendgenski zraci, difraktometar praha, Bragov zakon, difraktogram praha, bazalt.

1. UVOD

Ni jedno fizičko svojstvo materijala se ne može objasniti, a da se pri tome ne zna kakva je struktura tog materijala, odnosno kako se struktura menja pod različitim uslovima. Danas se praktično ne može zamisliti ispitivanje materijala bez rendgenske difrakcije. Rendgenska difrakcija (eng. X-Ray Diffraction, XRD) se može definisati kao nedestruktivna eksperimentalna metoda, koja se zasniva na korišćenju X-zraka i njegovoj difrakciji. Ova metoda se koristi za identifikaciju minerala kao i mineroloških sastava materijala, jer vrsta minerala određuje svojstva finalnog proizvoda kao i njegovu potencijalnu primenu.

Tokom proučavanja katodnih zraka 1895. godine, Vilhelm Konrad Rendgen je otkrio rendgenske zrake (Röntgenstrahlen) i kako nije poznavao njihovo poreklo nazvao ih je X-zraci. Rendgenski zraci su elektromagnetni talasi, što znači da su nosioci promenljivog elektromagnetnog polja.

Odgovorno lice:
Vladimir D. Pavkov

e-pošta:
pavkow@vin.bg.ac.rs

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Čvrsto telo u kojem su atomi, joni ili molekuli, koji ga čine, rapoređeni pravilno po određenim zakonitostima i ponavljaju se u sve tri dimenzije naziva se kristal. Osnovna ponavljajuća jedinica koja definiše kristal naziva se jedinična ćelija.

Čvrste supstance se mogu pojaviti u sledećim oblicima:

- kao čisti monokristali ili monokristali koji sadrže nečistoće,
- kao polikristalni materijal koji je sačinjen od velikog broja različito orijentisanih kristalita jedne ili više kristalnih faza,
- kao tanki filmovi jedne faze nataložene na drugoj fazi i
- kao amorfne supstance i staklo.

Nijedna pojedinačna eksperimentalna metoda ne daje sveoubuhvatni odgovor na svojstva materijala, međutim činjenica je da je osnovna metoda za karakterizaciju kao i analizu polikristalnih materijala rendgenska difrakcija.

2. RENDGENSKA DIFRAKTOMETRIJA PRAHA

Materijal u sprašenom obliku koji se sastoji od više istovrsnih ili raznovrsnih sitnih kristala naziva se polikristalni materijal [1]. Rendgenska difraktometrija praha (eng. X-Ray Powder Diffraction, XRPD) se može definisati kao metoda za analizu i karakterizaciju polikristalnih materijala. Na osnovu ove metode mogu se dobiti podaci o materijalu koji se odnose na: fazni sastav, zastupljenost prisutnih faza, strukturu kao i mikronaprezanja [2].

Metodom rendgenske difraktomerije praha mogu se analizirati kako uzorci u obliku praha tako i masivni uzorci i tanki filmovi od nanometarskih do mikrometarskih veličina zrna, što daje ovoj metodi široku primenu u analizi različitih materijala (minerali, stene, metali, legure, keramički materijali, polimeri, karbonski materijali, kompoziti itd.). Veoma je važno istaći da je ova metoda izuzetno precizna i nedestruktivna odnosno uzorak se nakon ispitivanja može sačuvati i koristiti za dalju analizu. Dovoljna je jako mala količina materijala od 2 do 20 mg da bi se izvšila analiza ovom metodom [2].

Ispitivanje polikristalnog uzorka metodom difrakcije u cilju identifikacije prisutnih kristalnih faza naziva se kvalitativna rendgenska analiza. Ukoliko se vrši određivanje masenih udela pojedinih kristalnih faza u uzorku tada je reč o kvantitativnoj rendenskoj analizi [1].

Rendgensko zračenje

Da bi se dobili podaci o kristalnoj strukturi nekog materijala koristi se zračenje čija talasna dužina odgovara međuatomskom rastojanju u kristalima, pri čumu takav uslov ispunjavaju rendgenski, odnosno X-zraci, koji se nalaze između ultraljubičastog i γ – zračenja. Rendgenski zraci su elektromagnetni talasi koji se odlikuju: visokom frekvencijom, malom talasnom dužinom i visokom energijom. Opšte je poznato da rendgenski zraci imaju frekvenciju od $3{\cdot}10^{16}$ do $3{\cdot}10^{19}$ Hz, talasnu dužinu između 0,01 i 10 nm i energiju od 120 eV do 120 keV.

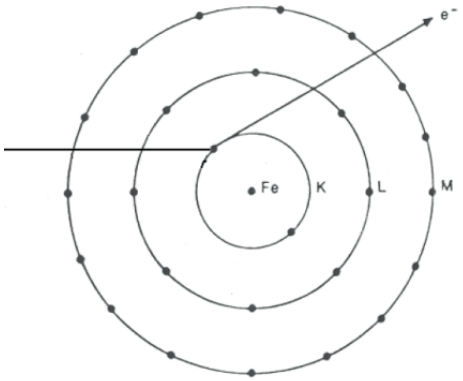
Mogu se razlikovati "meki" i "tvrdi" X-zraci u zavisnosti od vrednosti napona, odnosno pri nižim vrednostima napona dobijaju se "meki" X-zraci [3]. Dobro je poznato da "meki" rendgenski zraci (soft X-rays) imaju talasnu dužinu od 0,1 do 10 nm (0,12 do 12 keV), dok "tvrdi" rendgenski zraci (hard X-rays) imaju talasnu dužinu od 0,01 do 0,1 nm (12 do 120 keV).

U difrakcionoj analizi koristi se rendgensko zračenje malih talasnih dužina, što odgovara energijama fotona od 1 keV do 120 keV. Kako je talasna dužina rendgenskog zračenja približna veličini atoma, primena ovog zračenja je pogodna za određivanje strukturnog uređenja atoma i molekula u različitim materijalima [4, 5]. Zraci sa manjom talasnom dužinom imaju veću prodornost, pa tako prilikom korišćenja rendgenskog zračenja potrebno je pridržavati se propisanih zaštitnih mera na radu, s obzirom da X-zraci mogu biti izuzetno štetni po ljudsko zdravlje.

Nastanak rendgenskog zračenja

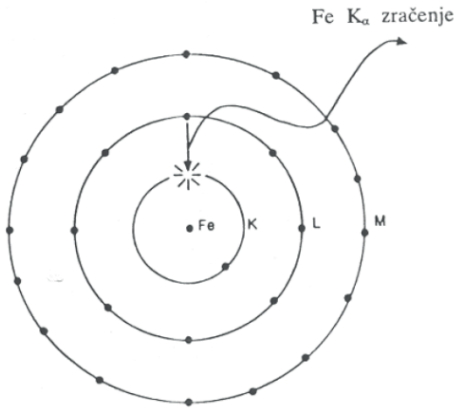
U atomu, elektroni su raspoređeni u orbitalama, odnosno ljuskama (K, L, M, N ...). Elektroni su u ljuskama vezani energijama koje su karakteristične za svaki element. Energija zavisi od privlačne sile jezgra koja zavisi od broja protona u njemu. Energija vezivanja elektrona u unutrašnjim ljuskama je veća od energije vezivanja elektrona u spoljašnjim ljuskama, pa se elektroni u unutrašnjim ljuskama nalaze u povoljnijem energetskom položaju. U susednim unutrašnjim ljuskama razlika u energijama vezivanja elektrona je veća nego između elektrona u spoljašnjim ljuskama.

Ukoliko se atomu, nekim procesom, ukloni elektron iz unutrašnje ljuske, na njegovom mestu će nastati vakancija (upražnjenost, nepopunjenost ili prazno mesto), slika 1.



Slika 1. Uklanjanje elektrona iz atomske ljuske [6]

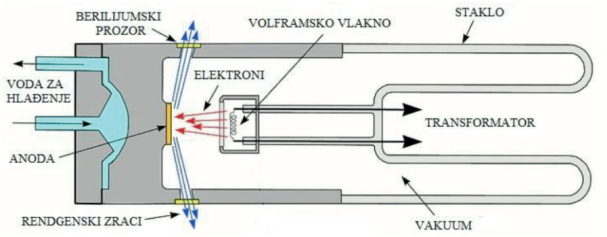
S obzirom da su atomi sa vakancijom u unutrašnjoj ljusci nestabilni, u jako kratkom vremenu će elektron iz neke od spoljašnjih ljuski preći na upražnjeno mesto. Kako elektroni iz spoljašnjih ljuski poseduju višu energiju, prilikom njihovog prelaza na upražnjeno mesto oslobodiće se energija u vidu karakterističnog rendgenskog zračenja, slika 2.



Slika 2. Nastanak rendgenskog zračenja [6]

U različitim unutrašnjim ljuskama mogu nastati vakancije pa tako elektroni mogu prelaziti sa različitih viših energetskih nivoa. Dakle, kod svakog elementa može nastati zračenje različitih energija, tj. talasnih dužina, odnosno mogu nastati različite linije karakterističnog zračenja.

U oblasti kristalografije, za dobijanje rendgenskih zraka koristi se rendgenska cev prikazana na slici 3. Rendgenska cev predstavlja staklenu cev sa berilijumskim prozorima kroz koje izlazi rendgensko zračenje, a pritom je u potpunosti pod vakuumom. Rendgenski, odnosno X-zraci se stvaraju u vakuum cevi sa naponom od 30 do 150 kV [1, 2].



Slika 3. Šematski prikaz rendgenske cevi [7]

Katoda je zatopljena na jednoj strani rendgenske cevi, dok se anoda nalazi naspram nje. Namotano volframsko vlakno, koje predstavlja katodu, zagreva se do usijanja, a kao posledica toga dolazi do emitovanja termalnih elektrona. Termalni elektroni imaju usmereno kretanje sa katode na anodu, gde usled napona, od nekoliko desetina kilovolti, između ove dve elektrode dolazi do ubrzanja elektrona. Tokom udara elektrona u anodu dolazi do oslobađanja energije koja se potom pretvara u kontinualno odnosno "belo" zračenje i prolazi kroz berilijumske prozore na rendgenskoj cevi. Anoda je konstruisana tako da ima sistem hlađenja kroz koji struji voda u cilju sprečavanja njenog oštećenja usled pregrevanja.

Procesom galvanizacije može se naneti sloj metala na anodu, kao što su Fe, Cr ili Mo, u cilju dobijanja zračenja određene talasne dužine, odnosno karakterističnog zračenja. Snop elektrona poseduje dovoljnu energiju da izbije elektrone iz unutrašnjih ljuski nekog metala od kojeg je izrađena anoda, usled čega dolazi do oslobađanja energije određene talasne dužine. Dve najvažnije linije koje nastaju su: Kα linija (usled izbijanja elektrona sa K ljuske pri čemu je popunjava L ljuska) i Kβ linija (usled prelaza elektrona sa M ljuske popunjavajući K ljusku) [2].

Važno je istaći da karakteristično rendgensko zračenje manje talasne dužine emituju elementi koji poseduju veći atomski broj Z. Najčešće se koriste rendgenske cevi sa bakarnom anodom talasne dužine 1,5443 Å ili molibdenskom anodom talasne dužine 0,7107 Å (*Angstrem* (Å), 1 Å = 0,1 nm = 10^{-10} m).

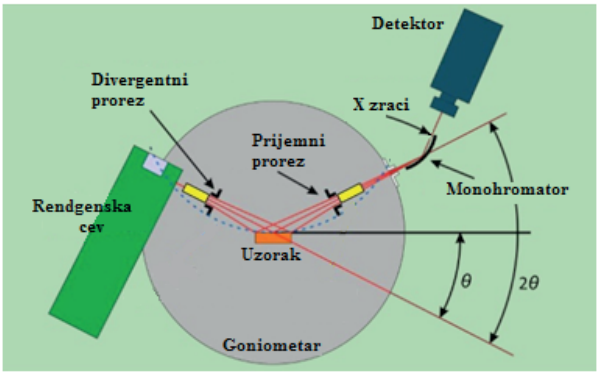
U metodi rendgenske difrakcije praha koristi se rendgensko zračenje koje je monohoromatsko i koje se dobija uz pomoć kristala – monohromatora ili filtera. Monohromator ili filter je postavljen na put rendgenskim zracima ispred ili iza sprašenog uzorka u zavisnosti

od opremljenosti difraktometra za prah. Kristal monohromatora može se napraviti od grafita, nikla, kvarca ili nekog drugog materijala.

Princip rada difraktometra za prah

Uređaj uz pomoć kojeg se može dobiti difraktogram praha polikristalnog materijala naziva se difraktometar za prah. Jednu od najvažnijih komponenti difraktometra za prah, predstavlja rendgenska cev uz pomoć koje se generiše rendgensko zračenje. Pored napomenute rendgenske cevi, difraktometar za praha se sastoji od sledećih elemenata: generator (izvor visokog napona), goniometar, detektor, sistem za hlađenje i računar.

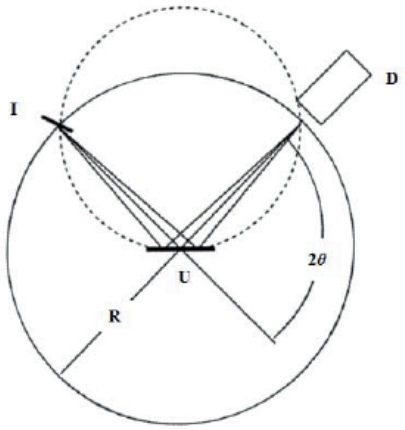
Princip rada difraktometra za prah prikazan je na slici 4. Iz izvora rendgenskog zračenja, u ovom slučaju rendgenske cevi, rendgenski zraci prolaze kroz divergentni prorez. Sužen rendgenski zrak pada na pripremljeni, odnosno sprašeni uzorak koji je postavljen na nosač i nalazi se u osi goniometra. Difraktovani zraci sa površine uzorka prolaze kroz prijemne proreze, a potom ulaze u detektor koji se kreće konstantno po difraktometarskom krugu oko ose goniometra.



Slika 4. Princip rada difraktometra za prah (θ - θ geometrija) [8]

Kod θ - θ geometrije, kao što je prikazano na slici 4, uzorak miruje u horizontalnom položaju, a istim brzinama zakreću se rendgenska cev i detektor. Ugao pod kojim rendgenski zraci padaju na sprašeni uzorak se menja tokom eksperimenta, a pri tome detektor registruje promene intenziteta difraktovanog zračenja. Zabeleženi impulsi u detektoru prenose se na brojački lanac, a potom se softverski obrađuju i dobija se difraktogram praha kao rezultat.

Dva kruga su karakteristična za parafokusnu geometriju, a to su fokusni i goniometarski krug. Na fokusnom krugu koji ima promenljiv radijus, prikazan je isprekidanom linijom na slici 5, nalaze se: izvor zračenja (I), uzorak (U) i detektor (D). Uzorak se istovremeno nalazi u centru goniometarskog kruga, prikazan punom linijom na slici 5, koji ima konstantan radijus (R) [9]. Pravilno postavljen uzorak za ispitivanje se nalazi u centru goniometarskog kruga dok istovremeno tangira fokusni krug.



Slika 5. Izgled geometrije goniometra sa karakterističnim krugovima (fokusni i goniometarski krug) [9]

Bragov zakon

Rasipanje rendgenskih zraka je pojava do koje dolazi kada rendgenski zraci dođu u kontakt sa površinom uzorka, odnosno polikristalim materijalom i tada atomi počinju da deluju kao sekundarni izvori zračenja. Do interakcije između rasutih rendgenskih zraka dolazi kada se deo talasa pojača, deo oslabi ili se u potpunosti međusobno poništi, pri čemu se ova pojava naziva difrakcija i u nastavku rada biće objašnjena Bragovim zakonom.

Niz ekvidistantnih ravni moguće je postaviti kroz kristalnu rešetku, pri čemu ove ravni predstavljaju zamišljene ravni koje se međusobno nalaze na istom ekvidistantnom rastojanju *d*. Ravni kristalne rešetke obeležavaju se Milerovim indeksima i predstavljaju cele brojeve. Milerovi indeksi predstavljaju recipročne vrednosti odsečaka koje data ravan pravi na kristalografskim osama. S obzirom da napomenute ravni deluju kao poluprovidna ogledala, pa se sa njih jedan deo zraka reflektuje sa gornje ravni, deo zraka može proći kroz nju i tako reflektovati sa sledeće ravni ili u potpunosti proći kroz ceo kristal [1, 10].

Bragov zakon odnosno difrakcija rendgenskih zraka na ekvidistantnim ravnima u kristalu prikazana je na slici 6. Tri ravni M, N i O se nalaze na istom ekvidistantnom rastojanju d. Na susedne ravni M i N padaju snopovi rendgenskih zraka A i B, talasne dužine λ. Sa slike 6 se jasno uočava da snop zraka BB' treba da pređe duži put od snopa AA' za deo CDE. Da bi se ostvarila konstruktivna interferencija, odnosno da bi zraci A' i B' bili u fazi, potrebno je da razlika puteva bude jednaka celom broju talasnih dužina, tj. CDE = $n\lambda$. Ukoliko je CD = DE = $d \sin\theta$, onda je CDE = $2d \sin\theta$ [1], pa sledi jednačina:

$$n\lambda = 2d \sin\theta. \quad (1)$$

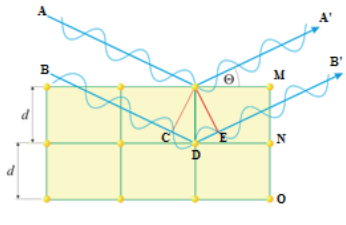
Jednačina (1) predstavlja Bragovu jednačinu, odnosno Bragov zakon [11, 12, 13, 14], gde je:

d - ekvidistantno rastojanje nekog niza kristalografskih ravni,

θ - upadni ugao zraka u odnosu na te ravni,

n - ceo broj i ujedno označava red refleksije – spektra,

λ - talasna dužina rendgenskih zraka.



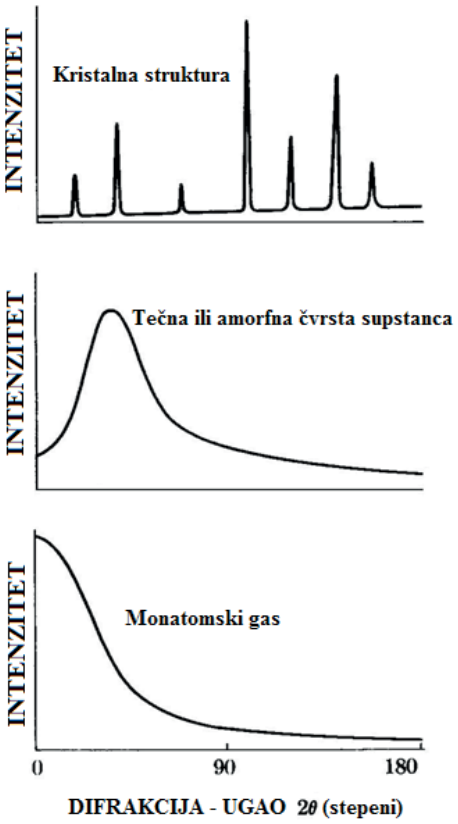
Slika 6. Bragov zakon difrakcije [15]

Ukoliko je zadovoljena Bragova jednačina javlja se konstruktivna interferencija, odnosno reflektovani snopovi su u fazi. Refleksije su difrakcioni maksimumi nastali pozitivnom interferencijom.

Do destruktivne interferencije, odnosno do opadanja intenziteta dolazi ako upadni snop zraka pada na kristal pod uglom različitim od Bragovog ugla θ [4]. Usled destruktivne interferencije dolazi do međusobnog poništavanja zraka, jer reflektovani zraci nisu u fazi. Zraci reflektovani sa jedne ravni uvek su u fazi s obzirom da prelaze iste puteve [16, 17, 18].

Difraktogram praha

Difraktogram praha predstavlja rezultat snimanja nekog polikristalnog materijala na difraktomertu za prah, odnosno može se reći da difraktogram praha predstavlja rezultat dejstva rendgenskih zraka na polikristalnom materijalu. Svaki difraktogram praha sastoji se od pikova. Ono što odlikuje svaki pik je intenzitet i širina na poluvisini. Na apscisi se nalazi položaj pika koji je određen uglom 2θ (°), dok se na ordinati difraktograma nalazi intenzitet koji je predstavljen brojnim vrednostima. Na slici 7 prikazani su difraktogrami različitih agregatnih stanja materije.



Slika 7. Difraktogrami različitih agregatnih stanja materije [19]

Širina na poluvisini predstavlja širinu difrakcione linije koja se meri na polovini visine pika. Difrakcione linije koje imaju širinu na poluvisini oko 0,1° 2θ definisane su kao oštre [2]. Iz položaja i intenziteta pikova, ako su faze kristalne i ako njihova trodimenzionalna periodičnost nije narušena, može se izvršiti identifikacija određene faze ili faza, njihova zastupljenost kao i struktura.

Kod amorfnih materijala javljaju se široki pikovi [20, 21]. U slučaju da je periodičnost narušena i da čvrsta faza ima nizak stepen kristaliniteta, onda se za takvu fazu kaže da je amorfna, odnosno staklasta. Pikovi na

difraktogramu praha će biti širi što je stepen kristaliniteta niži, odnosno širina pika je u funkciji stepena kristaliniteta.

Kako realni kristali nemaju savršenu strukturu, tako je svako kristalno zrno sačinjeno od više kristalita između kojih se nalaze granice podzrna. Može se reći da su najčešći uzrok širenja refleksija mali kristaliti dimenzije ispod 0,2 μm koji sačinjavaju kristalno zrno. Nezavisnu refleksiju će dati svaki kristalit, ali kao posledica malih razlika u položajima refleksija na difraktogramu praha doći će do formiranja jedne široke refleksije [2].

Na širenje difrakcionih linija pored veličine kristalita utiču i mikronaprezanja kao posledica mlevenja materijala ili ograničenog rasta kristalnog nukleusa. Ukoliko su kristaliti mali, ispod 50 Å, a pri tom postoje mikronaprezanja, neke slabe refleksije mogu nestati, tj. postaju toliko široke da se ne vide na difraktogramu [2].

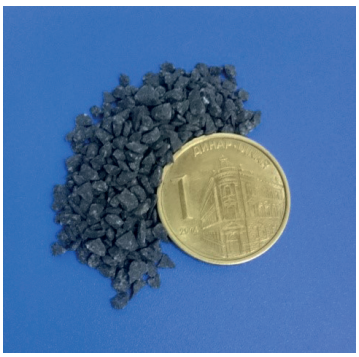
Dve glavne karakteristike koje određuju izgled difraktograma praha su položaj difrakcionih maksimuma i njihov intenzitet. Položaj maksimuma je u funkciji uslova datih Bragovim zakonom, dok intenzitet zavisi od različitih faktora. Veličina kristalita ima značajan uticaj na izgled difrakcionih maksimuma, odnosno što su kristaliti sitniji, njihova raspodela u prahu je homogenija, ali je širina difrakcionih maksimuma veća [14].

Na osnovu dobijenih eksperimentalnih vrednosti koji se nalaze na difraktogramu praha, vrši se upoređivanje sa podacima iz literature koji se mogu naći u JCPDS (eng. Joint Committee on Powder Diffraction Standards) datoteci, pri čemu se određuje prisustvo kristalnih faza. Za identifikaciju neke kristalne faze, neophodno je da se svi pikovi na difraktogramu praha poklapaju sa pikovima na JCPDS kartici.

3. IDENTIFIKACIJA STRUKTURE BAZALTA PRE I POSLE TERMIČKOG TRETMANA UZ PRIMENU XRPD METODE

Difrakcioni podaci, za ispitivane uzorke, prikupljani su na sobnoj temperaturi na difraktometru za prah proizvođača Rigaku, model Ultima IV. Tokom ispitivanja, korišćeno je $CuK\alpha_{1,2}$ zračenje (λ = 1,54178 Å) nastalo u rendgenskoj cevi pri jačini struje od 40 mA i naponu od 40 kV. Zračenje je monohromatizovano Ni filterom, pri čemu je filter postavljen ispred detektora. Digitalnim brojačem D/teX se beleži difraktovano zračenje. Za dobijanje grafičkog prikaza difraktograma kao i analize korišćen je softver PDXL.

Kao uzorak za ispitivanje, metodom rendgenske difraktometrije praha, korišćen je bazalt sa lokaliteta "Vrelo" Kopaonik, R. Srbija, slika 8. Bazalt je magmatska stena. Pripada grupi tvrdih stena homogene građe. Dugo vreme hlađenja lave na površini zemlje dovodi do stvaranja sitnozrnastog bazalta. Bazalt, zbog svojih svojstava, nalazi široku primenu u mnogim granama privrede, a proizvodi od bazalta mogu biti adekvatna zamena metalnim materijalima.

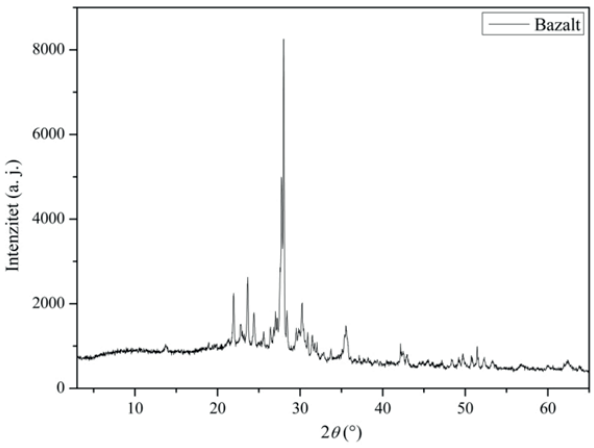


Slika 8. Bazalt sa lokaliteta "Vrelo"

Bazalt, dimenzije od 1 do 3 mm, je usitnjen drobljenjem u merzeru. Usitnjeni bazalt je nakon toga prosejan na veličinu čestica praha ispod 45 μm, a potom mleven u ahatnom avanu u cilju dobijanja finog homogenog praha. Materijali visoke tvrdoće, kao što je bazalt, teže se sprašuju, pa je potrebno duže vreme mlevenja. Da bi se dobio verodostojan difraktogram praha, neophodno je dobro sprašiti uzorak, jer što je veći broj čestica praha podvrgnut difrakciji, veća je verovatnoća da se na difraktogramu pojave jasno definisane refleksije kao posledica difrakcije X-zraka.

Kada je prah sprašen, vrši se njegova priprema za ispitivanje. Naime, silicijumski monokristalni nosač uzorka, površine 1 cm^2, se popunjava sprašenim bazaltom, potom se prah pritiska staklenom pločicom, a zatim se uklanja višak praha sa nosača nakon čega je uzorak spreman za snimanje. Veoma je važno napraviti glatku i ravnu površinu na nosaču koja neće narušiti fokusnu geometriju difraktometra.

Intenziteti difrakcionih maksimuma prikupljani su u intervalu od 3 do 65° 2θ, sa korakom od 0,02° i brzinom 2 °/min. Dobijeni difraktogram praha bazalta prikazan je na slici 9.

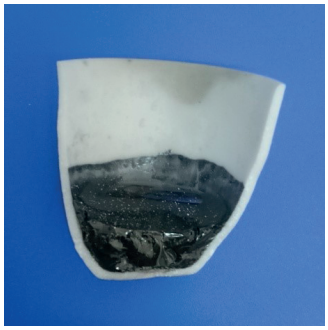


Slika 9. Difraktogram praha bazalta

Na difraktogramu praha bazalta, slika 9, mogu se uočiti jasno definisani oštri pikovi jakih intenziteta. Na osnovu difraktograma može se reći da je bazaltni agregat sačinjen od minerala dobre strukturne uređenosti. Nešto malo viši fon ukazuje na prisustvo amorfne faze u bazaltu.

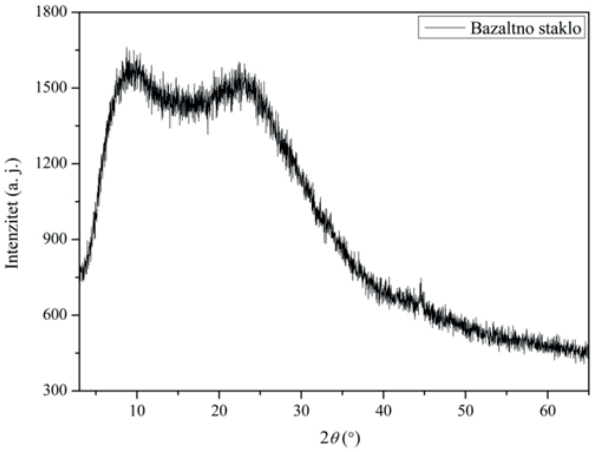
U cilju ispitivanja strukture bazalta usled izlaganja visokoj temperaturi, iznad tačke topljenja, a potom naglom hlađenju, usledio je naredni eksperiment. Naime, prah bazalta je stavljen u korundni tigl zapremine 25 ml. Tigl sa uzorkom je zatim postavljen u visokotemperaturnu vakuumsku peć. Temperatura zagrevanja je bila 10 °C/min sve do temperature od 1400 °C. Uzorak je bio podvrgnut temperaturi od 1400 °C u periodu od 1h, a potom hlađen brzinom od 25 °C/min, s obzirom da peć ima sistem vodenog hlađenja.

Zbog zagrevanja bazalta iznad tačke topljenja, a potom naglim hlađenjem, bazalt se transformiše u bazaltno staklo, odnosno iz kristalne strukture prelazi u amorfnu. Na slici 10 je prikazan poprečni presek tigla sa bazaltnim staklom nakon termičkog tretmana.



Slika 10. Poprečni presek tigla sa bazaltnim staklom

U cilju identifikacije strukture bazaltnog stakla, tigl je razbijen kako bi se izvadio uzorak. Uzorak je potom izdrobljen i samleven. Usitnjeni prah bazaltnog stakla je zatim snimljen na difraktometru, a kao rezultat je dobijen difraktogram bazaltnog stakla, slika 11. Intenziteti difrakcionih maksimuma prikupljani su u intervalu od 3 do 65° 2θ, sa korakom od 0,02° i brzinom 2 °/min.



Slika 11. Difraktogram bazaltnog stakla

Na difraktogramu praha bazaltnog stakla, slika 11, može se uočiti široki pik, visokog fona, što ukazuje da je ova faza amorfna. Ukoliko je periodičnost u kristalu narušena i ako čvrsta faza poseduje nizak stepen sređenosti onda se ona naziva staklastom, odnosno amorfnom. Faze niskog stepena sređenosti se lako prepoznaju na difraktogramu po karakterističnim širokim difrakcionim maksimumima pri malim uglovima $2q$, što se jasno vidi na difraktogramu bazaltnog stakla. Do transformacije kristalne strukture u amorfnu došlo je iz razloga što rastopljeni bazalt zbog naglog pada temperature ne kristališe, već trenutno očvršćava i zadržava amofrnu formu kao staklo.

4. ZAKLJUČAK

Za dobijanje faznih kao i strukturnih podataka, na osnovu koji se može izabrati optimalan put od sirovine do finalnog proizvoda željenog sastava i karakteristika, važnu ulogu ima metoda rengdenske difraktometrije praha. Pri ispitivanju faznih transformacija materijala, nastalih tokom različitih tehnoloških procesa, ova metoda je od neprocenjivog značaja.

Za ispitivanje različitih materijala najčešće se koristi metoda praha, a od instrumenata difraktometar za prah

zbog svojih prednosti, kao što su: jednostavna priprema uzorka, kratko vreme eksperimenta kao i tačnost dobijenih rezultata.

Ovom metodom moguće je izvršiti sledeće analize: utvrđivanje strukture materijala, posredna identifikacija hemijskih elemenata i jedinjenja, kvalitativna fazna analiza, kvantitativna fazna analiza, razmak između susednih atoma, greške u kristalnoj strukturi, veličina, oblik i orijentacija kristalita u uzorku.

Na osnovu svega nevedenog, XRPD metoda nalazi primenu u mnogim oblastima pri čemu treba posebno izdvojiti: nauku o materijalima, geologiju i farmaciju.

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SOFTWARE AND INFORMATION ENGINEERING & INTERNET AND DEVELOPMENT PERSPECTIVES

THE EVALUATION OF THE TECHNICAL QUALITY OF WEB SITES WITH CONTENTS IN ARABIC AND SERBIAN LANGUAGES

Ali Elsadai*,
Milan Tair,
Nikola Savanović

Singidunum University,
Belgrade, Serbia

Abstract:
In this paper, authors present the result of an experimental study which covers the technical evaluation of 200 websites. Of the total, 100 are with content in the Arabic language and 100 are with content in the Serbian language. The technical evaluation covers the most common web development practices which are usually neglected. These include the application of the responsive page design, page download speed, the analysis of the most frequent HTML code errors and warnings, the use of CSS and JavaScript compression and the use of HTTPS certificates for secure connections. The test data is obtained with a script which collects information from a list of domains. The script processes the acquired information and performs code validation using the W3C HTML Validator tool. This paper presents a comparison of the evaluation results of web sites in Arabic and web sites in Serbian. The paper points out the most common technical problems and inadequacies of web sites in Arabic and Serbian languages. This research aims to help developers to maintain and improve their web page development processes and to avoid making common errors, which lead to increased incompatibility of web page with different browsers.

Keywords:
technical evaluation, browser compatibility, HTML code validation, web sites in Arabic, web sites in Serbian.

1. INTRODUCTION

Quality has become an essential requirement for creating web pages. Technical quality is as important as aesthetic and functional quality. Valid and clean code, free of errors is only one of the parameters which define valid web page code. In the past, the World Wide Web lacked standards for coding, web page design and browsers compatibility. Programmers adhered to their own experience to use practices they themselves deemed good. Because there were no standards to provide these guidelines, many web pages faced troubling issues with web browser incompatibility and even incompatibility between different versions of web browsers made by the same vendor. Alongside these incompatibilities, there was a general lack of interest in writing clean and maintainable code. This was mostly due to the fact that web sites were mostly static

Correspondence:
Ali Elsadai

e-mail:
aelsadai@singidunum.ac.rs

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and seldom required updating. Due to the fact that the Internet was rapidly expanding and the number of web sites was grooving almost exponentially, these issues became apparent early on.

In the effort to unify the development practices concerning the web, the World Wide Web Consortium (W3C) invests resources to create web standards, guidelines, and other supporting materials through a number of work groups. [1]

Presently, W3C is engaged in the process of specifying and standardising a number of APIs which should be made available to web pages in all browsers which adhere to these standards. [2]

Historically, web browser vendors have been quick to implement certain standards and specifications, but not all. [3] Nowadays, browser vendors have become motivated to implement newer standards and specifications more promptly than before. W3C has defined standards which provide a framework that allows all web pages to be rendered and handled in the same manner by all web browsers, regardless of version and vendor. These standards bring the World Wide Web to its maximum potential. They act as guidelines for both the developer and the browser vendors.

When web pages are developed in accordance with these guidelines, their behaviour is predictable and the graphical rendering should be unified. Because of this, it is important to comply fully with standard ways of using web components defined in the HTML specifications. W3C has created tools which check if web pages comply with these specifications. Those tools are called code validators. W3C provides validators for both the HTML and CSS code. These tools make compliance checks easier for developers. [4]

Even non-professionals can create web sites using web pages authoring tools. Such tools employ the WYSIWYG principle (What You See Is What You Get) to allow users to visually design their web pages without ever needing to type code. These authoring tools can generate web page HTML code with errors. These errors can be less or more critical in terms of standard compliance. Also, some professional web site developers do not use validation tools. This may lead to unclean code which might cause web site rendering errors. [5]

Another important factor is the download speed. This measurement depends on many factors. Some of the factors are the current traffic load on the server, network latency, communication channel speed etc [6]. In this paper, we explain how this issue was dealt with.

In this research we have compared web sites with content in Serbian and Arabic languages. Aside from the HTML code quality, we have analysed the compression ratio of CSS, and JavaScript files as well as a number of different metrics, among which is the text to HTML ratio. The text to HTML ratio is calculated by measuring the total number of visible/rendered characters on page with the amount of HTML code in the body, responsible for generating the rendered view showing that text. This ratio is always less than one. In text heavy web pages, the greater the value of this ratio the better the web page is in terms of this metric. [7] [8]

Usually, the better text to HTML ratio for pages with less HTML code overall improves the load speed and has positive influence on the user experience [9]. Search engines determine rankings of web pages in their search result indices by their quality of code as well as the content which is indexed [7].

One of the web site optimization techniques involves CSS and JavaScript code compression. Code compression is the process of removing any and all unnecessary characters from CSS and JavaScript files. This process must be conducted in such a way so that the functionality of the code remains absolutely the same, while the text size is reduced. In most cases, removing unnecessary whitespaces is sufficient. Whitespace characters include spaces, tabs, new lines and carriage returns. Additionally, in certain places in the code, semicolons can be removed when their removal will not affect the validity of the syntax [10]. Code compression is sometimes called minification. Ultimately, the final result is the reduction of the file size. This, in term, reduces the time required to download the file over the Internet from the server to the client. The reduction of the number of whitespaces in certain conditions help increase the page rendering speed because of the way web browsers parse CSS and JavaScript files before interpreting the code. [11]

This paper aims to give an insight into the quality of web sites created in different regions for different language and culture groups and compare their technical aspects, performance, usability and compliance with search engine optimisation guidelines. We give a comparative analysis of the results for each language group at the end of the paper alongside the results shown for each of the language groups separately. This is done in order to determine if there is a notable difference in quality and usability. The analysis of the comparison will show if there are clear indications where these metrics mostly differ. Also, we will list the most notable causes of the observed technical quality differences.

2. METHODOLOGY

The main purpose of this research is to analyze and compare the difference between evaluated technical qualities of web sites with contents in the Serbian and Arabic languages. The paper tests the technical aspects, code validity, performance, optimisation and usability of rendered web site pages on two screen sizes, one for the Desktop and one for the mobile device types.

The process of acquiring research data was automated using a script written in PHP. This script collects data from a predefined list of Internet domains. The list was compiled using web site ranking platforms and portals such as Alexa and a list of different web site directory indices.

For each of the domains in the list, a number of steps are performed in order to acquire the needed data. The steps in the data acquisition process are:

1. Download the HTML content of the home page;
2. Acquiring the screenshot of the home page in two screen size settings: Desktop and Mobile;
3. Calculating text to HTML ratio;
4. Download all required CSS and JavaScript files;
5. Perform HTML code validation;
6. Analyse CSS and JavaScript for compression;

The first step stores additional information such as the download time, latency etc. which is used in the future for better sorting web sites with similar evaluation results, for additional distinction.

The screen shots are made in typical screen resolutions of 1366x768 [12] and 750x1334 [13].

The text length for the text to HTML ratio is acquired using the JavaScript innerText property of the topmost page element, compared to the HTML code length. Both text values are trimmed before determining their length. However, these two string values are not normalized by removing unnecessary whitespaces before taking their respective lengths. The text to HTML ratio result is kept as a floating point value with all decimal points, without rounding. The tool used for performing the HTML code validation is the W3C offline HTML5 code validator tool. [14] The W3C Markup Validation service is a free service and is available online or as a standalone tool that can be ran on the user`s computer. Our automated analysis script uses the standalone program version.

The CSS and JavaScript analysis step gives additional information asides from determining if the CSS and JavaScript files are compressed or minified. The script stores data such as the total lines of CSS, total length of the CSS file, the number of whitespace characters, the ratio of whitespace characters to the total file length, the number of lines, the number of non-empty lines, the average number of characters per line, the ratio of the average characters per line to the total file length. The same types of measurements are taken from the JavaScript files as well. These measurements are used to determine the quality of the file compression or minification process. In general, files with large average characters per line and the smaller number of lines are considered minified if they have a small number of whitespace character to total file length ratios. These observations are made based on empirical observations and by comparing minified and non-minified source code files for both CSS and JavaScript documents. Code minification or compression can be used to influence the overall score of the web site in regards to the performance. This is due to the fact that compressed files are downloaded faster that non-compressed ones which saves bandwidth and takes less time to complete. Additionally, minified files are parsed more quickly before processing by web browsers.

One other piece of information is acquired about web sites during the first step. When attempting to download the HTML code of the web site at a certain domain, it is possible that the web server would redirect the browser to an SSL encrypted path. This information is used to confirm that the web site primarily uses the SSL encrypted HTTPS protocol for transferring information. This piece of information can be used to additionally differentiate two web sites with similar evaluation scores in the final step of the sorting process.

After all of the domains have been processed, an analysis of the acquired data is automatically performed. During this analysis, additional information is generated for each of the domains, relative to the average, total or other aggregate values generated from the collective data analysis.

Information that is additionally determined for each of the domains include the differences and deviations of CSS and JavaScript metrics as well as the differences and deviations of HTML and text related metrics from the appropriate aggregate value for those metrics, determined during the final analysis of the acquired data.

Key analytical insights for the evaluation process derive from the list of detected HTML code validation errors. Upon the completion of data acquisition for all domains, the list of all errors is collected and grouped and counted by their type. After performing this

reduction for the first time, the result was manually evaluated and a list of common HTML errors was compiled. In order to easily create an automated mechanism for counting these errors in the final report, per domain, regular expressions were made for each of the common errors. The final list of error includes the count of the type of error and not the count of the specific error. We have made regular expressions that group errors by type. The grouping of HTML validation errors is done using the preg_match function in PHP for each of the detected errors. Errors that match any of the regular expressions are counted against the type of that specific error in the report.

3. EXPERIMENTAL RESULTS

After running the automated acquisition and analysis script with our list of domains, we have reviewed the results and created a report. This section presents our research results.

HTML code validation analysis results

Modern web browsers have made progress in parsing and rendering HTML code even when it has many errors and inconsistencies. This fault tolerance does allow most web pages to be rendered even though there might be errors with certain elements. However, not all broken HTML code can be rendered properly. [5]

Invalid code can greatly impact the user experience. This occurs when code segments with error behave in different ways from expected in different web browsers [15]. Because of this, we consider the HTML code validity an important measure. The results of the analysis of all the tested domains are presented herein.

The average number of HTML validation errors of all 200 tested web sites is 23.29. Of all the web sites, 67% have less errors that this average value. Even though 67% of web sites with less than 23.29 errors statistically show that the majority of web sites are well developed in terms of HTML code validity, the real issue is the type of the error and not the error count. In this research, we have not conducted an analysis of the impact of particular types of errors on usability of the rendered website.

This result can be further broken up into web sites in Serbian and web sites in Arabic languages. The average error count of web sites in Serbian is 23.75 and 66% of those web sites have less than the mentioned average error count. The average error count of web sites in Arabic is 22.82 and 67% of those web sites have less than the mentioned average error count. According to this, there is no significant difference between web sites in Serbian and web sites in Arabic.

Text to HTML ratio analysis results

A small text to HTML ratio can indicate that a web site has an unnecessarily large amount of HTML code that is rendered into a page with small amounts of text. This can be an issue because web browsers need more time to process, parse and render a lot of HTML elements that interact and influence each other when styled with different CSS rules. This can impact the page load speed. Page load speeds impact the user experience is a significant ranking factor for search engines, such as Google's Panda update [10]. This impacts text heavy web sites, such as blogs. However, some web sites are oriented towards multimedia such as images and videos. Those web sites might not have a lot of text, but do require a lot of HTML code to render all the required elements that hold the multimedia content. Since there is no clear way to automatically determine the type of the content, this metric is taken into account with reserve. Regardless, the results can be aggregated and presented. The presentation of the results of the analysis of this metric is given herein.

By analysing the acquired results, we have determined that most web sites have a text to HTML ratio which is close to the average value of 5.813%. Also, the average text content length is 7867 characters, while the average HTML content length is 202406 characters. Some web pages optimize their HTML code. Optimization reduces the HTML code length by removing unnecessary whitespaces [16]. Therefore, not all web sites can be directly compared by this metric. This should be taken into account when reviewing the results of the analysis. By analysing these results, we can conclude that 32% of web sites have a text to HTML ratio which is higher than the average value. Higher values of the text to HTML ratio are better. Therefore, we can conclude that, regarding this metric, the majority of web sites are technically worse as they have text to HTML ratios which are lower than the average.

We can break these results into those for web sites in Serbian and web sites in Arabic. The data is show herein.

Serbian websites achieved the following results:

Table 1. Comparison of page text and code analysis results

Average values for:	Arabic sites	Serbian sites
Text length (characters)	7883	7850
HTML length (characters)	198432	206379
Text to HTML ratio	5.76%	5.86%
Average load speed (sec)	1.11	1.33

Along with these comparative results, we have made additional conclusions:

- 31% of the Serbian web sites have higher text to HTML ratio than the overall average.
- 35% of the Arabic web sites have higher text to HTML ratio than the overall average.

According to these results, we can conclude that there is no significant difference between the text to HTML metrics of web sites in Serbian and Arabic.

CSS optimization analysis results

Since web pages are styles using CSS, having CSS files downloaded separately or in a web package alongside the page`s HTML content is unavoidable. To reduce the page load and rendering speeds, it is important to deliver these files as quickly as possible [9]. It is important to parse them, process them and apply the defined styles as quickly as possible. Otherwise, the user experience would be impacted. In order to reduce this impact, CSS should be optimized, regardless of the method of CSS delivery. When web sites observe good practice where CSS files are delivered as one combined CSS file or at least as a few separate files, those files need to be downloaded before they can be processed. It is recommended that those files are optimised to reduce the load time during the first page load, until the files are cached. [17]

There are different methods of CSS code optimisation and compression. As explained earlier in the paper, most are based on removing unnecessary characters such as whitespaces, the last semicolon in the style sheet set etc. This method is the one that our script is considering when determining if the CSS code was optimised. However, there are other methods and steps that can further deduce the syntax while retaining the original intent of the code.

Consider the example of a CSS style definition for a div element given in the code listing below.

```
div {
    margin-top: 5px;
    margin-right: 10px;
    margin-bottom: 5px;
    margin-left: 10px;
}
```

Listing 1. An example of CSS before optimization

The CSS code shown in Listing 1 can be optimized by replacing the separate edge margin properties with a combined margin property as shown in Listing 2.

```
div {
    margin: 5px 10px 5px 10px;
}
```

Listing 2. An example of CSS after optimization

Further, this code can be compressed by removing unnecessary whitespaces and symbols. The final optimized and compressed CSS code which retains the initial intent and function is shown in Listing 3.

```
div{margin:5px 10px 5px 10px}
```

Listing 3. An example of optimized CSS after compression

The combination of CSS optimization and compression is referred to as code minification. The idea is that the original source code footprint can be minified (minimized) to increase the speed of delivery over the network and the time of processing, parsing and applying to the loaded page [18].

For better performance, all the external CSS files should be included in one file and minified. In a study done on the 10 most visited web sites in US, the process of CSS code minification resulted in a 21% file size reduction. [19]

When we observe statistical information from the CSS analysis, we can see that the average number of CSS lines per domain is 561.6. The average number of characters per domain is 112467.6 and the average ratio of whitespaces to total file length is 2.58%, while average ratio of the average number of characters per line to total file length is 9.37%. Only 22.5% of web sites have a higher than average white space to character ratios. This indicates that most web sites probably employ a method of CSS file minification. This is confirmed by the fact that 20.5% web sites have a higher than average character per line to total length ratios.

The following table shows average values for this metric.

Average values for:	Arabic sites	Serbian sites
CSS line count	206	926.53
CSS character count	130030	94926.75
White space count	3046	4937.33
Characters per line	17883	3835.97
White space to character ratio	1.738%	3.445%
Characters per line to total length ratio	10.539%	7.18%

JavaScript optimization analysis results

JavaScript is an interpreted scripting language, usually executed on the client side. An example of an implementation used on the server side is Node.js. We focus on the JavaScript code that we can acquire, from the client side. When the web page is delivered, it usually requests more resources to be obtained in order for it to function properly. Asides from the already mentioned CSS style sheets, the page can request additional JavaScript files. When these JavaScript files are delivered from the server to the client, they are executed on the client side, in the browser.

JavaScript can be used to enhance many functionalities of a web page. Some of them include the possibility of dynamically loading additional content into the page. This allows the original page to be smaller and hence faster to download and render the initial structure, while all additional data is loaded asynchronously and shown at a later time. This increases the load time of the initial web page, but can sometimes lead to an impression that the web page takes longer to be ready for use after it seems to have been loaded.

As with CSS files, it is important to deliver JavaScript files as soon as possible. Therefore, the practice of minification can be applied to JavaScript files as well. The purpose is the same as with CSS files. However, the method is slightly different, but not as much.

One step in JavaScript file minification is the removal of unnecessary white space characters and symbols. Other steps include the minification of local variable names within functions. This is done to decrease the overall size of the file.

Our results show that JavaScript files have an average of 1413 lines and 630592 characters. The average whitespace count is 26218. This means that the average whitespace to total length ratio 3.341%. The average number of characters per line of code is 2876. And 1.57% average characters per line to total length ratio.

Only 24% of web sites have a higher than average white space to character ratios. This indicates that most web sites probably employ a method of JavaScript file minification.

Average values for:	Arabic sites	Serbian sites
JS line count	1050	1764
JS character count	660979	601051
White space count	24080	28289
Characters per line	4277	1476
White space to character ratio	2.5888%	4.079%
Characters per line to total length ratio	2.3796%	0.7738%

Responsive design analysis

Responsive web design is the ability of a web site to adapt its content to different screen sizes. This improves user experience. It is especially important for devices with smaller screen sizes. Responsive web sites allow for better web site discoverability. The responsive web design analysis was the only step that was done manually and not with an automated tool. The acquisition of two screenshots of each web page in two characteristic resolutions was automated. After analysing all web sites, we have found that 80% of web sites are responsive. This means that they do provide a visually adequate representation of their content to users of devices with smaller screen sizes. When we compare web sites in Arabic and web sites in Serbian, the results are almost identical. We have found that 81% of Arabic web sites are responsive and that 80% of Serbian web sites are responsive. In conclusion, Arabic and Serbian web sites do not differ significantly regarding this metric.

Secure communication analysis

Hyper Text Transfer Protocol Secure (HTTPS) provides a method of connecting to a web server in a secure

manner, using encryption. Browsers help users distinguish between secure and insecure web sites by showing the HTTPS protocol in the URL and visually by marking the URL in a different colour. Most commonly, secure web sites have their URLs marked in green. [20] According to Statoperator, 48.71% of Alexa top 1,000,000 web sites use the HTTPS protocol and are secured using valid SSL certificates. [21] ISRG has found that 73.7% of the web sites that have been visited using Firefox are secured and use the HTTPS protocol. [22]

From our results, we can conclude that 74.5% of analysed web sites do use the HTTPS protocol and are secured with a valid SSL certificate. Of all Arabic web sites that we have tested, 78% are secured using SSL certificates. Of all Serbian web sites that we have tested, 71% are secured using SSL certificates. Once again, this shows that there is not a very significant difference between web sites in Arabic and web sites in Serbian.

4. DISCUSSION

By reviewing the experimental results, we can conclude that there is no significant difference regarding the technical quality of Serbian and Arabic web sites. As we have elaborated in the experimental results section, on average, there were 24 HTML code errors in Arabic and 23 HTML code errors in Serbian web sites. Of all 200 tested web sites, 67% had less than the average number of HTML code errors. Since at least a portion of the content is generated manually, and not as a result of program generated structures, we can assume that developers either use validation tools or are reasonably well trained to write clean and good quality source.

As for the page content analysis, we have assumed that web sites are text dominant. Therefore, the text to HTML ratio was considered a factor. The average text to HTML ratio for all tested web sites was 5.813%. Only 33% of web sites had a higher than average text to HTML ratio. As with the previously discussed metric, the difference between Serbian and Arabic web sites concerning the text to HTML ratio is also insignificant. Arabic web sites have had a 5.86% text to HTML ratio, while the result for Serbian web sites was 5.76%. These results show that the tested web sites require a lot of HTML code in order to render a small amount of textual content. Such results can even affect page load speed and web site ranking. [8]

Regarding the CSS minification, Serbian web sites have, on average, four times the number of CSS lines than the average of all tested web sites, but less than the average number of characters in all CSS files per web site. As shown in the experimental results section, the difference between Serbian and Arabic web sites in regard to this metric are not significant. Also, the average number of whitespace characters and the ratio of whitespace characters to the total file lengths indicate that, on average, web sites do employ minification.

The results are similar in regard to JavaScript minification, as both Serbian and Arabic web site groups show signs that they use source code minification techniques.

Compared to the statistics on the use of HTTPS by the top one million web sites on the Internet, which concludes that 48.71% of them use encryption, the top Serbian and Arabic web sites show much better results in this regard, because 74.5% of analysed web sites use SLL to encrypt their traffic.

5. RECOMMENDATIONS

Based on the results of our analysis, we can make certain recommendations that can help increase the technical quality of web sites. Since the validation of the HTML code leads to cross browser consistent behaviour, faster web site rendering, and fewer errors, it is an important aspect in technical evaluation. Therefore, we suggest that all developers should frequently check the output HTML code of their web pages using HTML code validation tools such as the World Wide Web Consortium`s HTML Validator. This tool is free and it is available as both an online service hosted by the W3C and a standalone executable package for major platforms. Developer can integrate this tool into their test environments and have it check generated web pages whenever tests are automatically performed upon committing new changes to the repository.

From our results, it would seem that CSS and JavaScript minification is already a practice employed by developers. Those who do not yet minify their files should consider the benefits of this practice. Also, automation of code minification is a well documented and easy to set up. The automation can be integrated into build scripts that can perform automated CSS and JavaScript minification at the same time while testing HTML code validity, as mentioned in the previous paragraph.

This practice does not only reduce the file size and decrease the file download speed, but also leads to faster web page rendering on the client side. It can have a direct positive impact on the user experience. Therefore,

it is not only a metric that leads to the better technical score, but also the overall usability and quality of the produced web site.

Generally, it is observed that web sites use much more HTML code than is needed to generate a smaller amount of textual content. This practice is bad if we consider web pages as primarily sources of textual content. However, modern web sites also use a lot of multimedia content which cannot be treated as text and therefore a lower text to HTML ratio is expected. Still, it is not recommended. We recommend that developers take the time to better design their web page components in such a way that less HTML code is required to generate the same full visual representation of their target content, be it text, images, animations or videos. Less HTML code impacts the overall web page size, which leads to less bandwidth use, faster web page delivery and faster parsing and rendering. Overall, higher text to HTML ratios with less HTML code in general is a target developer should aim for.

6. CONCLUSION

We can confirm that the technical quality of top web sites in Serbian and Arabic languages is good. The difference in quality of these two groups is insignificant. The majority of web sites have less than the average number of HTML code validation errors. We recommend the use of HTML code validation tools to check for error before publishing web sites. CSS and JavaScript file minification is a practice that the majority of top Serbian and Arabic web sites already employ. Both the HTML code validation and CSS and JavaScript minification are important metrics in the technical evaluation. Another technical metric that we have analysed is the use of encryption. Compared to the top web sites on the Internet, both Serbian and Arabic sites show better results. Asides from technical metrics, we have evaluated one of the most important user experience metrics for modern sites. Responsive web page design is an important factor in determining the quality of a web site. It directly impacts web site accessibility and therefore user experience. We have concluded that the great majority of Serbian and Arabic web sites are responsive. Their share is around 80%. The top one hundred Serbian and the top one hundred Arabic web sites are technically very well made. There is still space for improvement. We have given recommendations regarding steps that would lead to solving the most common issues. Applying recommended steps in the development process would help produce technically better quality sites.

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DEVOPS AND MODERN SOFTWARE DELIVERY

Damir Solajic*,
Anamarija Petrović

Levi9 Technology Services,
Novi Sad, Serbia

Abstract:
Delivering software is often a long, difficult and risky process. Defects and integration issues pop-up at the very last moment and cause dissatisfaction to end users, the development teams and business stakeholders. Furthermore, lack of collaboration between different teams generally results in the implementation of wrong functionality, integration and deployment errors and finger-pointing. The goal of this paper is to summarize the best DevOps practices relevant to software delivery. These practices are a result of a systematic and continuous improvement of the software delivery process and range of behavioral and cultural changes in the way of working and technical improvements in the software delivery process.

Keywords:
DevOps, Lean, Continuous Delivery.

1. INTRODUCTION

In the traditional organization of the software development process, a stream of work flows from an idea from business and marketing departments to product management and design departments who translate this idea into business requirements and specifications. These product requirements are then handed over to software development teams who are converting them into software code. The running code is inspected by a quality assurance, who test it against their interpretation of the original product requirements. The IT Operations team performs preparation of appropriate environments and deployment of the code. At the very end, often too late, work gets tested on security aspects by an Infosec team.

Furthermore, Development and IT Operations have quite opposed goals. Development has a prime objective to introduce new features and therefore bring change into the system, while the goal of IT Operations is to preserve stability and prevent change as a possible cause of instability. All these teams are usually in the separate organizational departments, behaving like silo's, trying to protect their realms. This conflict leads to poor software and service quality and bad customer experience. Such a way of working very much lacks attention to what should be the common goal, which is the fast and continuous delivery of valuable software to customers [1].

Correspondence:
Damir Solajic

e-mail:
d.solajic@levi9.com

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This process has at least five critical handover moments, where the information is being transitioned between different departments and distorted due to different interpretations. From a time perspective, this traditional silo organization causes significantly higher lead times from a business idea to implementation, due to a proportional delay in every silo. If we define Wait Time as the ratio of Busy vs. Idle, then at 50% utilization wait time will be 1 unit of time. At 90% this will be nine units. With earlier mentioned five handover moments total wait time would be 45 units of time [2].

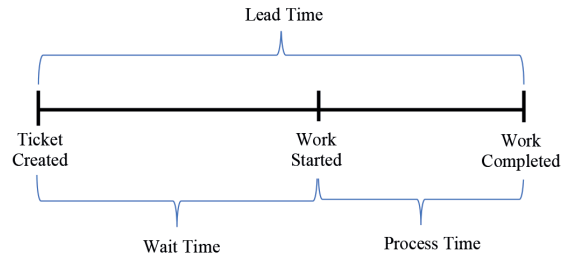


Fig. 1. Definition of Lead Time as a sum of Wait Time and Process Time

"When people are trapped in this downward spiral for years, especially those who are downstream of Development, they often feel stuck in a system that preordains failure and leaves them powerless to change the outcomes. This powerlessness is often followed by burnout, with the associated feelings of fatigue, cynicism, and even hopelessness and despair." [2]

We must change the way of working, and we believe that DevOps practices are showing us the best way forward.

High performing IT organizations that are applying DevOps practices are outperforming their less performing competition by deploying code thirty times more frequent with sixty times higher success rate, having two hundred times faster lead time for implementation of changes and 168 times faster mean time to restore the service [3]. These companies have higher growth rates, but also higher employee satisfaction and lower rates of employee burnout. They manage to consistently provide stable, reliable and secure service to their customers.

DevOps approach enables organizations to create a stable way of working, where small poly-skilled teams can efficiently and independently develop, test and deploy code and add value to customers, quickly, safely, securely, and reliably. DevOps approach allows organizations to maximize productivity, enable organizational learning, create high-trust, high employee satisfaction collaborative culture that helps them win in the competitive market.

The DevOps practices are complementing Lean and Agile Software Development practices and can be classified into three areas [4]:

- Ensuring smooth and fast Flow of work from product design and development to operations and ultimately to the customer
- Enabling fast Feedback from operations to development, to facilitate quick detection, recovery and, in the end, to prevent problems from happening again
- Creating a high-trust culture of Continuous Improvement that allows initiative and experimentation and embeds a culture of organizational learning.

"DevOps defines technology value stream as the process required to convert a business idea into a technology-enabled service that delivers value to the customer" [2], so the primary task of Flow, Feedback and Continuous Improvement is to ensure fast and reliable delivery of useful software to the customer.

2. FLOW

The goal of DevOps practices of Flow is to ensure smooth flow of work from Product Design, through Development into the Operations. Since the software code has value only when it is in the production and used by the customers, the goal is to increase flow and reduce lead time from a business idea to software deployed in the production.

First and foremost, to be able to organize the work, we need to make all work in the value stream visible: product backlog items, software defects, production incidents, service requests, everything. We can organize issues in the form of Kanban or Scrum boards and promote a pull system of work. Furthermore, this approach enables us to perform value stream analysis which gives us a starting point for our improvement actions. One way of making this analysis is a value stream map presented on a figure below.

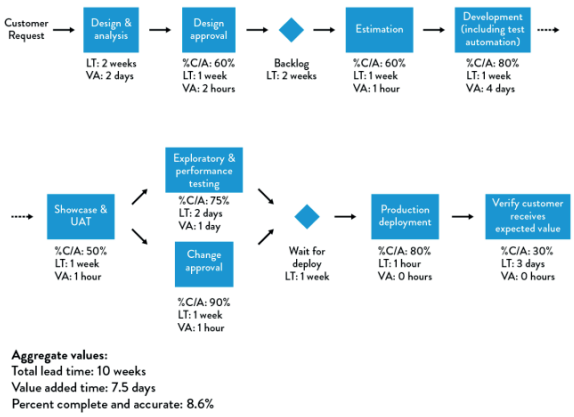


Fig. 2. Value Stream Map [4]

Just like in the manufacturing, based on the Theory of Constraints, to improve the flow of the process, we should subordinate everything to identifying and improving the bottleneck. Improving flow at any work station before the bottleneck would cause a further pile-up of the inventory at the bottleneck (e.g., un-checked-in code) while improving anything behind it, will cause further starvation of the work stations behind (e.g., nothing to test). Such an improvement process is in principle a continuous improvement cycle, similar to the well-known Plan-Do-Check-Act Deming cycle.

The causes that disrupt productive flow in the technology value stream, usually called sources of waste, are: defects, partially done work, waiting, motion, task switching, extra processes that do not add value, extra features, non-standard or manual work and heroics [4]. The goal of a continuous improvement cycle is to make these wastes and hardships visible and to work on eliminating them.

We used the following techniques in our continuous endeavor to reduce waste and improve flow.

Reduce the Number of Handoffs

Initially, we integrated software development and quality assurance teams into one team. Not only personnel were integrated, but also activities. Testing activities are executed from the very start of the delivery iterations with for instance preparation of test cases. Introduction of automated testing not only significantly reduced wait time but also contributed to a way of working where the whole team participates in the testing activities, thus enabling a smoother flow and greater flexibility.

The second step encompassed improving collaboration between Development and IT Operations. Depending on the case, we used two approaches: separate functional teams or integrated feature teams (sometimes named as market-oriented teams). With the functional team approach, IT Operations team is responsible for enabling full self-service possibilities for software development teams, so that software development teams can perform all activities without a need to make a request to IT Operations. These activities especially encompass provisioning of environments and deployment activities which were critical handover moments due to a large amount of waste created (due to wait and defects). For all other activities, each software development team has a designated point of contact in IT Operations team. This contact is responsible for understanding the scope of the work of the development team and ensuring that the self-service platform is serving the needs of the development team.

In the feature teams approach, IT Operations is an integral part of the software development teams, and their activities are planned and executed together with all the other activities. Furthermore, the natural exchange of the knowledge contributed to the fact that developers started performing deployments, while system engineers understood better the functioning of the applications.

At the third step, we focused on improving the collaboration with product management. The goal of this step was to reach a common understanding of each other's work and to improve the quality of requirements and specifications. We applied the techniques of Specification by Example [5]: specifying collaboratively (e.g., user story mapping sessions, refinement sessions), illustrating using examples and living documentation that enabled building the right things and building them right.

Reduce Batch Sizes

The Flow can be increased by reducing intervals of work, minimizing batch sizes, building quality in from the very start and preventing defects flowing to downstream work centers. Batch size proved to have a leading role in increasing flow, consequently reducing lead time and improving quality.

In the software development value stream, batch size equals to the amount of an undelivered code. Large batch sizes, due to integration issues, directly increase lead time and decrease quality. Lower quality means

massive disruptions to downstream work centers being Quality Assurance, IT Operations, and Security. On the other side, reducing batch sizes leads to shorter lead times, enables faster error detection, while the defects are still small, which, by default, implies shorter recovery times. Modern software delivery practices prefer optimizing Mean Time to Restore (MTTR) more than Mean Time Between Failures (MTBF), which in principle means being able to recover fast from failures that will inevitably happen, compared to of minimizing the number of defects. Reducing batch sizes is achieved by shortening delivery iterations and by integrating code frequently.

Limit Work in Progress

Work in progress is one of the most significant sources of waste in the software development process. Unfinished tasks are an inventory that is never used but creates costs. Without being managed, work in progress is piling up, causes multitasking and task switching which consequently severely degrades a flow. Work in progress needs to be limited to ensure it is getting finished. Limiting work in progress makes it also easier to identify problems which are preventing work completion. If, for example, limiting work in progress causes that we do not have any work, although it might be tempting to take a new task, it would be smarter to see what is causing a delay in upstream work center and fix that problem.

Continuously Identify and Improve Constraints and Eliminate Waste

As stated above, a focus should always be on one and only one constraint. We need to identify that constraint and work on improving it continually. Improving on anything besides that constraint is a pure waste at that moment in time. Usual sources of constraints in the software development process are unclear requirements, disruption in environment provisioning, deployments, test execution, and non-evolving architecture. Furthermore, we should continuously work on removing waste from our process, firstly minimizing rework by preventing the flow of defects to downstream work centers.

In all cases above, it proved, that although organization structure is important, the culture is fundamental. The culture is a way how people act and react, especially in times of need. Ownership of the product and improvement mindset are critical success factors for any team. The teams that took ownership, homogenized, continuously improved, team members helped each other, acted regardless of individual competencies or preferences and at the end successfully delivered high quality.

Continuous Delivery

Technical practices of Flow implemented through Continuous Delivery pipeline [6] enable integrated and automated flow of work from the keyboards of the developers to the production environment. These practices establish a repeatable and reliable process for software development teams to continually check-in code changes in the version control system, perform automated tests against it and deploy it to production.

We can divide these practices into five areas:

- Version Control practices
- Continuous Integration
- Test Automation
- Infrastructure Automation
- Automated Deployment

All source code (application, tests, configuration, data, infrastructure) changes are checked-in to a single Version Control System. All code changes are performed either on the master branch (so-called trunk-based development) or short-lived feature branches. Binaries are kept in the artifact repository, but also can be recreated from the source code. Practices like feature toggles enable integrating the code without affecting other functionalities.

Each check-in (potentially) triggers a Continuous Integration build. Each integration is verified by an automated build and by unit and integration tests execution to detect component and integration errors as quickly as possible. This approach leads to a reduced number of integration problems and allows the teams to develop software more rapidly. In the case of a broken build, all ongoing activities stop until the problem is solved and the build becomes releasable again.

Test Automation as a practice enables automated execution of tests by comparing actual and expected results. Test Automation encompasses unit, integration, functional, performance and security tests and reduces the need for manual testing to a minimum. It requires right skillset from both testers as well as developers and their continuous teamwork, but also requires quality embedded in the architecture of the software itself.

Infrastructure Automation enables automated on-demand provisioning and configuration of hosting environments. With modern "Infrastructure as a Code" tools like Puppet or Chef and public or private cloud and container possibilities, this enables us to quickly spin-up any environment from the code, run our tests and deallocate the environment when automated tests finish. Even more, we can run as many testing environments as we need and ease resource dependencies. Software development teams can provision production like environment very early and continuously ensure that application is running reliably. With this approach, we guarantee that all environment changes are executed from the code, therefore disabling possibility for manual errors. Faulty machines or environments can quickly be decommissioned, and put new ones in their place since it is easier to rebuild than to repair.

Finally, Automated Deployment covers the so-called "last mile" of the deployment pipeline. This part of the process can be fully or semi-automated. Full automation of the deployments is usually used in the case of testing environments, while in the case of production environment we potentially want to keep the additional level of control which includes the manual step of exploratory or smoke testing before an automated deployment. Deployment process needs to be an automated self-service so that any team member can deploy an application to any environment, reliably and without fear of making a mistake. It is crucial that we decouple deployments (installation of a specific version of the software to a particular environment) from releases (exposing new functionality to customers). Executing deployments should be easy, stress-free, repeatable activity. Releasing new features requires a careful selection of the right strategy to make it such. Two groups of release patterns exist, environment-based and application-based. Environment-based release pattern requires that different versions of an application exist in different environments. The actual release is then executed merely by making the desired environment available to all or only a group of users (so-called blue-green releases and canary releases). With application-based release patterns, the new release is codified (with feature toggles) in the application and configuration code and made available with the right code changes (so-called dark launching).

Tooling is not a solution for Continuous Delivery by itself. It is just a mean that should help to create an integrated and automated solution, that in combination with the right culture of taking ownership creates a fast and smooth flow of work from the business idea to the successful product used by end customers. Most importantly, to make Continuous Delivery a success, Development, Test and IT Operations teams need to work together as one delivery team from the very start.

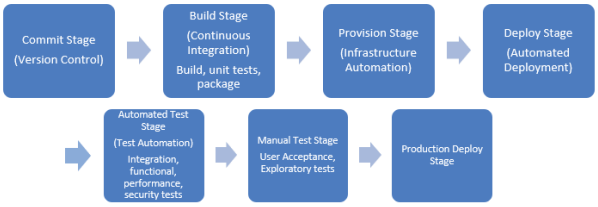


Fig. 3. Example Continuous Delivery Pipeline

Based on our experience, software and system architecture choices very much determine our ability to set continuous delivery in practice. Systems should be architected for testability, deployability, and monitorability and architecture itself should be able to evolve based on the needs of the system. Modular, loosely-coupled, well-encapsulated architectures, with well-defined interfaces exposed through APIs, have low architectural entropy and enable a much higher degree of adaptability and agility in general. Legacy, monolithic systems require much more effort to reach a satisfactory level of automation, but the patterns like strangler application pattern or branching by abstraction enable incrementally evolving a whole system, step-by-step leading to an entirely new one. These patterns allow the evolutionary design of the application architecture while allowing everybody to work on the same source code.

3. FEEDBACK

The goal of DevOps practices of Feedback is to enable fast and constant feedback loops, with the aim to create a more reliable, secure and resilient system. Our continuous care should be to detect problems while they are still small and easy to fix, to find them before they are visible to our customers and to prevent major system outage. In the end, we need to learn from problems and embed these learnings to future work.

We can do this only by creating, amplifying and shortening feedback loops so that we see the problems as they occur. Failures are inevitable in any complex system, so we must design a safe system of work, where work is done without fear, with confidence that errors will be detected quickly, long before serious consequences.

Identifying problems as they occur enables us to validate or invalidate possible causes quickly and to be faster and therefore cheaper in finding and fixing the issues.

Solving Problems as They Occur

In the case when the issues occur, whether these are production issues or broken build during continuous integration, we should team-up to solve the problem quickly. Like in manufacturing, with Andon cord of Toyota Production System, the production line should be stopped until the problem is solved. Upon solution, we should share learnings throughout the organization to further improve the processes. This approach, compared to fixing when we have time, prevents the problem, as a source of waste, going to a downstream work center, where the cost and effort to repair it would be significantly higher. Moreover, it prevents the accumulation of technical debt.

Stopping all other work and especially preventing the start of new work before the problem is solved, ensures that new errors are not introduced into the system until current ones are resolved. The work center could potentially have the same problem in the next operation if we do not address it right away. The issues are often a result of specific circumstances in the complex systems, and, if not treated immediately, it is likely to be impossible to reconstruct particular events that were leading to them and therefore much more difficult to investigate the cause and find the solution. Good version control commenting practices and change logs prove to be an efficient instrument for tracing the source of problems.

Team Ownership

We reinforce the feedback loop if Development teams participate in the support activities together with IT Operations and others. Support activities also include standby support during out-of-office hours. The risk of being woken up in the middle of the night makes everybody being much more diligent. In such cases, not only developers better understand the hardships of downstream work centers, but also more quality gets built-in. At many high-performing organizations with a functional way of working, development teams are responsible for running their services in the production until the services are stable enough to be transitioned to IT Operations. With this approach we push quality closer to the source, encourage teams to automate their processes and above all, to take ownership and responsibility for the product and services they are providing. The team should additionally use techniques of contextual inquiry, where they sit together with the end users to understand how they use the product and what are possible improvements from the usability perspective.

Peer-reviews and Change Coordination

Peer review process proved to be a useful practice of feedback that results with an increase of quality of the code and enables knowledge sharing. Modern version control repositories enable peer-review through pull request process where each check-in gets reviewed by a predefined number of designated experts. This process requires discipline to keep review batch sizes small so that review is easier to plan and perform. It also enables moving away from inspections and approvals which are typical for low-trust environments with command-and-control cultures. High performing organizations rely more on peer reviews than on external approval of changes [3].

In multi-team environments, it is imperative to ensure change coordination and scheduling of changes. When the deployment batch size is more significant, change success rates go down, while a number of incidents and recovery time grow. Therefore, especially in a multi-team environment, it is essential to keep different teams working on the same tact, having them synchronized and managing the dependencies between them well. A possible approach is to have every team represented in the separate integration team that takes care of coordination, integration, and synchronization of work.

Create Centralized Telemetry

Technical practices of Feedback require creating means of centralized monitoring for gathering telemetry. We establish centralized monitoring with monitoring server(s), which collect different data (events, logs, and metrics) using agents running on the monitored objects (virtual machines, containers, physical equipment) or by entering data from different sources through an API. Modern automation techniques enable that each machine or application can take care of parameters they want to be monitored on and make sure that either they are automatically registered or dynamically discovered by the monitoring server.

The gathered data we call telemetry and classify it to:

- Business telemetry (e.g., number of sales transactions, number of new users, number of logins)
- Application telemetry (application health/faults, transaction times, applications logs, external systems)
- Client telemetry (application errors and crashes on the client side)
- Environment telemetry (operating system, networking, database, storage, web traffic, CPU, memory)
- Deployment Pipeline telemetry (deployment frequency, deployment status, static code analysis metrics, code coverage metrics)

Telemetry helps us to pinpoint and solve the problems faster, whether it is a defect in the application code, in the environment, data or external. It enables a disciplined approach to problem-solving, where we can react based on the facts and not on the notion (e.g., restarting a server whenever we have a problem, without finding the underlying cause). Solving problems should also encompass adding new telemetry, that will enable easier discovery and prevention of such issues in the future. This process should be repeated for ever-weaker failure signals (incidents and near misses) with the aim to achieve pro-active problem prevention.

The telemetry should be accessible and shared with the entire value stream. Retrieving telemetry information from the telemetry system should be self-service, through dashboards and APIs and not by opening tickets for IT Operations. Adding business and application telemetry should be easy through code instrumentation and APIs. Furthermore, telemetry information should be put out on display in highly visible locations, through so-called information radiators. Having telemetry accessible and visible enables us to quickly notice the problem, structurally solve it based on the facts and not only have a significantly better time to recover, but also strengthen the relationship between Development and Operations by creating empathy and trust between upstream and downstream work centers.

Continuously Analyze and Improve Telemetry

Different graphical visualization tools can visually represent telemetry data. These tools, as well as different statistical analysis tools, can help us to analyze and use telemetry data for various purposes which range from trend analysis and predictions (e.g., the prediction for auto-scaling), outlier and anomaly detection, to smart, pro-active alerting and escalation. Furthermore, these tools enable us to cross-reference different metrics to find correlations between business outcomes or application defects and application, environment or deployment telemetry. Usage of simple statistical methods for data with normal distribution can prove to be quite useful for pro-active alerting and automated actions in the case of outlier detection (detection of nodes that are different from others). More complex algorithms might be needed to analyze the data with non-normal distribution to achieve good anomaly detection or predictive analysis.

Experimenting

When we have our continuous delivery and telemetry system with relevant data in place, we become much more agile. Agility enables us to perform user research by experimenting in production and quickly validate or invalidate our business ideas. Without user research, there is a high chance (research [4] shows 2 out of 3) that our features deliver no value to our organization, while they make our codebase more complex, difficult to maintain and change. Furthermore, "the effort to build these features is made at the expense of delivering features that would deliver value" [4].

A/B testing or hypothesis-driven development techniques enable us to implement business ideas in minimalistic form, quickly try them in production, compare the outcomes with expectations and make informed decisions. We can do this without risk, in some cases even in a fully automated fashion, since the telemetry system and automated release techniques safeguard us from negative outcomes. A/B or split testing is a well-known marketing technique that enables validation of an idea by comparing control and treatment specimen. When we release a new feature (treatment) to a targeted group of users (canary releasing), we can compare the telemetry data with control specimen and decide on the validity of our business idea before further investment in its development. If the idea proves to be invalid, we can switch it off with feature flags. If the implementation is faulty, we can decide to fix forward or to rollback.

4. CONTINUOUS LEARNING AND IMPROVEMENT

Finally, DevOps practice of Continuous Learning and Improvement creates the culture of continuous learning and experimentation, constant creation of individual knowledge which is turned into organizational knowledge with the primary goal to improve our service. Only high-trust culture, without room for fear and punishment in the cases of errors and mistakes, can be a constructive ground for continuous improvement. This culture leads to the creation of safe systems of work, that result in high-quality software products with embedded resilience and safety.

Enable Organizational Learning

Safe systems of work mean that when incidents occur, we look for long-term structural solutions that prevent such incidents from happening again. We do this through a disciplined, systematic approach by avoiding any blaming of the ones potentially responsible for the problem. We should also avoid creating more processes and procedures that would "prevent" such problems from happening. Blaming and bureaucracy do not prevent nor solve the problems, but they do cause fear, which results in issues usually remaining hidden until real disasters happen. We must avoid it and instead we should define failure as an opportunity for learning and improvement.

After the solution of the incident, we conduct blameless post-mortem sessions, where we discuss what led to the incident and what measures, technical and behavioral, we can take to prevent it from happening again. We use this approach for serious to less serious issues, eventually getting to near-misses and being able to prevent problems before they occur. We record these sessions into our knowledge database, promote this knowledge into the organization and embed it as broader organizational learning. Knowledge database should be easily searchable and accessible for everyone. Furthermore, team channels or chat rooms proved to be useful platforms for sharing knowledge for resolution of incidents and broader knowledge exchange, so logs from those sessions should also be accessible. All these local discoveries should be converted into global knowledge and global improvements.

In the end, "code is the ultimate truth" so we should keep knowledge in the version control repositories accessible, not only the software code, tests, and configuration but also living documentation [5], in the form of codified specifications expressed in Gherkin test cases and automated tests.

Institutionalize the Improvement of Daily Work

"In the absence of improvements, processes do not stay the same – due to chaos and entropy processes degrade over time." [2]

When we avoid fixing the problems structurally, continuously patching them with workarounds, our problems and technical debt accumulate. Eventually, technical debt makes any new work quite expensive or, even worse, prevent the organization from completing any further work. Reserving time to deal with technical debt, adding new automated tests to detect boundary conditions, adding new production telemetry, identifying categories of changes that require peer-review, organizing Kaizen Blitzes or Hackathons and conducting exercises with Game-Days proved to be useful instruments to continuously improve the application and level of our service.

Based on our experience some 5 – 20% of the software development team time should continuously be used to pay the technical debt. This time should be wisely used to introduce improvements and innovation. We should always use a chance for "opportunistic refactoring" and "always leave the code a little bit better than we found it" [7]. While Kaizen Blitz exercises enable teams to self-organize and work for a predefined amount of time on fixing any problem they find essential, Game-Day testing allows them to improve resilience, reliability, and stability of their applications by introducing instability and failure into the system. On the other side, Hackathons enable teams to work on their innovative ideas.

In the end, whatever we do, we should value the improvement of our daily work more than a daily work itself. It is a responsibility of leaders to create conditions in which their teams can thrive. They should promote the value of continuous learning, disciplined problem-solving, calculated risk-taking, continuous questioning and experimentation over just being careful.

5. CONCLUSION

Based on our extensive experience, we are fully convinced that the DevOps approach to software delivery is

a modern and comprehensive approach that results in high-quality software products and customer satisfaction. These practices require a change in the technology aspect of the value stream, through modernization, automation, and innovation. Even more importantly, it needs a change in the cultural and behavioral approach to software development as a practice, through taking ownership of the work, responsibility for our products and services, optimizing work streams and teaming-up during problems. When applied together, these practices lead to the state-of-the-art software development process, quality products, happy employees and satisfied customers.

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INCREASING UNIT TEST RESILIENCE BY DECREASING POINTCUT FRAGILITY

Michal Hucko,
Valentino Vranić*

Institute of Informatics, Information Systems and Software Engineering,
Faculty of Informatics and Information Technologies,
Slovak University of Technology in Bratislava, Bratislava, Slovakia

Abstract:
By operating at a very detailed level, unit tests are very susceptible to changes in production code. Writing unit tests in aspect-oriented programming can help with their maintainability. However, the existing approaches do not take into account so-called pointcut fragility: a failure to address the intended join points due to small changes in the base code. An approach to increasing unit test resilience to changes in production code by decreasing pointcut fragility is proposed in this paper. The approach is implemented in AspectJ with JUnit used as a test oracle. The approach has been evaluated on several scenarios encompassing typical code modification that render unusable the tests written in a simple object-oriented way. The approach proposed in this paper managed to make the test resilient to the most of the changes introduced by these scenarios.

Keywords:
software testing, aspect-oriented programming, pointcut fragility, AspectJ, Java.

1. INTRODUCTION

Writing production code requires writing huge amounts of testing code. In particular, this is true for so-called unit tests: the tests that address the smallest testable parts. Test driven development practically requires to cover the whole production code with unit tests.

By operating at a very detailed level, unit tests are very susceptible to changes in production code. Even minor changes in production code often make unit tests obsolete or even pointless.

Writing unit tests in aspect-oriented programming can help with their maintainability. Aspect-oriented programming paradigm with its separation of crosscutting concerns suits well this purpose. The idea is that the aspects can be used to throw runtime exceptions which can be handled by the test oracles such as JUnit [1]–[3]. With aspect-oriented programming, the tests are maintained completely outside of the production code, being attached to it at the points they need to introspect, known as *join points*. These are specified declaratively as sets of well-defined points in program execution by constructs called *pointcuts*. However, the existing approaches do not take into account so-called *pointcut fragility*: a failure to address the intended join points due to small changes in the base code.

Correspondence:
Valentino Vranić

e-mail:
vranic@stuba.sk

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In this paper, we will look at the possibilities of increasing unit test resilience to changes in production code by decreasing pointcut fragility. For this, we will use the AspectJ programming language, a widely known embodiment of aspect-oriented programming based on Java. The rest of the paper is structured as follows. Section 2 explains pointcut fragility. Section 3 proposes an approach to increasing unit test resilience to changes in production code by decreasing pointcut fragility. Section 4 presents the implementation, and Section 5 resents the evaluation of the approach. Section 6 discusses related work. Section 7 concludes the paper.

2. POINTCUT FRAGILITY AND TESTING

Consider this simple aspect written in AspectJ:

```
public aspect SampleAspect {
   around(Message msg):
   call(init Counter.countLetters(..)) && args(msg) {
      // Process message
   }
}
```

Even small changes to the code this aspect affects, such as changing the return value type of the `countLetters()` method, can make its pointcut fail to address the corresponding join points. This pointcut breaks on a small change: it's fragile.

Koppen and Störzer identified the following situations that cause fragile pointcuts in AspectJ to break [4]:

1. Renaming classes, fields, and methods
2. Moving a method or class, which invalidates the pointcuts based often used lexical primitive pointcuts `within()` and `withincode()`
3. Adding or removing classes, fields, and methods, which results either in making pointcuts fail to cover new elements or in making them target what does not exist any more

Writing tests capable of dealing with dynamically evolving systems is a challenge [5].

3. APPROACH

Here, the actual approach to increasing unit test resilience to changes in production code by decreasing pointcut fragility is proposed. The approach assumes the unit tests are written in AspectJ, while the production code is written in Java.

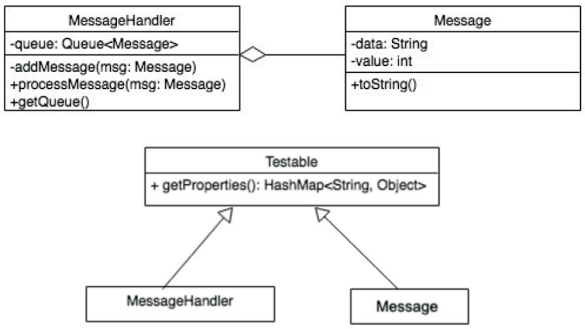


Fig. 1. The classes being tested inherit from Testable

First of all, if we are able to identify all the classes and methods that need to be tested and if we can provide them with good and stable structure and names as we design them, we can overcome future problems with fragile pointcuts. Of course, we can hardly predict all the changes to come.

In most cases, we are simply faced with the code to be tested without the possibility to redesign it to ease the testing. Even under such circumstances, we can identify the classes to be tested. We need a mechanism to put all these classes under a common handle. One way of doing this is to make the tested classes inherit from a special common class. This is exactly what is being used in the approach proposed in this paper. This common supertype for all classes to be tested is named Testable. The easiest way to ensure inheritance without having to modify the production code is to use the declare parents AspectJ inter-type declaration. Thanks to inheritance, the testing aspect can refer to all these classes regardless of their names and how they change over time. For Testable, an interface could have been used instead of a class, which would spare the only possible extends relationship at the classes to be tested. Pointcuts are established around the Testable class as a common supertype with a reasonable use of wildcards in signatures within the pointcuts. Java reflection is used to access necessary objects within advice bodies. All this accommodates future changes in method signatures.

The actual tests are implemented as aspects. As with all tests, the tests implemented as aspects signal undesired situations. The signaling is implemented so that the aspect that implements a test raises a dedicated exception denoted as `TestingException`. This exception is derived from the original Java Exception class and it points to the place where its instance occurred.

The test oracle is running the code which is being tested. After the target pointcut has been reached, the testing aspect-oriented code is executed. If this code does not raise a `TestingException`, the test has passed.

4. IMPLEMENTATION

Consider the situation depicted in the upper part of Figure 1. The `MessageHandler` class represents a message handling unit which handles incoming messages through its `processMessage()` method.

As is depicted in the lower part of Figure 1, both of these classes should inherit from the Testable class, which implements the class reflection through the `getProperties()` method. This method returns a `HashMap` of properties for a given instance.

As a test oracle, the implementation presented here uses the JUnit framework. Each test calls some method of one of the classes being tested and catches a `TestingException`. If the exception occurs, the test is considered to have failed.

Consider these two unit tests:

1. Before adding a `Messageobject` to the `MessageHandler` queue, the actual queue object must be initialized
2. The messages with a specific value assigned are not to be added to the queue within the `processMessage()` method call

Their implementation could look like this:

```
public aspect MessageHandlerTestingAspect {

   protected boolean init = false;

   declare parents: MessageHandler || Message
         extends Testable;

   pointcut initReached(Testable mh): target(mh)
     && call(* *Handler.*init*(..));

pointcut addReachedHandler(Testable mh):
  target(mh) && call(* *Handler.*add*(..));

pointcut addReachedMessage(Testable msg):
   call(* *Handler.*add*(..)) && args(msg);

after(Testable mh): initReached(mh) {
   init = true;
}

   before(Testable mh) throws TestingException:
      addReachedHandler(mh) {
      if (!init) {
         TestingException ex =
            new TestingException("Not Initialized");

            ex.setSource("Queue was not initialized.");

            throw ex;
      }
   }

   void around(Testable msg) throws TestingException:
      addReachedMessage(msg) {
      Object value = null;

      try {
         value = msg.getProperties().get("value");
      } catch (IllegalArgumentException |
         IllegalAccessException e) {
      }

      if ((int) value != 2) {
         proceed(msg);
      } else {
         TestingException ex =
            new TestingException("Not Initialized");

      ex.setSource(
         "Trying to add a forbidden message.");

      throw ex;
      }
   }
}
```

The first test is implemented by the `initReached()` and `addReachedHandler()` pointcuts and first two pieces of advice (of the after and before type). The second test is implemented by the `addReachedMessage()` pointcut and the remaining piece of around advice. The declare parents statement is used to introduce the inheritance.

5. EVALUATION

The increased unit test resilience to changes has been evaluated on several scenarios applied to the situation presented in the previous section:

1. Changing the `MessageHandler` class name. In this scenario we changed the `MessageHandler` class name to `Handler` and to `SomeThing`. The testing aspects were able to handle the names derived from `Handler`. In case of `SomeThing`, they failed.
2. Changing the name of the `Message` class. In this scenario we changed the name of `Event`. Because our aspects are using wildcards, all the modifications to parameter names were fine.
3. Adding an extra argument to the `processMessage()` method. We added an integer argument named `j` to the method call. The testing aspects handled this situation.
4. Renaming an argument in the `processMessage()`. We renamed the `msg` argument to `msg2`. The testing aspects handled this situation, too.
5. Renaming the `init()` method. We renamed the `init()` method to `initQueue()` and `prepareQueue()`. The same problem occurred as in the first scenario. Since we rely on the method name to contain the `init` string, we are unable to handle situations where this string is not present.

Each of these scenarios would make the tests written in a simple object-oriented way obsolete or broken. Here, it has been demonstrated that just by adding wildcards to pointcut definitions and making all tested classes inherit from the Testable class using the corresponding AspectJ inter-type declaration, the testing aspects can be made more resilient to code refactoring changes.

6. RELATED WORK

Xu and Yang proposed a method for unit testing using aspects [2]. They identified that the separation of crosscutting concerns suites well to unit testing. They used so-called application specific aspects for testing functionality of a program. They also used testing aspects to raise runtime exceptions. They implemented the tests in the Aspect-Oriented Test Description Language (AOTDL). AOTDL code can be translated by JAOUT/translator to AspectJ code. In the end, they used JAOUT/translator for automatic generation of JUnit test classes. These play a role of test oracles that handle test exceptions from the testing aspects.

Xu and Yang also presented JAOUT as a tool for automatic generation of unit tests using testing aspects [3]. Combining both of their approaches, their tool was able to test the code with given testing aspects written in AOTDL.

Sakurai and Masuhara proposed test based pointcuts [1]. They used unit tests to specify join points at which the actual aspects are being weaved. The whole process consists of two main steps. First, unit tests (implemented using JUnit) are executed and the sequences of the join points they address are being recorded. Afterwards, when one of the recorded sequence matches, the corresponding aspect is weaved. This approach mitigates the effect of pointcut fragility. Sakurai and Masuhara used a special notation like:

```
test(get(* Fixtures.invalidUser));
```

for specification of pointcuts. They used the AspectBench Compiler to develop their prototype.

Using aspect-oriented programming for testing is widely present in the JBoss server. The principle is the same as with the previous approaches. The aspects used for testing the functionality are throwing exceptions in case of failure and the test oracles are catching them. According to the documentation,[1] aspects are defined in separate XML files and they can be added or replaced at runtime. Mock objects are used for actual testing, and the JUnit framework is used as a test oracle.

Hughes et al. [6] reported using aspect-oriented programming to test a distributed system called the AGnuS. In their work, they identified several key problems in dealing with software testing. One of them is the reuse of testing code in other applications, which is very close to the objective of the approach proposed in this paper. For this, Hughes et al. enriched AspectJ syntax with special tags which use Java reflection API. The approach proposed in this paper does not require any changes to the underlying programming languages, i.e., Java and AspectJ.

7. CONCLUSION AND FURTHER WORK

An approach to increasing unit test resilience to changes in production code by decreasing pointcut fragility has been proposed in this paper. Pointcut fragility is decreased by imposing a common supertype on tested classes and, consequently, by establishing pointcuts around this common supertype with a reasonable use of wildcards in signatures within the pointcuts accompanied by using reflection to access necessary objects within advice bodies to accommodate future changes in method signatures. The approach is implemented in AspectJ with JUnit used as a test oracle.

The approach has been evaluated on several scenarios encompassing typical code modification that render unusable the tests written in a common object-oriented way. The approach proposed in this paper managed to make the test resilient to the most of the changes that have been made to the production code.

The approach could be extended to employ a synonym dictionary to generate additional (predicted) possibilities and build them into pointcut declarations. JAOUT tool [3] could be used to automate this process. However, this needs to be balanced, as extensive pointcuts may obscure the intent. Furthermore, automatically recorded tester actions over the system being tested [7] could be used to interactively generate pointcuts.

3D visualization of software models [8]–[10], along with virtual reality [11], [12] could be used to model and generate more robust pointcuts. More robust pointcuts would be of help in aspect-oriented refactoring [13], in capturing events in complex event processing [14], [15], and in defining language semantics through aspects [16].

1 http://docs.jboss.org/aop/1.3/aspect-framework/userguide/en/html/

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LEGAL DOCUMENT MANAGEMENT: AN INTEGRATED APPROACH

Stevan Gostojić*,
Marko Marković

Faculty of Technical Sciences,
University of Novi Sad,
Novi Sad, Serbia

Abstract:
In this paper, we introduce the main legal document management concepts. Furthermore, we review legal document types and formats, legal document life-cycle phases, and legal document management systems components implementing those phases. Several successful cases studies of legal document management are identified. Based on the review and the case studies, we identify several issues in legal document management and give recommendations on how to overcome those issues. The recommendations come down to using standardized document and metadata formats, publishing documents and metadata using open data recommendations if possible and using standards-abiding software.

Keywords:
legal document management, legal document formats, legal document life-cycle, semantic documents, open access.

1. INTRODUCTION

According to [1], the most widely used document management standard, a document is information that is identified, structured, processed, controlled and interchanged as a unit. Therefore, a legal document can be defined as a document containing legal information (i.e. legal norms and legal facts). For more information about legal documents management, see [2].

In most contemporary legal systems, the government is divided into three branches: the legislative (i.e. the parliaments), the executive (i.e. the public administration) and the judicial (i.e. the courts of law). Therefore, legal documents can be broadly divided into legislative, executive and judicial documents (although other types such as contracts do exist) although other types of legal documents such as contracts also exist. In this paper, we focused on legislative documents as the most complex legal document type.

A document management system (DMS) is an information system that manages documents through their life-cycle by supporting document structural types, metadata assignment, version control, business process definition, execution and monitoring, document indexing, retrieval and browsing, user collaborations, security management and

Correspondence:
Stevan Gostojić

e-mail:
gostojic@uns.ac.rs

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integration with other information systems. Documents are inputs and outputs of business processes consisting of a sequence of activities according to particular procedural rules.

In recent years, several legal document management systems, information systems that are specialized to manage legal document life-cycle, have been developed and came into operational use. Those systems are used by the government, legal offices and legal departments in large companies.

We review the application of ICT to legal document management in local self-governance, territorial autonomy and state bodies offering G2C (government to citizens), G2B (government to businesses) and G2G (government to government) services. The digitization of business process implementing those services can increase the effectiveness and the efficiency of business processes and saves time and money to citizens, business, and public officials participating in them.

The rest of this paper is structured as follows. In the next section, we review legal document formats (the static aspect of legal documents). Legal document life-cycle (the dynamic aspect of legal documents) is introduced in the third section. The fourth section explicates several successful case studies of legal document management. The paper is summarized and recommendations are given in the concluding section.

2. DOCUMENT FORMATS

There are numerous formats developed for representing legal documents. In [3] generations of legal document formats are recognized as a categorization based on characteristics of these formats.

The first generation consists of XML standards that are focused on text and structure of legal documents. This approach is similar to data presentation using database entities and typographic elements.

The second generation standards introduce a document model and descriptions of text, structure, and metadata. However, these layers of a legal document are loosely interconnected.

Document standards from the third generation are based on patterns and clearly differentiate layers of text, structure, metadata, and ontology.

Besides patterns, the fourth generation applies additional constraints using grammars (e.g. RELAX NG, Schematron, DSD) to ensure prescriptiveness in document model.

Legal semantic web [4] brings the idea of the semantic web application to the legal domain. This perspective distinguished several layers of legal semantic web technologies. The first layer enables the identification of legal resources. The second layer structures legal documents using XML. The third layer allows for creating assertions about legal documents. The fourth layer introduces legal ontologies connected with general ontologies. The fifth layer gives a formal representation of legal norms.

Legal Document Identifiers

For identification of legal resources, there are several formats available.

CELEX numbers [5] are initially introduced by CELEX database for identification of legal documents in European Communities. CELEX number consists of four parts representing the sector, year of publication, document type, document number [6]. CELEX numbers lack support to embed elements of a national identification system.

European Legislation Identifier (ELI) [7] provides a mechanism for the identification of legislative documents. It is based on Uniform Resource Identifier (URI) and besides identification purposes, ELI offers a set of metadata and an ontology to facilitate information interchange between member states.

European Case-Law Identifier [8] provides a standard for identification of court decisions of EU member states. ECLI consists of five elements: ECLI keyword, country code, national court code, the year of decision and decision unique number. ECLI format is able to embed national coding of court decisions. In addition, ECLI provides a minimum set of metadata for decisions to facilitate searchability of case law.

URN:LEX [9] is proposed as a convention for identifying, naming, assigning, and managing persistent resources in the legal domain. It is applicable to different types of legal documents including legislation, case law, regulations, bills, etc. Extensibility of URN:LEX enables support for encapsulation of a national identification system.

Legal Document Metadata

Metadata has an important role in the description of legal documents. Several standards listed below provide metadata sets and legal ontologies.

LKIF Core Ontology [10] is built for describing basic legal concepts. It consists of three layers: top level, intentional level, and legal level. The top-level defines mental, physical and abstract concepts, and occurrences. The intentional level defines concept and relations for describing the behavior of rational agents. The legal layer contains concept definitions for expressing normative statements. For applicability in a particular legal domain, besides LKIF Core ontology as a core ontology, a domain ontology is required.

Judicial Ontology Library (JudO) [11] is an ontology enabling the representation of knowledge for reasoning and argumentation in judgments. JudO consists of two modules: a core ontology and a domain ontology. Judo core ontology describes general legal concepts derived from LKIF-Core ontology. Judo domain ontology represents concepts and rules from the Italian Civil Code and Consumer Code and from related judgments. JudO ontology is a helpful resource for judgment annotation but has its limitations when modeling exceptions to some legal rule.

CEN Metalex provides a vocabulary of metadata for describing legal resources using RDF statements. Concepts are defined using OWL schema [12]. It distinguishes three basic classes: BibliographicThing, Event, and EventParticipant. CEN Metalex XML Schema allows integration of RDF statements and thereby secures that retrieved legal resources and corresponding metadata are up-to-date.

FOLaw is an ontology specifying functional dependencies between knowledge [13]. FOLaw recognizes six types of knowledge naming normative knowledge (typical legal knowledge), world knowledge (legal view on a real-world domain), responsibility knowledge (connection between norms and violation consequences), reactive knowledge (sanctions for a violating behavior), creative knowledge (creation of fictive legal entities), and meta-legal knowledge (resolves inconsistencies between legal rules).

LRI-Core ontology [14] connects common sense concepts with legal concepts. It consists of two layers: foundational ontology and legal core ontology. Foundational or upper ontology focuses on five categories of concepts: physical, mental, abstract, roles and occurrences. Core layer provides support for the development of legal domain ontologies.

To enable interoperability of legal information system in member states ELI standard gives a set of legislative metadata. The metadata set is divided into groups of metadata relevant for work level, expression level, and manifestation level. Some of the work level metadata are an identifier, type of legislation, subject, authority, and publication date. Expression level metadata contains a language, title, description, etc. Metadata at the manifestation level are a URI of expression, link to file, and publisher.

ELI Ontology [15] defines a model of metadata to enable the description of legal resources and their sharing over the web. It is based on existing vocabularies e.g. Functional Requirements for Bibliographic Records (FRBR) model, Simple Knowledge Organisation System (SKOS) and Dublin Core [16].

ECLI standard gives a minimal set and an optional set of metadata that should be assigned to court decisions for their retrieval using search engines. The metadata is based on the Dublin Core Metadata Initiative. Some of the metadata from the minimal set are an identifier, creator, date, language, publisher, type, etc. Among optional metadata are a title, subject, abstract, description, references, etc.

Legal Document Content

Many document formats are available for content representation of legal documents. Most of them are based on XML format. Some of them that belong to the third generation of legal document standards are described below.

MetaLex [17] is a legal document interchange format. MetaLex proposes a document model, a metadata set and an ontology for expressing metadata. It is also called the lowest common denominator for other legal document standards. MetaLex becomes the CEN MetaLex standard, proposed by CEN standardization committee [18]. CEN MetaLex is built on experience collected from implementations of Norme In Rete and Akoma Ntoso standards.

Akoma Ntoso [19] project managed by United Nations Department of Economic and Social Affairs (UN/DESA) [20] offers a standard for representing parliamentary, legislative and judiciary documents in XML format. Akoma Ntoso XML schema provides building blocks for structural and semantic markup of legal documents. Besides several supported types of legal documents, Akoma Ntoso XML schema provides a generic type of document enabling representation of custom document types.

LegalDocML format [21] proposed by OASIS LegalDocML Technical Committee [22] provides an XML

format called LegalDocumentXML. It defines a legal document format for parliamentary, legislative and judicial documents. It is based on Akoma Ntoso standard adopting Akoma Ntoso Version 1.0 specification along with Akoma Ntoso naming conventions.

United States Legislative Markup (USLM) [23] is an XML schema designed to support the representation of legislative documents in the US. USLM is modeled to maximize compatibility with Akoma Ntoso standard. Therefore, USLM shares many similarities with Akoma Ntoso Schema, particularly in the naming of elements and attributes. USLM provides two document models: abstract and concrete models. The abstract model is a general model composed of basic tags, while the concrete model is a derivation of abstract model introducing specific terminology.

LegalRuleML is standard proposed by OASIS LegalRuleML Technical Committee [24] as a rule interchange language for legal domain. It is based on RuleML language [25] extending its capabilities to support features of legal rules. Extension of RuleML is performed using two modules, one for legal metadata and second is for legal operators i.e. deontic operators and operators for managing behaviors (violation and reparation).

3. DOCUMENT LIFE-CYCLE

Document life-cycle is "a period from the conceptual idea to the logical and physical deletion of a document" [1]. A document goes through several life-cycle phases: initiation, preparation, establishment, use, revision, withdrawal, and deletion. During the initiation phase, a document is identified and classified according to some classification scheme. The document content is created during the preparation phase. In the establishment phase, the document content is verified and the document is available for active use. During the revision phase, the document content is changed. This implies that the document has to pass through the preparation, establishment and use phases again. When a document is no longer actively used, it is withdrawn from the system. Usually, it remains in the system in the archived state. Finally, depending on the document type and the system rules, the document is completely (physically) removed from the system.

We established relationships between the activities executed on legislative documents (i.e. enactment, promulgation, publication, coming into force and repealing) and legal document life-cycle phases (i.e. initiation, preparation, establishment, use, revision, withdrawal, and deletion). Those relationships were established in order to ease interoperability between components and systems.

The legislation is initialized and prepared by its sponsors (or their representatives) in the form of a bill. From that point onward, the content of legislation can be changed with amendments only.

The establishment life-cycle phase corresponds to enactment, promulgation, publication and coming into force of legislation. As a consequence of the enactment phase, the content of the legislation is created in the prescribed form, by the prescribed subject in accordance with the prescribed procedure. The publication of legislation is an activity that results with the content of legislation being communicated to the subjects it applies to.

The legislation is used from the moment it comes into force to the moment it is repealed (or even after it has been repealed in some cases). Coming into force is an activity that includes legal norms contained in the legislation into a legal system and the repealing is an opposite activity that excludes legal norms from a legal system. In the use phases, lawyers and citizens retrieve and browse legislation and apply legal norms contained in it to concrete legal cases.

The withdrawal phase corresponds to the repealing.

The deletion phase is usually not relevant to legislation because legislation is usually not deleted, but is archived for future use after it has been repealed.

The revision phase corresponds to amending. The amending procedure is similar to enactment procedure.

According to [26], the main components of a legislative document management systems are an editor, a converter, a name resolver, a validator, and post-editing software tools.

An editor is a fundamental tool for the generation of legislation in a standardized XML format used as an interface to activate, control and verify the automatic conversion tool, as a tool to manually mark-up a document, and as a tool for direct insertion of both text and markup.

A converter works by examining the typographical and textual regularities of a document in the legacy format and converting that document to a standardized XML format.

A validator checks if a document complies with the requirements.

Post-editing tools enable indexing, retrieval, and browsing of legislation, business process management, transformation to other formats, etc.

Therefore, editors, converters, and validators are used to implement initiation, preparation, establishment, and revision life-cycle phases and post-editing tools are used to implement use, withdrawal, and deletion life-cycle phases. Several legal document management system components, that entered into operational use, are presented in the next section.

4. CASE STUDIES

Most legal document management systems do not use standardized legal document formats or components. Thus, proprietary formats and software prevail. In this section, we review several (components of) legal document management systems that can be considered case studies of standards-abiding integrated document management approach.

According to ELI Implementation Overview [27], 12 countries currently adopted ELI standard. However, in many other countries, there are portals introducing ELI standard. For example, the official portal for publishing legislation in Serbia PIS [28] proposed the identification of legislative documents using ELI.

ECLI identifier for case law is implemented in the Court of Justice of the European Union, the European Court of Human Rights, the Boards of Appeal of the European Patent Office and 12 Member States [29]. Furthermore, ECLI implementation in seven other EU countries is in progress.

Language Independent Markup Editor called LIME [30] is a web-based document editor enabling markup of nonstructured documents. Using appropriate plugin different document formats are supported. Currently, there are entry points for creating documents in Akoma Ntoso format and LegalRuleML format. LIME is an editor and a validator according to the classification given in the previous section.

Indigo Platform [31] is a document management system for legislative documents. Indigo is developed as a web application providing an environment for managing legislation to end users. Additionally, Indigo implements REST API enabling developers to use legislative documents in their projects. Akoma Ntoso XML format has been chosen for representation of document content and metadata. Indigo manages indentation for subsections and automatically generates the document cover page and table of contents. Still, only the Akoma Ntoso act document type is supported. Indigo Platform is an editor, a converter, and a validator.

In 2013, the UK started the LDAPP project for development of legislative drafting, amending and publishing tools [32]. The project is based on open standards and open source technologies and it has entered in beta phase. Akoma Ntoso has been chosen as XML markup language. Existing API for accessing UK legislation is extended to support Akoma Ntoso format. Government bodies participating in this project are the two Houses of the UK Parliament (the House of Lords and the House of Commons), the Scottish Parliament, the Office of the Parliamentary Counsel, the Scottish Government's Parliamentary Counsel Office, and The National Archives. According to the description given in [32], LDAPP implements all document life-cycle phases.

MetaLex Document Server (MDS) [33] provides access to Dutch regulation in CEN MetaLex format. The document metadata is available as RDF triples in accordance with MetaLex ontology. Document identifiers are based on URI patterns used by UK legislation portal. Initially, a document set from legacy regulations database is transformed from proprietary document format to CEN MetaLex XML format and RDF format. For each document, MDS offers three manifestations, XML, RDF and HTML. MDS is a post-editing tool.

LexML project in Brasil was started to provide a platform for collecting and enabling access to legal documents from executive, legislative and judiciary branch [34]. Portal was launched in 2009 and it provides documents produced by 15 government bodies. Identification of legal documents is based on URN:LEX standard and documents are represented using XML format similar to Akoma Ntoso Schema. LexML is a post-editing tool.

Authoring Tool for Amendments (AT4AM) is a web-based authoring tool for amendments [35]. It enables users to create and table amendments and is used by the European Parliament for amending legislation. On the basis of AT4AM another open source tool called AT4AM for All has been developed. Both tools rely on Akoma Ntoso XML schema as a document format. As an amendment management system, AT4AM implements all phases of legal document life-cycle.

5. CONCLUSIONS

In this paper, we reviewed legal document types and formats, legal document life-cycle phases, and software components that support legal document management and presented several case studies of legal document management systems that we identified as examples of good practice.

Based on the review of legal document formats, legal document management system components and case studies, we propose several recommendations that can advance legal document management.

Firstly, we recommend the adoption of a standardized legal document format. That format should support document identification, metadata assignment, and representation of both the content and the form of documents. It should be based on W3C recommendations and specialization of those recommendations in the legal domain.

Secondly, we recommend publishing legal documents according to open linked data recommendations if privacy and confidentiality considerations do not dictate otherwise. Attention should be paid to the technical and legal openness of published documents and metadata. Documents and metadata should be linked to other documents and metadata to promote the network effect.

The third recommendation is that each public body should be allowed to introduce standards-abiding (components of) legal document management systems on their own. However, one public body should offer hosting, maintenance and support for the generic implementation of a legal document management system to public bodies without the resources necessary for an independent operation of the system.

In the future, we plan to investigate how similar principles can be applied to executive and legislative documents.

As proposed in [36], the semantic document approach can be applied to the legal domain. The semantic representation of legal documents is the first and necessary step of the approach, continuing with the semantic modeling of metadata (the implementation of legislative metadata layer) and ending with the semantic enrichment of legislative document workflow. This approach can facilitate easier implementation of domain-specific services.

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INTEGRATION OF ARTIFICIAL INTELLIGENCE WITH CLOUD SERVICES

Aleksandar Petrović*,
Miodrag Živković

Singidunum University,
Belgrade, Serbia

Abstract:
Recently, we have entered a new era, which is known as the cloud era. Interest in cloud computing continues to increase, and many companies have already moved their IT in the cloud. On the other hand, advances in artificial intelligence opened new possibilities which can be used to improve current cloud technologies. This paper explores those possibilities and what is already achieved with the integration of artificial intelligence and cloud-based storing solutions. A brief explanation of both technologies is given, followed by a more widened approach to the benefits they achieve together. Analysis of social as well as of financial benefits is presented. We approached these possibilities and indicated the ways in which artificial intelligence can be fused with cloud storage. Solutions to the obstacles to these technologies are suggested through their examination. Further research and development options are submitted while instructing caution for the damage artificial intelligence and cloud could do together.

Keywords:
artificial intelligence, cloud, innovation, productivity.

1. INTRODUCTION

Productivity challenges and economic data storage were observed as a large problem for the corporations until cloud storage was introduced. Cloud was not immediately considered as a serious solution to this problem. However, the cloud has striven and became one of the most important and fundamental technologies on which other technologies rely on. Besides backup, high level of organization was essential for big databases. Artificial intelligence has first been applied for organizational matters of the cloud and then became essential to it. Currently, the most advanced cloud platforms are those that are fused with the power that AI (artificial intelligence) offers. Artificial intelligence is also important for big data analytics and it strived with cloud and AI advancements. Big data is important because humans exchange uncountable units of data in real time, not to mention the amount of data that was generated historically. This information is invaluable if approached correctly. The space for improvement of society's standards is wide but the focus is on getting more for less. Cloud and AI give society a better value for money compared to the

Correspondence:
Aleksandar Petrović

e-mail:
aleksandar.petrovic.17@singimail.rs

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traditional technologies in the past. Better organization, achieving access to information that was not accessible before, and keeping information safer than before is the goal of these technologies that are the pillars of today's information technology world.

2. BACKGROUND

Cloud

Elementary use of cloud services is relying on the scalability of data storage, as any required capacity can be achieved without planning and at any point in time. This eliminates the number of servers and their capacity prediction for the reason that the service providers always offer possibilities to increase or even decrease the capacity of storage and to manage other services that the client is paying for. Cloud platforms have a much higher potential than just storing data due to distributed computing power. The more important part of the cloud's scalability is the ability to distribute more hardware resources to a certain user when it is required. These situations occur when it is needed to store more data or more processing power is required from a service that is provided. Users only pay for the resources that they have been using, those resources being more storage or power. Migration of the services to the cloud greatly reduces the costs of any organization. Servers and additional required equipment are costly, especially when it comes to large scale operations. The implementation of the cloud removes the need for server management and reduces maintenance costs. Productivity and efficiency benefits are paramount when considering all the advantages that cloud offers. Vast benefits include always accessible data which provide the flexibility to widen the availability of support services and to remove limits from using only the on-premises equipment. Always having access to provided services requires replicating and distributing data to more than one cloud server and that redundancy is one more service that is achieved through the cloud, backup. Containerization of applications is another focal cloud service [1]. Instead of virtualizing complete operating systems, containers are made from the application layer. This allows for easy application distribution through the cloud and improved storage efficiency. Containerization provides more flexibility and utilizes resources better than traditional virtualization. As machine learning was getting more sophisticated it started offering opportunities for cloud servers to exploit including artificial intelligence. Cloud providers, working with massive amounts of data, acknowledged the opportunity to develop self-improving algorithms. Amazon provides advanced analytics service as one of the basic services of its extensive ever-developing AI arsenal [2].

Artificial intelligence

Artificial intelligence technologies are becoming more sophisticated and as they are getting better they are also posing a bigger threat to humans if they become mishandled. AI technology is being slowly introduced to the general masses in the forms of deep learning enhanced devices as well as optimizing smartphone hardware for AI-based software. Examples of this kind are Amazon's DeepLens, which is able to recognize human emotions from analyzing photographs, and an application Homecourt [3], that watches while the subject plays and it makes personalized suggestions. Smartwatches use AI in combination with body sensors to detect possible unintended falls of the subject, high blood pressure, and even possible diabetes. Commercial usage is still in its early stage but the fact that they are making their place in the market is encouraging. Systems with integrated or hardware enabled AI are able to learn from their mistakes and adapt to different problems that are presented to them. The learning process concerning artificial intelligence is called machine learning, or on a higher level, the evolution of machine learning, the deep learning. Machine learning is primitive compared to deep learning and consists of algorithms that analyze data, extract knowledge from it, and then present a solution to the given problem [4]. This process grants a trained machine capable of completing the task that would otherwise require hours of coding. Some of the learning methods are decision tree learning, inductive logic programming, clustering, and reinforcement learning. Deep learning is different in a way that it layers algorithms with the goal of creating an artificial neural network. Neural networks are attempting to imitate the human neural system with an emphasis on the way human neurons connect with each other. In comparison to natural neural networks, artificial ones are made of layers, connections, and directions of data propagation. Artificial neurons carry a factor of correctness concerning the data they are analyzing. When every neuron is put into the equation total outcome is calculated by the feedback of each neuron. None of these methods achieved the goal of general AI (artificial intelligence) [5], qualified for completing any type of task. Striving for automatization of as many jobs as possible, especially

jobs that are hazardous, led to implementing AI to the robots. AIs are superior to humans when it comes to carrying out defined tasks, but they are not immaculate. Their performance depends on the level of training they have been through and how long did it last. The learning process is to tell them where they went wrong and to let them figure out on their own how to overcome it. The danger of having everything automatized is frightening the society but is also what everybody wants. Many professions will go extinct but the machines working for us should not be considered immoral. This field is not fully explored nor defined. Standards need to be applied but that is only possible when complete understanding of artificial intelligence is achieved.

3. THE SYMBIOSIS OF AI AND CLOUD

Artificial intelligence needs to learn and to be trained, and there are two methods, supervised and unsupervised learning [6]. With supervised learning, AIs are presented with training datasets, that are boundaries of a correct outcome of the operation. The structure of a dataset consists of basic facts about the objects in the problem. Should a returned value appear incorrect, a supervisor will intervene and direct the AI to the correct solution of the problem. The difference concerning unsupervised learning is that training datasets and outcomes are not defined. Their purpose is to solve complex problems with binary logic while only using the submitted data. Returned values are not systemized exclusively as correct and incorrect answers. Every answer is calculated to a degree of probability. Semi-supervised learning is in most cases an acceptable solution to the needs of an average client. This occurs due to incomplete or inaccurate data on the matter. The combination enables usage of reference data when it is available and applies calculated probability when such data is nonexistent. Various roles [7] can be assigned to an AI in retail, supply chains, news, financial services, healthcare, etc., but what is undoubtedly needed are massive amounts of data [8]. Adaptation of content in advertisements to the needs of every user, optimization of routes, prediction of changes in demand, are data demanding processes, but the biggest potential and the highest requirements are held by the healthcare industry. AI integration with the smart scanners could provide automatized visual diagnostics, reduce the maintenance expenses, reduce the human error, enable robotized surgical assistance, and improve the data keeping.

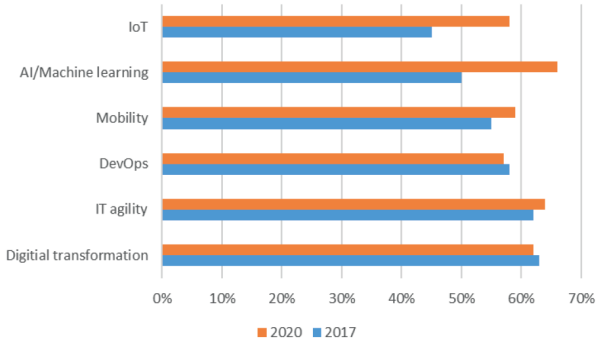


Fig. 1. Factors driving public cloud engagement in the United States in 2017 and 2020

Possibilities of connecting an AI to a cloud have various benefits to both sides. Cloud servers hold a lot of data and that is an invaluable resource to any AI, but if more AIs are connected, they can learn from each other's mistakes. When one particular AI learns a process, it can easily transfer the knowledge to other AIs, which drastically increases the potential of such symbiosis. In the past, AI's growth was hindered due to limited datasets, it was unable to analyze all the real-time data. Big data is the fuel that powers AI. Advancement of big data analytics removed these obstacles. Tools have been created that enable rapid analysis and technology is now agile enough to access colossal datasets. Due to the cloud's scalability, AI services provided from the cloud are as well scalable. When an enterprise wants to expand AI concerning projects the cloud permits adding computing power or requesting more hours of the full capacity of servers from the providers [9]. Renting AIs is a great way of getting access to advanced computing power while minimizing the costs by not paying for all the infrastructure and by accomplishing highest efficiency because of paying only for the time or percentage of the power used. Cloud AI is easier to use because AIs need to be trained, as said before, and that development process is very expensive. It is a goal to implement an AI in all cases where it can increase efficiency. AIs are great for completing various tasks, but they are usually specialized for one task only. The most popular use is with tremendously large databases. Huge databases need sorting, which calls for machine learning. Analytics tools offer classification and superior organization. Prior to the implementation of artificial intelligence with data analysis methods analysts spent more time on preparing the data than on its analysis. The innovation AI brought was with the automatic ingestion of data, classification, and organization of all data sources.

4. EXAMPLES

In the next chapter, we reviewed the most popular cloud AI solution providers, the variety of the services they provide, their influence on the current market, and the leverage each one possesses. The dominating companies in AI development are the first comers that invested largely into cloud architecture because their main business, or at least one of the top five most important businesses, was working with enormous amounts of data. These companies accumulated unthinkable amounts of information as results of gathering it so it could be provided on demand, users of its services generating massive amounts of it, and even for staying the longest in the business. Based on their main fields the companies specialized their AI in different ways. The one adoption of AI that most of them are developing is text-to-speech and vice versa, a comparison of these services will be presented into detail. The slightly different competitor is certainly Google for developing its specialized processing unit for AI that brings the hardware advantage over the other companies. More word on this project in the following paragraphs. Besides the scientific contribution from Google, Amazon is the leader in consumer AI, but the way the market is developing is sometimes proving better in a couple of ways to even develop private cloud networks with AI, but more word on this in Chapter IV, and the most dominant in the field of independent developers is Microsoft for its widespread systems over the years that it has been active. There is a fair market of companies that are offering cloud computing services but there are also those that are not embracing the trend. The most worrisome behavior comes from Apple. The company has been renting Microsoft's cloud infrastructure for a long period of time before transitioning onto Google's infrastructure. This profoundly hurts Apple's finances and there have been rumors of Apple Pie project, of which very little is known, but considering Apple's behavior of ignoring the tech trends and later releasing a much better version of them, this does not extinguish all hope. It is certainly disappointing to watch Apple sit this one out on the bench because of the great success their personal assistant, Siri, achieved. The other companies worth mentioning besides the giants like Google and IBM are Oracle AI, Salesforce and Baidu.

Amazon

The most consumer and profit-oriented are certainly the AWS (Amazon Web Services). This is not a surprise, taking into account that the company operates in the trading market and that its main principle is supply and demand. However, a common user of the large online marketplace should not underestimate the company and think it has not evolved into a tech giant. The substantial revenue generated needed to be reinvested and the natural way was to explore advanced online advertising and algorithms to suggest similar and products of interest to the certain user. Amazon's Kindle, Prime, and Music easily revealed that the company is expanding from trading. The company later introduced its cloud services that became a huge success. Gaining momentum, the company largely widened the scope of services that were covered with AWS. One of the services that the users most familiarize with is Amazon Personalize. The service is based as an advanced tool for product placement based on an over the years perfected machine learning algorithm. The main benefit is that it allows exploitation of machine learning in software solutions with extensive prior knowledge of it. The user pays only for the time that has been used to process the data that is forwarded to it. Besides software services, Amazon has to offer AI optimized hardware such as DeepLens, a deep learning camera that can detect an extensive range of human emotions from the footage it captures. DeepLens comes with an online library of pre-trained deep learning modules, and some of them are trained to recognize a cat or a dog, a face, an activity, and the name of the object. This AWS is compatible with SageMaker, Amazon's machine learning developer studio, which provides great compatibility. The most successful Amazon service and the product is Alexa. Exploiting Amazon Web Services like Polly and Rekognition, Alexa became a powerful personal assistant that is more popular on the market than the competing companies' personal assistants [10].

Microsoft

The second biggest cloud AI provider is Microsoft. The leverage Microsoft has when it comes to the machine and deep learning is the immense number of devices that it has in its ecosystem. Set aside the diversity Microsoft is one of the companies with the largest numbers of devices that run its operating system. A large number of Windows-based hardware allowed a smooth introduction of Azure, Microsoft's cloud computing platform in 2010. Microsoft developed its own cloud computing service that supports many different programming languages with an accent on development. Azure possesses environments for building, testing,

managing, and deploying software solutions. The most important available tools included are the Visual Studio with a tool for AI, Azure Machine Learning Studio, and AI Toolkit for Azure IoT Edge. Azure also provides an excellent text-to-speech service.

Google

Google's role in developing AI through the cloud is not as high profile as Azure or AWS, but the contribution of this data giant is far from mediocre. Like other competitors, Google provides visual recognition, speech-to-text, text-to-speech, translations, and a machine learning engine. Google's edge is undoubtedly the biggest data flow and the amount of data collected. An interesting twist to Google's video deep learning is the ability to search for text and even images in the video. Besides, the obvious advantage of acquiring the most data Google's biggest leverage is its self-developed processing unit specialized for its machine learning engine. It is called TPU (Tensor Processing unit) and it provides from fifteen to thirty times faster performance than any CPU or GPU [11].

IBM

The tech giant has not been in the spotlight for a long time so it is unexpected for it to have the most diverse cloud computing services with around a hundred and seventy services. The substantial number of services the company owns to the grouping of its BlueMix cloud service, SoftLayer data centers, and Watson AI group. Watson provides highly sophisticated analytics services, speech-to-text conversion, various translations scenarios, and visual recognition.

Charts

The charts we presented show how many companies use certain providers' infrastructure and the usage of the most popular personal assistants. It is important to remember that the users' choices heavily influence the future of technological development. It is interesting that Microsoft is right behind Amazon in cloud computing and that Google is lacking so much in comparison to the prior two. It was expected of Apple's personal assistant to dominate the market considering Apple's smartphone dominance, but Google proved the power of the Android platform and fortified its second-best position.

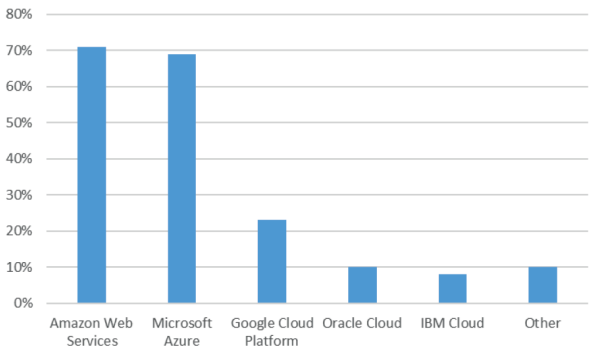


Fig. 2. Cloud Infrastructure as a Service (IaaS) vendor currently in use in organizations worldwide as of 2018

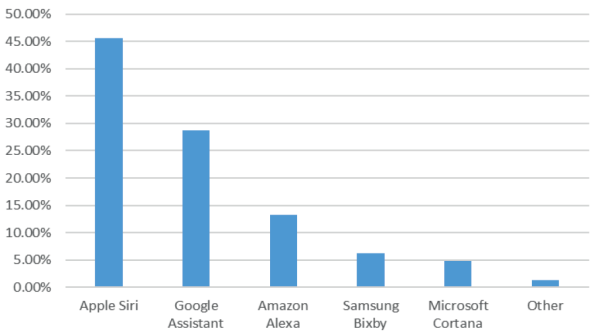


Fig. 3. Market share of voice assistants in the U.S. (May 2018)

5. OBSTACLES FOR FUTURE IMPROVEMENT

Technical

The merging of AI and cloud resulted in a significant increase in efficiency and innovation potential [12]. While operations expand, larger data workloads are worked with, and possibilities are perceived to reduce the expenses. Intelligent data storage layer on the cloud offers high efficiency and scalability that are mandatory solutions to this problem. Cloud has a vast set of tools that are striving to securely analyze data economically. Distinct ways [13] of data processing offer different results in the prioritization of real-time data or the focus on being as accurate as possible. It is difficult for the most advanced systems to keep up with the amounts of data that is generated at the moment and it is even more time consuming to analyze all the data on a certain subject. Management of exponential data growth in a scalable, efficient way is the goal and that is why datasets

are put together. The purpose of a dataset is to contain analyzed data only on the matter that is of interest at that moment. AI can have a massive impact on the preparation of datasets and simplifying the job for humans. More powerful infrastructure is required for fined tuned results and that is why computing power is a serious obstacle for artificial intelligence and cloud as well. Both branches need very sophisticated infrastructure to provide the services they offer, especially if such systems are developed privately. Establishing private cloud networks that integrate AI, besides the infrastructure costs yields costs as big in human resources. Regular maintenance and supervision crews are expensive due to the essential always-online support and the expenses multiply when a group of experts is assigned to train an AI. In spite of the obvious disadvantages, developing a private cloud computing network can be more cost-effective if there is a need for cloud computing service to run frequently. Creating a general AI is attempted and closest the general effort has gotten is the multitasking [14] methods which are divided by the way they connect tasks to each other. Tasks can be divided after connecting all the data on them or the data on each task can be divided and later connected when the tasks are completed separately. AI's biggest disadvantage currently is the inability to deal with different occupations. General artificial intelligence is what is thought about when it is talked about AIs. Currently, the AIs that are available are very sophisticated algorithms with a possibility of expansion under certain conditions, which is the main reason why the actual perfect assistant cannot yet be implemented.

Legal

Artificial intelligence has been encountering problems with the various governments. The law is getting twisted when it comes to criminal liability and jurisdiction that it would have [15]. Some have redefined their laws according to the AI, but those regulations are only a work in progress. Legal workers have been battling to achieve controlled access to permissions that the AI technologies need without violating human rights [16]. Examples of practical usage include image processing, geotagging [17], three-dimensional environment processing, speech analysis, and data mining. The examples listed above need access to cameras, microphones and a lot of historical data. Algorithms are used to analyze images to extract information as well as in real time with the autonomous vehicles that require radar and laser data to understand three-dimensional geometries. Text analysis has even more application because of the massive amounts of data being generated daily. It is used to obtain information, apply a classification or to pull out particular pieces of data. This sort of analysis is also considered as data mining. Large quantities of data are needed to reap the full benefits of the analytics tools. Individual's security is questioned when a lot of data is analyzed, especially because confidential data is needed for some analysis. The sensitive analyzed data is valuable to hackers and if carelessly stored and used can be a threat. In certain cases storing that kind of data on the cloud is unpermitted and there are also limitations to where the data is stored geographically. International companies that handle personal information that is necessary for its services to function properly are having problems with countries that have strict privacy laws. Most countries are not allowing storage of personal data of its citizens on cloud servers that are geographically in different countries. When simplified to its lowest level, keeping sensitive information on hardware that is out of legal jurisdiction from its country of origins is violating a lot of constitutional rights. When presented in this way there is no doubt that it could be argued that is unacceptable to handle sensitive information like that, but when put into perspective, an individual shares a considerable amount of personal information on the web and the direction that digital privacy should be taken into is education, awareness, and simplifying the means to protect oneself.

6. CONCLUSION

Innovations that the combination of cloud and artificial intelligence brought can be of great importance to society. Raising the standard for human lives is a philanthropic deed that we should all commit to. In the present-day devices with sophisticated software are growing and multiplying exponentially, tons of data are injected into the systems. The corporate world has a wide spectrum of opportunities that would not be presented to them if it were not for the analysis of massive amounts of information. For some time, it has been a common practice for operations to store important and even all of the data in the cloud. Artificial intelligence gives wings to the organization and classification methods of that vary storage. The inventors should continue perfecting the solutions that are currently used and with great effort, a general AI could see the light of day. AI must not be underestimated and neglected because it is at this moment a double-edged sword. That is why the

legal regulations should be prepared even before. It is a high risk but it cannot be said with certainty that it will bring a high reward.

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CONSTRUCTION OF TRAINING DATA FOR PRICE PREDICTION OF A REAL ESTATE FROM INTERNET ADS

Mladen Vidović*,
Ivan Radosavljević,
Aleksandra Mitrović,
Zora Konjović

Singidunum University,
Belgrade, Serbia

Abstract:
The paper presents a model for constructing a data set aimed at predicting a price of a real estate (houses and flats) from the standard Internet ads. The model for predicting a real estate price includes, in addition to standard real estate's features (area, number of bedrooms, etc.) appearing in ad, attractiveness of a real estate location as well as information on some additional interior facilities (e.g., refrigerator, dish-washing machine, stove, etc.). The proposed training set construction model uses OpenStreetMap's Overpass API for determining attractiveness of a real estate's location, and a convolution neural network for detecting interior facilities from real estate photos.

Keywords:
real estate, advertising, price, prediction.

1. INTRODUCTION

Purchasing a real estate (house or flat) is a large and relatively infrequent investment for the majority of the people. Therefore, a realistic price estimation is an extremely important task. The price of a real estate is influenced mainly by a real estate features like number of bedrooms, bathrooms, area but also some other characteristics like location and internal facilities [1, 2].

In general case the price of a real estate is determined by its owner or a real estate agent. Their estimations rely upon personal experience, interests and sometimes even emotional aspects. An objective price estimation could help both buyers and sellers to check if the proposed price is justified.

This paper proposes the model for preparing a training data set aimed creation of a regression model for predicting real estate price that includes information on attractiveness of a real estate's location as well as information on some of its additional interior facilities.

2. REGRESSION MODEL FOR REAL ESTATE'S PRICE PREDICTION

A regression model for real estate's price prediction for which the treining set is constructed is a Gradient Boosted Trees (GBT) model [3,4]. Gradient boosting works in a way to create a lower-performance

Correspondence:
Mladen Vidović

e-mail:
mvidovic@singidunum.ac.rs

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model first, and evaluating its output. Thereby, in gradient boosting algorithm its residual (i.e., errors) are considered instead of initial classificator's predictions. The pseudo-code of this algorithm goes as follows:

1. Using a dataset train the initial model F_0:

$$F_0(x) = y$$

2. Using residuals of an initial model train a new model $h_0(x)$:

$$h_0(x) = y - F_0(x)$$

3. Create a new model $F_1(x)$ by combining output of an initial model and a model obtained by using initial model's residuals:

$$F_1(x) = F_0(x) + h_0(x).$$

Initial models as well as the models trained using residuals are arbitrary classifiers or predictors. In the case of a *GBT (Gradient Boosted Trees)* algorithm, these models are decision trees.

3. TRAINING SET

For the purpose to establish a training set, three data sets are created here.

The first data set, the basic one, comprises data on basic real estate techical features like number of rooms, number of bathrooms, area and the similar.

The second data set contains real estate's geo-coordinates. This data set is later on used to extend the basic data set with information related to a quality of a real estate neighbourhood like vinicity of schools, restaurants, etc.

Finally, the third data set contains information both about a quality of a real estate neighbourhood, and data about its additional interior facilities.

The basic data set is created from the ads downloaded from the real estate advertising web page nekretnine.rs [5]. The Python Scrapy library [6] was used for this download. The initial URLs are retrieved from this page with a criteria to search only for flats advertised for selling in Serbian cities Belgrade and Novi Sad. Some of these elements are:

1. Price in euros (target attribute).
2. Address represented by mandatory street, city and state.
3. Number of rooms.
4. Number of bathrooms.
5. Floor.
6. Total number of floors in the building.
7. A list of corresponding photos' URLs.

There are 17 attributes in total that are described in details in [7]. The initial data set contains 95942 ads and 662396 photo URLs.

A separate data set was created of 18374 ads that contains real estate's geo-coordinates. This set was later used to collect data on real estate's location aimed at estimating its attractiveness.

The third data set that contains relevant interior facilities is determined by applying a convolution neural network to the photos attached with an ad.

4. CREATION OF A TRAINING SET

Data preprocessing

By applying explorative analysis it was observed that some ads do not have price attached, which makes them useless for training purposes, so these ads were discarded.

Next step was determination and removal of outlayers, i.e., a noise in the data. For that purpose the price and area are used considering valid only ads with declared price between 10000 and 1000000 euros and area between 10 m^2 and 300 m^2.

For the data set with data on location and detected interior facilities a correlation matrix was created that has shown that no highly correlated data exist and, hence, no removal of the data was needed.

After applying the explorative analysis results, the number of the ads left was 61942. Table I depicts an overview of the removed ads.

Textual contents of ads containing categorial and enumerative attributes are appropriately transformed. Enumerative attributes are encoded as vectors of binary values, where the value 1 denotes a presence and the value 0 denotes an absence of the corresponding attribute.

It is obvious from the Table I that the largest number of ads was removed due to missing data about the floor of the apartment, while the smallest number of removals was due to price above limit.

Table 1. Removed Data overview

Removal due to	Number of removed ads
Missing price	535
Price below limit (10000 €)	436
Price above limit (1000000 €)	24
Area below limit (10 m²)	37
Area above limit (300 m²)	227
Missing floor	32742

For all created data sets the minimal, maximal and average values for price and area were determined.

As shown on Figure 1, (the symbols 1, 2 and 3 denote basic, location extended, and location&internal facilities extended data respectively), prices ranges and distributions are equal in all three sets. This is what is reqired for a good training set, so our sets are acceptable for the intended purpose.

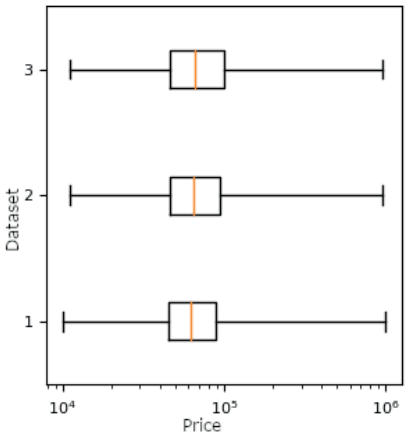


Fig. 1. Prices ranges and distributions in the data sets

Determining data about location quality

Using Overpass API [8] for OpenStreetMap [9], important objects are obtained within a given circle with a real estate as a center. Three radius values were selected, the first one from 0m do 150m, the second one from 150m to 500m, and the third one from 500m to 1000m. Within each of corresponding circles a search was performed for relevant objects and areas comprising:

1. public objects like schools, day nurseries, restaurants, hospitals, etc.;
2. Tourist objects like galleries, hotels, historic monuments;
3. Areas with a special purpose like waste disposal, industrial areas;
4. Resorts and relaxing places, sport centers, parks, paly grounds, etc.

The retrieved elements are added as attributes of a real estate to be used for the further analysis of the location quality. Thereby, only the existence of a certain object's type was considered, not the number of such objects. A proximity of the downtown was determined as an additional quality factor. The coordinates of city center are used as given by OpenStreetMap. The distance of a real estate from the city centre was computed using haversine formula for calculating the distance between two points on the sphere.

An analysis of the obtained objects in apartments' neighborhoods has shown that two larger radius are almost identical for the majority of real estate and as such of no use for the training purpose. Therefore, only the area within the smallest radius was included, i.e., only the objects within the distance of 150 meters from the real estate were considered. Also, some objects like a zoo and prison have not been detected, so they were removed. Remaining objects are added with attribute values 1 or 0, respectively indicating presence or absence of an object.

In order to avoid a huge number of attributes, a clustering of real estate based on retrieved objects in their vicinities was done. For the clustering the k-means algorithm was applied. Figure 2 shows model performance in terms of number of clusters, while the Table II depicts a clusters' overview for k=5.

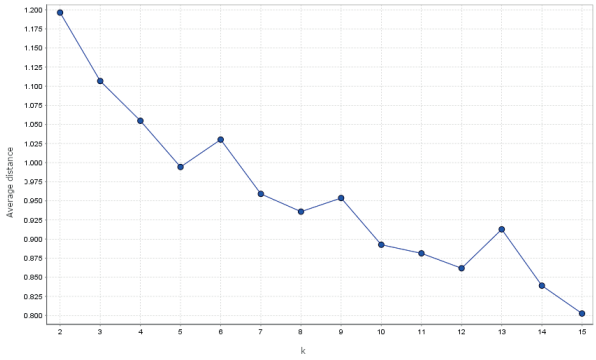


Fig. 2. Model performance in terms of clusters

Table 2.Clusters Overview For k=5

Cluster	Number of examples	Mean price	Mean area	Average price	Average area
0	1837	63860	59	77621	64.2
1	1629	85000	74	117629	78.8
2	510	71585	59.5	103373	66.6
3	2955	70560	64	93827	68.2
4	11443	60000	58	76110	63.2

In order to determine the parameter k, an iterative clustering was done with k-values varying from 2 to 15. Then the average distances of clusters' centres from the clusters' elments were considered as to observe an "elbow". From the diagram on Fig. 2 one can conclude that 5,8, and 12 are potential "elbows", i.e. optimal numbers of clusters. Finally, the number of clusters is determined empirically.

Detecting interior facilities from the photos

A set of 7998 annotated photos is used for training a convolution neural network with 25% of photos marked off for testing. Some labels are removed because no real estate with those labels were present in the data set.

The Tensorflow Object Detection API [10] was used for dealing with network. In order to reduce the training time, the network was used that was pre-trained on the COCO (Common Objects in COntext) data set containing objects to be detected on the photos [11]. Afterwards, a fine tuning of the network was done, i.e. the weights of the shallow layers were retained for basic features extraction, and the deeper layers are than additionally trained using photos from ads.

The pre-trained Faster R-CNN ResNet101 [12] with 101 layers was used, characterized with a good performance on the COCO data set and relatively short training time per photo.

After each convolution layer a batch normalization is performed.

The Rectified Linear Unit is used as an activation function of convolution layers.

The network also has two pooling layers for dimension reduction, one on the input where the max pooling is done with a kernel size 3 and step 2, and one on the output where average pooling is performed with kernel size 7 and step1.

One fully connected layer with a softmax activation function is on the network output.

The network input was fed with manually annotated photos form ads for the additional network training.

In order to reduce input layer, actually to reduce a training time and hardware requirements, the images are scaled to have maximal height and width of 800 pixels and minimal height and width of 600 pixels. Prior to training, an augmentation of data set was performed aimed at creating a more robust model and avoiding network over-fitting. The augmentation method that were applied are:

- Image horizontal flip, and
- Image illumination change.

The training was done in 50000 epochs.

An example of the detected interior facilities is shown on Figure 3.



Fig. 3. An example of the detected interior facilities

Once the network was trained, it is used for detecting objects on the photos from 9862 ads having both geo-

data and images. Images from these ads were not the part of the network training set and, consequently, they were not annotated.

The performance evaluation for the network was carried out using the data set previously marked off for a testing and not used for the training. Two metrics are used for evaluation. The first one is AP (average precision) that applies to a single class, while the second one is MAP (*Mean Average Precision*) which applies to all classes and represents an average of APs. The results for the achieved AP values are presented in [5], while the MAP value for this data set is 0.594.

5. RESULTS OF THE DATA USE FOR TRAINING A GBT MODEL

Model training and evaluation are done for the basic data set, data set with a neighborhood attractiveness estimation, and the data set with a neighborhood attractiveness estimation and internal facilities detected from the photos.

Each data set was split into a training set with 80% of elements and a test set with 20% of elements. Then, additional 20% of elements are pulled out to form a validations set.

Model is trained on the training set and its parameters are then optimized on the validation set. Optimization was iterative by changing the values of the relevant parameters and comparing the model's performance on the validation set. The metrics used for performance evaluation was R^2. The GBT ensemble is optimized by the depth of the regression three and number of estimators.

For the basic data set the optimal tree depth was 12 and the number of estimators was 70. For the data set with geo-coordinates but no interior facilities the optimal tree depth was 9 and the number of estimators was 80 both before and after adding a cluster label. Finally, for the data set containing both geo-coordinates and interior facilities with only basic data about real estate, optimal three depth is 12 and the number of estimators is 70. After adding data on location quality the optimal three depth of 11 and number of estimators of 60 were obtained. With all available data, optimal depth is 12 and optimal number of estimators is 60. Table IV depicts the achieved performance for various data sets.

Table 3. GBT Model Performance For Various Data Sets

Data set	R^2 achieved on validation set
Basic data	0.77
Geo-coordinates, no clusters	0.767
Geo-coordinates with clusters	0.856
Geo-coordinates and images, basic data	0.768
Geo-coordinates and images, with clusters, no interior facilities	0.839
Geo-coordinates and images, with all available data	0.816

6. CONCLUSIONS

In this paper a model for constructing training set is proposed for predicting an objective price of real estate from Internet ads relying upon its features. Real estate features include, along with its basic technical characteristics, the attractiveness of a real estate's location and interior facilities extracted from the photos accompanying the advertisements.

A real estate's location attractiveness determination is based on relevant objects located within a circle with 150 meters radius. Those objects are determined using the Overpass API for OpenStreetMap.

For detection interior facilities of a real estate, a convolution neural network was used. The MAP (*Mean Average Precision*) achieved by the network was 0.594.

There are several directions that could be taken to improve the quality of the training set.

Firstly, a larger number of the annotated images could improve the network's performance, while the feature interior facilities could also be improved by creating a unified estimate using, for example, a clustering technique.

Real estate's location could be used to derive some additional attributes lake prices of the surrounding real estate, which according to some previous research proved to be an important factor of the price.

Finally, authors' impression is that a free text describing the real estate contains substantial information about its basic features, which indicates that text mining techniques could be useful for improvement of the quality of data set.

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DRONOVI U POLJOPRIVREDI – IT PODRŠKA, ZAKONSKE REGULATIVE I PREDNOSTI UPOTREBE

Slaviša Ilić[1,*],
Žaklina Spalević[1],
Miloš Ilić[2]

[1]Univerzitet Singidunum,
Beograd, Srbija
[2]Fakultet tehničkih nauka,
Univerzitet u Prištini sa privremenim
sedištem u Kosovskoj Mitrovici, Srbija

Rezime:
Ubrzani razvoj i sve veća popularnost bespilotnih letelica (dronova), kao i prednosti njihove upotrebe otvorili su mogućnosti za njihovom primenom u poljoprivredi. Hardverska i softverska rešenja koje koriste dronovi novijih generacija se razvijaju velikom brzinom. U cilju unapređenja poljoprivredne proizvodnje sve je značajnija upotreba dronova različitih kategorija i namena. Upotreba dronova u poljoprivredi ogleda se kako u prikupljanju podataka sa terena o zdravstvenom stanju biljaka, tako i u primeni u procesu zaprašivanja, uzorkovanja zemljišta i prihrani biljaka. Svaka bespilotna letelica u zavisnosti od svoje namene odlikuje se specifičnom hardverskom opremom i softverskim funkcionalnostima koje obezbeđuju njeno korišćenje. Svaka upotreba dronova praćena je setom zakonskih regulativa kojih je korisnik letelice dužan da se pridržava. Cilj ovog rada je poređenje različitih tipova dronova dostupnih za korišćenje u poljoprivredi. Pregled i poređenje oblasti primene poljoprivrednih dronova dat je sa aspekta implementiranih hardverskih i softverskih rešenja, prednosti i nedostataka korišćenja, kao i zakonskih normi kojima je regulisana ova oblast.

Ključne reči:
DJI, NDVI indeks, zaprašivanje, kategorije dronova.

1. UVOD

Razvoj informaciono komunikacionih tehnologija (ICT) posebno u oblasti kreiranja i obrade velikih skupova podataka, intenzivno doprinosi kreiranju sistema i softverskih rešenja primenljivih u svakodnevnom životu i radu ljudi. Jedna od novijih oblasti primene informaciono komunikacionih tehnologija jeste njihova primena u oblasti poljoprivredne proizvodnje i proizvodnje hrane. Primena ICT resursa na rešavanje problema i unapređenje procesa poljoprivredne proizvodnje doživljava veliku ekspanziju poslednjih nekoliko godina. Koncept primene ICT tehnologija u poljoprivredi poznat je kao precizna poljoprivreda ili e-poljoprivreda. Precizna poljoprivreda predstavlja proces poljoprivredne proizvodnje koji uključuje primenu informacionih tehnologija, satelitske navigacije, primenu različitih vrsta senzora, praćenje radnih mašina, kao i analizu prikupljenih podataka i proces donošenja odluka [1].

Odgovorno lice:
Slaviša Ilić

e-pošta:
islave@live.com

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Jedna od tehnika koja se sve češće primenjuje u novije vreme jeste snimanje proizvodnih poljoprivrednih površina iz vazduha [2]. Korišćenjem bespilotnih letelica vrši se prikupljanje potrebnih informacija baziranih na seriji fotografija i snimaka površina na kojima se vrši uzgoj poljoprivrednih proizvoda. U grupu letelica za prikupljanje potrebnih snimaka ubrajaju se sateliti, avioni, baloni, kao i sve popularniji mali dronovi. Posmatrano iz ugla funkcionalnosti i ekonomskih izdataka, korišćenje satelita i aviona zahteva određeno vremensko trajanje, sprovođenje odgovarajuće procedure kao i ekonomsku naknadu za svaki od načinjenih letova. Ovako organizovani letovi za potrebe snimanja proizvodnih površina ne mogu se ponavljati iznova i iznova. Praktično, primenom aviona i satelita nije moguće ponavljanje leta nad istom površinom više puta u toku dana.

U poređenju sa upotrebom satelita i aviona, dronovi nude mehanizam rada koji je značajno jednostavniji. Pored jednostavnosti upotrebe još jedna od prednosti kojom se dronovi izdvajaju jeste i opremljenost velikim brojem senzora različite namene i funkcionalnosti. Neki od senzora kojima su dronovi opremljeni su optički senzori, infrared senzori, senzori za radio detekciju, nivelaciju, pozicioniranje i izbegavanje prepreka itd. Pored senzora, dronovi su opremljeni različitim tipovima kamera. Neke od kamera koje se mogu naći kao standardna ili dodatna oprema dronova su kamere za snimanje RGB spektra, NIR, RE, MultiSpec i ThermoMap kamere. Upotrebom dronova otklanja se glavni nedostatak upotrebe satelita i aviona, a to je ponovna i višestruka upotreba za snimanje konkretne proizvodne poljoprivredne površine. Pritom, ponavljanje procesa snimanja upotrebom dronova dobija se po znatno nižoj ceni [3].

Dronove karakterišu i male dimenzije, laka prenosivost sa jedne lokacije na drugu, kao i mogućnost brzog i jednostavnog sklapanja na konkretnoj lokaciji. Takođe, karakteriše ih i brza upotreba, i za razliku od ostalih bespilotnih letelica mali prostor na zemlji za potrebe poletanja i sletanja. Bez obzira na činjenicu da upotreba dronova zauzima značajnije mesto u poslednjih nekoliko godina, dronovi su zvanično u komercijalnoj upotrebi prisutni još od 1980. godine. Neke od oblasti primene dronova u poljoprivredi su zasnovane na obradi fotografija načinjenih ovim letelicama i dobijanju značajne količine informacija o stanju useva na poljoprivrednim površinama. Takođe, oni se koriste i za potrebe obavljanja određenih poljoprivrednih procesa kao što su hemijska zaštita, setva i prihrana.

2. OBLASTI UPOTREBE DRONOVA U POLJOPRIVREDI

Zahvaljujući prednostima kojima se odlikuje, praktična primena dronova u različim oblastima privrede i industrije je sve više zastupljena i beleži značajnu ekspanziju u razvoju. Uz automatizaciju poljoprivredne proizvodnje primenom novih tehnologija, prepoznaje se i upotreba dronova za dalja unapređenja. Neke od mogućnosti primene dronova u okviru poljoprivredne proizvodnje uključuju: praćenje stanja useva i mapiranje proizvodnih površina, klasifikaciju biljaka na proizvodnim površinama, praćenje pojave bolesti i štetočina, detekciju površina na kojima je došlo do pojave stresa kod biljaka usled prevelike količine vode ili prisustva drugih faktora, detekciju površina na kojima je potrebno izvršiti zalivanje ili odvodnjavanje, procenu biomase biljaka, kao i monitoring korovskih zajednica prisutnih na proizvodnim površinama [4].

Praćenje stanja useva na proizvodnim površinama predstavlja jednu od redovnih aktivnosti u poljoprivrednoj proizvodnji. Izazovi praćenja stanja useva povećavaju se usled sve prisutnijih klimatskih promena, i nepredvidivih vremenskih uslova. Tradicionalno posmatranje gajenih biljaka posebno useva na proizvodnim površinama obavlja se odlaskom i obilaskom istih. Ukoliko se radi o velikim proizvodnim površinama, kao i ukoliko se radi o njihovoj razuđenosti na veći broj lokacija, obilazak zahteva izvesno utrošeno vreme. U isto vreme nepovoljni vremenski uslovi mogu odložiti obilazak proizvodnih površina i time onemogućiti blagovremenu detekciju potencijalnih problema u proizvodnji. Upotreba dronova opremljenih odgovarajućim setom senzora nudi poljoprivrednim proizvođačima mogućnosti praćenja i nadgledanja proizvodnih površina svakoga dana bez obzira na veličinu parcela i vremenske uslove. Na primer, pomoću drona se može obaviti let iznad celokupne proizvodne površine za svega nekoliko minuta. Na osnovu načinjenih fotografija tokom ovakvog leta poljoprivredni proizvođač dobija tačne informacije o stanju useva [5]. Pritom, eliminisan je tradicionalni obilazak cele parcele, što značajno redukuje utrošeno vreme. Obrada kreiranih fotografija i evidentiranih prostorno vremenskih podataka primenom kompijuterske vizije i data mining metoda, mogu se kreirati modeli preciznog razvoja useva. Takođe, adekvatnom obradom prikupljenih podataka mogu se detektovati neefikasnosti proizvodnje, što omogućava blagovremeno reagovanje i upravljanje usevima.

Dronovi opremljeni hiperspektralnim, multispektralnim ili termalnim senzorima pogodni su za korišćenje u domenu detektovanja na kom delu proizvodne površine se javlja nedostatak vlage, kao i eventualno prisustvo veće količine vode. Nedostatak vlage u zemljištu kao i veće prisustvo vode mogu uzrokovati stres kod biljaka, kao i probleme sa normalnim fiziološkim razvićem. Na ovakav način se vrši blagovremeno detektovanje delova proizvodnih površina na kojima je potrebno obaviti navodnjavanje ili pak odvodnjavanje. Dodatno, nakon nicanja biljaka, a u toku procesa rasta, korišćenje dronova omogućava izračunavanje vegetativnog indeksa [2]. Vegatativni indeks opisuje relativnu gustinu nicanja useva i njegovo zdravstveno stanje. Takođe, na osnovu vegetativnog indeksa može se odrediti količina energije ili toplote koju kultura emituje. Svi navedeni parametri koriste se u procesu procene fiziološkog stanja biljaka. Dobijeni podatak o gustini nicanja biljaka nosi u sebi informaciju o tome na kojim delovima površine je potrebno izvršiti prihranu kojom količinom đubriva, kao i o prvim procenama očekivanog prinosa.

Procena zdravstvenog stanja biljaka od velike je važnosti u pogledu blagovremenog detektovanja pojave bolesti i štetočina i njhovog adekvatnog suzbijanja. Upotrebom dronova opremljenih za snimanje proizvodnih površina korišćenjem vidljivog i infrared (NIR) dela spektra, može se detektovati koje biljke reflektuju različitu količinu zelene svetlosti i NIR svetlosti, a uz procenu vlažnosti zemljišta, dobijaju se multispektralne slike proizvodnih površina kojima se prate promene na biljkama kao indikatori njihovog zdravstvenog stanja. Aktivno praćenje omogućava brzo reagovanje u slučaju detekcije pojave bolesti što može povećati sposobnost biljaka da se izbore sa bolestima. Ukoliko pak usled pojave bolesti dođe do propadanja biljaka, načinjeni snimci kao i podaci dobijeni na osnovu ovih snimaka mogu poslužiti kao dokaz kod osiguravajućih kompanija. Primena u praksi pokazuje da su dronovi veoma korisni kada se radi o davanju tačne procene u gubicima na proizvodnim površinama prouzrokovanim kako pojavom bolesti i štetočina, tako i vremenskim nepogodama u vidu grada i mraza. Praktično, ovakvi podaci dobijeni snimanjem konkretnih površina predstavljaju digitalne dokaze [6].

Mapiranje proizvodnih površina u cilju evidencije zasejanih biljnih kultura može se obaviti upotrebom dronova. U isto vreme pored evidencija o biljnim kulturama zasejanim na konkretnim površinama, na osnovu načinjenih snimaka može se izvršiti i monitoring korovskih zajednica prisutnih na datim površinama. Na ovakav način se eliminiše potreba za hemijskim tretmanima nad celim površinama, već se tretman može vršiti samo nad površinama na kojima je evidentirano prisustvo korovskih zajednica.

Nabrojane mogućnosti primene dronova zasnivaju se na obradi fotografija i video zapisa dobijenih preletom iznad proizvodnih površina. Let iznad proizvodnih površina obavlja se prema unapred definisanim putanjama. Odgovornost za praćenje putanja i kontrolisanje leta može biti dvostruko regulisna. Jedan od vidova moguće realizacije jeste kontrolisanje leta letelice od strane lica sa zemlje, dok drugi način predstavlja autonomni let letelice korišćenjem sistema za pozicioniranje. Ostvareni cilj se ogleda u uspešnom snimanju celokupne proizvodne površine praćenjem unapred zadatih putanja, kako ne bi došlo do izostavljanja nekog dela površine.

Pored primene dronova u domenu kreiranja fotografija i video zapisa proizvodnih površina, sve češća primena ovih tipova letelica ogleda se u: vršenju hemijske zaštite biljaka, analizi zemljišta, kao i obavljaju setve biljaka. Pored bespilotnih letelica poznatih kao dronovi, u ovu kategoriju se takođe ubrajaju i bespilotni helikopteri.

Upotreba dronova u oblasti hemijske zaštite biljaka ogleda se u snimanju površine pod gajenim biljkama i donošenju odluke na kojim delovima površine je potrebno uraditi hemijsku zaštitu. Nakon donošenja odluke, korišćenjem adekvatne opreme, dron može podesiti svoju visinu i položaj u odnosu na površinu zemlje i izvršiti hemijsku zaštitu prskanjem odgovarajuće količine hemijskog preparata. Prednost upotrebe ovakvog načina hemijske zaštite ogleda se u efikasnoj hemijskoj zaštiti u realnom vremenu, uz minimalni utrošak vremena i redukciju utrošene količine hemijskih sredstava.

Na ovakav način se vodi računa o zaštiti životne sredine i posebno se umanjuje mogućnost zagađenja podzemnih voda. Stručnjaci procenjuju da poljoprivredni dronovi mogu obaviti hemijsku zaštitu zaprašivanjem do četrdeset puta brže nego što je to slučaj sa tradicionalnim zaprašivačima. Pritom, upotrebom dronova za potrebe hemijske zaštite može se uštedeti do 90% vode, kao i od 30% do 40% pesticida. Samim tim mali dijametar pokrivenosti doprinosi boljoj pokrivenosti površine, kao i uspešnijoj zaštiti. Svakako neizostavna je i činjenica da u procesu zaštite nema direktne aktivnosti čoveka. Praktično, lice koje upravlja dronom nalazi se na bezbednoj udaljenosti od površine koja se zaprašuje, tako da se znatno redukuje uticaj pesticida na čoveka.

Pored hemijske zaštite dronovi su takođe u upotrebi i kada se radi o analizi zemljišta. Njihovom upotrebom vrši se mapiranje zemljišta u skladu sa količinom hranljivih materija u zemljištu. Ovakva informacija otvara

mogućnosti analize zemljišta u domenu određivanja kultura koje je moguće posejati na konkretnoj površini. Takođe, nakon sejanja, analiza zemljišta obavljena drnovima obezbeđuje podatke za potrebe prihrane i navodnjavanja gajenih biljaka. Praktično, na osnovu uzoraka zemljišta i analize zemljišta moguće je odrediti koji delovi su podložniji isparenju, a samim tim se na datim površinama javlja veća potreba za navodnjavanjem.

Setva gajenih biljaka predstavlja jednu od složenih i vremenski zahtevnih poljoprivrednih procesa. Upotreba dronova za potrebe setve dostigla je stopu uspešnosti od 70%. Pritom, upotrebom dronova dolazi do smanjenja troškova setve čak do 85%. Praktično, setva se obavlja tako što dronovi ispaljuju mahune sa semenom i biljnim hranivom u zemlju, obezbeđujući na taj način biljci sve hranljive sastojke potrebne za osnovne životne potrebe.

3. KATEGORIZACIJA DRONOVA

Unapređenje procesa poljoprivredne proizvodnje može se obaviti korišćenjem dva tipa bespilotnih letelica ili dronova. Jedan od tipova predstavljaju dronovi sa fiksnim krilima, dok drugi od tipova predstavljaju kvadkopteri ili takozvani multi rotor dronovi. Jedni i drugi se odlikuju različitim setom opreme, različitim načinom rada, pa samim tim i različitom namenom. Osnovne razlike između ova dva tipa dronova ogledaju se najpre u načinu poletanja i sletanja, brzini leta, kao i maksimalnom vremenskom trajanju leta. Dronovi sa fiksnim krilima najčešće poleću lansiranjem iz ruke korisnika, dok multirotor dronovi mogu poletati sa zemlje vertikalno naviše. Što se tiče procesa sletanja, dronovi sa fiksnim krilima za proces sletanja zahtevaju veću površinu na kojoj će se uz smanjenje visine spustiti po zemlji. Multi rotor dronovi sletanje obavljaju spuštanjem vertiklano naniže sve do nivoa zemlje, tako da im za sletanje ne treba više površine od one koju sami zauzimaju. Ukoliko se ove dve kategorije uporede po brzini i maksimalnom trajanju leta uočava se da dronovi sa fiksnim krilima ostvaruju manju maksimalnu brzinu letenja, ali pritom imaju veće maksimalno vreme leta, čime je obezbeđena veća površina koju ovi dronovi mogu pokriti. Multirotor dronovi karakterišu se i mogućnošću podizanja određenog tereta, čime je omogućena bolja opremljenost kamerama, kao i opremom za zaprašivanje i prihranu biljaka. Sa druge strane, dronovi sa fiksnim krilima nemaju mogućnost podizanja većeg tereta, pa je samim tim ograničena mogućnost njihovog dodatnog opremanja kamerama i potrebnim senzorima.

Jedan od predstavnika dronova sa fiksnim krilima je *Sensefly eBee*. Ovaj dron karakteriše se ekonomičnošću s obzirom na male dimenzije i kvalitetan sistem za snimanje. Osnovna verzija ovog drona obuhvata opremljenost infracrvenom kamerom. Takođe, kao dodatan vid opreme može se instalirati kamera za kreiranje 3D termalne mape prostora [7]. Putanja leta ovog drona može se odrediti korišćenjm računara sa zemlje. Praktično, letelica se putem kreiranog softvera dostupnog korisnicima povezuje sa računarom, čime je omogućeno podešavanje putanje pre početka leta ovog drona. Kreirani softver omogućava i menjanje prvobitne putanje tokom trajanja leta. Tokom jednog trajanja leta ovaj dron može preleteti između 22km^2 i 40km^2. Oblast pokrivenosti tokom jednog leta uslovljena je visinom leta i težinom opreme. Tehnički podaci pokazuju da maksimalno vreme leta iznosi 59 minuta, dok je rezolucija na tlu do 1cm po pikselu [8].

Jedan od možda najpoznatijih predstavnika multi rotor dronova, komercijalno dostupan na tržištu i širokog spektra namene svakako je DJI Phantom 4 Pro. Ovaj dron se odlikuje velikom brzinom leta od maksimalnih 72 km/h. Pritom, velika brzina leta mu omogućava let pri velikoj udaljenosti od lica zaduženog za upravljanje letelicom. Maksimalna udaljenost između letelice i daljinskog upravljača je do 7 km. Letelica je opremljena sa tri seta vizuelnih sistema koji imaju zadatak da u trodimenzionalnom prostoru mapiraju i vode računa na prepreke ispred, iza i ispod letelice, kako bi se izbegli sudari (detektuju se objekti udaljeni i do 30 m od drona). Osim ova tri seta sistema, sa obe strane Phantom 4 Pro nalaze se infracrveni sistemi za detekciju prepreka, koji mogu da primete strana tela na udaljenosti od 0.2 do 7 m od drona. Pored standardne funkcionalnosti za povratak do bazne stanice, ovaj model sadrži i takozvanu *Landing Protection* opciju koja vodi računa da prilikom sletanja letelica ne sleti na neravan teren ili u vodu. Ovaj dron opremljen je kamerom visoke rezolucije čime je obezbeđeno snimanje 4K videa. Kvalitet videa uz metapodatke prikupljene ostalim senzorima daje velike mogućnosti u pogledu kreiranja mapa terena, klasifikacije biljaka kao i određivanja zdravstvenog stanja biljaka na osnovu NDVI indeksa [9].

Dron oznake M6E-X firme *Bejing TT Aviation Technology* jedan je od predstavnika multi rotor dronova namenjenih upotrebi u poljoprivredi za potrebe obavljanja hemijske zaštite i prihrane biljaka. Praktično, za pomenute namene koristi se jedna letelica, pri čemu se vrši montaža odgovarajućeg uređaja u zavisnosti od toga da li je potrebno vršiti hemijsku zaštitu ili prihranu

biljaka. Zapremina kontejnera u koji se smeštaju pesticidi iznosi 10 litara. Pritom, maksimalno vreme leta sa punim kontejnerom iznosi 11 minuta, dok maksimalno vreme leta sa praznim kontejnerom iznosi 30 minuta. Maksimalna brzina leta iznosi 15m/s, dok je maksimalna visina leta limitirana na 3500 m. Prečnik dizne za raspršivanje preparata iznosi 60 - 180μm. Radna efikasnost ovog drona je 1,8 do 2,5 hektara / 10 min pri brzini zaprašivanja od 4,8 – 6 m/s [10]. Ovakva primena omogućava efikasnu hemijsku zaštitu uz visok procenat zaštite korisnika.

4. PRIMERI UPOTREBE DRONOVA U POLJOPRIVREDI

Primeri upotrebe dronova u poljoprivredi sve su učestaliji. Tokom 2014. godine u Južnoj Africi korišćene su male bespilotne letelice za potrebe kreiranja snimaka vinograda i procene zdravstvenog stanja nakon svake prihrane organskim đubrivom. Najpre je pomoću dronova rađeno mapiranje površina na kojima je bilo potrebno primeniti prskanje organskim đubrivom. Nakon toga bi na osnovu kreiranih mapa bila vršena prihrana, a nakon prihrane rađeno je novo mapiranje. Ponavljanjem postupka mapiranja vršeno je poređenje dobijenih slika. Počevši od 2015. godine novi set zakona koji reguliše ovu oblast u Južnoj Africi stupio je na snagu. Prema novom setu zakona za svako lice koje upravlja dronovima zahteva se pilotska dozvola, licenca izdata od strane Ministarstva saobraćaja, kao i odobrenje za upotrebu svakog pojedinačnog drona.

Tokom 2016. godine u Indiji dronovi su korišćeni kako bi se odredilo koliko površina pod kafom je zasejano. Takođe, snimanjem proizvodnih površina dobijeni su podaci o tome kolika je gustina biljaka na posejanim površinama, a sve u cilju određivanja mogućeg očekivanog prinosa ove biljke. U istoj godini objavljen je pravilnik kojim se reguliše korišćenje dronova i ostalih bespilotnih letelica. Ovim pravilnikom predviđeno je da svaka bespilotna letelica mora da ima jednistveni registracioni broj. Takođe svaki od operatera mora da ima dozvolu za upravljanje letelicom, kao i osiguranje za svaku konkretnu letelicu koja leti na visini većoj od 120m.

U Japanu su dronovi korišćeni za potrebe hemijske zaštite. Tokom jednog ciklusa zaštite bilo je više od dva miliona časova leta. Težina korišćenog drona iznosila je 94kg. Hemijska zaštita obavljana je korišćenjem principa unapred definisane putanje i GPS navigaciong sistema. Na teritoriji Japana 2015. godine stupila su na snagu nova pravila za korišćenje dronova. Prema ovim pravilima, dozvola za upravljanje dronom potrebna je samo u slučaju kada je visina leta veća od 150 m iznad zemlje, u blizini aerodroma ili iznad gusto naseljenih mesta. U suprotom, let se mora obavljati danju, na minimalnoj daljini od 30m van prostora gde se okuplja veći broj ljudi.

5. PRAVNE REGULATIVE PRIMENE DRONOVA

Upotreba dronova kako u komercijalne svrhe, tako i domenu poljoprivrede, regulisana je vazduhoplovnim propisima. Vazduhoplovni propisi u pogledu upotrebe dronova razlikuju se u zavisnosti od regiona. Tako na primer, u Nemačkoj nije potrebna bilo kakva dozvola za rukovanje letelicom ukoliko njena masa ne prelazi 5 kg, pri letu u kome udaljenost letelice od daljinskog upravljača nije veća od 1,5km. [11].

U Americi je za upravljanje ovakvim letelicama potrebno posebno odobrenje prilikom svakog poletanja. Takođe se zahteva da svako lice koje upravlja letelicom poseduje pilotsku dozvolu za upravljanje određenim tipom bespilotnih letelica. Slično Americi, u Kanadi je takođe potrebno posebno odobrenje koje se može dobiti usmeno od kontrole vazdušnog saobraćaja kojoj pripada područje na kome se sprovodi let. Takođe, pored obobrenja za konkretan let, lice koje upravlja letelicom mora da prođe određenu vrstu obuke. U sklopu dozvole za upravljanje, obavezna je i uplata osiguranja koje pokriva slučajeve pada letelice, jer može dovesti do povređivanja ljudi, životinja kao i do materijalne štete nad objektima [12].

U Republici Srbiji u skladu sa članom 8. Konvencije o međunarodnom civilnom vazduhoplovstvu (Čikaška konvencija) nijedan vazduhoplov kojim se može upravljati bez pilota ne sme da preleće teritoriju Republike Srbije bez posebnog odobrenja ili suprotno uslovima iz tog odobrenja. Bespilotni vazduhoplovi se mogu koristiti u privredne, naučne, obrazovne, sportske i druge svrhe tako da ne ugrožavaju bezbednost vazdušnog saobraćaja [13]. Za eventualnu štetu koja je nastala usled korišćenja bespilotnih vazduhoplova je odgovorno lice koje koristi bespilotni vazduhoplov. Članom 1 pravilnika o bespilotnim vazduhoplovima definisano je da se bez ikakve dozvole na teritoriji Republike Srbije može upravljati jedino vazduhoplovima čija je operativna masa manja od 0.5 kg, ako njihova brzina ne prelazi 20 m/s i koji dostižu maksimalno do 15 m dužine leta i maksimalnu visinu do 10 m. Sve ostale bespilotne letelice su podeljene u četiri kategorije prema tehničkim karakteristikama. Za svaku od kategorija definisan je

set odobrenja i dozvola koje lice koje upravlja letelicom mora da ima prilikom upravljanja. Bespilotim letelicama svrstanim u sve četiri kategorije može se upravljati bez dozvole za poletanje izdate od strane Direktorata za civilno vazduhoplovstvo, isključivo u slučajevima kada se bespilotna letelica koristi samo danju, pri čemu sve vreme mora da bude u vidnom polju lica koje njome upravlja. Maksimalna dozvoljena visina leta bespilotne letelice u ovakvom slučaju je 100 m iznad tla. Maksimalna dozvoljena horizontalna udaljenost bespilotne letelice od lica koje upravlja bespilotnom letelicom je 500 m. Takođe, bez obzira na kategoriju kao ni na odobrenje leta od strane Direktorata za civilno vazduhoplovstvo nije dozvoljeno korišćenje bespilotne letelice čija je operativna masa veća od 150 kg, kao i bespilotne letelice čiji je let u potpunosti kontrolisan od strane računara koji se nalazi u letelici. Članom 12 pravilnika definisano je da lice koje upravlja bespilotnom letelicom koja se koristi u privredne svrhe, kao i lice koje upravlja bespilotnom letelicom kategorije 2, 3 i 4 može da bude samo punoletno lice koje je zdravstveno sposobno i koje je položilo proveru znanja iz predmeta vazduhoplovni propisi [14]. Članom 15 pravilnika definisano je da prilikom upravljanja bespilotnom letelicom lice koje upravlja letelicom mora kod sebe da ima uputstvo proizvođača za korišćenje bespilotne letelice, kao i original ili overenu kopiju odobrenja Direktorata za konkretnu letelicu, akt o prihvatanju izjave o osposobljenosti, kao i potvrdu o položenoj proveri znanja. U cilju vođenja pravilne evidencije o bespilotnim letelicama na teritoriji Republike Srbije sve bespilotne letelice koje se koriste u privredne svrhe, kao i bespilotne letelice kategorije 2, 3 i 4 koje se koriste u neprivredne svrhe, upisuju se u Evidenciju vazduhoplova [15]. Ukoliko se izvrši poređenje zakonskih regulativa Republike Srbije sa drugim zemljama, može se uočiti velika sličnost. Sličnost se ugleda kako u registraciji dronova, tako i u obaveznom poznavanju vazduhoplovnih propisa od strane operatera letelice. Takođe, prisutna su i poklapanja kada je upitanju udaljenost letelice od aerodroma, visina leta, kao i let u liniji vidljivosti.

6. ZAKLJUČAK

Primena dronova u poljoprivredi obuhvata različite oblasti. U zavisnosti od oblasti primene, zahtevanih funkcionalnosti i specifičnih potreba i uslova rada, vrši se odabir letelice koja će odgovoriti formiranim zahtevima. U procesu odabira letelice pored osnovnih karakteristika letelice po pitanju performansi leta, figuriraju i komponente poput skupa potrebnih senzora, opremljenosti kamerama i opremom za hemijsku zaštitu i prihranu. Trenutno, praktična primena dronova širi se znatno brže od većine industrija. Velike investicije kao i pravne regulative kojima je regulisana upotreba dronova utiču na brzinu razvoja ovih letelica i njihovog korišćenja u domenu poljoprivredne proizvodnje. Posmatrano sa stanovišta pravnih regulativa kojima se reguliše upotreba dronova, u pojednim zemljama evidentan je pomak u domenu kreiranja slabijih ograničenja, kako bi upotreba ovih letelica bila jednostavnija i konfornija.

Tehnologija na kojoj se bazira upotreba dronova u okviru poljoprivredne industrije čini poljoprivrednu proizvodnju jednom od visokotehnološki naprednih oblasti. Praktično, korišćenjem dronova prikupljeni podaci se obrađuju u realnom vremenu, čime se vrši aktivno procesiranje i donošenje odluka. Upotreba dronova i analize podataka imaju veliki potencijal pružanja podrške u rešavanju nekih od najozbiljnijih problema sa kojima se suočava poljoprivredna proizvodnja. Takođe, prednosti ovakve upotrebe mogu se smatrati višestrukim.

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PREDLOG METEOROLOŠKE STANICE NAMENJENE UPOTREBI U POLJOPRIVREDNOJ PROIZVODNJI

Majid Hamid Abdullah[1,*],
Žaklina Spalević[1],
Miloš Ilić[2],
Petar Spalević[2],
Nenad Stanojević[2]

[1]Univerzitet Singidunum,
Beograd, Srbija
[2]Fakultet Tehničkih nauka,
Univerzitet u Prištini sa privremenim sedištem
u Kosovskoj Mitrovici, Srbija

Rezime:
Aktivnosti vezane za poljoprivrednu proizvodnju uslovljene su meteorološkim uslovima. Praćenje promena meteoroloških uslova kao jednog od preduslova u procesu donošenja odluka u okviru poljoprivredne proizvodnje može predstavljati kompleksan problem. Složenost ovog problema nastaje zbog nedostupnosti meteoroloških stanica poljoprivrednim proizvođačima. Rešenje problema ogleda se u kreiranju i korišćenju meteorološke stanice posebno dizajnirane za potrebe praćenja meteoroloških i prostorno vremenskih parametara na proizvodnim poljoprivrednim površinama. Predloženi model meteorološke stanice predstavlja rešenje koje uključuje dovoljan broj senzora za prikupljanje meteoroloških i prostorno vremenskih parametara. U isto vreme realizacija ovakvog rešenja karakteriše se ekonomskim izdacima nekoliko puta manjim od komercijalnih rešenja meteoroloških stanica dostupnih na tržištu.

Ključne reči:
Raspberry Pi, DS18B20, ZigBee XBee, SIM900 GSM/GPRS.

1. UVOD

Precizna poljoprivreda u osnovi se zasniva na praćenju trenutnih meteoroloških parametara i kreiranju što je moguće preciznije predikcije zasnovane na meteorološkim parametrima. U zavisnosti od meteoroloških uslova mogu se razlikovati dnevne aktivnosti kao i aktivnosti koje će se obavljati u nekom budućem periodu. Posmatrano iz ugla meteoroloških promena praćenje meteorloških uslova nastaje kao spoj primene nauke i tehnologije u cilju predikcije stanja atmosfere za datu oblast posmatranja [1]. Korišćenjem sistema za praćenje meteoroloških promena agronomi kao i poljoprivredni proizvođači mogu prikupiti informacije o različitim vremenskim parametrima kao što su: temperatura vazduha, vlažnost vazduha, brzina i smer vetra, količina padavina, itd. Pored pomenutih meteorloških parametara meteorološke stanice mogu vršiti i merenje specifičnih parametara kao što su vlažnost zemljišta, vlažnost lista biljke, itd. Na osnovu trenutnih merenja meteoroloških parametara kao i meranja vršenih tokom dužeg vremenskog perioda u prošlosti, mogu se kreirati precizni modeli izvršenja poljoprivrednih aktivnosti.

Odgovorno lice:
Majid Hamid Abdullah

e-pošta:
majid.hamidabdullah@yahoo.com

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Različiti tipovi meteoroloških stanica, posebno automatizovanih, koriste se za prikupljanje potrebnih podataka. Kada se govori o opremljenosti meteorološke stanice u cilju adekvatnog korišćenja svaka od meteoroloških stanica trebalo bi da bude opremljenja odgovarajućom grupom senzora. Skup senzora kojima će konkretna meteorloška stanica biti opremljena zavisi od unapred definisane namene.

Prostorno vremenski parametri pored meteoroloških parametara čine još jednu od bitnijih komponenti u radu meteorloške stanice. Značajnost prostorno vremenskih parametara posebno se ogleda ukoliko na određenom lokalitetu postoji sistem od više meteoroloških stanica. Ovakav sistem u najvećem broju slučajeva povezan je sa jednom jedinstvenom baznom stanicom do koje se vrši slanje izmerenih vrednosti meteoroloških parametara. Prostorno vremenska komponenta svakog od paketa podataka uvodi mogućnost klasterizovanja podataka na osnovu lokacije na kojoj su izmerene date vrednosti kao i na osnovu vremena kada je merenje izvršeno. Na ovakav način ukoliko se na različitim lokalitetima uzgajaju različite kulture omogućeno je preciznije sagledavanje meteorološke situacije posmatranjem isključivo meteoroloških merenja za dati lokalitet.

Izmerene vrednosti meteoroloških i prostorno vremenskih parametara na nekom udaljenom lokalitetu ne znače puno ukoliko se očitavanje istih mora obaviti na samom lokalitetu. Kako se meteorološke stanice namenjene upotrebi u poljoprivredi nalaze na proizvodnim površinama koje su udaljene od mesta stanovanja lica koje prati promenu parametara iste bi trebalo da poseduju mogućnost slanja podataka do bazne stanice. Praktično pored opremljenosti meteorološke stanice potrebnim senzorima ona mora biti opremljena i odgovarajućim hardverom kojim će omogućiti slanje podataka. Uspešno slanje paketa podataka ne sme biti uslovljeno rastojanjem između meteorološke i bazne stanice. Kako je realizacija meteorološke stanice u velikoj meri uslovljena i cenom komponenti dostupnih na tržištu, kada se govori o komponentama koje bi se mogle iskoristiti u cilju realizacije sopstvene meteorološke stanice gotovo sve komponente je moguće kupiti na slobodnom tržištu. Na ovakav način kreiranje sopstvene meteorološke stanice može biti znatno povoljnije od kupovine komercijale stanice nekog od poznatih proizvođača.

Cilj ovog rada orijentisan je ka kreiranju modela meteorološke stanice namenjene upotrebi u poljoprivrednoj proizvodnji. Rad je organizovan na sledeći način. U drugom delu zada opisane su odabrane meteorološke i prostorno vremenske komponente meteorološke stanice. U trećem delu zada dat je opis komponenti za prenos paketa podataka. Dok poslednja dva poglavlja predstavljaju zaključak i popis literature.

2. KOMPONENTE METEOROLOŠKE STANICE

Predloženi model meteorološke stanice kreiran je na bazi opreme dostupne na tržištu sa osvrtom na praktičnu efikasnost i ekonomske izdatke. U cilju odabira najadekvatnijih komponenti izvršena je analiza komponenti dostupnih na tržištu. Analizirane su karakteristike komponenti propisane od strane proizvođača, kao i tržišna cena istih.

Računar meteorološke stanice

Jednu od osnovnih komponentni meteorološke stanice zauzima Raspberry Pi 3 Model B računar koji upravlja radom svih senzora. Raspberry Pi je računar malih dimenzija sa operativnim sistemom na Micro SD memorijskoj kartici. Pored malih dimenzija i niske cene, karakteristike ovog računara ne zaostaju za karakteristikama personalnih računara. Karakteristično za treću generaciju ovog računara je i to da radi na GNU/Linux platformi kao i na Windows 10 platformi [2]. Na ovakav način daje dobru osnovu za eventualno proširenje i komunikaciju sa drugim uređajima. Rad ovog računara zasnovan je na Broadcom BCM2837B0, ARM Cortex-A53 64-bitnom procesoru brzine od 1.4GHz. Ovaj procesor zasniva se na moguća četiri jezgra, pri čemu svako od jezgara sadrži sopstvenu L1 memoriju. Pored L1 memorije procesor poseduje i jednu deljivu L2 memoriju. Povezivanje senzora sa ovim računarom obavlja se preko ulazno izlaznih pinova opšte namene (*eng. General Purpose Input/Output pins - GPIO*) koji se nalaze na ploči računara i kojih ima ukupno četrdeset. GPIO pinovi mogu se konfigurisati kao ulazni pinovi opšte namene, kao izlazni pinovi opšte namene ili kao jedna od šest alterantivnih specijalnih namena. Svih četrdeset GPIO pinova je podeljenje u tri banke u skladu sa pomenutim procesorom. Svaka od banaka ima svoj VDD ulazni pin. Takođe svaka od banaka se napaja sa 3,3V. Od ukupnog broja pinova dva pina pružaju napajanje od 5V, dok takođe dva pina pružaju napajanje od 3,3V. U isto vreme na ploči se nalazi veći broj pinova uzemljenja koji nisu konfigurisani. Sve ostali pinovi su kao što je navedeno pinovi opšte namene čiji je izlaz postavljen na 3,3V dok je ulaz tolerantan do 3,3V. Ovo praktično znači da se pinovi koji su dizajnirani kao izlazni mogu postaviti na napajanje do 3,3V ili manje.

Temperaturni senzor

Poznato je da je jedna od karakteristika temprature vazduha njena oscilacija tokom data. Kako su pojedini poljoprivredni procesi zavisni od dnevnih temperatura veoma je važan i odabir odgovarajućeg temperaturnog senzora. Analiza temperaturnih senzora na osnovu karakteristika datih od strane proizvođača prikazana je u tabeli 1.

Za merenje spoljašnje temperature iz opisane grupe senzora odabran je DS18B20 temperaturni senzor. Ovo je temperaturni senzor koji dolazi postavljen na kraju kabla dužine 91 sm i prečnika 4mm. Dužina kabla omogućava montažu senzora na određenoj udaljenosti od Raspberry Pi uređaja. Takođe sami senzor je vodootporan. Zbog načina povezivanja kao i svoje vodootpornosti savršen je za primenu u spoljašnjim uslovima.

Tabela 1. Poređenje temperaturnih senzora

Oznaka senzora	**Merni opseg [°C]**	**Propisana tačnost [°C]**	**Napajanje [V]**	**Približna cena [din]**
DS18B20	-55 do +125	± 0,5	3,0 – 5,5	1200,00
DS18B20-H	-55 do +125	± 0,5	3,0 – 5,5	1800,00
DS1818-10	-40 do +85	± 8,5	3,3	240,00
DS1822	-55 do +125	± 2,0	3,3 – 5,5	780,00
DS18B20Z	-55 do +125	± 0,5	3,0 – 5,5	768,00

Senzor za merenje temperature i relativne vlažnosti vazduha

Relativna vlažnost vazduha još jedan je od meteoroloških parametara za čije praćenje je potrebno odabrati odgovarajući senzor. Senzori za merenje relativne vlažnosti vazduha najčešće se na tržištu nalaze u kombinaciji sa temperaturnim senzorima. Naime u okviru jednog senzora vrši se kombinovano merenje dva parametra. Upravo iz ovog razloga vršeno je poređene performansi najzastupljenijih kombinovanih senzora za merenje temperature i relativne vlažnosti vazduha. Rezultati analize poređenja dostupnih senzora prikazani su u tabeli 2.

Pored prikazanih razlika između navedenih senzora koje se odnose na merne opsege vlažnosti vazduha i temperature, kao i propisane tačnosti prilikom merenja još jedna od karakteristika kao što je bio slučaj sa temperaturnim senzorom jeste otpornost na vremenske uslove. Ukoliko se posmatra uticaj spoljašnih uslova na rad senzora u grupu senzora otpornih na vremenske uslove mogu se uvrstiti HIH6030 i senzori koji pripadaju seriji SHT1x. Pored sličnih tehničkih karakteristika kojima se odlikuju, kao i činjenice da su oba senzora otporna na vremenske uslove, činjenica koja ih razdvaja jeste cena. SHT1x senzori kao što se može videti iz tabele 2 daleko su skuplji nego što je to slučaj sa HIH6030 senzorom. Međutim detaljnijim poređenjem i istraživanjem utvrđeno je da HIH6030 senzor nije dovoljno otporan na vremenske ulove, tačnije pravilan rad ovog senzora može ometati prašina i kondenzacija.

Dodatna ulaganja u zaštitu ovog senzora od vremenskih uslova, izvedena tako da ne utiču na njegove performanse skoro da bi izjednačila cenu ovog senzora sa cenom senzora iz serije SHTx. Takođe činjenica da senzori serije SHTx dolaze unapred zaštićeni sa mogućnošću povezivanja putem kabla otvara dodatne pogodnosti u njihovom korišćenju. Kako se u ovoj seriji nalaze tri po karakteristikama različita senzora izvršen je odabir jednog. Prema tehničkim karakteristikama SHT15 senzor odlikuje se najpreciznijim merenjima. Pritom opeseg merenja, napajanje i cena ovog senzora su istovetni kao što je to slučaj sa ostalim senzorima ove serije.

Tabela 2. Poređenje senzora za merenje temperature i relativne vlažnosti vazduha

	Relativna vlažnost		Temperatura			
Oznaka senzora	*Merni opseg [%]*	*Propisana tačnost [%]*	*Merni opseg [°C]*	*Propisana tačnost [°C]*	*Napajanje [V]*	*Cena [din]*
SHT15	0 - 100	±2.0	-40 do +120	±0,3	2,4 – 5,0	6000,00
HIH6030	0 - 100	±4,5	-40 do +100	± 0,5	2,3 – 5,5	800,00
DHT22	0 - 100	± 2-5	-40 do +80	± 0,5	3,0 – 5,0	1800,00
SHT10	0 - 100	±4,5	-40 do +120	± 0,5	2,4 – 5,0	6000,00
SHT11	0 - 100	±3.0	-40 do +120	±0,4	2,4 – 5,0	6000,00
AM2315	0 - 100	± 2,0	-20 do +80	± 0.1	3,5 – 5,5	3600,00
DHT11	20 – 80	± 5,0	0 do +50	± 2,0	3,0 – 5,0	600,00

Senzor za merenje količine padavina

Svi uređaji za merenje količine padavina dostupni na tržištu rade na istom principu pa samim tim nije bilo potrebe za nekim detaljnijim analizama i poređenjima. Odabrani uređaj za merenje količine padavina u osnovi je posuda koja se sama prazni. Ovaj uređaj napravljen je kao levkasti sud u kome se sakuplja kišnica i kanališe do posuda za sakupljanje. Kada se sakupi dovoljna količina vode dolazi do prevrtanja posude i njenog pražnjenja. U isto vreme posuda na suprotnoj strani se pozicionira u položaj za punjenje. Količina vode koja je potrebna da bi izvršila prevrtanje posude i njeno pražnjenje iznosi 0,2794mm kiše. Dati podatak pokazuje da je uređaj projektovan tako da evidentira i male količine padavina. Sa svakim pražnjenjem posude vrši se i zatvaranje električnog kola pomuću prekidača što se evidentira pomoću digitalnog brojača ili prekidom mikrokontrolera. Praktično svako pražnjenje uzrokuje inkrementiranje brojača. Ukupna količina padavina za dati period izračunava se množenjem vrednosti brojača i količine vode potrebne za iniciranje pražnjenja. Unutar grebena između pomenute dve posude nalaizi se mali cilindrični magnet koji pokazuje prema zadnjem zidu. U samom zadnjem zidu nalazi se pomenuti prekidač. Praktično kada se jedna od posuda prevrne magnet prolazi prekidač i uzrokuje njegovo trenutno zatvaranje. Ukoliko je prekidač povezan sa GPIO pionom na mikrokontroleru njegovo zataranje će generisati niski signal koji se može otkriti i evidentirati kao inkrement za jedan. Ovakav uređaj za merenje količine padavina može se povezati na dva načina. Uobičajeno dolazi opremljen RJ11 priključkom iako koristi samo dve žice, jednu crvenu i jednu zelenu. Praktično ukoliko na mikrokontroleru postoji mogućnost povezivanja preko RJ11 utikača isti se može iskoristiti. Sa druge strane ukoliko ovakva mogućnost ne postoji može se povezati preko ulazno izlaznih pinova opšte namene uklanjanjem utikača i povezivanjem pomoći žica. Prednost ovog uređaja je rad bez spoljašnjeg napajanja. Praktično rad uređaja je zasnovan na mehaničkim principima pa samim tim ne zahteva bilo spoljašnje napajanje bilo napajanje preko mikrokontrolera.

Senzor za merenje brzine i smera vetra

Senzor za merenje brzine vetra tradicionalno se naziva anemometar i sastoji se od nekoliko polulopti koje pod uticajem vetra rotiraju na zajedničkoj osovini. U najvećem broju slučajeva najprostiji mehanizam rada zasniva se na mehaničkom delovanju magneta na prekidač kao što je to bio slučaj sa senzorom za količinu padavina. U tabeli 3 dato je poređenje različitih anemometra dostupnih na tržištu.

Kao što se može videti iz date tabele osnovna razlika između navedenih anemometra zasniva se na preciznosti merenja, izlaznom signalu kao i na osetljivosti samog anemometra. Pod osetljivošću anemometra smatra se minimalna jačina vetra koja je potrebna da pokrene rotaciju i samim tim inicira merenje. Za potrebe realizacije meteorološke stanice odabran je Adafruit1733 anemometar. Značajno za odabrani anemometar s obzirom da je namenjen primeni na otvorenom jeste da je otporan je na uticaj vremenskih uslova, koroziju kao i uticaj vlage. Materijali od kojih je napravljen obezbeđuju

trajnost uređaja kao i tačnost prilikom merenja brzine vetra. Tačnost ovog anemometra kao što se može videti veoma je zadovoljavajuća i iznosi ±1m/s. Brzina vetra potrebna za pokretanje merenja kod ovog tipa anemometra obezbeđuje merenje vetra gotovo najmanje jačine. Maksimalna brzina vetra koju dati anemometar može evidentirati daleko je viša od brzine vetra potrebne za istraživanja u oblasti predikcije i iznosi 70m/s. Takođe za pomenuti senzor definisano je i ograničenje u vidu maksimalne spoljašnje temperature na kojoj anemometar može raditi i koja iznosi od -40°C do +80°C. Odabrani anemometar dolazi sa kablom za napajanje i prenos očitanih vrednosti dužine 3m, što omogućava njegovo pozicioniranje na vrh nosača.

Tabela 3. Poređenje senzora za merenje brzine i smera vetra

Ознака	**Стартна брзина [m/s]**	**Мерни опсег [m/s]**	**Тачност [m/s]**	**Излазни сигнал [V]**	**Цена [din]**
Adafruit1 733	0,2	0,5 - 70	± 1	0,4 - 2	5500,00
BAN 1093558	0,2 - 0,4	0,2 - 32,4	± 1	0,4 - 2	6200,00
JL-FS2	0,4 - 0,8	0,0 - 30	± 1	0 - 5	8000,00
Met One 010C	0,22	0,0 - 50	± 0,07	11	29000,00
Met One 013	0,45	0,0 - 67	± 0,11	11	20000,00

Pokazivač smera vetra još jedan je od senzora koji spadaju u grupu meteoroloških senzora. Posmatrano iz domena funkcionalnosti može se smatrati da je ovaj senzor možda i najsloženiji od svih meteoroloških senzora. Ukoliko se posmatra mehaničko rešenje ovog senzora pri čemu bi isti radio bez dodatnog ulaznog napajanja pokazivač smera vetra sastojao bi se od osam preklopnika od kojih je svaki povezan sa različitim otpornikom. Svaki od osam otpornika ima različitu otpornost, što obezbeđuje šesnaest različitih mogućih kombinacija otpornosti. Magnet u okviru pokazivača pravca vetra prilikom rada može zatvoriti dva preklopnika od jednom što omogućava pokazivanje do 16 različitih pozicija. Ovo se praktično dešava u momentima kada je pozicioniran na pola puta između dva preklopnika. Kako bi se očitao pravac vetra sa pokazivača pravca vetra potrebno je izmerenu otpornost dobijenu sa senzora konvertovati u analognu vrednost. Umesto direktnog merenja otpornosti jednostavniji pristup je merenje napona na pokazivaču pravca koji varira u odnosu na to koja kombinacija otpornika je trenutno uključena u kolo pomoću preklopnika. Ovo praktično znači da se vrši merenje analogne vrednosti. Praktično pokazivač pravca će konstantno kao izlaznu vrednost davati opseg napona. Na ovakav način kreira se izlazni napon koji se može izmeriti pomoću A/D konvertora. Potreba za korišćenjem dodatnog A/D konvertora proizilazi iz činjenice da Raspberry Pi poseduje samo digitalne ulaze. Jedan od popularnijih A/D konvertora je MCP3008. Integrisano kolo ovog konvertora sastoji se od 16 pinova sa 8 analognih ulaza koji se mogu koristiti kao kolo za konverziju. Takođe poseduje 10-bitni ADC što praktično znači da ima 1024 mogućih izlaznih vrednosti za referentni napon od 5V. Najmanja vrednost promene napona koju ovaj konverter može detektovati iznosi 5V/1024=4.88 mV.

Senzor za merenje vlažnosti zemljišta

Uloga senzora za merenje vlažnosti zemljišta ogleda se konstantnom merenju količne vode u zemljištu u cilju održavanja odgovarajuće vlažnosti potrebne za pravilan uzgoj biljaka. Senzor za merenje vlažnosti zemljišta postavlja se ispod nivoa zemlje na unapred definisanoj dubini. Dubina postavljanja senzora zavisi od biljne vrste koja se gaji na datoj površini. Princip rada senzora za merenje vlažnosti zemljišta dostupnih na tržištu zasniva se na dve sonde. Kroz sonde se u zemlju prenosi električna energija, nakon čega se na osnovu izmerene otpornosti izračunava nivo vlage. Veća vlažnost zemljišta omogućava bolju provodnost, a samim tim i manju otpornost, dok suva zemlja slabo provodi električnu energiju zbog većeg otpora. Senzori za merenje vlažnosti zemljišta dostupni na tržištu istovetnih su karakteristika. Presudni parametar u odabiru odgovarajućeg bila je cena. Za potrebe realizacije modela meteorološke stanice odabran je Octopus senzor za merenje

vlažnosti zemljišta. Ovaj senzor napaja se konstantnim napajanjm od 3,3V do 5V što odgovara potrebama realizacije meteorološke stanice s obzirom na činjenicu da se napajanje može vrštiti direktno sa Raspberry Pi uređaja ili sa spoljašnjeg napajanja. Izlazni signal kojim se prenosi izmerena vrednost je u granicama od 0 – 4,2V što takođe odgovara potrebama realizacije modela.

Senzor za merenje vlažnosti lista

Pojava vlažnosti lista biljke izučava se decenijama unazad posebno u oblasti fitopatologije i poljoprviredne meteorologije. Direktno merenje vlažnosti lista je veoma problematično, jer je veoma teško povezati senzor na list biljke. Sama pozicija lista, njegova izloženost suncu kao i zdravstveno stanje stalno su promenljivi. Kako bi se izbegli ovi problemi razvijeni su senzori koji vrše procenu moguće vlažnosti listova u čijoj se blizini nalaze. Princip rada ovih senzora zasniva se na merenju dialektrične konstante gornje površine senzora. Ovakav senzor može detektovati prisustno najmanje količine vode ili leda na svojoj površini. Kako se na tržištu mogu naći različiti senzori za merenje vlažnosti lista u tabeli 4 su prikazani analizom obuhvaćeni senzori.

Iz grupe analiziranih senzora prikazanih u tabeli 4 na osnovu potrebni karakteristika odabran je Decagon senzor. Princip rada ovog senzora zasniva se na detekciji promene električne otpornosti između pozlaćenih elemenata mreže od koje je napravljen. Praktično kao i ostali senzori ove grupe decagon senzor merei dielektričnu konstantu u zoni približno 1cm iznad površine senzora. Poznato je da je dielektrična konstanta vode 80, leda 5, što je znatno veće od dielektrične konstante vazduha koja iznosi 1.

Tabela 4. Poređenje senzora za merenje vlažnosti lista

Oznaka	Napajanje [V]	Izlazni napon [mV]	Radna temperatura [°C]	Dužina kabla [m]
Decagon	2,5 - 5	320 - 1000	-20 do +60	5
PHYTOS 31	2,5 - 5	320 – 1250	-40 do +50	5
Vantage Pro	3,0	2500 – 3000	-20 do +60	5
ADCON Wet	2,2 – 12,0	0 - 2500	-20 do +60	3
260-RK300-04	12,0 – 24,0	0 - 5000	-40 do +70	3

Senzor emituje signal u mV koji je proporcionalan dielektričnoj vrednosti u zoni merenja, i samim tim proporcionalan količini vode ili lega na površini senzora. Debljina fiberglasa od koga je napravljen ovaj senzor iznosi 0,65mm što je približno debljini lista biljke. Ukoliko je toplota lista procenjena na 1425J m^{-2} K^{-1}, a njegova debljina na 0.4mm onda je kapacitet toplote senzora s obzirom na njegovu debljinu 1480J m^{-2} K^{-1}. Upravo iz ovog razloga kondenzacija vlage na senzoru kao i njeno isparenje se odigrava istom brzinom kao na normalnom lišću. Vremenski period jednog očitavanja iznosi 10ms. Ovaj senzor može se montirati na samoj meteorološkoj stanici ili u okviru biljke među njenim lišćem. Ukoliko se senzor montira na biljci dužina kabla može se povećati u odnosu na inicijalnih 5m bez uticaja na samo merenje i prenos očitanih vrednosti. Proces povezivanja senzora može se realizovati na dva načina. Prvi od načina je korišćenje Decagon data logera, dok je drugi od načina korišćenje nekog drugog uređaja u zamenu za data loger. Kako se u slučaju predloženog modela meteorološke stanice ne koristi Decagon data loger potrebno je prekinuti originalni priključak i povezivanje uraditi pomoću žica koje se nalaze u samom kablu.

Komponente za prikupljanje prostorno vremenskih parametara

Prostorno vremenska komponenta svakog od paketa podata poslatih sa metorološke stanice do bazne stanice kao što je ranije navedeno značajna je u domenu postojanja sistema meteoroloških stanica povezanih na jednu baznu stanicu. Pritom ove dve komonente se mogu razdvojiti na prostornu i vremensku komponentu. Bez obzira da li postoji jedna ili više meteoroloških stanica vremenska komponenta značajna je zbog evidentiranja vremena očitavanja parametra, kao i praćenja promena meteorloških vrednosti tokom perioda trajanja dana.

Prostorna komponenta sa druge strane nije potrebna ukoliko postoji samo jedna meteorološka stanica i ukoliko je ona uvek na istoj lokaciji. Prostorno vremenska komponenta je uključena u okviru modela meteorološke stance upravo zbog postojanja potrebe za realizacijom sistema koji sadrži više od jedne meteorološke stanice. Za potrebe određivanja prostorno vremenskih koordinata u model meteorološke stanice uveden je GPS modul. Zbog postojanja većeg broja hardverskih rešenja GPS modula koja se mogu iskoristiti i povezati sa Raspberry Pi računarom izvršena je analiza u cilju odabira najedakvatnijeg. Karakteristike poređenih modela date su u tabeli 5.

Tabela 5. Poređenje karakteristika prostorno vremenskih komponenti

Oznaka	Tačnost [m]	Napajanje [V]	Vreme startovanja [s]	Opseg osvežavanja [Hz]	Baund rate [bps]	Cena [din]
Adafruit PA6H1F1702	3	3,0 - 5,5	34	1 - 10	9600	5000,00
MediaTek GPS-2261	3	5,0	36	1 - 10	9600	3000,00
GPS-NEO-6M-001	3	3,0 - 5,0	36	1 - 10	38400	2000,00
PA6C1V1438	3	5,00	36	1-10	9600	1800,00

Za potrebe realizacije meteorološke stanice odabran je Adafruit PA6H1F1702 GPS modul. Hardversko rešenje ovog modula izgrađeno je oko MTK3339 chipset-a, koji predstavlja GPS modul visokog kvaliteta, koji može pratiti do 22 satelita kroz 66 kanala. Ovaj GPS modul ima visoko osetljivi resiver od -165dBm prilikom praćenja, kao i ugrađenu antenu. Odlikuje se takođe malom potrošnjom energije do 20mA prilikom ogređivanja lokacije, kao i modom mirovanja koji se odlikuje još manjom upotrebom energije. U verziji 3 ovog modula moguće je povezivanje spoljašnje antene koja omogućava preciznije određivanje pozicije.

3. KOMPONENTE ZA PRENOS

Udaljeni pristup i slanje podataka od meteorološke stanice do bazne stanice predstavlja dodatni problem koji zahteva posebnu analizu u cilju kreiranja adekvatnog rešenja. Kao jedno od potencijalnih rešenja nameće se korišćenje bežičnih senzornih mreža u vidu prenosa podataka putem radio frekvencije, ili prenosa podataka putem GSM mreže. Primena jedne ili druge tehnologije kao i eventualna primena hibridnog rešenja koje bi obuhvatilo korišćenje obeju tehnologija uslovljena je rasporedom meteoroloških stanica, njihovom međusobnom udaljenošću kao i konfiguracijom terena na kojem su meteorološke stanice postavljene.

Prenos parametara radio frekvencijom

Proces prenosa parametara moguće je realizovati primenom hardverskih rešenja koja će omogućiti korišćenje radio frekvencije. Teorijski posmatrano u okviru već pomenutih hardverskih uređaja na meteorološkoj stanici potrebno je dodati radiofrekventni primopredajnik. Bazna stanica sa druge strane takođe mora da poseduje radiofrekventni primopredajnik. Ukoliko se radi o sistemu u kome se nalazi veći broj meteoroloških stanica u zavisnosti od primenjenog hardverskog rešenja meteorološke stanice i bazna stanica moraju se postaviti tako da zadovoljavaju određenu topologiju [3]. Sama topologija uslovljena je konfiguracijom terena kao i maksimalnom linijom vidljivosti između bazne stanice i meteoroloških stanica. Primenjeno na modelom opisanu meteorološku stanicu odabir hardverskog rešenja za radio primopredajnik mora biti takav da koristi isto napajanje kao i Raspberry Pi računar. Poređenje radio frekvetnih modula dostupnih na tržištu i adevatnih za primenu u slučaju ovako kreirane meteorološke stanice dato je u tabeli 6.

Tabela 6. Poređenje RF modula XBee familije

Naziv familije	Frekvenca	Način sklapanja	Protokol
XBee ZigBee	2.4GHz	TH/SMT	ZigBee
XBee 802.15.4	2.4GHz	Through-Hole	802.15.4
XBee S2C 802.15.4	2.4GHz, 900MHz	TH, SMT	802.15.4
XBee DigiMesh 2.4	2.4GHZ	Through-Hole	DigiMesh

Pored opisanih karakteristika odabrano hardversko rešenja mora da poseduje tehničke mogućnosti povezivanja sa Raspberry Pi računarem u cilju adekvatnog slanja i prijema podataka i upravljačkih signala. Teorijski posmatrano praktična realizacija ogleda se u nabavci dva istovetna radio frekvetna modula, od kojih će jedan biti postavljen na meteorološkoj stanici, dok će drugi biti postavljen u okviru bazne stanic. Takođe u zavisnosti od konfiguracije terena i maksimalne propagacije signala u okviru linije vidljivosti postoji i mogućnost uvođenja dodatnih pojačavača snage signala. Pojačavači snage signala primenjuju se ukoliko je potrebno signal preneti na veću razdaljinu od maksimalne razdaljine koju osnovni predajnik može preneti. Takođe pojačavači se koriste u slučajevima kada je teren brdovit ili kada postoje prepreke koje utiču na propagaciju samog signala. Praktično pojačavač pojačava oslabljenu snagu signala i potrebno ga je postaviti na mestu do koga signal emitovan sa predajnika dolazi oslabljen. Kao što se može videti u tabeli 6 različite familije radio frekventnih modula pogodnih za realizaciju slanja podataka sa meteorološke stanice dostupne su od strane kompanije Digi International[1]. Svaka od familija karakteriše se različitim funkcionalnostima uređaja koje obuhvata.

Nakon eliminacije određenih kategorija RF modula, a na osnovu tehničkih karakteristika preostalih familija i kategorija RF modula za potrebe realizacije prenosa podataka od modelom opisane meteorološke stanice do bazne stanice odabrana je Digi XBee S2C 802.15.4 kategorija koja pripada XBee S2C 802.15.4 familiji RF modula.

Prenos parametara GSM/GPRS mrežom

Prenos parametara sa jednog mobilnog uređaja do drugog mobilnog uređaja može se obaviti korišćenjem GSM (*eng. Global System for Mobile Communication*) ili GPRS (*eng. General Packet Radio Service*) mreže. Generalno posmatrano mobilna mreža slična je fiksnoj telefoniji. Osnovna razlika ogleda se u mogućnostima neograničene mobilnosti pretplatnika koja je ostvarena korišćenjem bežičnog interfejsa sa sistemom. GSM je praktično evropski standard za digitalne mobilne sisteme zasnovan na korišćenju tri različita frekventna opsega: 900MHz, 1800MHz i 1900MHz. Osnovne prednosti ove tehnologije ogledaju se u mogućnostima ostvarivanja međunarodnog saobraćaja, visokom kvalitetu prenosa govornog signala, većoj sigurnosti prenosa informacija, kao i mogućnostima koje ovaj standard otvara kada je u pitanju implementacija različitih drugih servisa [4].

Danas je na tržištu moguće pronaći različite GSM/GPRS modeme koji nude različite mogućnosti povezivanja kao i različite načine komunikacije i slanja podataka. Uzimajući u obzir limitirane mogućnosti napajanja, način povezivanja kao i rad u otvorenim uslovima meteorološke stanice jedno od rešenja koje se izvojilo jeste SIM900-TTL UART GSM/GPRS model kompanije Rhydo Technologies (P) Ltd[2]. Pomenuti GPS/GPRS TTL UART modem je zasnovan na Quad-band GSM/GPRS enginu u oznaci SIM900A. Ovaj engine radi na sledećim frekvencijama: 850MHz, 900MHz, 1800MHz i 1900MHz. Veoma je kompaktan u pogledu veličine kao i korišćenja u sklopu GSM modema. Ovaj modem je dizajniran za rad u okviru 3.3V/5V TTL kola, što mu omogućava direkno povezivanje kako sa mikrokontrolerima koji rade na 3.3V tako i sa mikrokontrolerima koji rade na 5V [5]. Povezivanje na izvor napajanja može se ostvariti u opsegu od 5V-12V. Propusni opseg može se podešavati u opsegu od 9600kb/s do 115200kb/s. Sami propusni opseg podešava se pomoću AT komandi. Inicijalno modem je podešen na propusni opseg od 9600 kb/s. Povezivanje modema sa mikrokontrolerom zasnovano je na dva provodnika (Tx, Rx) za komunikaciju i jedan provodnik za napajanje [6]. Ovaj GSM/GPRS TTL modem ima interni TCP/IP stek koji omogućava uspostavljanje internet konekcije putem GPRS-a. Pogodan je kako za slanje SMS poruka tako i za korišćenje od strane aplikacija za slanje paketa podataka putem TCP/IP, kao što je slučaj sa meteorološkim stanicom.

1 Digi International, https://www.digi.com/

2 Rhydo Technologies (P) Ltd, http://www.rhydolabz.com/

Kako bi se obavilo poređenje performansi pomenuta dva komunikaciona modula unapred su definisani kriterijumi poređenja koji su u direktnoj vezi sa potrebama realizacije komunikacije meteorološke stanice sa baznom stanicom. Parametri koji su uzeti u obzir prilikom poređenja jesu: način povezivanja modula, potrošnja električne enegije, maksimalna moguća razdaljina između meteorološke stanice i bazne stanice u pogledu prenosa signala, brzina prenosa podataka.

Celokupno poređenje ZigBee XBee S2C 802.15.4 radio frekventnog modula sa SIM900 GSM/GPRS modulom bazirano na nabrojanim parametrima pokazalo je da je SIM900 GSM/GPRS modul bolje rešenje za realizaciju komunikacije u sistemu meteorološka stanica bazna stanica. Bežični telekomunikacioni sistem zasnovan na korišćenju ovog modula omogućava veću mobilnost same meteorološke stanice, nezavisnost komunikacije od međusobne udaljenosti meteorološke i bazne stanice, kao i veću brzinu prenosa podataka. Veća potrošnja energije ovog modula u odnosu sa odabrani RF modul zanemarljiva je činjenica spram svih navedenih prednosti.

4. ZAKLJUČAK

Primena meteorološke stanice u okviru poljoprivredne proizvodnje pokazuje višestruke prednosti. Prednosti primene ogledaju se kako u domenu praćenja promena meteoroloških parametara i donošenju odluka o dnevnim aktivnostima na poljoprivrednim proizvodnim površinama tako i u domenu kreiranja velikih skupova meteorloških i prostorno vemenskih podata. Kreiranjem velikih skupova podataka omogućava se njihova buduća analiza, čime se dobijaju šabloni među podacima pogodni za korišćenje u procesu predikcije i donošenja odluka.

Realizacija meteorološke stanice bazirane na jednostavnom skupu komponenti dostupnih na tržištu prikazana u ovom radu odlikuje je niskom cenom realizacije. Pritom niska cena realizacije nije uticala na kvalitet komponenti, njihovu preciznost i mogućnost rada u spoljašnjim uslovima.

U velikom broju slučajeva proizvodne poljoprivredne površini nemaju konstantan izvor napajanja, pa je samim tim jedan od problema u realizaciji meteorološke stanice namenjene upotrebi u poljoprivredi i napajanje iste. Jedna od ideja za budići rad upravo je realizacija napanja putem fotonaponskog panela. Nastavak ovog istraživanja pored realizacije napajanja putem fotonaponskog panela ogleda se i u realizaciji softverskog rešenja koje bi obuhvatalo prijem paketa podataka sa meteorološke stanice i njihovu dalju obradu.

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INFORMACIONE TEHNOLOGIJE IZ DISKURSA UMREŽENOG DRUŠTVA I DRUŠTVA ZNANJA

Branislav Banić[1, *],
Milica Andevski[2]

[1]Univerzitet Singidunum,
Beograd, Srbija
[2]Filozofski fakultet,
Novi Sad, Srbija

Rezime:
Revolucija informaciono-komunikacionih tehnologija reflektuje se kroz reorganizacije, transformacije i inovacije ekonomske, tehničke, političke, obrazovne prirode. Nove tehnologije donose novu dinamiku u obrazovanju pojedinaca, grupa, utiču na naučni i tehnološki napredak, u smeru veće međusobne umreženosti i zavisnosti. Okosnica svih ovih promena implikuje se kroz konstrukte umreženog društva i društva znanja. Hod prema društvima znanja otvara i nove dileme, potrebu da se razjasne osnove međusobnih odnosa unutar „umreženog društva“, novih tehnologija, interakcije u kontekstu Web 2.0, a da pritom težište nije samo na konkretizaciji ključnih kompetencija rukovanja novim informacionim tehnologijama, nego na pitanju, kako da zamislimo i šire dimenzije procese učenja, interakcije, socijalizacije u rukovanju. U radu će se razmotriti priroda medijskih kompetencija u pristupu informacionim tehnologijama.

Ključne reči:
informacione tehnologije, društvo znanja, umreženo društvo, medijske kompetencije.

1. UVOD

Da bismo opisali treću industrijsku revoluciju i sve promene koje je prate u sistemu znanja, obično se koristi model „neopipljivog” i model „mreža“. Odlike industrijske revolucije u ekonomskom diskursu reflektovale su se u sve većoj dematerijalizaciji individualnog ljudskog rada, a nju je omogućila upotreba mašina umesto ljudskog rada, razvoj usluga i pojava virtuelnog prostora u digitalnoj revoluciji. Ovladavanje neopipljivim, društvu donosi veće strateške prednosti i moć, nego ovladavanje opipljivim, omogućava izgradnju i korišćenje satelita i svetsku dominaciju. Spajanjem globalizacijskog procesa (koji ima tendenciju ujedinjavanja globalnih tržišta) i tehnoloških mutacija (koje smanjuju cenu telekomunikacija i omogućavaju ubrzavanje i povećanje količine informacija koje se šalju) nastala su umrežena društva, kako se nazivaju prema radovima Manuela Castellsa [1].

U svakoj društvenoj organizaciji postoji niz mreža unutar kojih pojedinci stvaraju posebne odnose: porodične, etničke, ekonomske, profesionalne, društvene, verske, političke, ali i sve istovremeno. U kontekstu

Odgovorno lice:
Branislav Banić

e-pošta:
bbanic@singidunum.ac.rs

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informacijske revolucije nastali su organizacijski oblici koji se više ne mogu ograničiti na logiku prostorne usmerenosti i konvencionalnog donošenja odluka. Tradicionalne vertikalne hijerarhije sve više ustupaju mesto rastućim horizontalnim odnosima koji najčešće nadilaze društvene i nacionalne granice. Ovakvi uslovi definisali su pojavu rastućih društava znanja sa ekonomijom znanja i potrebom za upravljanjem znanjem. „Umrežena društva" - „Društvo mreža", Manuela Castellsa nudi mogućnosti za analize pitanja komunikativne mobilnosti i raznovrsne translokacijske prostore komunikacije neophodne za razjašnjenje navedenih fenomena [1].

2. UMREŽENA DRUŠTVA: PROMENA MEDIJSKE KOMUNIKACIJE

Na šta se tačno odnosi koncept: Umrežena društva? Ako pođemo od razmišljanja Manuela Castellsa [1], onda se koncept odnosi na to da je, u tako nazvanim društvima, dominantni strukturni princip takav, da su privatni život ili krug prijatelja, preduzetništva ili politike – sva područja kulture i društva *strukturisani u mrežama.* „Network society" u svom najosnovnijem obliku je društvo zasnovano na mrežama koje rade sa informacijama i komunikacionim tehnologijama koje se nalaze u mikroelektronici i digitalnim kompjuterskim mrežama, koje stvaraju, obrađuju i distribuiraju informacije na osnovu znanja akumuliranog u čvorovima mreže" [2, 202].

Da bismo pravilno shvatili osnovnu formulaciju „umreženog društva" od pomoći je da to analiziramo u odnosu na koncepte promene medijske komunikacije, teorije medija i istraživanja medijatizacije. U teoriji medija, koja se povezuje posebno sa radovima Harolda Innisa, Marshalla McLuhan-a i Joshua Meyrowitz-a [2], za dominirajuće medije razlikujemo četiri tipa ljudskih kultura: prvo, tradicionalne oralne kulture, drugo kulture pisma, treće moderne kulture štampanja, četvrto, globalne elektronske kulture. U detaljnim istraživanjima [2] upadljive su, u predstavljanju teoretičara medija, jasne paralele sa razmišljanjima Castellsa, da se kod elektronske kulture uočava porast globalnih komunikativnih umreženja [1]. Istovremeno, se u nekim segmentima, medijska komunikacija posmatra i šire nego kod Castellsa, tako što se na primer satelitski televizor posmatra kao deo razvitka. "Dok štampanje omogućava nove načine širenja znanja, a industijalizacija široku skalu širenja proizvoda, elektronski mediji podstiču nove načine širenja iskustva" [2, 212].

Ako želimo da ovaj celokupni okvir učinimo korisnim za procenu konkretnih aktuelnih procesa promene, onda ga moramo komunikacijsko-teorijski popuniti.

O mogućnostima pristupa znanju i upravljanja znanjem. Sve dok korisnici mogu jasno da razlikuju sirove informacije (čak prevare i dezinformacije) od informacija koje čine temelj istinskog znanja, internet će funkcionisati kao ogromna baza ideja, bilo da je reč o informacijama, bilo o samom znanju. Međutim, hod prema društvima znanja otvara i nove dileme, jer u jeku brzih i gotovo nepreglednih promena, kada sve postaje otvoreno i spekulativno, treba razjasniti i osnove međusobnih odnosa i interakcije u kontekstu Web 2.0, a da pritom težište nije na konkretnom određivanju utvrđenih ključnih kvalifikacija za rukovanje novim tehnologijama, nego na pitanju, kako da zamislimo procese učenja i socijalizacije u rukovanju njima. Ovde bismo, pre svega, želeli da razmotrimo neke osnove koje su potrebne da bi se obradila pitanja usvajanja kompetencija u rukovanju novim tehnologijama.

3. IMPLIKACIJE NOVIH TEHNOLOGIJA: MEDIJSKA KOMPETENCIJA, INTERAKTIVNOST I SAMOSOCIJALIZACIJA

Pristup novim informacionim tehnologijama nosi mnoge teškoće koje je ponekada teško definisati. Potrebno je, kao i uvek u nauci, vremena da se novi razvoji i nove veze sagledaju i da se o njima razmisli. Ako se, npr. u kontekstu interneta, kaže, „normativna referentna tačka za unapređivanje medijske kompetencije bi trebalo da bude povećanje kvaliteta života u društvu znanja" [3, 11], onda će to sigurno naići na opšte odobravanje, ali je isto toliko teško spoznati šta se pod navedenim zaista podrazumeva. Najpre se radi o tome da se opišu novi razvoji u vezi sa novim tehnologijama, da bi se onda postepeno razjasnile njihove implikacije na međusobnu interakciju, komunikaciju učesnika kao i njihovih odgovarajućih kompetencija za pristup novim tehnologijama.

Kao primer upotrebe novih tehnologija možemo navesti E-Learning koji danas sve više postaje deo svakodnevice u procesu obrazovanja, učenja, posredovanja i usvajanja znanja i informacija. Michael Kerres i Alex Nattland u svojoj sistematici prave razliku između karakteristika Web 1.0 i Web 2.0 formata. „E-Learning 1.0" znači zatvoreno okruženje za učenje kao ostrvo na internetu sa sadržajima i alatima datim na raspolaganje[4, 46]. Nastavnik oprema ostrvo ovim sadržajima

4. MEDIJSKE KOMPETENCIJE U VEKU WEBA 2.0

Bilo bi problematično, medijske kompetencije i sa tim povezane standarde obrazovanja posmatrati primarno pod aspektom testiranja. Tada bi mogle dominirati one opasnosti, koje Tulodziecki povezuje sa definisanjem standarda obrazovanja:

- Dominacija zadatih ciljeva nauštrb učešća učenika i orijentacije ka procesu;
- Orijentacija ka razmeri ispitivosti umesto veze sa interdisciplinarnim idejama vaspitanja i obrazovanja;
- Orijentacija ka aktuelnim zahtevima umesto orijentacije ka budućnosti, koja bi bila važna s obzirom na munjevit razvoj u oblasti informatičke i komunikacijske tehnologije;
- Dominacija jednoobraznih zahteva spram pogleda na individualni razvoj kompetencija u okviru biografskog procesa [5, 25].

Suština ovoga bi bila da postoji opasnost da se medijske kompetencije preko kvalifikatorski definisanih standarda definišu kao proizvodi školske nastave koji se mogu dostići, ali ne u onom smislu, koji Erpenbeck i Sauter označavaju kao sposobnost da se misli i dela samoorganizovano odn. kao dispozicije samoorganizacije [6, 67]. Nastava sa digitalnim medijima je manje usmerena ka usko formulisanim ciljevima učenja, a više ka „didaktici usmeravanja“, koja polazi od, u principu, otvorenog dejstva procesa poučavanje-učenje [7]. Za stručno znanje, koje je u testovima uglavnom nesrazmerno mnogo zastupljeno, ovo znači: radi se o tome da se činjenice ne uče jednostavno napamet i mehanički aktiviraju, već da se usvajanje znanja posmatra u bliskoj vezi sa izgradnjom sposobnosti delanja [8, 78].

Ova usmerenost medijskih kompetencija ka shvatanjima dispozicija samoorganizacije nije od značaja samo zato što stilovi učenja, preko kojih se mladi suočavaju sa digitalnim medijima, počinju da se menjaju. Pre svega u anglosaksonskom području pod pojmovima „Netgeneration“, „Homo Zappiens“, „Digital Natives“, „Produser“ itd. postoji mnoštvo pristupa koji opisuju ovaj razvoj [9]. Prema Crossu odlučujuća odlika je u tome, što učenje sve više prelazi sa *push* principa na *pull* princip [10]. Učenje sve manje znači učenje usmereno programom, i pokušava da odgovori na promene koje se pojavljuju unutar nesigurne perspektive budućnosti. Ko se bavi digitalnim medijima, više uči isprobavanjem, eksperimentisanjem ili uz pomoć društvene mreže. Ciljano sastavljanje instrukcija ili vođenje formalnog kursa o uvodu u novi program danas se retko dešavaju – što za posledicu ima da ponuđači digitalnih medija (bilo hardwer, bilo softwer) danas po pravilu jedva i da prilažu instrukcije uz svoje proizvode. Istovremeno se lokus kontrole, koji su u tradicionalnoj nastavi određivali nastavnici, sve više prebacuje na kompleksne aranžmane učenika, trenere, predavače, tehnologiju i resurse [8, 37].

Upravo za ovu generaciju ne sme da se preceni značaj škole za prenošenje medijskih kompetencija. Pošto učenici i omladina intenzivno koriste medije pre svega u vannastavnoj svakodnevici, „Netzgeneration“ i tamo usvaja mnoštvo medijskih kompetencija kojima trenutno raspolaže. Ali šta onda u vezi sa ovim preostaje obrazovnim nastojanjima škole odnosno, da li je ona još uvek potrebna? Jer ako učenici u vannastavnim aktivnostima usvajaju medijske kompetencije koje im omogućavaju da sami u okviru samoorganizovanog učenja osvoje svet kompjutera, može se zapitati da li su uopšte napori od strane škole još uvek potrebni. Ipak, postoje dva niza argumenata koji zagovaraju održivu upotrebu kompjutera u školi.

Češća upotreba kompjutera u školi se zahteva, jer svakodnevna upotreba kod kuće snažno gura u prvi plan potrebe za zabavom: igranje kompjuterskih igara, stavljanje i skidanje muzike, gledanje video zapisa, četovanje preko MSN-a itd. Nasuprot tome, rad na kompjuteru u profesionalnoj svakodnevici postavlja druga težišta: obrađuju se tekstovi, radi se sa bazama podataka, koriste se kreativni softweri kao Mindmanager, obrađuju fotografije odgovarajućim programima itd.

Na osnovu toga, zadatak škole bi mogao biti popunjavanje praznina i sistematski rad sa onim softwerima, koji nisu u upotrebi tokom slobodnog vremena – kao npr. Office programi, programi za obradu slika i filmova itd. Profesionalno znanje i refleksivno znanje o informatičkom društvu i rizici rada sa tehnologijom bi mogli biti program za digitalno medijsko obrazovanje u školama. Jer to su oblasti o kojima se inače niko u društvu ne brine i koje se svakodnevnom upotrebom kompjutera ne uče automatski. Tako se u radu sa Web 2.0 stalno javljaju tvrdnje kako bezbrižno deca i omladina postupaju sa ličnim podacima na svojim profilima.

Kao drugo, mora se zaći iza pitanja zaštite i praznina u znanju i veštini i poći od toga da kompjuter i internet u tolikoj meri pripadaju svakodnevici dece i mladih, da sa tim povezane medijske kompetencije predstavljaju resurs koji bi škola morala mnogo više koristiti. Ako se medijska kompetencija posmatra iz ugla kompetencija

samoorganizacije, onda bi se u školskom kontekstu učenja morali postaviti zadaci koji tokom prakse samoorganizovanog učenja omogućavaju istovremenu primenu medijskih kompetencija, diferenciranje sposobnosti i razvoj sopstvenih kompetencija. Dakle, radi se manje o tome da se prenose jasno definisane i propisane veštine rada sa digitalnim medijima u smislu didaktike posredovanja, a više o tome da se u okviru didaktike omogućavanja podstiču samostalni procesi učenja, koji dopuštaju i neformalno i autodidaktičko učenje „sa medijima" i „o medijima" i koji se kao izvor uključuju u školsko učenje [8] [7].

Ovo naročito odgovara zahtevima koji su povezani sa Web 2.0. Takvi prostori za učenje „prevode" interaktivni Web u kontekst iskustva učenika i daju podsticaj i motivaciju da se ovaj Web ne konzumira isključivo pasivno. Pogotovo iz tog razloga Erpenbeck i Sauter stavljaju akcenat na razvoj kompetencije u mreži i naglašavaju „New blended Learning" u okviru Web 2.0. jer upotreba društvenog softwera pruža mogućnost da se međusobno povežu metode stvaralačkog rešavanja problema (stručna i metodička kompetencija), samorefleksije (personalna/lična kompetencija), društvene perspektive/pogledi i pogledi na svet (socijalna kompetencija) i individualna delanja (kompetencije aktivnosti) [6, 166].

Pojmovi medijske kompetencije prema Baacke-u [11] i Theunert-u [12] mogu imati veoma različita značenja:

- Razumeti medije: medijska kompetencija se može odnositi na razumevanje medijskih ponuda.
- Vladati medijima: medijska kompetencija se može odnositi na veštinu rukovanja medijskim aparatima.
- Upotrebiti medije: medijska kompetencija se može odnositi na efektivnu upotrebu medija u rešavanju školskih i poslovnih zadataka. Može se iskazati i u sposobnosti da se pomoću medija planira slobodno vreme i u njemu uživa.
- Stvarati medije: medijska kompetencija se može odnositi na sastavljanje medijskih ponuda.
- (Pr)ocenjivati medije: medijska kompetencija se konačno može odnositi na funkcije medijskog sistema. Medijska kompetencija u ovom smislu podrazumeva sposobnost da se obuhvate društveni odnosi i (pr)oceni sopstveno delanje pod normativnim i etičkim aspektima [13].

Sigurno da ove opšte medijske kompetencije igraju centralnu ulogu i u oblasti rukovanja novim tehnologijama. Pitanje, koje će se dalje razmatrati nije prožeto samo pojmom medijske kompetencije nego ide u dalju analizu, u smislu da li promenjene forme novih tehnologija menjaju način na koji se medijske kompetencije usvajaju? Principijelno je pretpostaviti da povećane mogućnosti povratne informacije, intervencije i organizacije, koje nove tehnologije nude korisnicima, imaju uticaj na medijsku socijalizaciju, vrstu usvajanja medijske kompetencije. Sledeća razmišljanja posvetićemo odnosu *povećane interaktivnosti*, kojom se opisuje diskutabilna promena novih tehnologija i *teorije (samo)socijalizacije*.

5. INTERAKTIVNOST U PROSTORU INFORMACIONIH TEHNOLOGIJA

Povećana „interaktivnost" u okviru novih tehnologija, problematizuje proces usvajanja i jačanja medijske kompetencije. Izraz Web 2.0 može da se stavi u kontekst promena vezanih za nove tehnologije i potrebe tačnijeg određenja interaktivnosti novih medija. Za naučno istraživanje novih tehnologija važno je da se razdvoje pitanja forme novih tehnologija i time otvorenih mogućnosti od pitanja konkretnog načina postupanja sa ovim mogućnostima: informacione tehnologije povećavaju korisnicima mogućnosti intervencije, kooperacije i povratne informacije. Ovde se naročito internet enciklopedija Wikipedia može navesti kao primer interaktivnog komunikacijskog prostora i prostora upravljanja znanjem kroz produkciju, organizaciju i prenošenje informacija i znanja. Protiv previše optimistične predstave o povoljnosti novih tehnologija, koje treba da omoguće i unaprede aktivno učešće učesnika, mora se ukazati i da se potencijal interaktivnosti mora dovesti u vezu sa stvarnom realizacijom ovog potencijala: tako u slučaju Wikipedije relativno mali broj aktivnih autora stoji spram mnogo recipijenata koji samo čitaju, a to je tendencija koja se može naći i u drugim oblastima interneta.

Interakcija u okviru novih tehnologija otvara razne mogućnosti intervencije, organizacije i povratne informacije [14]. Novi oblici tehnološki otvorene medijske komunikacije se označavaju kao „interaktivni" odnosno kao *interaktivnost novih medija*, a pri tome se radi o novim mogućnostima povratne informacije i organizacije za korisnike. Označavanje novih tehnologija kao „interaktivnih", usmerava analizu novih medijskih oblika komunikacije ka poređenjima sa direktnim face-to-face interakcijama [15] [16].

Postoje dva pristupa informacionim tehnologijama vezanim za medije: prvi pristup se odnosi na *problematiku forme medija* i on pokušava primereno da opiše nove forme medijske komunikacije. U središtu pažnje ovde

su novi tehnički razvoji i nove tehničke forme. Drugi pristup se fokusira na *subjektivna opažanja* novih medija i *načine rukovanja* njima [17]. Time se u naučnom proučavanju tehnologije medija nastavlja odavno etablirano suprotstavljanje mediocentričnih perspektiva i perspektiva okrenutih recepciji tj. korisnicima. Iz duge istorije ovog suprotstavljanja znamo da oba problema treba povezati jedan s drugim, medijsku problematiku forme i problem subjektivnog rukovanja medijima. U tom smislu forme nove tehnologije pokazuju šta je moguće, a subjektivni načini korišćenja pokazuju šta se od mogućeg može realizovati.

Pored problematike forme novih tehnologija, mogu se, kod proučavanja novih tehnologija birati *subjektivna opažanja i načini postupanja korisnika* kao polazna tačka. Interaktivnost novih tehnologija i njihov značaj proističu prvobitno iz korisnikovog praktičnog rukovanja njima. Ali šta znači praktično rukovanje novim tehnologijama? Na to upućuju neki rezultati jedne aktuelne onlajn studije pod naslovom: „*Onliner 2007: interaktivna mreža u veku interneta*" [18]. Kako studija pokazuje, interes za aktivnu participaciju u mreži raste od 2006. do 2007. godine sa jedne četvrtine na jednu trećinu korisnika interneta. Manje iznenađujuć je velik interes polovine korisnika između 14 i 19 godina. Ipak je udeo aktivnih producenata relativno mali: tri četvrtine kornisnika weblogova samo traži informacije. U slučaju Wikipedije je ovaj odnos još izraženiji, što je za mnoge sigurno iznenađujuće: samo 6% korisnika je bar jednom napisalo članak ili dodalo informaciju, slično je i kod video-portala. „Nesrazmerno mali broj aktivnih korisnika", tako balansiraju autori upotrebu različitih Web 2.0 ponuda, „'stvaraju' sadržaje atraktivne svima. Dodatna vrednost za mnoge korisnike očigledno nije mogućnost da sami aktivno učestvuju u mreži, već da mogu pasivno konzumirati atraktivne sadržaje" [18, 401].

U oblasti istraživanja novih tehnologija, potrebna nam je strategija istraživanja koja izbegava jednostranost. Ova jednostranost preti kada se fokusira samo na problem forme novih tehnologija ili samo na kontekste i procese subjektivnog načina rukovanja njima. Zahtev da se ne posmatra samo problem forme novih tehnologija nego i konteksti i načini rukovanja njima postavlja se i u oblasti interaktivnosti. Međutim, ovde ne vrebaju opasnosti samo u fokusiranju na problematiku forme novih tehnologija. Jednostranostima vodi i kada se misli da se odlike interaktivnosti mogu analizirati pre svega u praktičnom radu sa novim tehnologijama, ili kada se tvrdi da je Web 2.0 određena vrsta opažanja i korišćenja interneta [4, 38].

Mogućnosti nove komunikacije preko novih tehnologija (npr. kompjuter) ne treba posmatrati samo na nivou forme medija i subjektivnog opažanja i korišćenja, već i u *datim socijalnim kontekstima*. Nove mogućnosti onlajn-komunikacija i onlajn-grupa su „uvijene" u socijalne kontekste i što se tiče njihovih prednosti i mana, zavise od ovih konteksta: „Ako je interakcija u okviru onlajn-grupe povezana u društvenu mrežu, koja postoji i u oflajn-svetu, onda se to naziva *socijalno usađivanje onlajn-interakcije* u mreže oflajn-sveta" [19, 176]. Ovo usađivanje igra centralnu ulogu u organizovanju i poboljšavanju onlajn-interakcija. Ovde su tipični problemi mogućnosti kontrole ali takođe i građenja poverenja. Za rešavanje takvih problema je često od pomoći dodatno korišćenje mogućnosti direktnih interakcija van novih tehnologija. Procesi učenja i usvajanja kompetencija zasnovani na novim tehnologijama zavise od socijalnih uslova, koji se mogu organizovati i oblikovati.

6. (SAMO)SOCIJALIZACIJA I MEDIJSKA KOMPETECIJA

Opšti pojam (samo)socijalizacije se može staviti u različite kontekste dosadašnjeg istraživanja socijalizacije, ako kao i uvek cilja na spremnu samostalnost subjekata [20] [21] [22]. Teorije socijalizacije se mogu razlikovati po tome kako odmeravaju aspekte samosocijalizacije i socijalizacije koju vrši drugo lice (roditelji, nastavnici, vršnjaci...). Što se više usvajaju direktne spoljašnje mogućnosti uticaja, instrukcije i intervencije na subjektu, to se više naglašavaju procesi socijalizacije koju vrši drugo lice. Nasuprot tome, što se više naglašavaju procesi (samo) organizacije, (samo)regulacije i (samo)konstruktivnosti, to se više imaju u vidu aspekti (samo)socijalizacije.

Odnos (samo)socijalizacije i korišćenja novih tehnologija (tj. medijske kompetencije) nije nov i u širokom polju istraživanja masovne komunikacije je podrobno opisan i prodiskutovan [23]. Subjekti nisu, kako razna istraživanja okrenuta recepciji pokazuju, pasivno i bespomoćno ostavljeni uticajima medija, već oni individualno i samostalno rukuju medijskim ponudama novih tehnologija. Ovaj aspekt socijalizacije unutar novih tehnologija bi se morao izvoditi korak po korak prema istraživanjima tehnologija usmerenih na prinude i dejstva. Ophođenje sa novim tehnologijama zavisi od spoljnih konteksta i počiva na subjektivnim pretpostavkama. Novi naraštaji moraju u svojoj socijalizaciji prvo usvojiti kognitivne, jezičke i socijalne veštine da bi mogli rukovati novim tehnologijama medija [24]. Rukovanje medijima određuju socijalni uslovi i biografske situacije.

Recipijenti opažaju medijske ponude u odnosu na lično relevantne teme i određene probleme i manje ili više svesno, svoju životnu situaciju dovode u vezu sa medijskim ponudama. Upravo u oblasti masovnih medija konstruktivističke teorije socijalizacije medija vide mnoge mogućnosti za to da novi naraštaji sami ili u saradnji sa drugim osobama samostalno upravljaju procesom recepcije i rukovanjem medijima.

Pristup Web 2.0 tehnologiji vodi strukturalnim promenama u navikama učenja. Danas se susrećemo sa osobama, koje uz pomoć digitalnih medija, bez velikih troškova mogu da pristupe brojnim naučnim izvorima, i tako šire sopstvena područja interesovanja, produbljuju ih i dele sa drugima. Samo učenje i obrazovanje, na taj način, dobija nove impulse u toku života. Druga strana ovog razvoja, nažalost pokazuje, da ipak znatan deo stanovništva jedva da ima udela u mogućnostima koje nude digitalni mediji [1]. Stojimo na graničnoj tački na kojoj su značajni delovi stanovništva isključeni iz razvoja. To su ljudi koji nisu ovladali medijima, nedostaju im medijske kompentencije, interesovanje, jednostavno nisu u stanju da koriste za sebe podstreke obrazovanja na internetu.

Učenje tokom života se ne podudara sa deficitarnim uslovima. Ovde moramo da pazimo na grupe koje ne mogu da koriste ponude na net-u za poboljšanje svog procesa obrazovanja. Radi se o pojedincima koji zbog nesigurnosti, koja nastaje zbog brojnih ponuda na internetu, nisu u stanju da razviju sopstveni način viđenja i orijentacije i koji, naposletku, tokom upotrebe interneta, gube iz vida podsticajne dimenzije obrazovanja i zadovoljavaju se upotrebom digitalnim medijima iz čiste zabave ili za zabavu. Različita istraživanja korišćenja digitalnih medija, pokazuju da se ovo sreće kod znatnog dela stanovništva [25]. Jedan takav digitalni razdor ukazuje da postoji nešto kao velika nesigurnost što se tiče bezbednosti net-a kao i problemi sa hardware-om i software-om, kao i da nema izgrađenih veština (sposobnosti) da se koriste najrazličitiji izvori kao predmeti učenja. To ima za posledicu da se posećuje samo poznati teren na net-u i jedva da se diskutuje o novom, pošto dominira strah od gubitka orijentacije i nesigurnosti. Ova grupa korisnika, izlaz za svoje probleme vidi u suprotstavljanju procesima obrazovanja i većem orijentisanju na zabavu, čime znatno redukuju i svoje životne, poslovne i obrazovne šanse. Pošto verziranijim korisnicima interneta savladavanje ovakvih teškoća bolje polazi za rukom, među njima se, putem digitalnih medija, još više povećava ponor. Posredovanje medijske kompentencije bi moglo doprineti mogućnostima za redukovanje ovog ponora.

7. PREGLED I ZAKLJUČAK

Procesi obrazovanja se odvijaju u mnogo više „luka“ i „oaza“ nego što smo do sada primećivali i poznavali. Međutim, potrebne su sadržajne, formalne, etičke rasprave o vrednosti novih kultura učenja, kako bi se izazvali procesi refleksije i promena perspektive. Primeri iz svih područja Web 2.0 razjašnjavaju, da su pogodni i novi izvori znanja, koji se na jedan, još nepoznat način- „usput“, povezuju na svakodnevni način sticanja znanja, i koji služi za otkrivanje novih informacija i odnosa u učenju. Online-mediji pružaju mogućnosti učenja i obrazovanja: počevši od jednostavnih Internet pretraživača koji pojačavaju postojeća tumačenja, preko posećivanja blogova ili mreža znanja, koji menjaju pravac dosadašnjim uvidima ili proširuju i dopunjuju sama stručna mišljenja i znanja. Naposletku interakcija, participacija, oblikovanje i komunikacija u virtuelnom svetu ili virtuelnim društvima omogućavaju visoku fleksibilnost u ophođenju sa sopstvenom ili javnom saglasnošću kao i novo strukturisanje navika u učenju i obrazovanju [26]. Ovi razvoji ipak postavljaju nove vrste kognitivnih i motivacionih zahteva u učenicima.

Ko medijima suvereno vlada i medijski je kompententan, može svoju već postojeću praksu učenja da proširi. Iritacija koja se svakodnevno sreće i koja se može „izlečiti“ preko proširenih oblika znanja nudi ovom krugu učenika dobru mogućnost da relativno prijatno dopre do novih informacija. Korišćenje online-medija istovremeno znači i da rastu problemi selekcije, kako bi oni koji pretražuju, izabrali tačne, pouzdane, važne informacije iz „plime“ ponuda. Da se oni koji uče, ne bi izgubili u ovim ponudama, potrebne su kako strategije pretrage tako i jasno definisan cilj učenja koji već postojeća znanja proširuje ili optimalizuje. Digitalno učenje ne nudi, dakle, izvore izvesnosti i sigurnosti, često je potrebna etika, koja upravlja radnjom i koja pomaže da se prepozna orijentacija u radu. S obzirom na višestruke ponude, moralo bi se reći i „ne“ da bi se zaista samostalno oblikovao pravac u razvoju identiteta i zagarantovala smislenost života.

Za profesiju profesora odnosno za spremanje ponuda, to unapred znači povećanu potrebu za atraktivnim pripremanjem materijala za predavanje, za posredovanje istog i raste značaj moderatora i mentora u procesu učenja. Time se menja uobičajna podela uloga i struktura zadataka i unutar organizovanog konteksta učenja i poučavanja. U našoj koncepciji učenja i obrazovanja trebalo bi da nam bude važno naglašeno povećanje perspektiva na ekspanzivnu fleksibilnost i refleksivnost.

Nove mogućnosti Web-a mogu ovde da izgrade „oaze“ i „usidrenja“ unutar kojih se učenici usredsređuju na određeno vreme za određenu temu. Pedagoški koncepti doprinose u ovom kontekstu tome, da se postave mogućnosti i staze za spajanje i orijentaciju.

Pored ovih diferenciranih načina postupanja važno je i kako će se evolucija novih tehnologija i novih načina njihove upotrebe odvijati u budućnosti. U naučnom istraživanju novih tehnologija još uvek vlada nejasnoća. Gotovo fascinantne vizije novih tehnologija iz 90-tih su u međuvremenu potonule usled određenog razočarenja u analize. Postojeća shvatanja su polazila od sveobuhvatne pretpostavke da i demonizovanje dejstva novih tehnologija i ogromna pozitivna očekivanja od njih, za osnovu imaju pojednostavljeno i jednostrano shvatanje, koje se odnosi pre svega ili čak isključivo na problematiku forme novih tehnologija.

Diferenciranije i realističnije procene daljeg razvoja novih tehnologija moraju, osim toga, imati u vidu procese kontekstualno fiksiranog subjektivnog rukovanja njima. To važi i za odnos medijske kompetencije i novih formi medijske komunikacije označenih kao Web 2.0. Sa jedne strane se postavlja zadatak da se opišu mogućnosti stvorene novim formama novih tehnologija, a sa druge se, ni u kom slučaju, medijske kompetencije ne mogu jednostavno izvesti iz ovih novih mogućnosti. Analize procesa i okolnosti korišćenja novih tehnologija su neophodne za realizaciju principijalno datih potencijala. U medijsko-sociološkoj diskusiji se ovi potencijali opisuju kao interaktivnost. Veoma interaktivni mediji nude široke mogućnosti aktivnog učešća korisnika u oblastima informacije, komunikacije i zabave.

Početna euforija u međuvremenu je morala da napravi mesta i primetnom razočarenju. Tamo gde je znanje, modularno pripremljeno, vremenski i lokalno u svako doba dostupno, njegova upotreba, putem dostupnih medija informacione i komunikacione tehnologije, pokazuje, da naspram relativno malog procenta aktivnih učesnika stoji veliki broj recipirajućih korisnika.

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VALIDACIJA UPITNIKA STAVA O BEZBEDNOSTI HRANE TOKOM PUTOVANJA - PRIMENA MREŽNIH PLATFORMI U ISTRAŽIVANJIMA

Nataša Kilibarda,
Dušan Borovčanin*,
Ivana Brdar,
Miloš Milošević

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Cilj ovog rada bila je konstrukcija i validacija Upitnika stava o bezbednosti hrane tokom putovanja (SBH-P). Na uzorku od 746 ispitanika urađene su desktriptivna, korelaciona i analiza pouzdanosti i analiza varijanse. Rezultati analiza govore u prilog dobrih metrijskih karakteristika mernog instrumenta što predstavlja uslov za njegovo dalje primenjivanje u istraživanjima bezbednosti hrane tokom putovanja. Podaci su prikupljani preko Amazonove mrežne platforme MTurk, koja se pokazala kao efikasan način formiranja velikog globalnog uzorka.

Ključne reči:

MTurk, bezbednost hrane, putovanje, validacija, upitnik .

1. UVOD

U cilju očuvanja i unapređenja javnog zdravlja, između ostalih činioca, veoma je važno da se obezbede dovoljne količine higijenski ispravne odnosno bezbedne hrane ljudima. Bezbedna hrana je hrana koja nije štetna po zdravlje ljudi, ukoliko se priprema i/ili konzumira u skladu sa namenjenom upotrebom (*Codex Alimentarius*). Konzumiranje hrane koja nije bezbedna dovodi do pojave oboljenja koja se jednim imenom nazivaju bolesti prenosive hranom (Foodborn disease). Zvanični podaci Svetske zdravstvene organizacije navode podatak da je riziku od bolesti prenosivih hranom u čitavom svetu izloženo milijarde ljudi, milion njih oboli godišnje, dok pojedini slučajevi imaju čak i smrtni ishod. Procenjuje se i da 600 miliona ljudi (1 u 10 ljudi na svetu) godišnje oboli konzumirajući hranu koja nije bezbedna, a da 420.000 ljudi svake godine umre od posledica konzumiranja nebezbedne hrane [1]. Pored opisanog uticaja na pojedinca, nebezbedna hrana, dovodi do značajnih ekonomskih gubitaka pojedinih država koji nastaju kao posledica smanjenog izvoza hrane, šteta koje se nanose poljoprivredi ili se pak smanjuju prihodi od turizma, budući da rejting turističkih destinacija značajno opada usled pojave nebezbedne hrane [2].

Sa aspekta turizma, pojava bolesti prenosivih hranom na putovanjima, karakteriše se pojavom stomačnih tegoba poznatijih kao putničke dijareje. Ovaj problem pogađa od 20% do 60% putnika, i to uglavnom

Odgovorno lice:
Dušan Borovčanin

e-pošta:
dborovcanin@singidunum.ac.rs

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one koji tokom svojih putovanja posećuju nerazvijene zemlje [3]. U najvećem broju slučajeva simptomi bolesti su takvi da ne dovode do ozbiljnijih posledica po zdravlje, ali svakako u velikoj meri umanjuju uživanje u samom putovanju. U oko 20% do 40% slučajeva putnik mora da miruje u trajanju od 1 do 2 dana, 3% obolelih zatraži medicinsku pomoć, dok 1% posto mora da se hospitalizuje zbog pojave dehidratacije i težih oblika oboljenja [4].

Današnje vreme karakteriše se zahtevima koji se odnose na brže obavljanje posla, brže donošenje odluka sa manje korišćenih resursa, a da pri tome rezultati obavljenog procesa budu efikasniji i sa manje grešaka. Upotreba informacionih tehnologija u oblasti bezbednosti hrane, može pružiti odgovore na ovako visoko postavljene zahteve i to na način da ljudsko zdravlje ne bude ugroženo, odnosno da pruži značajnije garancije da je hrana koja se konzumira bezbedna. Samo neki od primera upotreba IT u oblasti bezbednosti hrane su:

- Sektori nabavke hrane koji su zasnovani na informacionim tehnologijama, omogućavaju svim učesnicima u lancu hrane, proizvođačima, dobavljačima i potrošačima, sledljivost duž celog lanca hrane, od „farme do trpeze“. Na ovaj način, omogućena je komunikacija svih učesnika u lancu hrane u realnom vremenu, što doprinosi blagovremenom prenošenju informacija o eventualnim rizicima, samim tim i pravovremeno preduzimanje preventivnih ili korektivnih mera, čime se čuva zdravlje ljudi.
- Specifični softveri koji su dostupni za pakovanja mesa i proizvode od mesa pružaju mogućnost da se održava i reguliše temperatura transporta ovih lako kvarljivih proizvoda, što doprinosi očuvanju njihove bezbednosti.
- Podaci koji se čuvaju i sakupljaju u cilju implementacije, sprovođenja i verifikacije HACCP sistema u objektima koji posluju hranom, primenom tehnologija zasnivanim na *cloud* sistemu, omogućavaju da se podaci ažuriraju i sinhronizuju i da im se može pristupiti iz različitih delova sveta što u velikom stepenu obezbeđuje i osigurava funkcionisanje HACCP i njegovo sprovođenje u cilju preventivnog delovanja i proizvodnje bezbedne hrane [5].
- Upotreba IT u istraživanjima koje koriste mrežne platforme u cilju prikupljanja podataka, koji se koriste za analizu i procenu stavova i znanja potrošača vezane za bezbednost hrane

Definicija bezbednosti hrane, ukazuje na značajan uticaj ljudskog faktora na samu bezbednost hrane, s obzirom da ljudi svojim neadekvatnim i nepravilnim postupcima sa hranom prilikom čuvanja, pripreme i konzumiranja, mogu uticati nepovoljno na njenu bezbednost. Iz tog razloga, važno je sprovoditi kontinuiranu edukaciju potrošača, ali i istraživanja u cilju prikupljanja i analize podataka o stavovima potrošača i njihovog znanja o postupcima koji se odnose na rukovanje hranom [6].

Zbog obima teme bezbednosti hrane, u ovom radu predmet analize biće sužen na specifičan domen bezbednosti hrane na putovanjima. Polazeći od opšte prihvaćene definicije stavova kao relativno trajnih dispozicija koje se sastoje od međusobno neraskidivo povezanih kognitivnih, konativnih i emocionalnih komponenti i koje se manifestuju kroz specifično ponašanje (bihejvioralna komponenta), odnosno kao sklonost da se razmišlja, oseća, reaguje i ponaša na određeni način [7], stav o bezbednosti hrane tokom putovanja definisan je kao skup međusobno povezanih informacija, znanja, navika, potreba, motiva i emocija koji rezultuju više ili manje bezbednim ponašanjem u domenu ishrane na putovanjima.

Tema bezbednosti hrane na putovanjima iako veoma važna kako sa aspekta javnog zdravlja, tako i sa turističkog, odnosno ekonomskog aspekta nije na zadovoljavajuć način obrađena u dosadašnjim istraživanjima [8]. Osnovni preduslov za otklanjanje ovog nedostatka, odnosno povećanja obima istraživanja bezbednosti hrane na putovanjima je konstrukcija validnih mernih instrumenata što takođe nije bio slučaj u dosadašnjoj istraživačkoj praksi. Zbog toga je cilj ovog rada konstrukcija i validacija mernog instrumenta koji će obezbediti uslove za dalje istraživanje teme bezbednosti hrane tokom putovanja.

2. PRIMENA MREŽNIH PLATFORMI U CILJU EFIKASNOG PRIKUPLJANJA PODATAKA

Ranije teorijske studije ukazale su na veliki potencijal upotrebe mrežnih platformi u formiranju velikih globalnih uzoraka ispitanika za potrebe naučnih istraživanja [9], što je jedan od osnovnih preduslova ispravne validacije mernih instrumenata. Pored, sada već tradicionalnih metoda prikupljanja podataka uz pomoć kompjutera putem email-a, društvenih mreža i mrežnih (on-line) upitnika, pojava platformi koje omogućavaju susret ponude i tražnje na tržištu jednostavnih poslova (crowdsourcing) predstavlja jedan od pionirskih vidova ostvarenja opisanog potencijala. Kraudsorsing je termin

koji među prvima iskoristio Džef Hou (Jeff Howe) definišući ga kao ponudau posla za anonimne spoljne saradnike (outsourcing) putem javnog poziva [10]. Jedna od najpopularnijih platformi ove vrste je i Amazonov Mehanikal Turk (Amazon Mechanical Turk) koji je nastao 2005. godine i služi za angažovanje spoljnih saradnika za pojedince i privredne subjekte na virtuelnim poslovima [11]. Ubrzo nakon njegovog nastanka, istraživači na akademskim institucijama i institutima su primetili da bi ovo mogao biti odličan resurs za prikupljanje podataka, ali se postavilo veliko pitanje pouzdanosti prikupljanja podataka na ovaj način. Do danas, sprovedeno je nekoliko studija koje su analizirale i predstavile strukturu ispitanika u istraživanjima sprovedenim preko MTurk-a [12, 13, 14]. Svi su saglasni u tome da ne postoje značajne rezlike u demografskoj strukturi učesnika u istraživanjima sprovedenih putem MTurk-a i drugih tradicionalnih metoda prikupljanja podataka. Štaviše, u pojedinim vrstama istraživanja ispitanici sakuljeni putem MTurk-a pokazuju se kao pouzdaniji izvor u odnosu na druge metode [12]. Pored klasičnih istraživanja putem popunjavanja upitnika, MTurk se pokazao i kao pouzdan alat za vršenje oeksperimentalnih istraživanja [15]. Upotreba Amazonovog MTurk-a dodatno je omasovljena standardiazcijiom procedura korišćenja ovog alata u društvenim istraživanjima [16]. Razlog za ovako široku upotrebu MTurka, leži sigurno i u činjenici da je danas internet prisutan na preko 26 milijardi uređaja ili na više od 3 puta više uređaja nego što postoji ljudi na zemaljskoj kugli [17]. Zbog svega navedenog MTurk je odabran kao platforma za prikupljanje podataka i u ovom istraživanju što će poslužiti i kao još jedna u nizu ilustracija prednosti upotrebe IT tehnologiju u naučno-istraživačkom radu, ovoga puta vezanom za specifičan domen bezbednosti hrane.

3. METOD

Istraživanje je izvedeno u dve faze. Prva faza se odnosila na konstrukciju upitnika, dok su u drugoj prikupljani podaci u cilju njegove validacije.

Konstrukcija upitnika

Nakon usmenog intervjua sa 20 ispitanika, formirana je prva verzija upitnika od 45 pitanja koja su se ticala kognitivnih, konativnih, emotivnih i bihejvioralnih komponenti stava o bezbednosti hrane tokom putovanja. Prvom verzijom upitnika izvedeno je usmeno anketiranje uzorka od 30 profesora i asistenata svih usmerenja Univerziteta Singidunum i Beogradskog Univerziteta na osnovu koga je formirana finalna verzija upitnika od 32 tvrdnje, uputstvo za ispitanike i finalna formulacija tvrdnji. Prilikom konstrukcije finalne verzije upitnika vodilo se računa da emotivna, kognitivna, konativna i bihejvioralna komponenta merenog stava budu ravnopravno zastupljene, ali i o ekonomičnosti i izbegavanju redundantosti tokom istraživanja. Na kraju je upitnik za potrebe validacione studije preveden na engleski jezik tehnikom dvostrukog prevođenja u nazad (back translation).

Prikupljanje podataka

Za potrebe prikupljanja podataka kreiran je korisnički nalog na platformi MTurk u ulozi poslodavca, odnosno subjekta koji podnosi zahtev (Requester). Nakon kreiranja naloga, kreiran je zahtev za izradu zadatka takozvanog HIT-a (Human inteligence task) koji su zainteresovani korisnici mogli da izvrše. Ukupan vremenski period za prikupljanje podataka iznosio je 16 dana. Nagrada za uspešno popunjen upitnik za izvršioce bila je 0.05$. Prosečno vreme popunjavanja upitnika iznosilo je 4 minuta.

Uzorak

Istraživanje je izvedeno na prigodnom uzorku od 746 ispitanika, 278 muškaraca i 468 žena prosečnog uzrasta 35.2 godina. Prema mestu stanovanja 76.6% uzorka čine stanovnici Severne Amerike, 12.9% stanovnici Azije, 7.4% Evrope, 1.6% Afrike, 1.1% Južne i Centralne Amerike i manje od 1% iz Australije. U uzorku su zastupljene sve uzrasne i socijalno-demografske grupe punoletnih ispitanike.

Veličina uzorka je odabrana nakon analize statističke snage za jednosmerni t-test razlike između prosečnih vrednosti dva nezavisna uzorka, pomoću $\alpha = 0.05$, snage $f = 0.80$, i za mali očekivani efekat ($d = 0.3$) [18, 19]. Uz navedene pretpostavke, minimalna veličina uzorka treba da iznosi 139 ispitanika u svakoj grupi, odnosno 556 ispitanika ukupno. Zbog specifičnosti teme i načina prikupljanja podataka broj ispitanika ženskog pola značajno je premašio projektovanu kvotu za vreme koje je bilo potrebno da se dostigne projektovani minimum ispitanika muškog pola čime je obezbeđena dodatna snaga statističkog zaključivanja kako za subuzorak isputanika ženskog pola tako i za ukupan uzorak.

Svi ispitanici su se sami prijavili za učešće u istraživanju, bili su unapred pismeno upoznati sa zadacima, da će podaci biti korišćeni isključivo anonimno i da u svakom trenutku mogu da se povuku iz istraživanja bez ikakvih posledica. Istraživanje je izvedeno u skladu sa Etičkim principima i kodeksom propisanim od strane Američe Asocijacije Psihologa (APA).

Postupak

Svi ispitanici su preko mrežne platforme MTurk dobili da reše anonimnu anketu koja se sastojala iz dva dela. Prvi deo su činila pitanja koja se odnose na socijalno-demografski status ispitanika (pol, obrazovanje, mesto rođenja, mesto stanovanja, bračni status, broj dece, obrazovni nivo, radno mesto), proučavanje tema vezanih za bezbednost hrane tokom školovanja i samoprocene: zabrinutosti za pojavu stomačnih tegoba na putovanjima, nivoa informisanosti o bezbednosti hrane i učestalosti iskustva pojave stomačnih tegoba na putaovanju. Drugi deo činio je Upitnik stava bezbednosti hrane tokom putovanja (SBH-P), koji je konstruisan na opisan način i sastoji se od 32 tvrdnje na koje se odgovara putem petostepene skale procene likerovog tipa.

Merenje

Nakon prikupljanja, u cilju vršenja daljih analiza podaci su kodirani i tranformisani u numeričku maticu. Podaci iz prvog dela ankete transformisani su u nominalne i ordinalne skale prema odgovorima ispitanika i njihovoj učestalosti. Odgovori na 32 tvrdnje iz SBH-P pretvoreni su u ukupni prosečni skor koji se kreće od izrazito negativnog i nebezbednog stava (1) do izrazito pozitivnog i bezbednog stava (5).

Obrada podataka

Na osnovu izračunatih ukupnih skorova ispitanika na SBH-P u cilju provere metrijskih karakteristika urađena je deskriptivna statistička analiza kako celog uzorka tako i subuzorka muškaraca i žena.

Zatim je na odgovorima ispitanika na svako pojedinačno pitanje u okviru SBH-P urađena analiza pouzdanosti putem izračunavanja Kronbahovog alfa koeficijenta i metodom podele na pola (split-half). Opisana analiza pouzdanosti sprovedena je takođe na ukupnom uzorku i subuzorcima muškaraca i žena.

Diskriminativnost upitnika proverena je analizom varijanse, odnosno poređenjem prosečnih odgovora na SBH-P ispitanika koji su tokom školovanja izučavali teme povzane sa bezbednošću hrane i onih koji to nisu.

Eksterna validnost ukupnog skora na SBH-P testirana je korelacionom analizom odnosno proverom povezanosti postignuća na SBH-P i samoprocene: zabrinutosti za pojavu stomačnih tegoba na putovanjima, nivoa informisanosti o bezbednosti hrane i učestalosti iskustva pojave stomačnih tegoba na putovanju.

Za potrebe transformacije sirovih podataka u numeričke matrice korišćen je Majksrosoft Eksel (Microsoft Exel) 2007, statističke analize su vrešene pomoću SPSS 20. softverskog paketa dok je analiza snage urađena korišćenjem Dži Pauver (GPower) 3.1.

4. REZULTATI I DISKUSIJA

Deskriptivna statistička analiza (Tabela 1.) urađena je na nivou ukupnih skorova Upitnika stava o bezbednosti hrane tokom putovanja (SBH-P) za ceo uzorak ispitanika kao i za poduzorke muškaraca i žena. Greška ocene prosečne vrednosti u populaciji znose 0.62% za ceo uzorak, 0.95% za muškarce i 0.62% za žene. Koeficijent varijacije iznosi 13.71 za ceo uzorak, 14.24% za muškarce i 13,58% za žene. Veličine Skjunisa i Kurtozisa ukazuju da ne postoje značajana odstupanja od normalne distribucije.

Tabela 1. Deskriptivna statitička analiza Upitnika stava o bezbednosti hrane tokom putovanja

Deskriptivna analiza[a]		**SBH-P U**	**SBH-P M**	**SBH-P Ž**
	N	746	278	468
	Min.	1.53	1.53	1.69
	Maks.	4.38	4.38	4.38
Aritmetička sredina	***Statistik***	3.21	3.16.	3.24
	Std. gr.	.02	.03	.02
	Std. dev.	.44	.45	.44
Skjunis	***Statistik***	-.11	-.11	-.12
	Std. gr.	.09	.15	.11
Kurtozis	***Statistik***	.02	-.31	-.15
	Std. gr.	.18	.30	.23

[a]Legenda: skor na upitnku stava o bezbednosti hrane na putovanjima za ceo uzotrak (SBH-P U) i pod uzorke muškaraca (SBH-P M) i žena (SBH-P Ž), standardna greška (Std. gr.), standardna devijacija (Std. dev.)

Rezultati deskriptivne statističke analize (Tabela 1.) na nivou ukupnih skorova SBH-P za ceo uzorak ispitanika kao i za poduzorke muškaraca i žena ukazuju na dobre metrijske karakteristike mernog instrumenta.

Analize varijanse pokazala je da postoje statistički značajne razlike u ukupnom skoru na SBH-P između ispitanika koji su tokom obrazovanja izučavali teme iz oblasti bezbednosti hrane i onih koji to nisu za ukupan uzotak [F(1,745)=27.24; p<.000], kao i za pod uzorke muškaraca [F(1,276)=15.01; p<.000] i žena [F(1,467)=15.37; p<.000].

Rezultati analize varijanse govore u prilog diskriminativnosti mernog instrumenta.

Analiza pouzdanosti (Tabela 2.) urađena je na nivou pojedninačnih odgovora ispitanika na sve 32 stavke iz SBH-P na ukupnom uzorku ispitanika, kao i na pod uzorcima žena i muškaraca merenjem Kronbah Alfa (Cronbach's Alpha) koeficijenta.

Tabela 2. Analiza pouzdanosti Upitnika stava o bezbednosti hrane tokom putovanja metodom Kromabahove alfe

Analiza pouzdanosti	Kronbah Alfa	Kronbah Alfa na osnovu standardizovanih stavki	Broj stavki	Broj slučajeva
Ceo uzorak	.80	.80	32	746
Muškarci	.81	.80	32	278
Žene	.80	.80	32	468

Pouzdanost SBH-P proverena je i metodom podele na pola (split-half) takođe na nivou pojedninačnih odgovora ispitanika na sve 32 stavke iz SBH-P na ukupnom uzorku ispitanika, kao i na pod uzorcima žena i muškaraca.

Rezultati analize pouzdanosti (Tabele 2. i 3.) govore o visokom nivou pouzdanosti mernog instrumenta, pogotovu uzimajući u obzir divergentnost merenih aspekata stava o bezbednosti hrane što rezultuje smanjenjem niva korelacije među stavkama (item-item).

Korelaciona analiza (Tabela 4.) pokazuje da postoje značajne pozitivne povezanosti ($p<0.00$) između skorova na SBH-P i samoprocene: zabrinutosti za pojavu stomačnih tegoba na putovanju, učestalosti iskustva pojave stomačnih tegoba na putovanjima i informisanosti o bezbednosti hrane. Dok je veza sa učestalošću pojave stomačnih tegoba slaba povezanost sa zabrinutoišću za pojavu stomačnih tegoba na putovanju i informisanosti o bezbednosti hrane umerenog tipa.

Tabela 3. Analiza pouzdanosti Upitnika stava o bezbednosti hrane tokom putovanja metodom podele na pola

Analiza pouzdanosti			Ceo uzorak	Muškarci	Žene
Kronbah Alfa	***Deo 1***	***Vrednost***	.77	.78	.76
		Broj stavki	16	16	16
	Deo 2	***Vrednost***	.63	.62	.64
		Broj stavki	16	16	16
Korelacija između delova			.54	.54	.53
Spirman-Braunov koeficijent	***Jednaka dužina***		.70	.70	.69
	Ne jednaka dužina		.70	.70	.69
Gutmanov koeficijent podele na pola			.70	.70	.69

Tabela 4. Korelaciona analiza: vrednosti r koeficijenata i njihova statistička značajnost za varijable samoprocene: zabrinutosti za pojavu stomačnih tegoba na putovanjima, nivoa informisanosti o bezbednosti hrane i učestalosti iskustva pojave stomačnih tegoba na putaovanju i ukupnog postignuća ispitanika na Upitniku stava o bezbednosti hrane tokom putovanja

Korelaciona analiza		Zabrinutost	Informisanost	Stomačne tegobe
SBHPU	**Pirsonova korelacija**	,478**	,320**	,294**
	Značajnost	,000	,000	,000
	N	746	746	746

Rezultati korelacione analize (Tabela 4.) govore u prilog eksterne validnosti mernog instrumenta.

Demonstrirana brzina i lakoća prikupljana obimnog globalnog uzorka potvrda je ranijih teorijskih predviđanja potencijala upotrebe mrežnih paltformi naučnim istraživanjima [9].

5. ZAKLJUČAK

Na osnovu iznetih analiza može se izvesti zaključak da je Upitnik stava o bezbednosti hrane tokom putovanja validan merni instrument pogodan za dalja istraživanja ove teme. Takođe, primena informacione tehnologije, odnosno mrežnih platformi u prikupljanju podataka obezbeđuje brzo i efikasno sprovođenja istraživanja, zbog čega se i ono preporučuje za dalju upotrebu kako u istraživanju ove teme tako i širег domena naučnih problema. Izbor mrežne platforme MTurk pokazala se kao dobar jer je obezebedio ekonomično, brzo i jednostavno prikupljanje velikog broja upotrebljivih podataka. Prikupljeni podaci, obrađeni primenom adekvatnih statističkih metoda i analizirani mogu mogu doprineti boljoj edukaciji putnika po pitanju bezbednosti hrane na putovanjima, što značajno može smanjiti broj oboljenja izazvanih nebezbednom hranom na samom putovanju.

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EFEKAT DEJSTVA ELEKTROMAGNETNOG ZRAČENJA BEŽIČNIH MREŽA I MOBILNIH TELEFONA NA ZDRAVLJE LJUDI

Emilija Spasić[1]
Slađana Spasić[2, 3, *],
Violeta Tomašević[3]

[1]Fakultet organizacionih nauka,
Univerzitet u Beogradu,
Beograd, Srbija
[2]Institut za multidisciplinarne studije,
Univerzitet u Beogradu,
Beograd, Srbija
[3]Univerzitet Singidunum,
Beograd, Srbija

Rezime:
U radu su predstavljena najnovija istraživanja uticaja elektromagnetnih zračenja, prouzrokovanih masovnom primenom bežičnih digitalnih elektronskih uređaja, na zdravlje ljudi i životnu sredinu. Ukazano je na potencijalan uticaj 5G mreža, mobilnih telefona, baznih stanica i poboljšanih bežičnih telefona na učestalost pojave malignih i nemalignih tumora na mozgu, kognitivnih i drugih poremećaja kod ljudi. Ukazano je i na aktivnosti raznih međunarodnih tela koja pokušavaju da uspostave zakonsku regulativu u ovoj oblasti. S obzirom da se na osnovu do sada dobijenih rezultata ne može sa pouzdanošću dokazati da li nove tehnologije donose više koristi ili štete ljudima i životnoj sredini, došlo je do polarizacije stručne javnosti u svetu po ovim pitanjima. Danas su sa jedne strane industrijski konzorcijumi koji ulažu velika sredstva u razvoj novih tehnologija, a sa druge strane oni koji osporavaju opravdanost ulaganja koja potencijalno ugrožavaju zdravlje ljudi.

Ključne reči:
radio talasi, elektromegnetno zračenje, mobi-lni uređaji, 5G mreža, zdravlje ljudi.

1. UVOD

Biološki sistemi su permanentno izloženi elektromagnetnim poljima (EMF – Electromagnetic Field) u obliku prirodnih geomagnetskih polja i elektromagnetnih polja emitovanih od strane tehničkih uređaja. Mnoge nove tehnologije, kao što su bežični prenos snage ili indukcioni kućni štednjaci, proizvode električna polja (EF – Electric Field), magnetna polja (MF – Magnetic Field) ili elektromagnetna polja u opsegu srednjih frekvencija (300 do 3000 kHz). Međutim, efekti takvih polja na biološke sisteme su, uprkos pojačanom interesovanju naučne zajednice, još uvek nedovoljno istraženi i kontroverzni [1]. Široko su rasprostranjeni zabrinutost i spekulacije u pogledu emisije radio frekvencija i elektromagnetnih polja (RF–EMF – Radiofrequency Electromagnetic Field) od strane telekomunikacionih baznih stanica i struktura, jer se neke od njih smatraju nesigurnim i opasnim za javno zdravlje. Naučnici, medicinski stručnjaci, političari, novinari i stručnjaci u kompanijama koje se bave mobilnim telekomunikacijama uključeni su u aktivnu debatu o tome da li su ljudi, ostali živi svet i okolina imuni na radio frekvencije ili se ponašamo neodgovorno prema sopstvenoj budućnosti [2].

Odgovorno lice:
Slađana Spasić

e-pošta:
sladjana.spasic@singidunum.ac.rs

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2. UTICAJ 5G MREŽE NA ZDRAVLJE LJUDI

Naučna istraživanja pokazuju da postojeće bežične tehnologije 2G, 3G i 4G, koje se koriste u mobilnoj telefoniji, računarima i mobilnoj tehnologiji uopšte, predstavljaju ozbiljan zdravstveni rizik po ljude, životinje, biljke i životnu sredinu zbog izloženosti talasima iz područja radio spektra [3].

Za opisivanje nove generacije mobilnih mreža razvijenih posle 4G LTE mobilnih mreža koje su danas u upotrebi, uveden je termin 5G. Peta generacija mobilnih tehnologija ili 5G mreža omogućava prenos velikih količina podataka velikom brzinom. Ona treba da bude podrška novoj tehnologiji koja omogućava postojanje „internet stvari" (Internet of Things), kao i povezivenje u sistem svih uređaja koji imaju Internet vezu. Međutim, 5G mreža može znatno da ugrozi naše zdravlje. U dokumentima kompanija koje se bave bežičnim tehnologijama jasno se navodi da će se sa uvođenjem 5G mreže povećati nivo radiofrekventnog zračenja u blizini mrežnih antena. Naučnici upozoravaju da, pre nego što počne sa radom 5G mreža, treba neizostavno sprovesti istraživanja o uticajima ove mreže na ljudsko zdravlje kako bi se osiguralo da javnost i životna sredina budu zaštićeni. Mnoge zemlje poput Kine, Indije, Poljske, Rusije, Italije i Švajcarske imaju vrlo stroge, zaštitne zakonske propise u vezi praga zračenja, tako da neće dozvoliti rasprostiranje 5G mreže preko svojih teritorija, jer bi povećano zračenje 5G mreže premašilo dozvoljene granice zračenja u ovim zemljama. Sa jedne strane, navedene zemlje postavljaju prepreke za uvođenje 5G tehnologije, a sa druge strane industrija ulaže velike napore kako bi se oslobodila tih ograničenja [4].

I pred toga što uvođenje 5G mreže u Evropi zahteva ogromnu investiciju od čak 500 milijardi dolara, za koju se ne može tvrditi da je u potpunosti isplativa, kao ključno, postavlja se pitanje da li je dopustivo ugroziti zdravlje ljudi radi bržeg prenošenja podataka.

Sve veći broj naučnih studija ukazuje na to da visokofrekventno elektromagnetno zračenje koje koriste mobilne tehnologije može naneti štetu ljudskom zdravlju izazivajući rak ili oštećenje muških polnih ćelija. Svetska zdravstvena organizacija, kao i druge kompetentne institucije, prepuštaju odgovornost malim grupama ljudi koje postavljaju granice za zaštitu populacije. Pri tome, veliki broj značajnih informacija koje se tiču zaštite ostaju sakrivene. Više od 400 fizičara i naučnika u internacionalnoj žalbi (peticiji) iz 2019. godine, u kojoj se zalažu za prestanak širenja 5G tehnologije, upozorava da implementacija 5G mreže preti da ostavi ozbiljne i nepovratne posledice na ljudsko zdravlje.

Biolozi, lekari i inženjeri već dve decenije istražuju uticaj radiofrekventnog zračenja koje potiče od mobilnih uređaja na zdravlje ljudi. Na najvećoj Internet platformi sa informacijama na ovu temu „EMF-Portal", realizovanoj na RWTH Univerzitetu u Ahenu, nalazi se više od 2000 naučnih studija. Prema proceni rezultata istraživanja, naučnici imaju duboko podeljena mišljenja u vezi sa ovom temom. Ova podeljenost mišljenja među stručnjacima proizilazi iz činjenice da je zagrevanje tkiva, do koga dolazi kada se tkivo izloži visokim dozama ovog zračenja, za sada jedini dokazan štetan efekat radiofrekventnih elektromagnetnih polja na zdravlje ljudi. Prema ICNIRP-u, postoji rizik da će energija koja se prenosi zračenjem dostići više od 2W/kg telesne težine. Međunarodna komisija za zaštitu od nejonizujućeg zračenja (ICNIRP - International Commission on Non-Ionizing Radiation Protection) je privatno naučno udruženje koje nema zvaničan karakter, ali zakoni koji štite ljude od visokofrekventnog zračenja strogo prate smernice ovog udruženja.

Analiza pozitivnoh efekata koje može da nam donese uspostavljanje 5G mreže pokazuje da je izgleda njena korisnost ipak marginalna, osnosno nije tolika da bismo zbog nje ugrozili sopstveno zdravlje. Tomas Magedanc (Thomas Magedanz), nemački naučnik i ekspert u oblasti telekomunikacija koji vodi 5G istraživanje na Fraunhofer institutu za komunikacione sisteme u Berlinu, objašnjava da za korisnike pametnih telefona, uvođenje 5G mreže pruža veoma malu direktnu korist jer postojeća 4G tehnologija već omogućava korisnicima mnogo toga. Kako on navodi, mnogo bi veća bila potencijalna indirektna korist od uvođenja 5G mreže koja se, na primer, ogleda u tome da bi u budućnosti ova mreža mogla da bude u funkciji bezbednog umrežavanja uređaja u bolnicama ili da služi kao privremena mreža na različitim događajima.

Trenutno, vlada Evropske unije vrši pritisak na mrežne operatere da što pre kupe licence za frekvencije koje su im potrebne od vlade, iako još nije jasno kako će opravdati takav trošak. U Nemačkoj i još osam drugih zemlja evropske ekonomske zone ova akcija i dalje traje. Selektivni otpori grupe naučnika uvođenju 5G mreže nisu dovoljni da bismo bili zaštićeni od potencijalne štete koja bi nastala uvođenjem ove mreže. Evropska unija trenutno ulaže 700 miliona evra u projekte razvoja 5G mreže, međutim nijedan od ovih projekata ne odnosi se na istraživanje rizika. Rizici koje nosi uvođenje 5G mreže su još uvek nepoznati i nedovoljno istraženi, dok je investicija u razvoj ogromna. U cilju zaštite ljudskog zdravlja, ali i smanjenja rizika od neuspeha ogromne investicije, možda je vreme da Evropska unija promeni prioritete u okviru ovog programa.

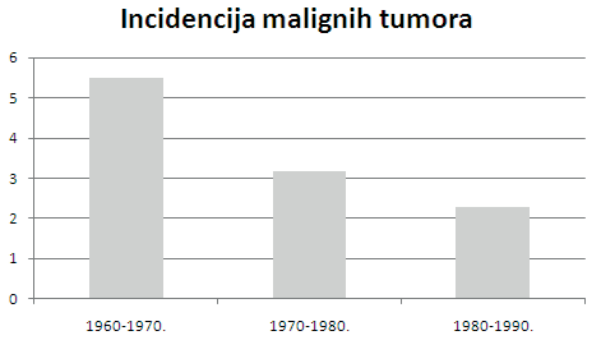
3. UTICAJ ELEKTROMAGNETNOG ZRAČENJA MOBILNIH TELEFONA NA ZDRAVLJE LJUDI

Mikrotalasi su elektromagnetni talasi sa frekvencijama od 1 do 300 GHz čija je primena široko rasprostranjena u savremenom društvu. Mobilni telefoni rade na frekvencijama UHF (Ultra High Frequency) talasa u opsegu od 300 MHz do 3 GHz, u zavisnosti od tipa telefona i dizajna. Uobičajena četiri frekvencijska opsega u kojima rade mobilni telefoni su 850/900/1800/1900 MHz.

Elektromagnetno zračenje uopšte može biti apsorbovano od strane organizma, pri čemu izaziva niz fizioloških i funkcionalnih promena. Poznato je da jaka elektromagnetna polja menjaju brzinu hemijske reakcije i koncentracije slobodnih radikala u organizmu. Mnoge složene električne aktivnosti koje se javljaju u centralnom nervnom sistemu, uključujući učenje i pamćenje, stoga su podložne uticaju elektromagnetnog zračenja. Štaviše, intenzivna upotreba mobilnih telefona učinila je elektromagnetno zračenje glavnim izvorom zračenja mozga. Zbog toga se centralni nervni sistem smatra jednim od najosetljivijih organa koji je meta mikrotalasnog zračenja.

Veliki broj studija je pokazao da mikrotalasno zračenje može izazvati niz neželjenih reakcija u centralnom nervnom sistemu, uključujući poremećaje spavanja, smanjenje sposobnosti učenja i pamćenja, itd. [5]. U [5] Zhi i sar. navode da od brojnih studija koje su sprovedene da bi se istražili efekti mobilnih komunikacionih uređaja na ljude, samo nekoliko je pokazalo da su mobilni telefoni i tumori mozga statistički povezani. Tako, ljudi koji su koristili mobilne telefone više od 10 godina imaju veći rizik od pojave tumora mozga. Takođe, oni koji su navikli da koriste svoj mobilni telefon pretežno sa iste strane imaju dvostruko veću verovatnoću pojave tumora mozga od onih koji to ne čine. Međutim, većina studija nije podržala zaključak da mobilni telefoni izazivaju tumore mozga. Jedna studija koju je objavila istraživačka grupa Interphone [6] pokazala je da ne postoji povećanje rizika od glioma ili meningioma kod korisnika mobilnih telefona. Pored toga, Larjavaara i sar. su u [7] otkrili da se gliomi ne nalaze nužno u oblastima mozga sa najvećom izloženošću zračenju.

Epidemiološke studije o korišćenju mobilnih telefona se trenutno sprovode širom sveta, ali naučni dokazi još uvek nisu dovoljno ubedljivi. Najnovija studija izvedena u Japanu [8] je imala za cilj da simulira učestalost malignih tumora mozga u kohortama koje su počele da koriste mobilne telefone kada su oni postali popularni u Japanu. Kako je prošlo više od 20 godina od početka upotrebe mobilnih telefona u Japanu, podaci o vlasnicima mobilnih telefona prikupljani su putem upitnika koji je sproveden putem Interneta, a ispitanici su rođeni između 1960. i 1989. godine. Udeo vlasništva nad mobilnim telefonom između 1990. i 2012. godine izračunat je po kohorti rođenja: 1960-ih, 1970-ih i 1980-ih. Nakon toga, koristeći udeo vlasništva, izračunata je učestalost malignih tumora mozga simulirajući rizične uslove. Kada je relativni rizik postavljen na 1,4 za 1640 h ili više kumulativne upotrebe mobilnih telefona, i kada je pretpostavljena srednja dnevna dužina poziva od 15 min. incidencija malignih tumora mozga u 2020. godini bila je 5,48 na 100.000 stanovnika za porodicu iz kohorte 1960-ih, 3,16 za kohortu rođenih 1970-ih, i 2,29 za kohortu rođenih 1980-ih godina (sl. 1). Prema modeliranim scenarijima, očekivano povećanje incidencije malignih tumora mozga se pokazalo oko 2020. godine [8]. Ova studija je otkrila da se u modeliranim scenarijima, povećanje incidencije malignih tumora mozga očekuje oko 2020. godine, ali i da treba ispitati da li, i u kojoj od ispitivanih kohorti, postoji povećana incidencija malignih tumora mozga.



Sl. 1. Učestalost malignih tumora mozga u 2020. godini na 100.000 stanovnika po periodima rođenja

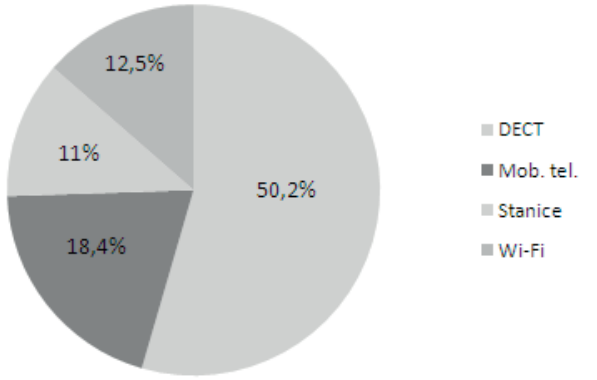
Tehnologije koje se brzo menjaju i intenzivna upotreba radiofrekventnih elektromagnetnih polja predstavljaju izazov za javno zdravlje. Broj korisnika mobilnih telefona, kao i korišćenje i izloženost drugim bežičnim uređajima za prenos podataka (WDT- Wireless Device Transmitter) povećali su se u proteklih nekoliko godina (sl. 1).

CERENAT je francuska nacionalna studija koja analizira upotrebu mobilnih telefona i rizik od nastanka tumora mozga. Nalaz CERENAT-a o povećanom riziku od glioma je u skladu sa rezultatima studijama urađenim u protekloj deceniji ili ranije, koje procenjuju efekte

primene mobilnih telefona [9]. Ova studija je imala za cilj analizu povezanosti između izloženosti zračenju mobilnog telefona i primarnih tumora centralnog nervnog sistema (glioma i meningioma) kod odraslih. Analizirano je ukupno 253 glioma, 194 meningioma i 892 odgovarajućih kontrola odabranih iz lokalnih biračkih spiskova. Nije primećena povezanost sa tumorom mozga kada se upoređuju redovni korisnici mobilnih telefona sa ne-korisnicima. Međutim, pozitivna asocijacija je bila statistički značajna kod najtežih korisnika kada se razmatra životno kumulativno trajanje razgovora (≥896 h za gliome i meningiome) i broj poziva za gliome (≥18.360 poziva). Rizici su bili veći kod glioma, temporalnih tumora, profesionalne i urbane populacije koja koristi mobilne telefone. Iako karcinogeni efekat radiofrekventnih elektromagnetnih polja kod ljudi ostaje kontroverzan, podaci studije [9] podržavaju prethodna saznanja o mogućoj povezanosti između veće upotrebe mobilnih telefona i tumora mozga, pa je predloženo da bi se mogli uključiti u etiologiju nekih tipova tumora mozga.

U CERENAT-u, izloženost radiofrekventnim elektromagnetnim poljima iz digitalno poboljšanih bežičnih DECT telefona (DECT - Digital Enhanced Cordless Telecomunications), koje je koristilo više od polovine populacije Francuske tokom perioda ove studije, nije evaluirana. Ako se uzme u obzir izloženost i DECT, kao i mobilnim telefonima, rizici od glioma su verovatno veći od objavljenih u CERENAT-u. Zato autori studije [10] zaključuju da bi radiofrekventna polja trebalo klasifikovati u Grupu 2A kao potencijalno karcinogena po ljude, a prema kriterijima koje koristi Međunarodna agencija za istraživanje raka (Lion, Francuska). Morgan i sar. u [10] takođe smatraju da je potrebno prikupiti dodatne podatke o izloženosti mobilnim i bežičnim telefonima, drugim bežičnim uređajima za prenos podataka, baznim stanicama mobilnih telefona i Wi-Fi ruterima kako bi se procenio i njihov uticaj na javno zdravlje.

Jasno je da je društvo sve više zabrinuto zbog efekata koje elektromagnetno polje radiofrekventnog opsega može da ima na ljudsko zdravlje, paralelno sa povećanjem izloženosti ljudi. Pojava uređaja za merenje ličnog izlaganja izloženosti zračenju otvara široke mogućnosti za istraživanja. Uprkos studijama koje su karakterisale izloženost ličnosti RF–EMF-u, deo populacije je još uvek zabrinut, u tolikoj meri da se pojavljuju čak i psihogeni, tj. "nocebo" efekti. Ideja najnovije studije date u [11] je bila analiza rezultata lične izloženosti RF–EMF-u u Albaceteu (166.000 stanovnika, SE Španija). Cilj je bio da se proceni efekat rezultata studije na percepciju učesnika studije u pogledu rizika, kako bi se bolje razumeo i promovisao značaj javnog zdravlja. Merenja su izvršena ličnim Satimo EME SPY 140 meračem izloženosti, koji je programiran da meri izloženost na svakih 10 sekundi u toku 24 sata. Studija je sprovedena na 75 volontera. Analizirano je njihovo lično izlaganje u 14 mikrookruženja u gradu, na primer, kod kuće, napolju, na poslu, itd. i razmatrane moguće razlike između izloženosti u tim mikrosredinama. Nakon učešća u studiji, 35 učesnika je popunilo upitnik o njihovoj RF–EMF percepciji rizika. Na upitnik je odgovorio i kontrolni uzorak od 36 ispitanika radi poređenja rezultata. Ukupna prosečna izloženost na 14 mesta mikrookruženja bila je 37,7 μW/m^2, a pojedinačni opsezi su bili između 0,2 μW/m^2 i maksimalno 264,7 μW/m^2 u DECT bežičnim uređajima. Takođe je utvrđeno da je za petak zabeležena srednja vrednost od 53,9 μW/m^2, za razliku od 23,4 μW/m^2 koja je dobijena za subotu. Zabeležena vrednost za noćnu izloženost iznosila je 27,5 μW/m^2 nasuprot 43,8 μW/m^2 zabeleženih u toku dana. Prosečna vrednost izloženosti je takođe pokazala razlike između radnih dana i vikenda, sa 39,7 μW/m^2 i 26,9 μW/m^2, respektivno. Glavni izvori koji su najviše doprineli srednjoj ukupnoj ličnoj izloženosti bili su DECT uređaji sa 50,2%, zatim mobilni telefoni sa 18,4% i stanice sa 11,0%, dok je Wi-Fi signal imao udeo od 12,5% (sl. 2).



Sl. 2. Udeo izvora zračenja u ličnoj izloženosti

U analiziranim mikrosredinama srednja izloženost domova i radnih mesta iznosila je 34,3 μW/m^2, odnosno 55,2 μW/m^2, respektivno. Na otvorenom, srednja vrednost je bila 34,2 μW/m^2, a glavni izvori bili su DECT, Wi-Fi i mobilne telefonske stanice, u zavisnosti od mesta. Analiza percepcije rizika pokazala je da 54% ispitanika smatra da su RF–EMF manje opasna nego što su to mislili pre učešća u istraživanju, dok 43% nije navelo

promene u percepciji. Samo 9% volontera koji su dobili informacije o svojim merenjima nakon studije procenili su mogući rizik RF–EMF–a vrednošću koja je veća ili jednaka 4 (na skali od 1 do 5) naspram 39% kontrola koje nisu učestvovale. Ramirez–Vazquez i sar. su u [11] zaključili da je izloženost RF–EMF–u opala znatno ispod granica preporučenih od strane ICNIRP–a i da je pokazala široku vremensku i prostornu varijabilnost. Glavni izvori izloženosti bili su bežične telekomunikacione mreže (DECT), zatim mobilni telefoni i Wi-Fi. Saopštavanje rezultata o izloženosti učesnicima studije je smanjilo njihovu percepciju rizika. Studije o kontroli upotrebe bežičnih telefona i riziku od pojave tumora na mozgu obično nisu proučavale stepen izloženosti glave zračenju bežičnih DECT telefona, a upravo ova studija je pokazala da su bežični telefoni doprineli sa 50% ukupnoj izloženosti radiofrekventnom zračenju, što je znatno u poređenju sa samo 18% od mobilnih telefona. Sledi da većina studija verovatno potcenjuje efekat upotrebe bežičnog telefona na rizik obolevanja od tumora mozga.

Najnovija studija Meo i sar. opisana u [12] ispitivala je uticaj baznih stanica mobilnih telefona postavljenih u blizini školskih zgrada na kognitivno zdravlje učenika. Dokazano je da je visoka izloženost RF–EMF–u koju proizvode bazne stanice mobilnih telefona bila povezana sa odloženim finim i ostalim motoričkim reakcijama, smanjenjem radne memorije i pažnje kod adolescenata u školi u blizini bazne stanice u odnosu na učenike koji su bili izloženi niskom RF–EMF–u.

Miller i sar. u [13] izveštavaju da epidemiološke studije (kontrola slučaja, kohorte, vremenski trend i studije slučaja) objavljene 2011. i podržane od strane Međunarodne agencije za istraživanje raka (IARC - International Agency for Research on Cancer), koja radi u okviru Svetske zdravstvene organizacije, kategorišu radiofrekventno zračenje sa mobilnih telefona i drugih bežičnih uređaja kao mogući karcinogen za ljude (Grupa 2B). Gliom je važan karcinom koji se javlja kod ljudi za koji se otkrilo da je povezan sa radiofrekventnim zračenjem u 9 studija slučaja–kontrole sprovedenih u Švedskoj i Francuskoj, kao i u nekim drugim zemljama. Povećanje trendova incidencije glioma zabeleženo je u Velikoj Britaniji i drugim zemljama, dok nemaligni ishodi bolesti uključuju akustični neurom i meningiom. Kada se uzmu u obzir nedavni eksperimenti na životinjama, nedavne epidemiološke studije osnažuju i podupiru zaključak da bi radiofrekventna zračenja trebalo kategorizovati kao karcinogene za ljude (IARC Grupa 1).

4. DISKUSIJA I ZAKLJUČAK

Zbog velike heterogenosti u dizajnu studija, ishoda i izloženosti sistema, kao i nedoslednih rezultata i metodičkih ograničenja u mnogim studijama, Bodewein i sar. u [1] smatraju da kvalitet dokaza za neželjene efekte ostaje nedovoljan za donošenje konačnog zaključka o istraživanim biološkim efektima EMF polja. Smatraju da u budućim istraživanjima efekti EF, MF i EMF treba da se istraže sistematičnije, tj. da studije treba da uzmu u obzir različite frekvencije (da bi se identifikovali potencijalni efekti zavisni od frekvencije) i različite jačine polja (da se ispitali efekti zavisni od praga jačine polja). Prioritet treba dati istraživanju akutnih efekata, kao što je indukcija fosfena, percepcija, ekscitacija nerava ili mišića i toplotni efekti. Ovo bi bio važan korak ka validaciji referentnih nivoa koje je preporučio ICNIRP kao nezavisna organizacija koja pruža naučne savete i smernice o zdravstvenim i ekološkim uticajima nejonizirajućeg zračenja na zaštitu ljudi i okoline. Bodewein i sar. u [1] takođe preporučuju da sve nove studije treba da imaju za cilj implementaciju visokokvalitetne dozimetrije i minimiziranje izvora opasnosti od pristrasnosti.

U svetlu napretka naučnih istraživanja koja se odnose na povezanost trajanja izloženosti zračenju mobilnih telefona i ekrana sa dugotrajnim rizikom od pojave raka, a koja je ustanovljena epidemiološkim i toksikološkim studijama, sadašnji dokazi su dovoljno jaki da se pređe sa nivoa predostrožnosti na nivo sprečavanja poznatih rizika. Dosadašnja istraživanja sprovedena su na tehnologijama koje su već uvedene, ali postoji izražena potreba da se za sve nove, netestirane tehnologije urade odgovarajuća testiranja pre njihove primene. Epidemiološke studije potvrđuju uticaj ranijih izloženosti zračenju, dok eksperimentalne studije daju indikacije budućeg rizika. Prema tome, eksperimentalne evaluacije i modeliranje su neophodni pre distribucije novih sistema kao što je na primer 5G mreža za koju nisu dobijeni podaci o bezbednosti. Nepostojanje sistematskog testiranja takvih tehnologija ne treba nipošto mešati sa dokazom sigurnosti ili nepostojanjem rizika. Tvrdi se da će se dodavanjem ove visoke frekvencije 5G zračenja već složenoj mješavini nižih frekvencija doprinijeti negativnom ishodu javnog zdravlja i iz perspektive fizičkog i mentalnog zdravlja.

Sagledavajući ekspanziju 5G mreže može se reći da se radiofrekventno zračenje sve više prepoznaje kao novi oblik zagađenja životne sredine. Kao i ostale uobičajene izloženosti toksinima, efekti zračenja RF–EMF–a će biti problematični za sagledavanje, ako ne i nemoguće da se

razjasne efekti izloženosti sa epidemiološkog stanovišta jer više ne ostaje neeksponirana tj. kontrolna grupa [14]. Ovo je posebno važno imajući u vidu da su ovi efekti verovatno uvećani sinergističkom izloženošću toksinima kao i drugim uobičajenim rizičnim ponašanjima. Efekti takođe mogu biti nelinearni tj. u ovom momentu nepredvidivi. Budući da tek treba sagledati i istražiti efekte na prvu generaciju koja je izložena životnom ciklusu „od kolevke do groba" na ovom nivou radiofrekvencija mikrotalasne (RF EMR) koje je napravio čovek, proći će godine ili decenije pre nego što budu poznate prave zdravstvene posledice.

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UPOTREBA SAVREMENIH SOFTVERSKIH REŠENJA U PRIPREMI I OBUCI ZA REAGOVANJE U VANREDNIM SITUACIJAMA

Miloš Milenković[1, *],
Dalibor Kekić[2],
Darko Glavaš[3],
Dušan Marković[4]

[1]Ministarstvo unutrašnjih poslova –
Sektor za vanredne situacije,
Beograd, Srbija
[2]Kriminalističko – policijski univerzitet,
Beograd, Srbija
[3]Grad Beograd – Sekretarijat za poslove
odbrane, vanrednih situacija, komunikacije i
koordinaciju odnosa sa građanima,
Beograd, Srbija
[4]Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Vanredne situacije, izazvane elementarnim nepogodama ili tehničko – tehnološkim nesrećama, sve su češća pojava, kako na lokalnom, tako i na globalnom nivou. Bilo koji oblik vanredne situacije sa sobom donosi i određene posledice u vidu ljudskih žrtava i materijalne štete. Pored toga, u većini situacija ostaju i posledice za čije je otklanjanje potreban duži vremenski period tokom faze asanacije i uspostavljanja uslova za život koji su bili aktuelni pre nego što je do vanredne situacije i došlo. U trenutnim uslovima, različiti oblici upravljanja nastoje da minimiziraju negativan uticaj vanrednih situacija izazvanih prirodnim ili ljudskim delovanjem. Jedan od načina jeste priprema i obuka subjekata i snaga koji su aktivno uključeni u pružanje odgovora, kao i stanovništva koje se nađe u opasnosti. Postoje različiti vidovi obuke, od onih koje uključuju višednevni progam i veliki broj učesnika, do individualnih modela namenjenih specifičnim korisnicima. Pored toga, uočena je potreba da se polaznicima obuke približe realne okolnosti u kojima se mogu naći u slučaju različitih rizika i opasnosti. Kao vrlo korisno sredstvo pokazala se upotreba savremenih softverskih rešenja u cilju simulacije vanrednih situacija. Kroz upotrebu različitih softvera polaznici obuke ili treninga mogu steći utisak kako izgleda kada se u realnosti dogodi, zemljotres, poplava, požar, hemijski akcident, ili neki drugi oblik elementarne nepogode ili tehničko – tehnološke nesreće. Aktuelno, u savremenim trening centrima čija je misija priprema stanovništva i operativnih snaga za reagovanje u vanrednim situacijama, sve više su u upotrebi savremena softverska rešenja koja simuliraju različite oblike vanrednih situacija i time pomažu u pripremi i obuci kako operativnih snaga, tako i različitih nivoa stanovništva.

Ključne reči:
vanredne situacije, obuka, simulacija, softverska rešenja.

1. UVOD

Savremeno društvo sve više se suočava sa posledicama vanrednih situacija izazvanih prirodnim ili tehničko – tehnološkim nesrećama. U oba slučaja, bez obzira da li se radi o posledicama delovanja prirode ili čoveka, nekada i minuti ili sekunde odlučuju da li će ljudi preživeti opasnost ili proći sa što manje gubitaka. U cilju minimiziranja posledica očekuje se da stanovništvo, kao i oni koji pružaju odgovor na vanredne situacije, budu što bolje pripremljeni na različite rizike. U tom pravcu razvijaju se različiti modeli i tehnike koje se koriste u pripremi, odnosno u obuci.

Odgovorno lice:
Miloš Milenković

e-pošta:
milos10jul@gmail.com

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Institucije koje se bave pripremom i obukom za reagovanje u vanrednim situacijama, sve više pribegavaju upotrebi različitih softverskih rešenja u cilju približavanja realnosti krajnjim korisnicima. Kako postoji raznolikost vanrednih situacija, isto tako na tržištu egzistira i određen broj različitih programskih paketa koji se mogu upotrebiti u cilju simulacije elementarnih nepogoda i tehničko – tehnoloških nesreća. Tačnije, teško je kreirati jedno softversko rešenje koje se može koristiti prilikom obuke za reagovanje u slučaju zemljotresa, ili poplave i pojave klizišta, odrona i erozija. Veliki broj prednosti je uočljiv kada je reč o ovakvom načinu obuke. Naime, u oblasti upravljanja u vanrednim situacijama, pokazalo se mnogo korisnijim kada prolaznici obuke praktično prođu kroz ono što ih može očekivati u stvarnosti. Na taj način stiču mnogo bolji utisak o potencijalnim opasnostima i na kraju obuke budu pripremljeniji. Pored toga, trenutna praksa pokazuje da, bez obzira na isplativost, samo države sa višim standardima mogu izdvojiti novčana sredstva za nabavku softverskih rešenja sa pratećom opremom koji se koriste u simulaciji vanrednih situacija. U svakom slučaju, osnovni cilj rada je da prikaže najefikasnije programske pakete koji se trenutno koriste, kao i da ukaže na svrsishodnost ovakvog načina pripreme i obuke za reagovanje u vanrednim situacijama.

2. PRIPREMA I OBUKA ZA REAGOVANJE U VANREDNIM SITUACIJAMA

Koncept obuke primenjuje se u velikom broju sfera savremenog poslovanja i delovanja društva. Ako se kao primer uzmu multinacionalne kompanije, obuka i trening zaposlenih je jedan od primarnih ciljeva poslovanja. Naime, u okviru procesa upravljanja ljudskim resursima, i nakon regruatacije i selekcije, novozaposlenima je potrebno da se što pre adaptiraju i prilagode na novu radnu sredinu, kao i da ovladaju radnim procedurama u cilju postizanja tražene efikasnosti i efektivnosti.

Poput prethodno navedene pripreme, koncept obuke svoju primenu nalazi i u drugim sferama rada i funkcionisanja društva. Jedna od sfera gde je koncept obuke sve više u primeni je upravljanje u vanrednim situacijama. Pre nego što se krene u detaljnije objašnjenje primene obuke u ovoj oblasti, neophodno je ukratko definisati šta to predstavlja vanrednu situaciju. Naime, evidentno je da se ovaj termin sve više upotrebljava, ali da postoje terminološke zabune. Za potrebe ovog rada iskoristiće se definicija vanredne situacije u skladu sa novim zakonskim rešenjem u Republici Srbiji koji definiše oblast smanjenja rizika od katastrofa i upravljanja vanrednim situacijama. Vanredna situacija je stanje koje nastaje proglašenjem od nadležnog organa kada su rizici i pretnje ili nastale posledice po stanovništvo, životnu sredinu i materijalna i kulturna dobra takvog obima i intenziteta da njihov nastanak ili posledice nije moguće sprečiti ili otkloniti redovnim delovanjem nadležnih organa i službi, zbog čega je za njihovo ublažavanje i otklanjanje neophodno upotrebiti posebne mere, snage i sredstva uz pojačan režim rada [1]. Drugim rečima, o vanrednoj situaciji se može govoriti samo kada su obim i posledice takve da prevazilaze redovno delovanje hitnih službi sa značajnim posledicama po život i zdravlje ljudi, kao i materijalna i kulturna dobra. U takvim uslovima od izuzetnog značaja je imati pripremljeno i obučeno stanovništvo, kao i operativne snage. Tačnije, mora se imati razvijen sistem obuke različitih kategorija koje mogu biti obuhvaćene rizicima i pretnjama od elementarnih nepogoda i tehničko – tehnoloških nesreća. U praksi, obuku i trening za reagovanje u vanrednim situacijama sprovode nacionalne institucije koje se organizaciono posmatrano deo ministarstava, direkcija ili drugih vladinih tela u čijoj je nadležnosti oblast upravljanja vanrednim situacijama. Najčešće su to trening centri osnovani na nacionalnom nivou, dok u nekim državama postoje primeri i regionalno osnovanih trening centara. Teorijski posmatrano, ključni faktor za uspešno obrazovanje i obuku u oblasti upravljanja vanrednim situacijama je formalno obrazovanje. To znači implementaciju nekih tema u školama, kako u osnovnim, tako in a nivou srednjeg obrazovanja. Postoji nekoliko opcija kako sprovesti ovu vrstu obrazovanja u školama. Formalno obrazovanje se odnosi na obrazovanje u institucijama (uglavnom školama) kroz institucionalizovani sadržaj nastavnih planova i programa [2]. Sa druge strane, obuka u oblasti upravljanja vanrednim situacijama treba da koristi prvenstveno neke metode neformalnog obrazovanja. Najčešće korišćene metode su: treninzi, aktivnosti podizanja svesti, publikacije, radionice i seminari, demonstracije, izložbe i simulacije, igre (u prethodnom periodu dostupne na internetu), obrazovanje kroz volonterske aktivnosti, i slično [3]. Kako je navedeno, simulacije predstavljaju jedan od načina obuke koja se koristi u delu nefomralnog obrazovanja i obuke za reagovanje u vanrednim situacijama. Naime, ova metoda se na vrlo kompleksan način može implementirati u okvirima formalnog obrazovanja. Sa druge strane, vrlo je korisno primenjivati metodu simulacije kada je reč o obukama u trening centrima i to pogotovo kada su u pitanje operativne snage, odnosno stanovništvo koje se ciljano priprema i obučva za reagovanje u vanrednim situacijama. Prema Ivancevich-u (1998) i Dessler-u

(2007), u osnovi, postoje četiri moguća pristupa obuci, od kojih je jedna upravo pripremna simulaciona obuka. Prema ovima autorima naglašava se da pripremna simulaciona obuka – je takva obuka gde oni koji učestvuju u ovom vidu obuke, stiču znanja i veštine u okruženju koje simulira realno radno okruženje što god je moguće više. Ova procedura je dosta skupa. Zaposleni koji su obučavani na ovaj način imaju, u određenom procentu, problem u prilagođavanju realnoj radnoj sredini koja je više stresna i manje bezbedna [4]. Kako se vidi u definiciji, ovakav vid obuke je izuzetno skup, a jedan od razloga je što se moraju koristite nastavna sredstva i oprema, poput savremenih softverskih rešenja, koja zahtevaju izdvajanje značajnih finansijskih sredstava. Takva situacija je i sa primenom metode simulacije upotrebom progamskih paketa u pripremi i obuci za reagovanje u vanrednim situacijama. Potrebno je dosta vremena i uloženih finansijskih sredstava kako bi se razvio jedan softver koji simulira opasnost od zemljotresa i poplava. Sa druge strane, velike su prednosti kada se koriste informaciono – komunikacione tehnologije prilikom simuliranja vanrednih situacija izazvanih različitim elementarnim nepogodama ili tehničko – tehnološkim nesrećama. Sigurno da je jedna od najvećih prednosti ta što se polaznici obuke dovode u realno okruženje, upravo onakvo kakvo ih očekuje u realnim uslovima kada dođe do vanredne situacije.

3. SAVREMENA SOFTVERSKA REŠENJA KOJA SE KORISTE U SIMULACIJAMA VANREDNIH SITUACIJA

Trenutno, nekoliko renomiranih svetskih proizvođača softvera radi na razvoju i izradi programskih paketa koji su mogu koristiti u svrhe obuke i sumulacije vanrednih situacija.

Jedan od primera je zajednička saradnja rumunske kompanije Deltamed i i holandskog konzorcijuma. Naime, rumunska kompanija izrađuje specijalizovana vozila sa posebnom opremom u koja se ugrađuju softverska rešenja za simulacije vanrednih situacija izrađena od strane holandskog konzorcijuma. Kompanija Deltamed je specijalizovani proizvođač vozila koja se koriste u radu hitnih službi. Upravo, jedan od tipova vozila predstavlja kamion koji je opremljen posebnim softverom koji proizvodi holandski konzorcijum i koji se koristi u obuci različitih kategorija koji mogu biti pogođeni vanrednim situacijama ili reagovati u svojstvu operativnih snaga.



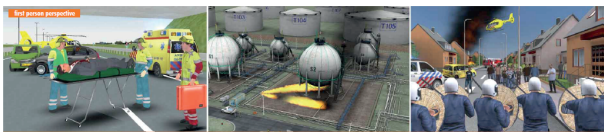
Slika 1. Izgled kamiona koji je opremljen softverom za simulaciju vanrednih situacija [5]

Prednost ovakvog načina realizacije obuke je prevashodno mobilnost. Treninzi i obuke se mogu realizovati na različitim lokacijama. U skladu sa potrebama, obuka ili trening se može organizovati na izdvojenim područjima i ne zavisi od raspoloživosti jednog objekta. Neke od najvažnijih karakteristika softvera koji se koristi u ovakvom načinu obuke su:

- Uključenost različitih scenarija – Softver omogućava da se razradi bilo koji oblik opasnosti, od manjih vanrednih događaja do vanrednih situacija sa ozbiljnijim posledicama,
- Realističnost u primeni - Učesnici obuke uz korišćenje softvera imaju tendenciju da doživljavaju incident kao veoma realističan. Stres i napetost tokom vežbi su prilično ozbiljni, jer su dileme i problemi koji se pojavljuju usko slični stvarnom životu. Učesnici dobijaju trenutne povratne informacije od posledica njihovih odluka,
- Traženje i prepoznavanje vizuelnih znakova – Softversko rešenje omogućava učesnicima da vežbaju prepoznavanje vizuelnih znakova i opasnosti.
- Neograničeno vežbanje bez obzira na lokaciju - Scenariji incidenata nude mogućnost obuke kad god i gde god to žele krajnji korisnici. Jednom kada se kreira softver, pruža se mogućnost da se koristi na različitim lokacijama. Ovo je naročito izraženo u kombinaciji sa vozilom koje proizvodi rumunska kompanija Deltamed.
- Procena opasnosti i komunikacija – Polaznici obuke vide scenario da bi imali uvid u celokupnu situaciju. Tokom timske obuke polaznici mogu koristiti različita sredstva komunikacije. Sa druge

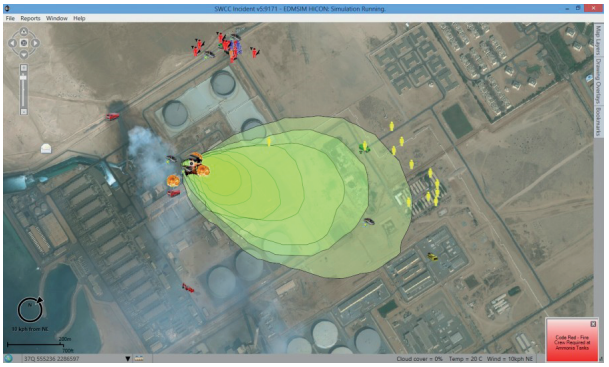
strane, instruktori su virtualno osoblje koje prati rad polaznika i iz kontrolne sobe može zadavati dodatna pitanja i sugestije.

- Komandovanje i kontrola tokom obuke – Polaznici su tokom cele obuke kontrolisani preko softvera od strane instruktora. Instruktor ima potpunu kontrolu i uvid u pružena rešenja i odgovore, odnosno predloge upotrebe različitih materijalno – tehničkih i ljudskih resursa. Instruktor ima mogućnost da menja scenario kako bi stekao uvid da li se polaznici mogu prilagoditi novim uslovima i donositi adekvatne odluke. Pored toga, ovakav vid softverskog rešenja pruža i mogućnost da se tokom timske obuke polaznicima omogući i redovna koordinacija „licem u lice" kroz sastanke u virtuelnom okruženju, organizovanje video konferencija i u cilju planiranja narednih akcija reagovanja.
- Evaluacija i povratne informacije - Nakon obuke instruktor pregleda radnje, aktivnosti i odluke sa polaznikom obuke. Instruktor, zahvaljujući ovom softverskom rešenju, može da se u svakom trenutku vrati nazad kroz scenario i da se na taj način sagleda konkretna situacija. [6]



Slika 2. Izvod iz jedne od obuka i upotrebe softverskog rešenja[6]

Sledeći primer softvera koji se koristi u simulaciji vanrednih situacija i u obuci jeste proizvod kompanije C4i. C4i je američka kompanija u privatnom vlasništvu čija je vizija da učini svet sigurnim kroz obuku i tehnologiju. Stručne oblasti koje pokriva ova komapnija uključuju najsavremenije simulacije i softverska rešenja za obuku i razvoj, a sve na osnovu prilagođenog softvera. Jedan od softvera koji je ova kompanija razvila za potrebe obuke za reagovanje u vanrednim situacijama jeste EDMSIM. EDMSIM je interaktivno, softversko rešenje za obuku za vanredne situacije. Softversko rešenje je posebno dizajnirano za operativne snage koje se aktiviraju u slučaju vanrednih situacija, kao i za operativne centre i civilno rukovodstvo. Softver je vrlo fleksibilan i prilagodljiv alat. EDMSIM omogućava timovima koji učestvuju u obuci da poboljšaju komunikaciju, provere planove i procedure za vanredne situacije, odnosno da bolje funkcionišu u okruženju koje realno prikazuje okruženje pogođeno elementarnom nepogodom ili tehničko – tehnološkom nesrećom [7].



Slika 3. EDMSIM – praktičns upotreba softverskog rešenja[7]

EDMSIM koriste različiti subjekti, poput US Northern Command, Vojska i Nacionalna garda SAD, NATO i mnogi drugi. Jedna od glavnih karakteristika EDMSIM skalabilnost. To podrazumeva da se obuka upotrebom ovog softverskog rešenja može koristiti na lokalnom, regionalnom i najvišem nacionalnom nivou, kako u odvojenom režimu, tako i istovremeno. Na taj način pružaju se dodatne mogućnosti da različiti nivoi upravljanja i odlučivanja istovremeno se obučavaju i provežbavaju procedure i pružanje odgovora u slučaju vanredne situacije. Jedan od bitnih dokumenta koji se koristi u svim fazama upravljanja u vanrednim situacijama jeste plan zaštite i spasavanja. EDMSIM pruža opciju da se sam plan implementira u okviru raličitih softverskih pozicija i da se nakon toga utvrdi kako polaznici obuke, koji su ujedno i krajnji korisnici plana, primenjuju plan u realnim uslovima. Operativnom osoblju koje učestvuje u obuci putem softvera EDMSIM na raspolaganje se stavljaju isti oni ljudi i materijalno – tehnički resursi koje bi na osnovu plana koristili i u realnim uslovima. U takvom vidu obuke softver stavlja i određena ograničenja. Na primer, planom je predviđeno da će se u slučaju poplave u zaštiti i spasavanju ugroženih građana koristiti tri specijalistička tima sa po 5 spasioca i da svaki tim ima čamac sa odgovoarajućom opremom. Ako polaznici obuke u rešavanju zadataka na osnovu predefinisanog scenarija, donesu odluku o angažovanju većeg broja spasilaca i opreme u odnosu na predviđene parametre planom, softver će izdati

upozorenje da odabrani resursi nisu na raspolaganju. Na osnovu toga, omogućeno je tokom obuke da polaznici prođu i kroz upravljanje resursima. Pre početka obuke, u softver EDMSIM se implementira jedan vid baze podataka koja sadrži sve informacije o dostupnim ljudskim i materijalno – tehničkim resursima koji su dostupni na osnovu teritorije obuhvaćene scenarijom. Jedna od prednosti upotrebe ovakvog softvera je što je veoma jednostavan za upotrebu. Grafička rešenja i način korišćenja su prilagođeni osobama za osnovnim nivoom znanja korišćenja kompjutera. Kao i prethodno opisano softversko rešenje, i EDMSIM omogućava evaluaciju nakon obuke, analizu urađenog i preporuke za poboljšanje rada u realnim uslovima.

Prethodna dva primera upotrebe softverskih rešenja su samo neki od raznolikog broja koji se trenutno nudi na tržištu. Ipak, za potrebe ovog rada uzeti su kao reprezentativni primeri s obzirom na činjenicu široke upotrebe i pozitivnih komentara polaznika obuke koji se se na ovaj način pripremali za reagovanje u vanrednim situacijama ili u svojstvu civila, ili kao pripadnici profesionalnih i operativnih jedinica.

4. PREDNOSTI I NEDOSTACI UPOTREBE SAVREMENIH SOFTVERSKIH REŠENJA U PRIPREMI I OBUCI ZA REAGOVANJE U VANREDNIM SITUACIJAMA

Kao i u većini drugih slučajeva, upotreba savremene tehnologije i programskih rešenja sa sobom nosi niz prednosti, kao i nedostataka. Slična je situacija i sa upotrebom savremenih softverskih rešenja u pripremi i obuci za reagovanje u vanrednim situacijama.

Sigurno da je najveća prednost što se kroz ovakav vid obuke polaznici dovode u približno realne situacije onima koje ih mogu očekivati u stvarnim uslovima kada dođe do vanredne situacije izazvane elementatnim nepogodama ili tehničko – tehnološkim rešenjima. Sa aspekta krajnjih korisnika u ovoj oblasti, od izuzetnog je značaja da se stekne utisak šta svaka od opasnosti može izazvati. Na primer, nije isto kada se realizuje obuka za reagovanje u slučaju poplava ili šumskih požara. Drugačija je taktika reagovanja, upotrebe opreme, načina evakuacije ugroženih lica i drugo. U skladu sa time, softverska rešenja pružaju mogućnosti impelemntacije različitih scenarija koja su prilagodljiva realnosti. Na taj način, ako dođe do iste ili slične situacije, unapred će biti pripremljeniji, s obzirom da su upotrebom softvera već prošli kroz proces donošenja odluka i upotrebe različitih materijalno – tehničkih sredstava. Dalje, na primeru prvog načina obuke koji je predstavljen u prethodnom poglavlju, izražena je još jedna prednost, a to je mobilnost u obuci. Naime, kombinacijom upotrebe softverskog rešenja u vozilu, omogućeno je da se obuka realizuje na različitoj teritoriji u skladu sa potrebom. Takođe, time se ostvaruju i značajne uštede i polaznici obuke ne moraju napuštati svoju radnu sredinu i dolaziti u trening centre koji su u većini situaciji geografski dislocirani. Dalje, prikazana softverska rešenja predstavlaju vrlo jednostavne platforme za krajnje korisnike. Nije potrebna dodatna obuka kako bi se polaznici pripremili. Kako je i naglašeno, od polaznika se očekuje osnovni nivo znanja o upotrebi informaciono – komunikacionih tehnologija.

To predstavlja značajnu prednost. Savremena obuka se ne može zamisliti bez dela koji se odnosi na evaluaciju. Naime, osobe koje prolaze kroz obuku, moraju na kraju dobiti neki vid izveštaja o svom radu koji bi sadržao i preporuke za dalji rad i unapređenje kompetencija. Upotreba softverskih rešenja u pripremi i obuci za reagovanje u vanrednim situacijama pruža i tu mogućnost. Tokom obuke, automatski se memorišu pružena rešenja i odgovori na različite zadatke i scenarija. Kada se završi obuka, instruktori mogu na vrlo jednostavan i lak način pregledati odgovore poalznika obuke i time izvršiti evaluaciju. Na kraju, prednost koju donosi ovakav vid obuke u oblasti vanrednih situacija jeste i mogućnost učenja na daljinu. Uz upotrebu internet tehnologija, omogućeno je da istovremeno u obuci učestvuju polaznici iz različitih krajeva što doprinosi i jačanju međunarodne saradnje u oblasti upravljanja u vanrednim situacijama.

Jedan od glavnih nedostataka koji se pojavljuje prilikom korišćenja savremenih softverskih rešenja u pripremi i obuci za reagovanje u vanrednim situacijama jeste finansijski aspekt. Naime, potrebno je izdvojiti značajna finansijska sredstva kako bi se softver kupio, dalje koristio i održavao. Na taj način, sužava se broj država i njihovih trening centara koji mogu sprovoditi odbuku upotrebom savremenih softverskih rešenja. Takođe, pokazalo se neisplativim i da države svoje predstavnike operativnih snaga upućuju u inostranstvo na obuku ucentre koji poseduju navedenu opremu. U vezi sa prethodnim, javlja se i sledeći nedostatak, a to je održavanje softvera. Prilikom nabavke softverskog rešenja definiše se i način na koji će se vršiti dalje održavanje, odnosno kako će se vršiti eventualne popravke u slučaju kvara. Postoji nekoliko mogućnosti, od dolazaka predstavnika kompanije koja je prodala softver da direktno reše problem, do daljinksih popravki putem posebnih aplikacija. U svakom slučaju, to predstavlja dodatni trošak koji

može odgovoriti nadležne institucije da sprovode obuku i pripremu za reagovanje u vanrednim situacijama putem savremenih softverskih rešenja.

5. ZAKLJUČAK

Savremene tendecije i posledice koje prouzrokuju vanredne tendencije izazvane elementarnim nepogodama i tehničko – tehnološkim nesrećama ukazuju na neophodnost da se i stanovništvo i operativne spasilačke snage što bolje pripreme i obuče.

U tom pravcu stvaranje realnih uslova u kojima se mogu naći tokom vanredne situacije, predstavlja jedan od primarnih ciljeva tokom obuke. Tako se i došlo na ideju da se tokom obuke koriste savremena softverska rešenja koja simuliraju različite rizike i opasnosti koje prouzrokuju vanredne situacije, kao što su zemljotresi, poplave, šumski požari, hemijski akcidenti i drugo.

Trenutno je aktuelno nekoliko softverskih paketa koji se mogu koristiti u ove svrhe. Izrađeni su od strane renomiranih svetksih kompanija koje posluju u oblasti informaciono – kmunikacionih tehnologija. Nadležne institucije za obuku na nacionalnom nivou time dobijaju mogućnost kupovine i dalje upotrebe programskih paketa koje mogu pomoći u pripremi kako stanovništva, tako i operativnih snaga, za što efikasnije reagovanje ukoliko dođe do vanredne situacije.

Kako je u radu naglašeno, prisutne su i prednosti i nedostaci ovakvog vida obuke. Takođe, više je pozitivnih stana primene savremenih softverskih rešenja u obuci za reagovanje u vanrednim situacijama. Međutim, izraženi nedostatak se ogleda u značajnim finanijskim sredstvima koja je potrebno izdvojiti za nabavku, upotrebu i dalje održavanje ovih softvera. Međutim, ako se ima u vidu do koji posledica dolazi nakon određenih vanrednih situacija, tačnije koliko je finansijskih sredstava potrebno da bi vratili uslovi života i boravka koji su bili i ranije, evidentna je isplativost realizacije ovakvog načina obuke za reagovanje u vanrednim situacijama.

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DATA SCIENCE & DIGITAL BROADCASTING SYSTEMS



COMPUTER VISION IN INDUSTRY

Dobrivoje Đurić*,
Vladimir Matić

Singidunum University,
Belgrade, Serbia

Abstract:
This paper presents a system of computer vision designed to be used in industry for product classification. The system is based on the TensorFlow and Keras software libraries and the Python programming language. In the production process, uniform cylindrical parts reach the conveyor designed so that each part can be in one of two possible positions. The computer vision system detects the exact position of the part, or its orientation, and this information is further used during the transportation process. The purpose of the procedure is for all parts to take the same orientation in relation to the production line.

Keywords:
industry, computer vision, machine learning, Keras, TensorFlow, Python, RaspberryPi.

1. INTRODUCTION

The classification presented in this paper refers to one type of product. In this case, the same type and size of the metal screws were used. The aim of the classification is to determine the orientation of each part in relation to the production line. In this case, the part can be in one of two possible positions and for that reason, two classes are used. One position implies that the top of the screw is pointed in the direction of production, and the other position means that the top faces the opposite direction. The result of the classification is used so that all the parts take the same orientation. In addition, there is also a third class related to all the cases when the object is not properly detected. For example, when the production part is not in the required position or if more than one part is present at a time.

The solution of the computer vision system is based on the programming language Python and the libraries Keras and TensorFlow. This paper also introduces the testing equipment used to verify the functionality of computer vision in real conditions. The testing equipment includes the mini-computer Raspberry Pi with a corresponding camera and a transport system prototype, which is used to shift the parts in order to

Correspondence:
Dobrivoje Đurić

e-mail:
dobrivoje.djuric.17@singimail.rs

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test the accuracy and reproducibility of the classification. In order to reduce the classification time, a simple algorithm is designed and executed fast enough on the testing equipment.

By executing the program on the testing equipment, the machine learning algorithm, which was trained on another computer, is loaded first. Following this, a program loop continuously reads the output of the camera and performs the classification. This part of the program also includes functions related to the automatic control of motors, which are used for transportation of the detected elements.

The low-cost solar tracking system [1], based on an open source hardware and machine learning algorithm, was an inspiration to use the Raspberry Pi.

The used literature can be divided into two sections, one dealing with the computer vision [2], [3] and [4], while the other section deals with artificial neural networks on which the machine learning algorithm is based [5] and [6].

2. PROCESS AND TEST EQUIPMENT DESCRIPTION

During the production process, uniform cylindrical parts reach the appropriate position one at a time in such a way that they take one of two possible orientations. The computer vision system detects the exact orientation of the part and this information is further used to rotate and shift it to the appropriate location. The aim of the procedure is for all the parts to assume the same orientation in relation to the production line. Instead of the real parts, metal screws were used for the purpose of testing.

The position that a free falling screw assumes can be compared to the V-profile considering its appearance. Due to its physical design, the metal screw always assumes a horizontal position, whereby its head can be turned left or right when observed from the position of the operator. The answer to the question of the direction that the head of the screw can face can be obtained using the computer vision.

A camera is placed above the position used for the rotation of the production part. During the image processing, the classification indicates whether the head of the screw is faced to the left or to the right. Based on the classification results, the screw can rotate 180°, if necessary. The aim is for all the parts to assume the same orientation, followed by transport according to the established procedures of manufacturing. The following illustration shows the testing equipment. In order to reduce the background influence, the V-profile is in black. Using these simple images the classification is more accurate, which is important because of the simple machine learning algorithm. The motor (M1) is used to rotate the parts and the motor (M2) for their transfer to the next position. Incremental encoders E1 and E2 are used for positioning.

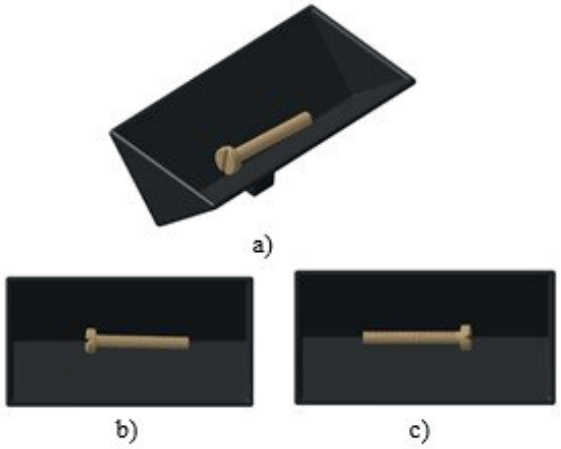


Figure 1. Illustration of product handler: a) isometric view, b) part is oriented to the right, c) part is oriented to the left in relation to the observer

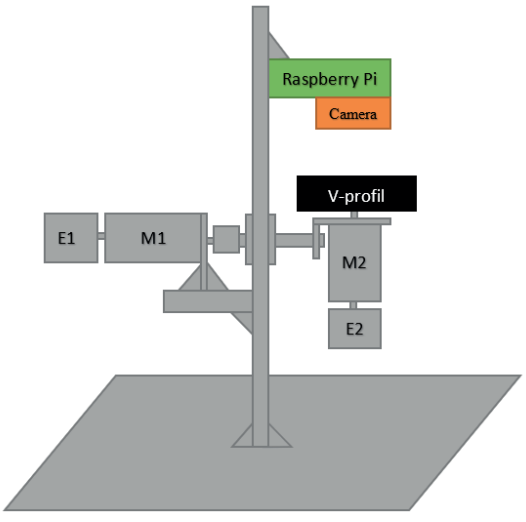


Figure 2. Illustration of testing equipment

Raspberry Pi computer is equipped with a camera and placed just above the position where the production part is located. In addition to the computer vision,

Raspberry Pi is also used to control the motors M1 and M2. It is equipped with a motor control card placed in the same casing as the computer. This testing equipment creates the images of the data set used in developing the machine learning algorithm.



Figure 3. Test equipment

3. CLASSIFICATION PROCEDURE

The classification procedure and material transport are fully automated. The program runs on Raspberry Pi, which is an integral part of the testing equipment. When executing the program, a pre-trained model of the artificial neural network is loaded, and then a program loop starts in which the classification procedure is continuously executed. If the result of the classification indicates that the production part is not well oriented, it has to be rotated 180° and then moved to the next position. Following this, the V-profile is ready to accept the new part. If the result of the classification indicates that the products are well oriented, they move to the next position without rotation.

When the object is not detected, a message is displayed as a warning. In this case it is necessary to manually execute the repositioning of the part or transfer it to the next position. The entire procedure is performed under usual room lighting and can be described through the following steps:

1. The production part reaches the position for inspection. In our case, the metal screw is placed manually.
2. The classification indicates whether the part is well-oriented or it needs to be rotated 180°.
3. The rotation of the production part, if necessary, is achieved using the M1 motor, shown in Figure 2.
4. The product is moved to the next position by changing the slope of the V-profile using the M2 motor. When a certain slope is reached, a free-falling production part leaves the V-profile.
5. At the end of the process, the V-profile returns to its basic position.

4. MACHINE LEARNING ALGORITHM

The machine learning algorithm is based on a convolutional neural network. The input data are color images with a 96 x 96 pixels resolution. Initially, Google's MobileNet algorithm was used. Good results were achieved in terms of accuracy, but due to the complexity of the algorithm and low processing capabilities, it was necessary to create a simpler algorithm.

A TensorFlow library was used to create a new algorithm. TensorFlow was released by Google and it can be used directly or by using wrapper libraries such as Keras. Keras is a library also developed by Google in order to simplify the development of deep learning models [5].

The algorithm architecture is defined in Table 1.

Table 1. Algorithm architecture

Layer (activation)	Filter Shape	Output Size
Conv2D ('relu')	3 x 3 x 32	94 x 94 x 32
Conv2D ('relu')	3 x 3 x 32	92 x 92 x 32
Conv2D ('relu')	3 x 3 x 64	90 x 90 x 64
Average Pooling 2D	2 x 2	45 x 45 x 64
Dropout	0.2	45 x 45 x 64
Flatten		129600
Dense ('relu')		12
Dense ('softmax')	Classifier	3

The accuracy and loss achieved during the training are shown in Figure 4 and Figure 5.

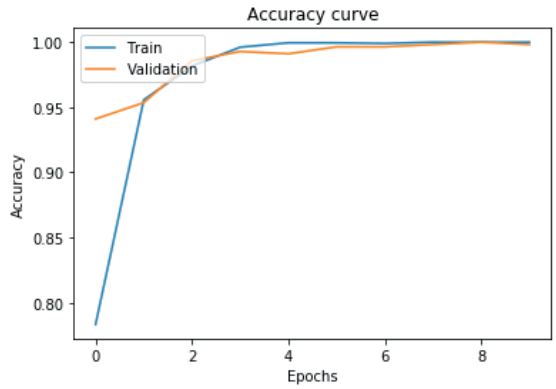


Figure 4. Model accuracy

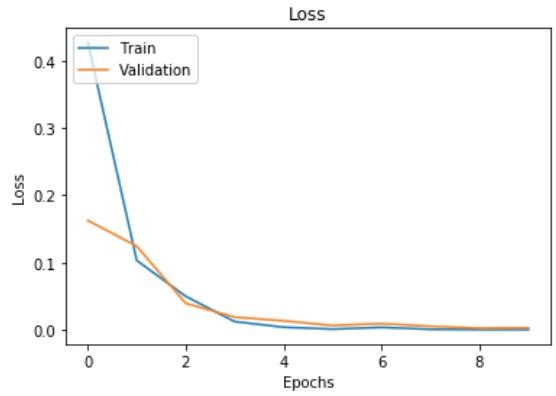


Figure 5. Model loss

Figure 6. Showing a sample of dataset images used for algorithm training.

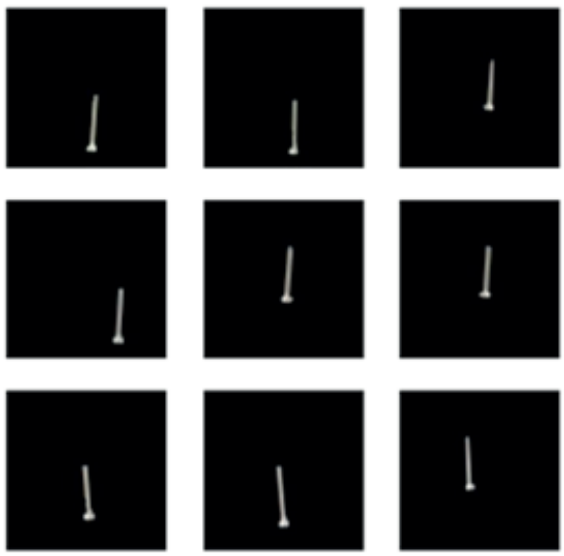


Figure 6. Sample of dataset images

5. IMAGE PREPROCESSING

The testing equipment initially made a small number of images for the data set, which were then multiplied by Keras to get more images for the training. Keras supports the *ImageDataGenerator* feature, which can create new modified images from the original ones. The changes include random rotations at an angle within a defined range, zooming, and shifting in horizontal and vertical direction. In this way, the initial small number of images produced a sufficiently large data set for model training. The class which indicates that an object is not recognized, or undefined, contains images of the empty V-profile.

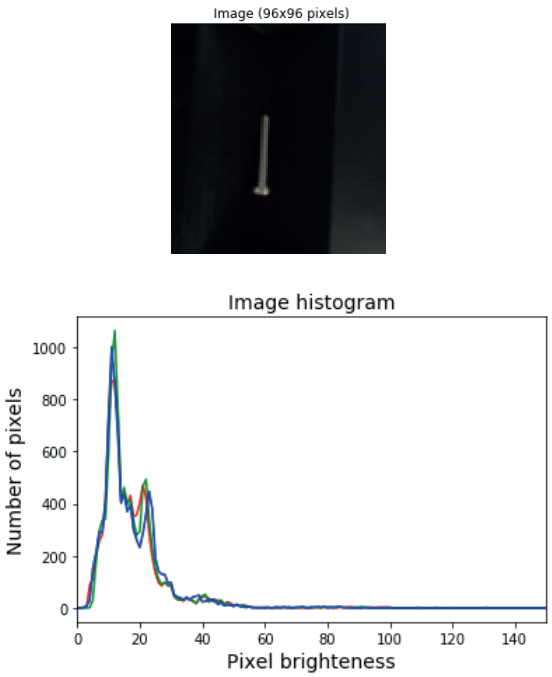


Figure 7. Screw (up) and its histogram (down)

In order to remove the background influence, which is in dark color, the pixel values are changed. All pixels values below the defined threshold are set to zero. The threshold is defined using a color histogram. Since all the images are similar, by analyzing the histogram for one image we can determine the common threshold for the entire data set.

The histogram in Figure 7. shows that the largest number of pixels has the value of RGB components below 50. This pertains to the dark background.



Figure 8. Image preprocessing

Figure 8. shows the image preprocessing results with the following explanation: a) original image, b) the result of the operation in which the pixel values are set to zero, if they were previously below the defined threshold, and c) the result of masking the image region. This kind of image preprocessing can be applied in industrially controlled conditions.

6. AUTOMATIC MATERIAL TRANSPORT

Manufacturing processes at modern industrial plants are based on a high level of automation. These processes are controlled by PLC (Programmable Logic Controller) which, according to the information obtained from sensors and according to the operating parameters, generates reference values used to control the actuators.

In order to increase the level of automation, computer vision is used to provide additional information about the process. In our case, the testing equipment does not include the PLC. Two motors with encoders are used for the transport of materials. Motors are controlled by the same computer, which is also used for computer vision.

A control card, located in the same casing with the Raspberry Pi computer and connected to it via the I2C interface, is used to drive the motors.

Two identical motors with gearboxes and incremental encoders are in use. Each incremental encoder is connected to the appropriate GPIO inputs of the Raspberry Pi computer, which are configured to initiate a program interrupt when detecting the front edge of the encoder pulse. The interruption executes a program code detecting the direction of movement and calculating the current position. The positioning is based on the number of encoder pulses.

The classification applies to the part of the program that is executed in an infinite loop. If three consecutive classifications are the same, the transport procedure is initiated. The procedure has two steps, the first is rotating 180° if necessary, and then shifting to the next position. The program changes the direction of the rotation in order to minimize the positioning error. If the screw has been rotated 180° in the clockwise direction, the next time the rotation will be counterclockwise. If the rotation is performed only in one direction, there is a possibility that small errors will accumulate over time, which would increase positioning errors after a large number of cycles.

7. CONCLUSION

The testing of the model in real time using the testing equipment achieved a satisfying accuracy and repeatability of the classification. Color images were used initially, and the results did not differ significantly from the gray scale images. Pre-processed color images have a dark background and a bright object, practically a small difference compared to gray scale images. The algorithm execution time is about 250 ms.

Image preprocessing in real time has a positive impact on the accuracy of the classification. By preprocessing the image, the background details are removed, which makes the image simpler. Because of using images in small resolution, program execution does not consume much time.

Lighting has a big impact, especially in terms of reflection. During the testing, the best results were achieved using regular room lighting. When the testing equipment was directly exposed to the source of light, there were intensive reflections on the surface of the object and the surrounding plastic used in the manufacture of the testing equipment. This considerably changed the results and in some cases, the classification could not be performed at all. On the other hand, the impact of the shadow was not observed. This is primarily because of the specific design of the device and the dark background.

In order to reduce the problem of illumination, images for the data set were taken under different levels of illumination. The intention was to resolve the issue by training the model in different conditions, which did provide certain improvement, but the problem was not resolved completely. The algorithm itself was also limiting because of its simplicity. When using a data set with complex images, more complex algorithms should be used.

Simple hardware produces satisfactory results. This was achieved using simple images and a small number of classes. If the number of classes is larger or images become more complex, more complex algorithms that require larger hardware capabilities would have to be used.

The tests have shown that more than one class for undefined states would be preferable. When one class includes different objects, it becomes complex. The best results were achieved when the class included only the images with the background of the object. In order to recognize the other irregular states, new classes must be added.

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CONVOLUTIONAL NEURAL NETWORK LAYERS AND ARCHITECTURES

Timea Bezdan*,
Nebojša Bačanin Džakula

Singidunum University,
Belgrade, Serbia

Abstract:
In recent years, computer vision which is one of the fastest growing artificial intelligence disciplines, has become increasingly important in our society due to its wide range applications in different areas such as health care and medicine (algorithms that can diagnose medical images for diseases), vision-based robotics, self-driving cars (that can see and drive safely). Convolutional neural networks are biologically inspired architectures and represent the core of deep learning algorithms in computer vision. In this paper, we represent the fundamental building blocks of convolutional neural networks and the most popular convolutional neural network architectures in the history, including those that have achieved the state-of-the-art performance on standard recognition datasets and tasks such as ImageNet Large-Scale Visual Recognition Challenge (ILSVRC). ILSVRC is one of the largest challenges in computer vision organized by Stanford Vision Lab since 2010 and every year teams compete to claim the state-of-the-art performance on the dataset.

Keywords:
computer vision, deep learning, image recognition, image classification, object recognition.

1. INTRODUCTION

Convolutional neural networks [1] (CNNs) are a specific type of artificial neural networks (ANNs), that has been demonstrated high performance on various visual tasks, including image classification, image segmentation [2], image retrieval [3], object detection [4], image captioning [5], face recognition [6], pose estimation [7], traffic sign recognition [8], speech processing [9], neural style transfer [10] etc.

Convolutional neural networks have become a rapidly growing area of interest in recent years, however, its development started much earlier. One of the most influential papers in this area was published by Hubel and Wiesel in 1959 [11]. They did a series of experiments, trying to understand how neurons work in the visual cortex. The researchers discovered that the visual cortex has a hierarchical organization, that there are simple and complex neurons in the primary visual cortex and that visual processing always starts with simple structures such as oriented edges, complex cells received input from lower level simple cells by

Correspondence:
Timea Bezdan

e-mail:
timea.bezdan.17@singimail.rs

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way of a receptive field. In 1980, Fukushima introduced Neocognitron [12], which was the first example of an artificial neural network model, that had an idea of simple and complex cells, discovered by Hubel and Wiesel. Fukushima put "S-cells" and "C-cells" into alternative layers, building up into a hierarchy, so-called "sandwich layers" (SCSCS…). S and C cells show similar characteristics to simple and complex cells in the visual cortex. "S-cells" has modifiable parameters and on the top of them, "C-cells" perform pooling. The network was not back-propagated at that time. LeCun in 1989 applied back-propagation [13] to train Fukushima's artificial neural network, the method has a 1% error rate and about 9% reject rate on zip code digits. In 1998, LuCun further optimized CNN using an error gradient-based learning algorithm [1]. In 2012 is proposed AlexNet [14], which has a more complex architecture, it was the first deep convolutional neural network (DCNN). AlexNet [14] achieved significant results and this success has brought about a revolution in computer vision. The significant results came from the efficient use of GPUs, ReLU [15] activation function, regularization technique called dropout [16] and data augmentation.

CNNs are designed to process data that come in the form of multiple arrays, for example, a color image composed of three 2D arrays containing pixel intensities in the three-color channels. They use their convolutional filters to extract information from images, earlier layers detect edges, later layers can detect part of objects, then even later layers may detect complete objects, such as faces, or other complex geometrical shapes [17]. The CNN composed by a set of layers that can be grouped by their functionalities, three main types of layers are: convolutional layer, pooling layer, and fully-connected layer.

2. CONVOLUTIONAL NEURAL NETWORK LAYERS

Convolutional layer

The convolution operation is one of the fundamental building blocks of a convolutional neural network. The convolutional layer's parameters consist of a set of learnable filters (kernels). Every filter is small spatially (along width and height), but extends through the full depth of the input volume. Typical filter sizes might have size 3x3, 5x5, 7x7. The third dimension of the filter corresponds to the number of channels in the input. The grayscale image depth is 1 and the color image has 3 (RGB) color channels.

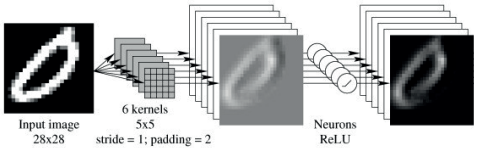


Fig. 1. One convolution layer [18]

During the forward propagation, each filter performs convolution on the input volume across the width and height and compute the dot products between the entries of the filter and the input at any position, this operation is followed by a nonlinear activation function (sigmoid, tanh, ReLU etc.), the resulting outputs are called feature maps. The feature map (also known as an activation map), gives the responses of the filter at every spatial position. An example of convolution layer followed by nonlinear activation is shown in Fig. 1. We stack these activation maps along the depth dimension and produce the output volume. The output volume depends on three hyperparameters: depth, stride and padding.

- The depth of the output volume represents the number of filters that are used in the convolution operation. Each filter is learning something different in the input, edges, blobs, colors.
- The stride is the number of steps that we slide the filter in the input. When the stride is 1 then we move the filters one pixel at a time. When the stride is 2 then the filters jump 2 pixels at a time as we slide them around. This will produce smaller output volumes spatially.
- Padding allows controlling the output size. Applying convolution to an input, reduce the output size that leads to losing information. To avoid that, we pad the input volume with zeros around the border. Two common choices are valid convolution and the same convolution. The valid convolution means no padding, the same convolution means that the output size remains the same as the input size.

The output size is calculated in the following way:

$$(n + 2p - f) / s + 1$$

Where n is the number of filters, p is the amount of padding, f is the filter size and s is the stride.

Pooling layer

CNNs often use pooling layer operation after convolution layers, its function is to reduce the dimension, also referred as subsampling or downsampling. Hyperparameters of pooling layer represent the filter size and strides. Most commonly used pooling layer is with filter size 2 and with stride 2. Two common types of pooling layers are max pooling and average pooling, where the maximum and average value is taken, respectively. Max pooling is used often than average pooling. Pooling layer does not have parameters to learn. The intuition of what max pooling is doing is that the large number means that there may be detected a feature. An example of convolution layer followed by pooling layer is shown in Fig. 2.

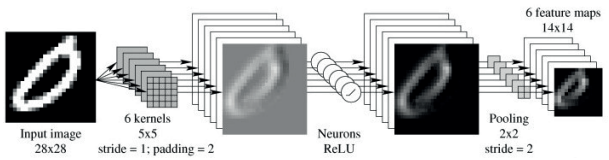


Fig. 2. Convolution layer followed by pooling layer [18]

Fully Connected layer

After several convolution and pooling layers, the CNN generally ends with several fully connected layers. The tensor that we have at the output of these layers is transformed into a vector and then we add several neural network layers. The fully connected layers typically are the last few layers of the architecture as shown in the Fig. 3, the dropout [16] regularization technique can be applied in the fully connected layers to prevent overfitting. The final fully connected layer in the architecture contains the same amount of output neurons as the number of classes to be recognized.

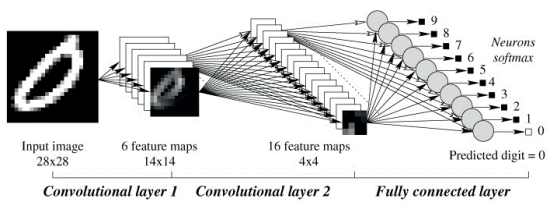


Fig. 3. Two convolutional layers followed by a fully connected layer [18]

3. CLASSIC CONVOLUTIONAL NEURAL NETWORK ARCHITECTURES

We have so far described different layers of CNN. Now, we present how these layers are combined to form the architecture of the network. The most common CNN architectures stack a few convolutional layers together, it follows the pooling layer, then this pattern repeats, and we add at the end the fully connected layers. Classic CNN architectures are LeNet-5 [1], AlexNet [14] and VGGNet [19].

LeNet-5

The LeNet-5 [1] was the first CNN, it proposed by Yann LeCun and his team at Bell Labs in 1998, this architecture is shown in Fig. 4. This network was devoted to digit recognition, LeCun et.al. used the system for handwritten signature detection in checks, and it was successfully deployed commercially for this purpose. It is composed only on few layers and few filters, due to the computer limitations at that time. As shown in Fig. 4, the architecture has two convolution layers, two average pooling layers, two fully connected layers and an output layer with Gaussian connection. LeNet-5 [1] has 60,000 parameters. As activation function, tanh activation function is used.

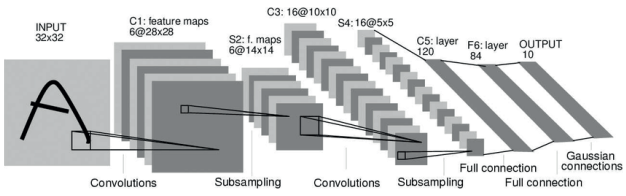


Fig. 4. Architecture of LeNet-5 [1]

AlexNet

The AlexNet [14] architecture was the first work that popularized Convolutional Networks in Computer Vision, it was the winner of the ImageNet ILSVRC [20] competition in 2012, it had a 15.4% top-5 error rate vs 26.2% for the next lowest network. AlexNet [14] follows the pattern of the LeNet-5 [1] architecture, but it was deeper, bigger, and featured convolutional layers stacked on top of each other. The tanh activation function, that was used in LeNet-5 [1], replaced with ReLU

function, as loss function, cross entropy loss function is used. AlexNet [14] used a much bigger training set. LeNet-5 [1] was trained on the MNIST dataset with 50,000 images and 10 categories, AlexNet [14] used a subset of the ImageNet dataset with a training set containing one million color images and 1000 categories.

The input image resolution is 224 × 224, the architecture consists of 5 convolution layers, three 2x2 max-pooling layers and 2 fully connected layers. As shown in Fig. 5, the filter size of the first convolution layer is (11, 11, 3, 96) with a stride of 4, and the first output shape is (55, 55, 96). As a regularization technique, dropout [16] is used in the fully connected layers to reduce overfitting. The total number of parameters in AlexNet [14] is 60 million.

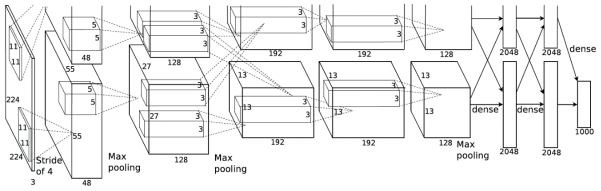


Fig. 5. AlexNet architecture [14]

VGGNet

The VGG Network [19] is introduced in 2014 by Karen Simonyan and Andrew Zisserman. At that time, it was considered as a very deep network. Its main contribution was in showing that the depth of the network is a critical component to achieve better recognition or classification accuracy in CNNs. VGGNet [19] shown in Fig. 6, used 3x3 filters, the authors give the intuition behind this that having two consecutive two 3x3 filters gives an effective receptive field of 5x5, and three 3x3 filters give a receptive field of 7x7 filters. The number of filters in the architecture double after every max-pooling operation.

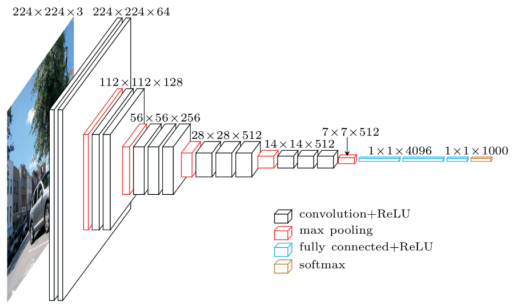


Fig. 6. VGGNet architecture [19]

4. MODERN CONVOLUTIONAL NEURAL NETWORK ARCHITECTURES

Modern CNN architectures are GoogleNet [21], Residual Network [22], Squeeze-and-Excitation network [23]. Each of them is described in more details in the following section.

GoogleNet

The network that won ILSVRC [20] in 2014 is the network GoogleNet [21]. GoogleNet [21], shown in Fig. 8, is considered to be the first use of modern CNN architecture, which is not composed only on successive convolution and pooling layers, it used inception [24] architecture, that is kind of network in network (NIN) [25]. An example is represented in Fig. 7. The inception module skips connections in the network essentially forming a mini-module and that module is repeated throughout the network. The inception module dramatically reduced the number of parameters in the network, GoogleNet [21] employed around 7 million parameters, which represented a 9 times reduction with respect to its predecessor AlexNet [14], which used 60 million parameters. Furthermore, VGGNet [19] employed about 3 times more parameters than AlexNet [14].

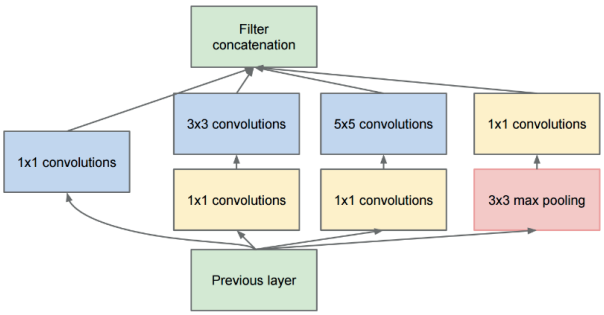


Fig. 7. Inception module [21]

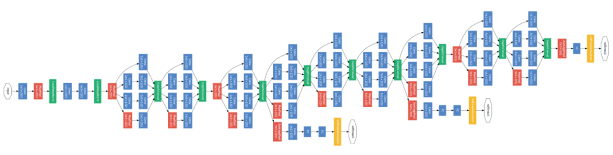


Fig. 8. Inception module [21]
GoogleNet architecture [21]

GoogleNet [21] uses 9 inception modules, and it eliminates all fully connected layers using average pooling to go from 7x7x1024 to 1x1x1024, eliminating a large number of parameters that do not seem to matter much. As a form of data augmentation, multiple crops of the same image were created and the network was trained on it. There are also several followup versions to the GoogleNet [21], most recently Inception-v4 [24].

Residual network

Residual network (ResNet) [22] was the winner of ILSVRC [20] 2015, it has in total of 152 layers. ResNet is built of a residual block, which is shown in Fig. 11, by stacking residual blocks together, each residual block has two 3x3 convolution layer, Periodically, double the number of filters and downsample spatially using stride 2. ResNet [22] features special skip connections and use of batch normalization [26] after every convolution layer. Deeper models are harder to optimize, the solution is to use skip connection, which allows to take the activation from one layer and feed it to another layer. Using that enables to train very deep networks and avoid vanishing and exploding gradient problem. To reduce the number of parameters, the ResNets [22] do not have fully connected layers, besides fully connected layer to output the 1000 classes. ResNet [22] is the first architecture that has better performance than human performance.

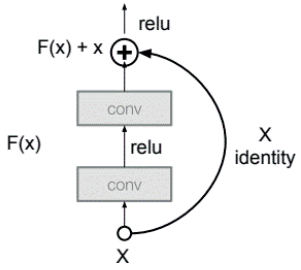


Fig. 9. Residual block [22]

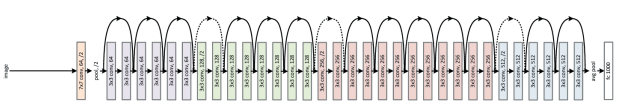


Fig. 10. ResNet [22]

Squeeze-and-Excitation Network

Squeeze-and-Excitation Network (SENet) [23] won the first place on ImageNet challenge in 2017 and significantly reduced the top-5 error to 2.251%. SENet introduce a building block for CNNs that improves channel interdependencies at a minimal additional computational cost. Besides significant improvements in performance, it can be easily added to an existing architecture. The SE block tries to use global information to selectively emphasize informative features and suppress less useful once by adding parameters to each channel of a convolutional block so that the network can adaptively adjust the weighting of each feature map. SE block consists of two operations, squeeze and excitation respectively. Squeeze-and-excitation block is shown in Fig. 13.

- The squeeze operation squeezes each channel to a single numeric value by using global average pooling to generate channel-wise statistic and reduce the dimension.

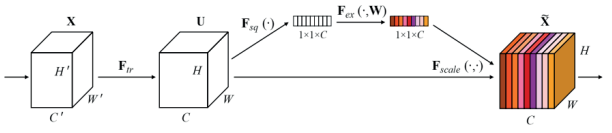


Fig. 11. Squeeze-and-Excitation block [23]

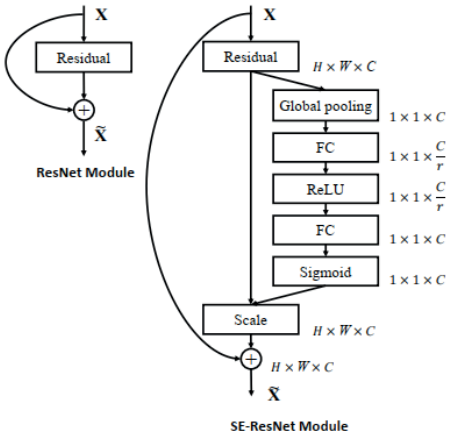


Fig. 12. The schema of the original Residual module (left) and the SEResNet module (right) [23]

- The excitation operation makes use of the information aggregated in the squeeze operation, determines which of the feature maps are important. This is done using a two FC layer around the ReLU non-linearity and in the end the as a gating mechanism, the sigmoid function is applied. The resulting weights applied to each feature maps to generate the output of the SE block which can be fed directly into subsequent layers of the network.

5. CONCLUSION AND DISCUSSION

This paper has outlined the basic concepts of Convolutional Neural Networks, explaining the layers required to build it and detailing how to best structure the network in most image classification tasks. CNN is better than other deep learning methods in applications to computer vision, it gives the best performance in image recognition problems and even outperforms humans in certain cases. The inception module, along with residual networks, has improved CNN performance and introduced new capabilities. The Inception module provides some scale invariance, while residual networks allow training deeper networks. The default choice of network architecture is ResNet or SENet.

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A REVIEW OF MACHINE LEARNING ALGORITHMS USED FOR LOAD FORECASTING AT MICROGRID LEVEL

Enea Mele

National and Kapodistrian University of Athens,
Athens, Greece

Abstract:
As load forecasting nowadays is a crucial and integral part of the energy production procedures a large number of forecasting methods has been proposed to address it. However, although there are many forecasting methods which take into account the advances in information, metering and control technologies in order to address the challenges of forecasting problems, the accuracy and efficiency levels required for each type of applications are yet to be determined. Technologies such as machine learning techniques have been proven useful for short-term electricity load forecasting especially in microgrids where a large variety of data should be included in the energy consumption prognosis. In this paper, we present an overview of the main machine learning algorithms applied to electricity load datasets for short-term forecasting such as Support Vector Machines (SVM), k-Nearest Neighbors (kNN), Random Forest and Artificial Neural Networks (ANN) and compare their performance efficiency, capabilities and limitations.

Keywords:
machine learning; short-term forecasting; electricity load profile; renewable energy sources.

1. INTRODUCTION

The penetration of distributed and renewable generation is increasingly growing and new systems such as microgrids are being implemented in the distribution network. This decentralized structure poses new challenges for reliable and quality services of the electricity distribution network and entities. In order to cope with these challenges tools such as short-term load forecasting have become important aspects of the decision making process for purchasing, selling as well as generating electric power, demand side management, and infrastructure development.

Accurate models for electric power load forecasting are essential to the operation and planning of microgrids, especially given the deregulation of the electricity market and the anticipated price fluctuations in all four markets of the target model. Novel techniques and models are taking advantage of the advances in artificial intelligence algorithms which allow for faster convergence, manipulating big data sets and solving more complex problems.

Correspondence:
Enea Mele

e-mail:
dimitrismele@gmail.com

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Algorithms that use available data for the training of a model, where the underlying system is more or less treated as a black box, are usually grouped under the term machine learning. Arthur Samuel was the one who coined the term ''Machine Learning'' in 1959, defining it as "the ability to learn without being explicitly programmed." Machine Learning, at its most basic form, is the practice of using algorithms to parse data, learn from them, and then make a determination or prediction about something in the world.

Many of the recent advances in smart devices are the result of deep learning, a subset of machine learning that uses layers of neural networks with which it is able to develop computer models that are roughly based on the structure of the human brain neurons. When machine learning systems are combined with big data they provide new capabilities and emerging technologies [1].

So instead of hard coding software routines with specific instructions to accomplish a particular task, machine learning is a way of "training" an algorithm to learn by itself. "Training" involves feeding huge amounts of data to the algorithm and allowing the algorithm to adjust itself and improve to perform a given task better and more quickly than expert humans [2], [1].

Machine learning is being used extensively in many problems where big amounts of data are generated, such as weather forecasting. In this work we focus on the electrical load. Long and midterm forecasting has been used for years by all electricity companies using more conventional algorithms, such as linear regression [3] and econometric models [4] with acceptable accuracy. The transition to the smart grid and the emergence of microgrids and distributed generation and storage is restating the forecasting problem and setting new requirements. The amount of data generated by the new grid architecture increases dramatically due to distributed generation, smart meters, electrical vehicles, and cannot be handled efficiently by conventional algorithms. Algorithms that are able to classify these data and use them to train systems are required [5]. For the management of microgrids, the short term forecasting problem needs to be solved. In order to attain high accuracy levels, access to a large amount of data such as the day of the week, the month of the year, the respective days and months of past years along with past and future environmental data are required.

This paper aims to establish the state of the art and investigate the latest trends and open challenges in short term forecasting for microgrids. In the following sections, we will present briefly the main families of algorithms used in these problems, such as support vector machines (SVM), k-Nearest Neighbors (kNN), Random Forest and artificial neural networks (ANN), and their performance with respect to the given problem.

2. MACHINE LEARNING

A more precise formalism regarding machine learning was given by Tom Michell in his book "Machine Learning" that has been repeated a lot since then:"Machine Learning is the process which, a computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E." [6]

Based on this definition it is easy to say that machine learning is closely related to computational statistics, which also focuses on prediction making through the use of computers and has strong ties to mathematical optimization, which delivers methods, theory and application domains to the field. Machine learning tasks may be classified into three broad categories, namely supervised, unsupervised and semi-supervised, depending on whether they use labeled or unlabeled data or both. Unlabeled data usually consist of samples artifacts that are created either naturally or by humans and can be obtained readily through sensors. On the other hand, labeled data typically takes a set of unlabeled data and augments each piece of that unlabeled data with some sort of meaningful "tag," "label," or "class" that is somehow informative or desirable to know. After obtaining a labeled dataset, machine learning models can be applied to the data so that new unlabeled data can be presented to the model and a likely label can be guessed or predicted for that piece of unlabeled data.

Supervised learning

The training data consist of a set of training examples. Each example is a pair consisting of an input object (typically a vector) and a desired output value (also called the supervisory signal). A supervised learning algorithm analyzes the training data and produces an inferred function, which can be used for mapping new examples. More specifically, a supervised learning algorithm takes a known set of input data and known responses to the data (output), and divides them into two sets, one called training set and one called test set. The observations in the training set comprise the

experience that the algorithm uses to learn. The test set is a similar collection of observations that is used to evaluate the performance of the model [7]. For example, a forecasting model could use the past data on the energy consumption of a building to create two sets, one for training and one for testing, use the first to train the algorithm to predict the future consumptions and then compare its results against the second set.

Some of the algorithms that have been used in supervised learning techniques for load forecasting are the Decision Trees, k-Nearest Neighbors (kNN), Naïve Bayes and Support Vector Regression (SVR).

Unsupervised learning

Unsupervised learning can be described as learning without a master. The algorithm is "left on its own" to determine the underlying structure or an input-output relationship using unlabeled data training sets. There is no feedback based on the prediction results, no error or reward signals are issued to evaluate a potential solution. The algorithms must recognize patterns or discover relationships between groups of input data [6]. Unsupervised learning uses procedures that attempt to find natural partitions of patterns as it does not always know what it is searching for, but can independently sort data and find compelling patterns. For example, an unsupervised load forecasting algorithm based on the association feature should be able to generate a pattern able to detect that the energy consumption at a given home is increased in the morning hours but is decreased during the evening and afternoon hours.

Some of the algorithms that are mostly used in unsupervised learning load forecasting are the K-Mean, the k-Nearest Neighbors (kNN) and the Neural Networks.

Semi-Supervised learning

Between supervised and unsupervised learning, there exists the semi-supervised learning. In this case, algorithms are trained on a combination of labeled and unlabeled data which means that the computer is provided with an incomplete training set in which some of the target outputs are missing. Semi-supervised learning is useful for various reasons. First, the process of labeling massive amounts of data for supervised learning is often prohibitively time-consuming and expensive. What's more, too much labeling can introduce human biases on the model. That means that including lots of unlabeled data during the training process actually tends to improve the accuracy of the final model while reducing the time and cost spent building it [6], [7].

Another categorization of machine learning tasks is by the desired output. If the output of the model is a class then it is a classification problem, if it is a number then it is a regression problem and if it is a set of input groups, it's a clustering problem.

In classification, inputs are divided into two or more classes, and the learner must produce a model that assigns unknown inputs to one or more (multi-label classification) of these classes. This is typically accomplished using supervised learning algorithms. In regression, which is also a supervised problem, the outputs are continuous rather than discrete and in clustering, a set of inputs is to be divided into groups. Unlike classification, the groups are not known beforehand, making this typically an unsupervised task.

3. LOAD FORECASTING MACHINE LEARNING ALGORITHMS

Electrical load forecasting algorithms are needed for prediction of the energy demand for the day ahead, a few weeks up to a year or a period of over a year. Traditional clustering and forecasting methods cannot have direct application to microgrids as the required power load is not only several times smaller than in region-wide areas, but also its curve presents a much higher volatility making the development of new techniques that deal with the higher uncertainty of the load behavior necessary [5].

In existing literature, a wild variety of algorithms have been designed to solve specific load forecasting problems with different levels of success. In the conventional grid, which was developed based on the vertically integrated state-owned electricity companies, forecasting was used for long – and midterm forecasting for economic operation and planning. The increasing penetration of renewable energy sources (RES), the interconnections between countries, cross-border electricity trading and wholesale energy trading created the need for next-day forecasting. Power companies have traditionally used simple forecasting models, like linear regression [3] and econometric models [4]. Nowadays, multiple regression models are used for very large systems [8], [9], large metropolitan areas [10], or small areas [11]. Artificial intelligence techniques have also been applied to energy forecasting using either neural networks [12], [13], or fuzzy logic [14], [15], [16].

Lately, efforts concentrate on unsupervised learning neural networks such as Self Organizing Maps (SOMs) [17] - [18], on Neural Networks [19] or on hybrid systems that combine both Self Organizing maps (SOMs) and algorithms such as support vector machines (SVMs) [20] or k-nearest Neighbors algorithm (k-NN) [5].

In the next section we focus on short and very short - term forecasting which is of interest for microgrids. Short term load forecasting (STLF) refers to a time horizon of one day or even less while the very short-term load forecasting (VSTLF) refers to a time horizon of one minute or less.

Table 1. Cycle updates & time horizons of load forecasting

	Cycle Update	*Horizon*
VSTLF	>= 1 Minute	1 day
STLF	1 Day	2 weeks
MTLF	1 Month	3 Years
LTLF	3 Years	30 Years

Table II summarizes the different time horizons of forecasting techniques with respect to different applications related to operations of the power grid.

Table 2. Applications of electric load forecasting

	VSTLF	***STLF***	***MTLF***	***LTLF***
Purchase and producion of electric power	✓	✓	✓	✓
Transmittion, transfer and distribution of electric power		✓	✓	✓
Management and maintance of electric power sources	✓	✓		
Management of the daily electric load demand	✓	✓	✓	✓
Financial and marketing planning			✓	✓

Long-term and medium-term forecasting despite the fact that they are not being used in microgrids because the forecast horizon in microgrids varies only from 1 day to 1 minute, still, they are quite important for other tasks. Long term energy forecasting is important for planning and expanding the power grid while midterm power and energy forecasting is needed for scheduling the fuel supplies, electrical energy imports/exports and the rational exploitation of the water reserves for optimal hydrothermal scheduling. Therefore, a wide range of models have been designed for these two forecast periods. For instance, an application based on fuzzy logic was developed for midterm forecasting which transformed the candidate input variables to differences or relative differences and selected the one to be used through correlation analysis [15].

4. SHORT-TERM & VERY SHORT-TERM FORECASTING

Support Vector Machine

Support Vector Machine (SVM) is a supervised machine learning algorithm which can be used for both classification and regression tasks and its formulation is based on the Structural Risk Minimization (SRM) principle, which has been shown to be superior to the traditional Empirical Risk Minimization (ERM) principle, used by conventional neural networks. SRM minimizes an upper bound on the expected risk, where as ERM minimizes the error on the training data. It is this difference which equips SVM with a greater ability to generalize [21].

The advantage of SVM is that it is effective in high dimensional spaces and uses a subset of training points in the decision function making it also memory efficient. However, the algorithm does not directly provide probability estimates, because they are calculated using an expensive five-fold cross-validation.

Support Vector Machines models can be found in many forecasting models for both medium-term forecasting and short-term forecasting or in combination with other algorithms. A case where SVM was compared favourably against other algorithms, such as the auto-regressive (AR) model using the same data for building and testing both models based on the root-mean-square errors between the actual and the predicted data is presented in [22] where SVM allowed the training data set to be increased beyond what is possible using the auto-regressive model or other neural networks methods. Increasing the training data to about two years improved the performance significantly based on the RMSE on testing

data that was not used on training or building the model. When 20000 data points were used for training the SVM model the root-mean-square error was reduced to 0.0028 compared with 0.0376 for the best results obtained using the AR model. In [23], a STLF method based on clustering using support vector machines (SVM) predicts the next day 48 half hourly loads. The daily average load of each day for all the training and testing patterns is first calculated and the patterns are clustered using a threshold value between the daily average load of the testing pattern and the daily average load of the training patterns.

k-Nearest Neighbors

k-Nearest Neighbors (kNN) is a supervised machine learning algorithm used for both classification and regression predictive problems.

kNN is a simple algorithm that stores all available cases and predicts the numerical target based on a similarity measure, e.g., distance, proximity, or closeness functions, as it is based on the assumption that similar data points are close to each other. It has been used as a non-parametric technique, meaning that it does not make any assumptions on the underlying data distribution, since the 1970's. kNN methods are known as non-generalized machine learning methods, since they simply "remember" all their training data and do not have the ability to generalize.

The main advantage of kNN is that it is robust to noisy training data, and effective if the training dataset is large. On the other hand, the user needs to determine the value of K, which corresponds to a positive integer, typically small, and the computation cost is high as it needs to compute the distance of each instance to all the training samples.

kNN models can be found in many forecasting models. For example a kNN algorithm was used to construct a novel hybrid model which comprised of a Wavelet Denoising-Extreme Learning Machine (ELM) and a kNN Regression in order to forecast the short-term electricity load in New South Wales. [24]. In [25], kNN models were used for day ahead load prediction, with only limited temperature forecasts, namely minimum and maximum temperature of a day, as the forecasting input. Recently the combination of kNN with Self Organizing Maps (SOM) to create a novel clustering and forecasting tool at the microgrid level has been proposed. The SOM algorithm carries out the clustering process and when all the data are clustered they serve as input to kNN for forecasting [5].

Random Forests

The Random Forest (RF) technique is used in many forecasting models due to its simplicity and the fact that it can be used for both classification and regression tasks. RF is a supervised learning algorithm which builds multiple decision trees and merges them together to get a more accurate and stable prediction. More specifically, it constructs a multitude of decision trees during training and yields the class that is the mode of the classes (classification) or mean prediction of the individual trees (regression). RF correct the decision trees habit of over fitting their training set because no single tree can learn from all of the instances and explanatory variables. No single tree can memorize all of the noise in the representation.

Its default hyperparameters often produce a good prediction result which make RF a very handy and easy to use algorithm. Its main limitation is the number of trees which it needs to yield these results. As the trees grow, the algorithm speed slows down and it becomes ineffective for real-time predictions.

RF has been widely used in forecasting models. In [26] , it was proposed to improve the accuracy of a STLF by combining it with a feature selection method based on the generalized minimum redundancy and maximum relevance. Another paper proposes using RF models for short-term electric load forecasting making use of an ensemble learning method that generates many regression trees and aggregates their results [27].

Artificial Neural Networks

Neural Networks (ANN) are a class of models within the general machine learning literature and also a specific set of algorithms that have revolutionized machine learning. The operating principle of ANNs is based on the functions of the human brain neurons and provide powerful tools for modelling, especially when the underlying data relationship is unknown. Moreover, they can identify and learn correlated patterns between input data sets and corresponding target values [13], [17], [28]. They have been successfully applied in a variety of scientific fields such as mathematics, engineering, medicine, economics, meteorology, psychology, neurology and many other.

The reason that they have been successfully applied in so many scientific fields lies in the fact that they operate in accordance with the four operating principles:

- The fairly large database that is required, i.e. known inputs should be compared with their corresponding outputs in order to "educate" the network.
- The comparison of the output value that is produced with the real one and the amendment of the weights in accordance with the "education rule".
- The calculated error which decreases with the increasing repetition number, works as a guide. The network is considered trained when the error becomes smaller than the threshold determined in the beginning of the process.
- The certification that the system is adequately trained when it responds correctly to new samples. The broad spectrum of the learning set is considered a criterion [13], [17], [28].

However, they also present limitations, such as:

- The fact that they are computationally intensive and therefore hardware dependent as they require processors with parallel processing power, depending to their structure.
- The completely obscure "black-box" treatment of the system being modeled: when an ANN produces a solution, it does not provide any insight about the why and how the result was obtained and this reduces its trustworthiness. Also, no specific rules apply for the determination of their network structure. Any appropriate network structure is achieved through experience, trial and error.
- ANNs work with numerical information. This means that all the problems have to be translated into numerical values before they are being introduced to ANN.
- The fact that the network's performance is evaluated against a specific preset error value, which is the criterion for ending the training. However, this error value does not necessarily yield the optimum results.

The forecasting models that have been implemented all these years on ANNs are dozens. For example, the model proposed in [29] for STLF in microgrids is based on a three-stage architecture which starts with pattern recognition by a Self-Organizing Map (SOM), a clustering of the previous partition via a k-means algorithm, and finally demand forecasting for each cluster with a MultiLayer Perceptron Model, which is a class of feed-forward ANN, validation was performed with data from a microgrid-sized environment provided by the Spanish company Iberdrola. In [30], a Self-Recurrent Wavelet Neural Network (SRWNN) is used as a forecast engine in a microgrid using the Levenberg-Marquardt (LM) learning algorithm to train the SRWNN. In order to demonstrate the efficiency of the proposed method, it was tested against actual hourly load data of an educational building supplied by a microgrid.

5. CONCLUSION

We have attempted to give an overview of the most often used machine learning algorithms such as Support machine vectors (SVM), k-Nearest Neighbours (kNN), Random Forest and Artificial Neural Networks (ANN) that have proved to be very efficient for load forecasting at the microgrid level. Machine learning algorithms are often used for short-term forecast or/and are combined with other algorithms creating novel forecasting models for both at the microgrid and metropolitan level.

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APPLICATION FOR STUDENT ATTENDANCE BASED ON FACE RECOGNITION

Aleksa Ćuk*,
Branivoj Miljković,
Miloš Todorović,
Aleksandar Ivanović,
Miodrag Živković

Singidunum University,
Belgrade, Serbia

Abstract:
Facial recognition represents a system for automatic recognition or identification of persons based on digital pictures of their face. There are multiple algorithms that the recognition software uses but it all comes down to comparison of input picture, that is the comparison of the biometric face features with the selected face pictures in the database. Facial recognition is mostly used in systems that are connected with safety and usually in two ways: recognition and verification. When it comes to recognizing the face parameters are compared with other faces in the database. For the verification, the face parameters of the person that is using another way of verification in the given moment, are compared with the information of that person in the database. This is done for the sake of making sure that the person who is requesting access is actually a person with allowed access. Even though facial recognition is less precise compared to fingerprint scanning or iris scanning, it is very well accepted because of its non-physical and non-invasive way of use.

Keywords:
face recognition, authentication, deep learning, PCA algorithm.

1. INTRODUCTION

The problems of conventional evidencing are inconsistency and the time it requires. It is efficient and consistent for keeping track of attendance of students on classes. The main characteristic of the program is recognizing and evidencing the attendance. This way the process is completely automatized since the presence is automatically evidenced and the time for manual noting of attendance is eliminated.

In the first step, it is necessary to make sure that the student is registered in the database. In the case that they aren't registered, the student should contact the administrator for the creation of their account.

Necessary hardware support for our project is a camera on which our registration is done, that is on which is the software installed. The purpose of the camera is to do proper registration of the user. There are no prerequisites for the camera). From the software side we have the communication between our main application and the database, which contains images of the people who are registered. After that, the user sees on

Correspondence:
Aleksa Ćuk

e-mail:
aleksa.cuk.15@singimail.rs

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the screen a message which tells him to remove glasses (if there are any) and to face the camera face front for the reason of precise recognition.

After the recognition, the user gets a message from the device about the successful registration.

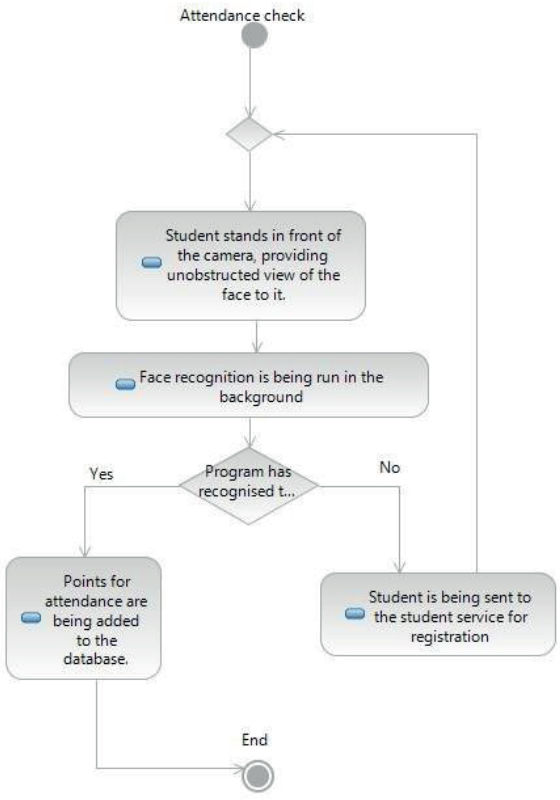


Fig. 1. Structure of our program

2. BACKGROUND

Authentication is a significant issue in system control in computer based communication. Human face recognition is an important branch of biometric verification and has been widely used in many applications, such as video monitor system, human-computer interaction, and door control system and network security. This paper describes a method for Student's Attendance System which will integrate with the face recognition technology using Personal Component Analysis (PCA) algorithm[1]. The system will record the attendance of the students in class room environment automatically and it will provide the facilities to the faculty to access the information of the students easily by maintaining a log for clock-in and clock-out time.

Over the past decade face detection and recognition have transcended from esoteric to popular areas of research in computer vision and one of the better and successful applications of image analysis and algorithm based understanding. Facial recognition generally involves two stages: Face Detection where a photo is searched to find a face, then the image is processed to crop and extract the person's face for easier recognition. Face Recognition where that detected and processed face is compared to a database of known faces, to decide who that person is. Since 2002, face detection can be performed fairly easily and reliably with Intel's open source framework called OpenCV. This framework has an in-built Face Detector that works in roughly 90-95% of clear photos of a person looking forward at the camera. However, detecting a person's face when that person is viewed from an angle is usually harder, sometimes requiring 3D Head Pose Estimation. Also, lack of proper brightness of an image can greatly increase the difficulty of detecting a face, or increased contrast in shadows on the face, or maybe the picture is blurry, or the person is wearing glasses, etc. Face recognition however is much less reliable than face detection, with an accuracy of 30-70% in general[2]. The Eigenface technique is considered the simplest method of accurate face recognition, but many other (much more complicated) methods or combinations of multiple methods are slightly more accurate.

3. FACIAL RECOGNITION

Facial recognition is a biometric software application capable of uniquely identifying or verifying a person by comparing and analyzing patterns based on the person's facial contours[3].

Facial recognition is mostly used for security purposes, though there is increasing interest in other areas of use. There are different facial recognition techniques in use, such as the generalized matching face detection method and the adaptive regional blend matching method. Most facial recognition systems function based on the different nodal points on a human face. The values measured against the variable associated with points of a person's face help in uniquely identifying or verifying the person.

Facial recognition techniques are quickly evolving with new approaches such as 3-D modeling, helping to overcome issues with existing techniques.

4. DEEP LEARNING

Deep learning is a part of machine learning which is convenient for solving problems from artificial intelligence, where algorithms are inspired by human brain, do calculation and learn from huge number of data. We refer to 'deep learning' because the neural networks have various layers that enable learning. Similarly to human way of learning, deep learning algorithm is learning from experience [4]. Methods from deep learning find their application in challenging fields where the size of data is exceptionally big: computer vision, processing of speech.

These are some examples of deep learning and list will continue to grow in future:

- *Facial recognition*

Face recognition is starting to be a normal thing in our lives, we start seeing it in every aspect of our daily routine. Face recognition can be used for unlocking phones or using some filters for apps like Instagram or Snapchat.

- *Virtual assistants*

In the world of Alexa, Siri and other, the virtual assistants of online service providers use deep learning to help understand your speech and the language humans use when they interact with them.

- *Translations*

In a similar way, deep learning algorithms can automatically translate between languages. This can be powerful for travelers, business people and those in government.

- *Autonomous cars*

Also known as a self-driving car is already being developed by the Tesla, BMW and Mercedes, Google also developing his own automated technology. Self-driving cars is still at testing stage, but partially automated technology has been around for the last few years, a car can park themselves, or follow a car in front of them or road lines.

- *Medicine and pharmaceuticals*

Deep learning can be use in various fields of medicine, from disease and tumor diagnoses to personalized medicines created specifically for an individual's genome.

5. APP DESCRIPTION

Idea

Facial recognition is a really a series of several related problems. First of all, it takes a look at a picture and finds all the faces in it. Secondly, focus on each face and be able to understand that even if a face is turned in a weird direction or in bad lighting, it is still the same person. Third it is able to pick out unique features of the face so that it can tell them apart from other people (Fig.1.).

Finally it will compare unique features of that face to all the people you already know to determine the person's name. This is all done since computers aren't able of high-level generalization. So we solve this by basically leading it though the steps and separately passing the results of each step.

Finding Faces

For the finding of faces in a picture HOG (Histogram of Oriented Gradients) is used (Fig.3.). That is, the first step in the process is that the picture is turned to grayscale. The point of this is to figure out how dark are the pixels compared to other pixels surrounding it and arrow is drawn that will show in which way the image is getting darker. This process is repeated for every pixel in the image, until each one is replaced by with an arrow. This actually gives us the gradient for the picture. But since saving the gradient for every single pixel gives us way too much detail, we'll break up the image in to a square of 16x16 pixels each and each square we will count up how many gradients point in each major direction. From this we get a greyscale picture that in some way represents a HOG pattern.

As for the percentage of the successful recognition, since in this phase we only implement the pictures in the code, the percentage is over 98%. This is for the reason that currently we only use one sample picture of the person that should use the database and one picture of a person that is not desired, for the sake of comparison. This other person can also be a desired person for the recognition while the other one is used for the comparison. There is also a simple flaw, that if a unregistered person has very similar face features and hairstyle compared to a person who's picture is already in the code, the person might get up to 86% successful recognition, but inconsistently (with spikes from 54% up to 86% and changes in the milliseconds).

Posing and Projecting Faces

After we isolated the faces in our image, we have to deal with a problem with direction of the face. The basic idea is, we will come up with 68 points that exist on every face, top of the chin, outside edge of each eye, the inner edge of each eyebrow. We will obtain this 68 point using the face landmark estimation. After that we will train machine learning [5]. After that we will train machine learning algorithm to be able to fine these 68 specific points on any face:

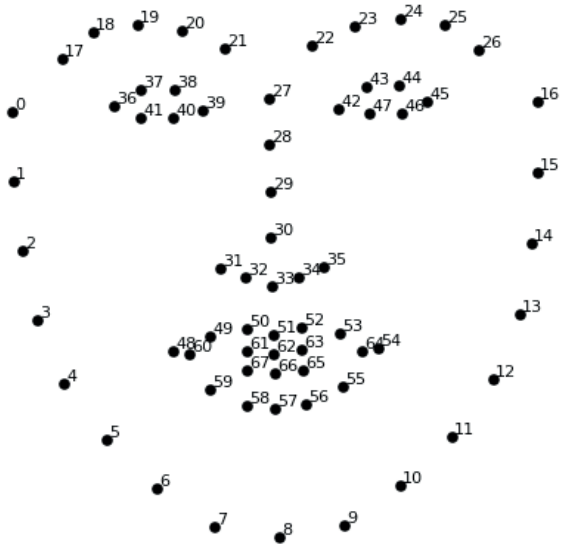


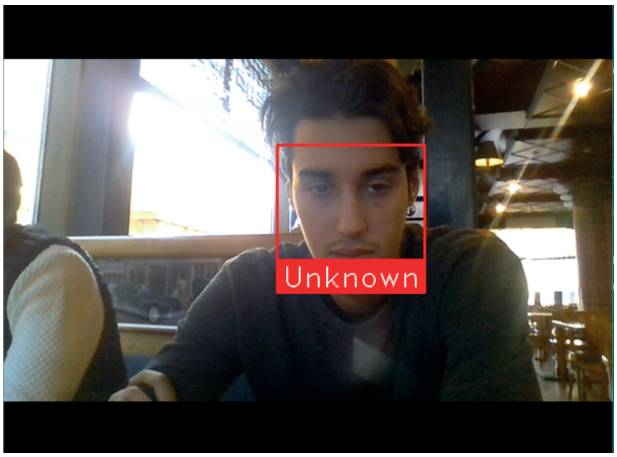
Fig. 2. Example of 68 face landmark

Encoding faces

Now we approach the problem of telling faces apart. This can be simply solved if we directly compare the face we find in step two with all the pictures we have of people in our database. For this to be done we would need to extract a few basic measurements from each face. This basic measurements are the 68 point from the face we got from the face landmark estimation (Fig.2.). From here we will turn these 68 point to the 128 measurements that will be compared to the 128 measurements in our picture in the database(Fig.4.).



Fig. 3. Example of face recognition of two persons: one in database, one that is not



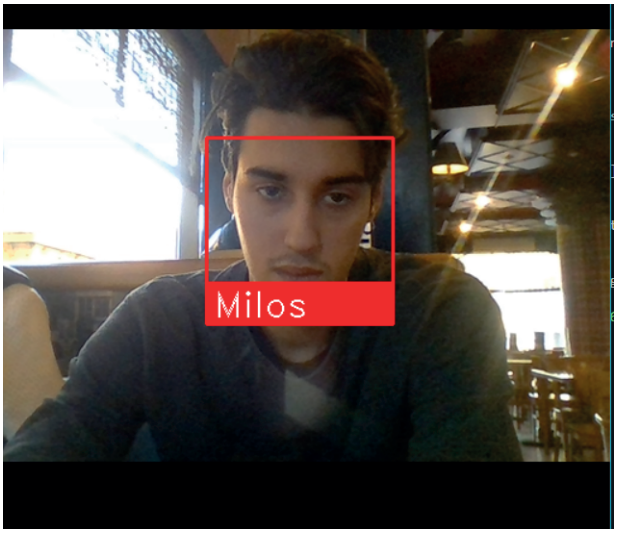


Fig.4. Example of a person before and after being registered

6. IMPLEMENTATION

Python

Python is a high level general-purpose programming language released 1991. It enables programming on both large and small scale. It features a dynamic type and automatic memory management. Python supports object-oriented, imperative, functional and procedural. It has a large supported standard library.

OpenCV

OpenCV has the advantage of being a multi-platform framework. It has so many capabilities it can seem overwhelming at first. A good understanding of how these methods work is the key to getting good results when using OpenCV. Fortunately, only a select few need to be known beforehand to get started. OpenCV's functionality that will be used for facial recognition is contained within several modules.

7. APPLICATION IN THE REAL WORLD

Since the usage of intelligent software is more and more present, facial recognition is also becoming a part of our day to day routine and there's no reason why it shouldn't be used for the automatization of taking evidence of attendance [6]. This represents our small contribution to modernizing the education system.

Examples of facial recognition in real life:

- *Prevent retail crime* - It lowers crime rates, by identifying know criminals when they enter retail establishments. Their photographs are kept in a database of criminals and the management is notified when a notorious person enters their shop.
- *Unlock phones* - This is where facial recognition has found most application up to date. Even though to some sense it is less consistent compared to fingerprint scanning, it is practically impossible to be surpassed by an undesired individual. For this reason, its ease of use and convenience, it is clear why its so used today in this field.
- *Smarter advertising* - It is somewhat used in advertising as well. The idea is to display more appealing adds to people based on their age and gender. Its usefulness is still being tested in this category.
- *Find missing persons* - One of the humane uses of facial recognition is to help fight against human trafficking. By ensuring that the missing persons are entered in the databases, we notify the cameras at public places (airports, train stations etc.) to be on alert for them and to notify the authorities.
- *Help the blind* - One of the groundbreaking implementations is helping blinding people in communicating in social situations. The app will notify the blind person with vibrations when the interlocutor is smiling.
- *Protect law enforcement* - Police is already using facial recognition in their daily routine. By being able to identify people from a distance, police officer can know how to approach situations more appropriately.
- *Aid forensic investigations* - Forensics also getting a helping hand with this technology by making the identification of people possible even though they might not be able to communicate in the given moment. And as well as tracking them on security footage.
- *Identify people in social media* - Identification on social media can make recognizing people much easier. May it be in the sense of making a suggestion for a tag on a picture or linking multiple accounts of the same person.
- *Diagnose diseases* - We can also identify certain diseases which manifest their symptoms through a person's face. An example is a rare disease DiGeorge syndrome. Facial recognition helped diagnose the disease in 96% of cases.
- *Recognize VIPs at sporting events* - It can also help with making the experience of people of interest more pleasant. An example would be VIPs at sporting events. By recognizing their picture on their seasonal pass, it can offer them better seats, exclusive parties and merchandise.
- *Protect schools for threats* - Facial recognition also offers aid at keeping public schools safer. By maintain a database of people who are not wanted in a school (expelled students, drug dealers etc.) the school security can be notified immediately when those people enter the schools property.
- *Casinos* - It can prevent card counters and known cheats to enter casinos if they have been registered as unwanted in their database.

- *Facilitate secure transactions* - It can be used as the only means in a transaction. By connecting a person's bank account to their information and an identification picture, we can completely eliminate credit cards and provide our face as credentials in a transaction.
- *Control access to sensitive areas* - It can be also used as another safety step when controlling dangerous facilities. That is beside a id card a face can would be required as well before entering laboratories, military bases, bank vaults etc.

8. CONCLUSIONS AND FUTURE WORK

The goal of our project is to make keeping track of attendance at events easier. There are many ways to evident people at events, for example using personalized cards, taking signatures at the beginning of an event, but we found that facial recognition is more practical than any other conventional way. We found that using facial recognition is quite challenging and we tackled many problems throughout the development. In the beginning there was a decision to be made, do we use a face recognition algorithm or do we use face encodings. We found that the latter one is more suitable for our application. Another decision that we made is to implement the pictures directly into our program instead of using a database, but only for our testing purposes. |Both the face recognition algorithms and a database can be easily implemented in the future, as the number of the users grows.

We left a lot of space for flexibility and testing to be done on our program. That includes testing its consistency as the number of users grows, as well as defining its specific purpose whether it is used for keeping attendance of students on a class, evidencing visitants on a meeting or seminar, or just simply keeping track of reservations in a restaurant. Depending on its specific purpose, it can be modified with simple implementations to fulfil the user's needs.

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CYCLIC CODES

Biljana Radičić

Singidunum University,
Belgrade, Serbia

Abstract:
In this paper, we consider cyclic codes and their extensions: quasi-cyclic codes and double cyclic codes. We show how their generator matrices can be obtained. The obtained results are illustrated by examples.

Keywords:
Circulant matrices, cyclic codes, quasi-cyclic codes, double cyclic codes, generator matrices.

1. INTRODUCTION

Let m and n be positive integer numbers, F be a field of characteristic 0 or its characteristic is coprime to n, and ω is a primitive n-th root of unity.

First, we give the definition of a circulant matrix.

Definition 1. (**A circulant matrix**) ([1]) A $n \times n$ matrix $C[c(x)]$ over the field F is called a circulant matrix associated with the polynomial

$$c(x) = \sum_{i=0}^{n-1} c_i x^i, \tag{1}$$

if $C[c(x)]$ has the following form:

$$C[c(x)] = \begin{bmatrix} c_0 & c_1 & \dots & c_{n-1} \\ c_{n-1} & c_0 & \dots & c_1 \\ \vdots & \vdots & \ddots & \vdots \\ c_1 & c_2 & \dots & c_0 \end{bmatrix}. \blacklozenge \tag{2}$$

As we can see, the matrix $C[c(x)]$ of the form (2) has the following property: the second row of the matrix $C[c(x)]$ is the right cyclic shift of its first row, the third row of the matrix $C[c(x)]$ is the right cyclic shift of its second row and so on. Namely, the i-th row of the matrix $C[c(x)]$ is the right cyclic shift of its $(i-1)$-th row. Thus, the matrix $C[c(x)]$ of the form (2) is completely determined by its first row. Circulant matrices have a very wide applications in numerical analysis, cryptography and

Correspondence:
Biljana Radičić

e-mail:
bradicic@singidunum.ac.rs

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coding theory. In this paper, we present their applications in coding theory. It should be also pointed out that circulant matrices belong to the class of Toeplitz matrices - matrices having constant diagonals. More information about Toeplitz matrices can be found in the following papers: [2] and [3].

Example 1. *Let* $c(x)=1-x$. Then,

$$C[c(x)]=\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}.\ \Diamond$$

Example 2. *Let* $c(x)=3+x+2x^3$. Then,

$$C[c(x)]=\begin{bmatrix}3 & 1 & 0 & 2\\ 2 & 3 & 1 & 0\\ 0 & 2 & 3 & 1\\ 1 & 0 & 2 & 3\end{bmatrix}.\ \Diamond$$

The following definition is *a generalization* of Definition 1.

Definition 2. (**A generalized circulant matrix**) A $m\times n$ matrix $C_g[c(x)]$ over the field F is called a generalized circulant matrix associated with the polynomial (1) if $C_g[c(x)]$ has the following form:

$$C_g[c(x)]=\begin{bmatrix}c_0 & c_1 & \dots & c_{n-1}\\ c_{n-1} & c_0 & \dots & c_{n-2}\\ \vdots & \vdots & \ddots & \vdots\\ c_{n-m+1} & c_{n-m+2} & \dots & c_{n-m}\end{bmatrix} \quad (3)$$

where all the subscripts j of c_j are modulo n. ♦

Remark 1. A generalized circulant matrix becomes a circulant matrix provided that $m = n$. ▼

Example 3. Let $c(x)=1-x$ and $m=4$. Then,

$$C_g[c(x)]=\begin{bmatrix}1 & -1\\ -1 & 1\\ 1 & -1\\ -1 & 1\end{bmatrix}.\ \Diamond$$

Example 4. *Let* $c(x)=3+x+2x^3$ and $m=3$. Then,

$$C_g[c(x)]=\begin{bmatrix}3 & 1 & 0 & 2\\ 2 & 3 & 1 & 0\\ 0 & 2 & 3 & 1\end{bmatrix}.\ \Diamond$$

Let us recall that ω is a primitive n-th root of unity.

Theorem 1. ([1], [4]) The eigenvalues of the matrix $C[c(x)]$ are:

$$\lambda_j(C[c(x)])=c(\omega^j),\ \ j=\overline{0,n-1}, \quad (4)$$

and the eigenvectors of the matrix $C[c(x)]$ are:

$$v_n(\omega^j)=\begin{bmatrix}1 & \omega^j & \dots & \omega^{(n-1)j}\end{bmatrix}^T,\ \ j=\overline{0,n-1}, \quad (5)$$

where $[\ ]^T$ is the symbol for the transpose of a matrix. ∇

Therefore,

$$C[c(x)]\,v_n(\omega^j)=c(\omega^j)\ v_n(\omega^j),\ \ j=\overline{0,n-1}. \quad (6)$$

Similar to the equality (6) (in relation to a circulant matrix), it can be obtained the following equality (in relation to a generalized circulant matrix):

$$C_g[c(x)]\,v_n(\omega^j)=c(\omega^j)\ v_m(\omega^j),\ \ j=\overline{0,n-1}. \quad (7)$$

Using the previous equality, it can be obtained the following equality:

$$C_g[c(x)]\,\Phi_{n,n}(\omega)=\Phi_{m,n}(\omega)\ diag(c(1),c(\omega),\dots,c(\omega^{n-1})), \quad (8)$$

where $diag(c(1),c(\omega),\dots,c(\omega^{n-1}))$ is a diagonal $n\times n$ matrix with the elements $c(\omega^j), j=\overline{0,n-1}$, on the main diagonal, $\Phi_{n,n}(\omega)$ is the $n\times n$ Fourier matrix i.e.

$$\Phi_{n,n}(\omega)=\begin{bmatrix}1 & 1 & \dots & 1\\ 1 & \omega & \dots & \omega^{n-1}\\ \vdots & \vdots & \ddots & \vdots\\ 1 & \omega^{n-1} & \dots & \omega^{(n-1)(n-1)}\end{bmatrix}, \quad (9)$$

and $\Phi_{m,n}(\omega)$ is its $m\times n$ generalization.

Remark 2. Let $r=\min\{m,n\}$. Any $k\times k$ submatrix of the matrix $\Phi_{m,n}(\omega)$ formed by its first k rows, where k is a positive integer number such that $k\le r$, is a Vandermonde matrix ([5], a French mathematician, musician and chemist Alexandre-Théophile Vandermonde) formed by k different elements, therefore it is a non-degenerate matrix. From that, we conclude that the rank

of the matrix $\Phi_{m,n}(\omega)$ is equal to r and the first r rows of the matrix $\Phi_{m,n}(\omega)$ are linearly independent. ▼

As we stated at the beginning of the paper, m and n are positive integer numbers and ω is any primitive n-th root of unity. Let n' be also a positive integer number, ω' be any primitive n'-th root of unity and F be a field of characteristic 0 or its characteristic is coprime to both n and n'.

Let $C_g[c(x)]$ and $C_g[c'(x)]$ be generalized circulant matrices associated, respectively, with the polynomials:

$$c(x)=\sum_{i=0}^{n-1}c_i x^i \text{ and } c'(x)=\sum_{j=0}^{n'-1}c'_j x^j. \tag{10}$$

Definition 3. (***A double circulant matrix***) A $m\times(n+n')$ matrix $C_g[c(x),c'(x)]$ over the field F is called a double circulant matrix associated with the polynomials (10) if $C_g[c(x),c'(x)]$ has the following form:

$$C_g[c(x),c'(x)]=\left[C_g[c(x)]\ \middle|\ C_g[c'(x)]\right]. \blacklozenge \tag{11}$$

Example 5. Let F be the field of complex numbers, $n=3$, $n'=2$, $c(x)=1-2x-x^2$ and $c'(x)=-1+2x$.

Then, for $m=6$,

$$C_g[c(x),c'(x)]=\begin{bmatrix}1&-2&-1&-1&2\\-1&1&-2&2&-1\\-2&-1&1&-1&2\\1&-2&-1&2&-1\\-1&1&-2&-1&2\\-2&-1&1&2&-1\end{bmatrix}. \lozenge$$

Example 6. Let F be the field of complex numbers, $n=4$, $n'=2$, $c(x)=1-2x-x^2$ and $c'(x)=-1+2x$.

Then, for $m=5$,

$$C_g[c(x),c'(x)]=\begin{bmatrix}1&-2&-1&0&-1&2\\0&1&-2&-1&2&-1\\-1&0&1&-2&-1&2\\-2&-1&0&1&2&-1\\1&-2&-1&0&-1&2\end{bmatrix}. \lozenge$$

Remark 3. (**in relation to Example 5.**) Using the elementary operations to the matrix $C_g[c(x),c'(x)]$, we obtain:

$$C_g[c(x),c'(x)]\approx\begin{bmatrix}1&-2&-1&-1&2\\0&-1&-3&1&1\\0&0&14&-8&1\\0&0&0&1&1\\0&0&0&0&0\\0&0&0&0&0\end{bmatrix}.$$

From that, we conclude that the matrix $C_g[c(x)\ c'(x)]$ has rank 4, and its first 4 rows are linearly independent. ▼

Remark 4. (**in relation to Example 6.**) Using the elementary operations to the matrix $C_g[c(x)\ c'(x)]$, we obtain:

$$C_g[c(x),c'(x)]\approx\begin{bmatrix}1&-2&-1&0&-1&2\\0&1&-2&-1&2&-1\\0&0&-2&-2&1&1\\0&0&0&2&1&-2\\0&0&0&0&0&0\end{bmatrix}.$$

From that, we conclude that the matrix $C_g[c(x),c'(x)]$ has rank 4, and its first 4 rows are linearly independent. ▼

2. CYCLIC CODES AND THEIR GENERATOR MATRICES

In this section, we consider cyclic codes and show how their_generator matrices can be obtained.

In coding theory:

- any $(c_0,c_1,\ldots,c_{n-1})\in F^n$, where F is a finite field whose characteristic is coprime to n, is called *a word over F*,
- any subspace C of F^n is called *a linear code over F*,
- the words in C are called *code words*,
- if $(c_{0,0},c_{0,1},\ldots,c_{0,n-1})$, $(c_{1,0},c_{1,1},\ldots,c_{1,n-1})$, … ,
- $(c_{r-1,0},c_{r-1,1},\ldots,c_{r-1,n-1})$ is a basis of the linear code C, then the $r\times n$ matrix

$$C_g=\begin{bmatrix}c_{0,0}&c_{0,1}&\cdots&c_{0,n-1}\\c_{1,0}&c_{1,1}&\cdots&c_{1,n-1}\\\vdots&\vdots&\ddots&\vdots\\c_{r-1,0}&c_{r-1,1}&\cdots&c_{r-1,n-1}\end{bmatrix} \tag{12}$$

is called *a generator matrix of the linear code C*.

The generator matrices are useful for *encoding* and *decoding*.

Let us consider the quotient ring $F_n[X]=F_{n-1}[X]/\langle x^n-1\rangle$ and point out that any polynomial $f(x)=\sum f_i x^i \in F_n[X]$ can be identified with a word $(f_0,f_1,\overset{i=0}{\ldots},f_{n-1})\in F^n$. Therefore, any ideal C of $F_n[X]$ can be observed as a linear code over F, called a *cyclic code over F*. Thus, any polynomial $c(x)=\sum_{i=0}^{n-1} c_i x^i$ generates *a cyclic code*:

$$C_{c(x)}=\{f(x)c(x)\bmod(x^n-1)\,|\,f(x)\in F[x]\}. \quad (13)$$

It is easy to see that the row vectors of the matrix (2) generate the linear code (13).

Remark 5. (***in relation to the matrix (2)***) In the general case, the row vectors of the matrix (2) are linearly dependent, so the matrix (2), in the general case, is not a generator matrix of a cyclic code (13). ▼

In the paper [6] the authors proved the following theorem (*in relation to a generalized circulant matrix*). Before we present the result from the paper [6], let us mention that the degree of a polynomial $f(x)$ is denoted by $\deg f(x)$.

Theorem 2. (Theorem 2.4. [6]) Let $C_g[c(x)]$ be the matrix of the form (3), $d=\deg d(x)$, where $d(x)=\gcd(c(x),x^n-1)$ and $r=\min\{m,n-d\}$. Then, the rank of the matrix $C_g[c(x)]$ is equal to r and the first r rows of the matrix $C_g[c(x)]$ are linearly independent.

Proof. The matrix $\Phi_{m,n}(\omega)\ diag(c(1),c(\omega),\ldots,c(\omega^{n-1}))$ has exactly $n-d$ non-zero columns because there are exactly d indexes j $(j=\overline{0,n-1})$ such that $c(\omega^j)=0$. Suppose that $j_t,(t=\overline{1,n-d})$ are the indexes such that $c(\omega^{j_t})\neq 0$. Then, the rank of the matrix $C_g[c(x)]\ \Phi_{n,n}(\omega)$ is equal to the rank of the following matrix:

$$\Phi_{m,n-d}(\omega)\ diag(c(\omega^{j_1}),\ldots,c(\omega^{j_{n-d}})), \quad (14)$$

where

$$\Phi_{m,n-d}(\omega)=\begin{bmatrix}1 & \ldots & 1\\ \omega^{j_1} & \ldots & \omega^{j_{n-d}}\\ \vdots & \ddots & \vdots\\ \omega^{j_1(m-1)} & \ldots & \omega^{j_{n-d}(m-1)}\end{bmatrix}. \quad (15)$$

Similar to Remark 2, we conclude that the rank of the matrix (15) is equal to $r=\min\{m,n-d\}$ and the first r rows of the matrix (15) are linearly independent. Since the matrix $diag(c(\omega^{j_1}),\ldots,c(\omega^{j_{n-d}}))$ is non-degenerate, it follows that the rank of the matrix (14) is equal to r and the first r rows of the matrix (14) are linearly independent. Therefore, based on (8), it follows that the rank of the matrix $C_g[c(x)]\Phi_{n\times n}(\omega)$ is equal to r and the first r rows of the matrix $C_g[c(x)]\Phi_{n\times n}(\omega)$ are linearly independent. Bearing in mind that the matrix (9) is a non-degenerate, it follows that the rank of the matrix $C_g[c(x)]$ is equal to r and the first r rows of the matrix $C_g[c(x)]$ are linearly independent. ∇

Remark 6. If follows, based on Theorem 2, that the first $r=n-\deg\gcd(c(x),x^n-1)$ rows of the matrix $C[c(x)]$ form a basis of the cyclic code $C_{c(x)}$. ▼

Therefore, based on Remark 6, we obtain the following results:

For Example 3, Since $c(x)=1-x$ i.e. $n=2$, it follows that $d=\deg\gcd(1-x,x^2-1)=\deg(x-1)=1$. So, $r=n-d=1$ i.e. the generator matrix of $C_{c(x)}$ is

$$C_g=[1\quad -1]. \ \Diamond \quad (16)$$

For Example 4, Since $c(x)=3+x+2x^3$ i.e. $n=4$, it follows that $d=\deg\gcd(3+x+2x^3,x^4-1)=\deg(x+1)=1$. So, $r=n-d=3$ i.e. the generator matrix of $C_{c(x)}$ is, in this case, the same as $C_g[c(x)]$. Thus,

$$C_g=\begin{bmatrix}3 & 1 & 0 & 2\\ 2 & 3 & 1 & 0\\ 0 & 2 & 3 & 1\end{bmatrix}. \ \Diamond \quad (17)$$

In coding theory, the question:

Whether or not the cyclic codes are asymptotically good?

is still open. ([7])

In the paper [8], Berman proved that cyclic codes are asymptotically bad if only finitely many primes are involved in the lengths of the codes.

Now, we consider the matrix $C_g[c(x),c'(x)]$ of the form (11) i.e. a double circulant matrix associated with the polynomials (10) and give the answer how to determine the rank of that matrix.

Similar to the equality (7), it can be obtained the following equalities:

$$C_g[c(x),c'(x)]\begin{bmatrix}v_n(\omega^i)\\ 0_{n'\times 1}\end{bmatrix}=c(\omega^i)v_m(\omega^i),\ i=\overline{0,n-1}, \quad (18)$$

$$C_g[c(x),c'(x)]\begin{bmatrix}0_{n\times 1}\\ v_{n'}(\omega'^j)\end{bmatrix}=c'(\omega'^j)v_m(\omega'^j),\ j=\overline{0,n'-1} \quad (19)$$

Also, similar to the equality (8), using the equalities (18) and (19), it can be obtained the following equality:

$$C_g[c(x),c'(x)]\cdot diag(\Phi_{n,n}(\omega),\Phi_{n',n'}(\omega'))=\Phi_{m,n+n'}(\omega,\omega')\,diag(c(1),c(\omega),\ldots,c(\omega^{n-1}),c'(1),c'(\omega'),\ldots,c'(\omega'^{n'-1}))\ .$$

Similar to Theorem 2, using the previous equality, in the paper [6], the authors also proved the following theorem.

Theorem 3. (Theorem 3.6. [6]) Let $C_g[c(x),c'(x)]$ be the matrix of the form (11), $l=\gcd(n,n')$,

$$d=\deg\frac{\gcd(c(x),x^n-1)\gcd(c'(x),x^{n'}-1)(x^l-1)}{\gcd(c(x)c'(x),x^l-1)} \qquad (21)$$

and $r=\min\{m,n+n'-d\}$. Then, the rank of the matrix $C_g[c(x),c'(x)]$ is equal to r and the first r rows of the matrix $C_g[c(x),c'(x)]$ are linearly independent. ∇

In the next section, we extend the definition of the cyclic codes.

3. THE QUASI-CYCLIC CODES OF INDEX $1\frac{1}{2}$

Let n be a positive integer number and F be a finite field whose characteristic is coprime to n. Let us recall that the quotient ring $F[X]/\langle x^n-1\rangle$ is denoted by $F_n[X]$.

The product

$$F_n[X]\times F_n[X] \qquad (22)$$

is a free $F_n[X]$ - modul of rank 2 and any $F_n[X]$ - submodule C of (22) is called *a quasi-cyclic code of index 2.* In general, any $F_n[X]$-submodule C of the free $F_n[X]$ - modul of rank m is said to be *a quasi-cyclic code of index m.*

Remark 7. Cyclic codes are just quasi-cyclic codes of index 1. ▼

In the paper [9], C. L. Chen, W. W. Peterson and E. J. Weldon showed that the quasi-cyclic codes of index 2 are asymptotically good. Moreover, for any integer $m>1$, the quasi-cyclic codes of index m are asymptotically good (see [10] and [11]) .

In the paper [6] (see also [12]), Yun Fan and Hualu Liu considered the quasi-cyclic codes of index $1\frac{1}{2}$ Namely, they considered, provided that n is a positive even integer number, the following $F_n[X]$ - modul:

$$F_n[X]\times F_{\frac{n}{2}}[X] \qquad (23)$$

Any submodule C of $F_n[X]$ - modul (23) is called a quasi-cyclic code of index $1\frac{1}{2}$.

Let

$$c(x)=\sum_{i=0}^{n-1}c_ix^i \text{ and } c'(x)=\sum_{j=0}^{\frac{n}{2}-1}c_jx^j\ . \qquad (24)$$

Then, any element ($c(x),c'(x)$) of the modul (23) generates a quasi-cyclic code $C_{c(x),c'(x)}$ of index $1\frac{1}{2}$ which is called a quasi-cyclic code of index $1\frac{1}{2}$ generated by ($c(x),c'(x)$). Namely,

$$C_{c(x),c'(x)}=\left\{\begin{matrix}(f(x)c(x)\bmod(x^n-1),f(x)c'(x)\\ \bmod(x^{\frac{n}{2}}-1))\end{matrix}\middle|\ f(x)\in F[x]\right\} \qquad (25)$$

The question is:

How to get a generator matrix of $C_{c(x)\,c'(x)}$)?

Namely, the $n\times(n+\frac{n}{2})$ matrix:

$$C_g[c(x),c'(x)]=\begin{bmatrix} c_0 & c_1 & \ldots & c_{n-1} & c'_0 & c'_1 & \ldots & c'_{\frac{n}{2}-1}\\ c_{n-1} & c_0 & \ldots & c_{n-2} & c'_{\frac{n}{2}-1} & c'_0 & \ldots & c_{\frac{n}{2}}\\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots\\ c_{\frac{n}{2}+1} & c_{\frac{n}{2}+2} & \ldots & c_{\frac{n}{2}} & c'_1 & c'_2 & \ldots & c'_0\\ c_{\frac{n}{2}} & c_{\frac{n}{2}+1} & \ldots & c_{\frac{n}{2}-1} & c'_0 & c'_1 & \ldots & c'_{\frac{n}{2}-1}\\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots & \ddots & \vdots\\ c_1 & c_2 & \ldots & c_0 & c'_1 & c'_2 & \ldots & c'_0 \end{bmatrix} \qquad (26)$$

is a double circulant matrix associated with the polynomials (24).

Remark 8. (***in relation to the matrix*** (26)) In the general case, the row vectors of the matrix (26) are linearly dependent. So, in the general case, the matrix (26) is not a generator matrix of the quasi-cyclic code (25). ▼

Before we continue, let us recall that n is a positive even integer number and F is a finite field whose characteristic is coprime to n.

In relation to the matrix $C_g[c(x),c'(x)]$ of the form (26), in the paper [6], the authors proved the following theorem.

Theorem 4. Theorem 4.1. [6]) Let $C_g[c(x),c'(x)]$ be the matrix of the form (26), $d_1=\gcd(c(x),x^{\frac{n}{2}}+1)$ and $d_2=\gcd(c(x),c'(x),x^{\frac{n}{2}}-1)$. Then, the rank of the matrix $C_g[c(x),c'(x)]$ is equal to $r=n-\deg(d_1\cdot d_2)$

and the first r rows of the matrix $C_g[c(x),c'(x)]$ are linearly independent i.e. the first r rows of the matrix $C_g[c(x),c'(x)]$ form a generator matrix of the quasi-cyclic code (25). ∇

The following example illustrates the result of Theorem 4.

Example 7. Let $F = Z_5$, $n = 6$, $c(x) = c'(x) = 1 + x + x^2$

Then,

$$C_g[c(x)\ c'(x)] = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{bmatrix}.$$

Since,

$$d_1 = \gcd(1 + x + x^2, x^3 + 1) = 1$$

and

$$d_2 = \gcd(1 + x + x^2, 1 + x + x^2, x^3 - 1) = 1 + x + x^2,$$

it follows that

$$r = 6 - \deg(1 + x + x^2) = 4.$$

Therefore,

$$C_g = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

is a generator matrix of the quasi-cyclic code $C_{1+x+x^2,\ 1+x+x^2}$ of index $1\frac{1}{2}$. ◊

4. DOUBLE CYCLIC CODES

In this section, n and n' are positive integer numbers and F is a field whose characteristic is coprime to both n and n'.

Now, we consider the product:

$$F_n[X] \times F_{n'}[X] \qquad (27)$$

as an $F[X]$- module. Any $F[X]$ - submodule C of that modul is called *a double cyclic code.*

Remark 9. (***in relation to the product*** (27)) Let us point out that the product (27) is neither an $F_n[X]$ - module nor an $F_{n'}[X]$ - module. Namely, the product (27) can be viewed as $F_k[X]$ - module, where $k = lcm(n, n')$.

Let $c(x)$ and $c'(x)$ be polynomials (10) and $C_g[c(x),c'(x)]$ be the matrix of the form (11). Then, any element ($c(x),c'(x)$) of the modul (27) generates a double cyclic code $C_{c(x),c'(x)}$ which is called a double cyclic generated by ($c(x),c'(x)$). Namely,

$$C_{c(x),c'(x)} = \left\{ \begin{matrix} (f(x)c(x) \bmod (x^n - 1), f(x)c'(x) \bmod \\ (x^{n'} - 1)) \end{matrix} \middle| f(x) \in F[x] \right\}. \qquad (28)$$

The question is:

How to get a generator matrix of $C_{c(x)\,c'(x)}$)?

From Theorem 3, it can be proved the following theorem.

Theorem 5. (Theorem 4.3. [6]) Let $k = lcm(n, n')$ and $C_g[c(x),c'(x)]$ be the $k \times (n + n')$ matrix of the form (11). Let $l = \gcd(n, n')$,

$$d = \deg \frac{\gcd(c(x), x^n - 1)\gcd(c'(x), x^{n'} - 1)(x^l - 1)}{\gcd(c(x)c'(x), x^l - 1)} \qquad (29)$$

and $r = n + n' - d$. Then, the rank of the matrix $C_g[c(x),c'(x)]$ is equal to r and the first r rows of the matrix $C_g[c(x),c'(x)]$ are linearly independent. ∇

The following example illustrates the result of Theorem 5.

Example 8. Let $F = Z_5$, $n = 3$, $n' = 2$, $c(x) = -x + x^2$ and $c'(x) = -1 + x$. Then, $k = lcm(3,2) = 6$ and $l = \gcd(3,2) = 1$;

$\gcd(-x + x^2, x^3 - 1) = x - 1$;
$\gcd(-1 + x, x^2 - 1) = x - 1$ and
$\gcd((-x + x^2)(-1 + x), x - 1) = x - 1$ i.e.

$d = \deg(x^2 - 1) = 2$.

So, based on Theorem 5, the rank of the following double circulant matrix

$$C_g\left[c(x),c'(x)\right]=\begin{bmatrix}0&-1&1&-1&1\\1&0&-1&1&-1\\-1&1&0&-1&1\\0&-1&1&1&-1\\1&0&-1&-1&1\\-1&1&0&1&-1\end{bmatrix}$$

is $r=3+2-2=3$ i.e. the first 3 rows of $C_g\left[c(x),c'(x)\right]$ are linearly independent. Thus, the first 3 rows of $C_g\left[c(x),c'(x)\right]$ form a generator matrix of the double cyclic code $C_{-x+x^2,\ -1+x}$ i.e.

$$C_g=\begin{bmatrix}0&-1&1&-1&1\\1&0&-1&1&-1\\-1&1&0&-1&1\end{bmatrix}$$

is a generator matrix of the double cyclic code $C_{-x+x^2,\ -1+x}$. ◊

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BENEFITS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN MARKETING

Kristina Kaličanin*,
Milica Čolović,
Angelina Njeguš,
Vladimir Mitić

Singidunum University,
Belgrade, Serbia

Abstract:
Artificial intelligence (AI) impacts numerous aspects of life in the form of smart devices and smart applications, designed to understand consumer behaviour, needs, and preferences in order to deliver customized experiences. AI has been one of the primary drivers of innovation in marketing. Marketers are already leveraging the advantages of AI to gain valuable insights into customers, competitors and markets. Besides, AI automate tasks, reduce costs, and improve workflows. This paper examines the current and potential applications of AI within marketing by providing comprehensive overview of existing academic research.

Keywords:
machine learning, marketing intelligence, smart application.

1. INTRODUCTION

Artificial intelligence (AI) is an essential tool for marketers. Especially in the era of big data, where the different format of a large volume of data are generated every second, without AI it would be impossible to get an insight of valuable data in real time. On the other side, customers have high expectations for a more personalized experience. Therefore, to get closer to the customer, and deliver the right message at the right time, marketers need to implement some AI application (e.g. chatbots, personal assistant, smart application).

What really makes marketing successful today is application of machine learning (ML) algorithms. ML represents the main pillar of artificial intelligence that consists of diverse mathematical models (e.g. statistics, probabilistic, neural networks). These models are applied on large datasets in order to identify patterns in data, to learn or to predict output values. Lately, with deep learning (DL) algorithms, computer's ability to learn and acquire new knowledge has become reality.

Correspondence:
Kristina Kaličanin

e-mail:
kkalicanin@singidunum.ac.rs

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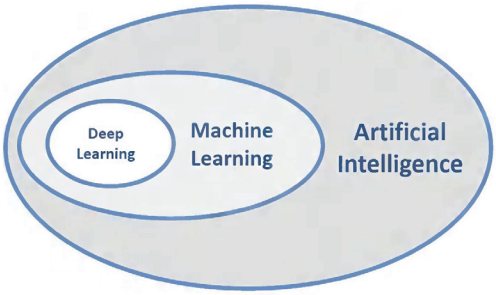


Fig. 1. The position of ML and DL in artificial intelligence

The most popular AI applications in marketing are: content creation, voice search, predictiveness analysis, lead scoring, ad targeting, and dynamic pricing. With these AI applications, marketers can analyse customers based on their movement and behaviour over time in order to achieve dynamic micro segmentation and forecast their future movements, in general. With all these specific information marketers can focus on the specific needs and create a long-term relationship with the brand. Micro-segmentation is helping brands to communicate in personal with each costumer and to improve loyalty and life time value. [1]

Brands are using the power of the AI for personalisation of email/SMS marketing campaigns, which provides better connection, and transformation of this users into clients. Digital advertising is the area with the most successfully adopted AI. Facebook and Google are good examples of AI and machine learning usage. They analyse the user's information, their interests, demographic in order to learn and detect the best audience for their brand. Predictive analysis is the usage of data, statistical algorithms and machine learning techniques with the goal to identify all the future conclusions based just on data history. Besides, AI can lower production costs, increase competitiveness and profit. [2] Therefore, AI does not exist to replace the jobs of marketers, neither advertisers but to help them to develop their creative and strategic potential. In addition they should learn to use advantages of AI.

In this paper the comprehensive analysis of AI and ML application in marketing is given. The paper is organized as follows. Section 1 introduces the basic concepts of AI and ML. Section 2 briefly represents literature review. Section 3 describes some of AI applications in marketing. Finally section 4 presents the conclusions.

2. MACHINE LEARNING ALGORITHMS AND THEIR APPLICATIONS IN MARKETING

Artificial intelligence and Machine Learning

The field of AI really came into existence with the birth of computers around the 1940s and 1950s. For the earlier period of its development, attention was clearly focused on getting computers to do things. [3] In period of 1960s and 1970s there was a real philosophical discussion about how close human brain and computer could be. Next decade from 1980s to 1990s brought a whole new approach. Artificial computer brains had opened up possibilities and created a completely new set of questions.

Next decade has brought advanced software intelligent agents. An intelligent agent is a software with a possibility to assist people and to act on their behalf. Agents can automate repetitive tasks, remember things that user forgot, learn from the user or can make recommendations. [4] AI could be intelligent in its own way now: there is a potential to be bigger, faster and better. People realized that artificial brain could outplay human brain. AI technologies are used in numerous internet tools: search algorithms, recommendation system and systems for creating web sites. [5]

The AI is unsurpassed by human brain nowadays. AI applications in the finance, military and manufacturing sectors are something that human brain cannot compete with. Artificial brains now have their own bodies. Three capabilities of AI are: to sense, comprehend and act. They are supported by the ability of the AI to learn from experiences and adapt over time. First capability includes images, sounds and speech. Facial recognition is the latest practical proof of improving productivity. Natural language and inference engines make better comprehension of collected information. AI systems can take different actions through technologies in physical world. Auto-pilot in cars is the best example. [6]

There are two types of AI: Strong and Weak AI. Strong AI can be also called artificial general intelligence. It includes all the machines with consciousness, mind and sense, and they are applied not in only one specific area. Weak AI, also known as artificial narrow intelligence, has focus on a very specific task (self-driving car). Behind AI, machine learning or more specific deep learning are algorithms with the aim to imitate the structure and function of the human brain. [7]

Artificial intelligence relies on machine learning (ML) algorithms that are applied on large datasets in order to identify patterns in data, to learn or to predict output values. According to Samuel (1959), ML is computer's ability to learn without specifying a set of program instructions. [8] Lately, with deep learning (DL), which are artificial neural networks algorithms, computer's ability to learn and acquire new knowledge has become reality. Relationship among these fields are shown in Fig. 1.

There are several types of ML such as supervised, semi-supervised, unsupervised and reinforcement. In supervised learning, smart applications are taught by example. It means that dataset consists of inputs and desired outputs. Some supervised learning models are classification, regression, forecasting. For example, emails can be classified as spam or not spam, and classification algorithm should look at existing observational data and filter the email accordingly.

In unsupervised learning, since there is no a target value, algorithm analyze data i.e. focuses on their relations, structures, and interconnections. Some unsupervised learning models are clustering, and association. An association model is often used for market basket analysis in order to identify relationships between the products or services that people buy, and according to that to understand and predict their future behaviour.

Marketing intelligence

AI is reshaping marketing today. Marketing Intelligence includes all kinds of information that companies collect about a specific market in which they want to enter. Companies collect and analyse external data before entering and investing in this area. The information can be about population age or about their spending habits. Marketing intelligence is there to help to break down the data into smaller subsets before the relevant company department gets them. Each department needs different information. There are four the most important parts of marketing intelligence. [9]

- Competitor intelligence;
- Product intelligence;
- Market understanding;
- Customer understanding.

Together with a Machine Learning it can help us to predict all the customers' digital actions, to target the right customers with the best content just across the perfect channel, and all this at right time.

Neuromarketing

Neuromarketing (NM) refers to designing the content to elicit particular neurological reactions that are associated with buying or emotions linked to buying. NM studies the brain (neural networks) responses to advertising and branding (e.g. emotion recognition), and the adjustment of those messages. Technologies, such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG) measures specific types of brain activity in response to advertising messages. With neuromarketing companies learn why consumers make decisions, and what parts of the brain are motivating them to do so. Recently, NM is getting more attention of scholars in different settings. [10]

3. LITERATURE REVIEW

Choudhury & Nur (2019) [11] have implemented several ML algorithms, such as logistic regression, decision tree, support vector, random forest, and multilayer perceptron classifiers in order to analyse customer's purchase behaviour for a retail superstore. They used dataset of 9259 customer sales data over the three months. To analyze customer purchase behaviour, they explored the quantity of each item that customer has bought. The results show that with multilayer perceptron 99.41% of accuracy has been achieved.

Lagree et al (2019) [12] have introduced a novel algorithm, titled GT-UCB that relies on probabilistic upper confidence bounds on the expected number of nodes, in order to find influential users in a graph. The goal is to maximize the spread of information on social media as part of the online marketing strategy. This type of online marketing is called influencer marketing, in which the sub-population of influential people is targeted instead of the entire base of potential customers. With proposed algorithm they showed that it leads to high-quality spreads.

A. Ajuri et al, (2018) [13] have shown how ML can help organizations to have more customers in their loyalty program. They described how discounts can make an influence on customers' decisions. They also think that managers should be involved in creating these programs because more loyal consumers will bring bigger revenue. Hospitality organizations should make loyalty programs with brands or with partners just because their costumers' experience will be improved and it will lead to increased loyalty.

S. Dimitreska et al (2018) [14] have explained in which way AI is reshaping marketing in an era when machines really understand all the problems and can find solutions, just like people do. Technologies have an impact on companies in a way of making better, more competitive and productive business. Their conclusion is that future will bring even higher expectations from customers and that AI will help marketers to understand personalized customers' needs and wishes. Thanks to AI companies will be able to modify all customers' needs and new campaigns in real time.

Syam & Sharma (2018) [15] have made a research of the fourth industrial revolution and its impact on personal selling and also on selling management. Their research was based on all seven steps which make the selling process. Their conclusion is that digitalization will have the biggest influence on selling process because it will be easier to understand consumers' behaviour and to make offers customized. They suggest to salespeople to use the advantage of ML and AI to study all the activities of the buying process in order to have more satisfied customers.

Olson & Levy (2018) [16] have tried to show deeper relationship between customers and marketers and to improve that they can build a lifetime value models. Their research shows some of the most attractive applications that people use and their impact on every day activities. Microsoft has the biggest influence and it helps marketers and doctors, also biochemists, in their work by analysing a lot of data with very useful patterns.

Al-Sukkar et al, (2013) [17] have revealed what can make an effect on the process of applying AI in shaping marketing strategies. Their conclusion is a list of recommendations: first one is a practice of developed technological programs which are based on AI. They also saw the effects of applying AI on shaping different strategies and what is their impact: cost leadership strategy – to reduce costs but to keep a quality; differentiation strategies – to attend providing the highest quality of all the products in the market; alliance strategy – joining alliances with suppliers and agents with the goal of making efficient marketing activities; diversification strategy – supplying market with different and multiple products; direct marketing strategy – it will increase the a possibility to get data basis about customers.

Nordlander, T. E., (2001) [18] have tried to improve that AI has already penetrated the business market. And the result of his research was positive, he found out that Microsoft Office packages have the best influence in working process. The main problem was the price for different and more useful programs for tracking production and the whole working process of big companies.

Stalidis, G. et al, (2015) [19] have presented how advanced data analysis, knowledge representation and neural networks technologies make together an intelligent information system for tourist destination marketing. After they added a new developed system based on Neural Network technology, they concluded that this new system could work out. Their efforts to classify unknown testing patterns were correct and they could manage it with acceptable accuracy.

4. AI APPLICATIONS IN MARKETING

There are numerous AI applications. One of the most popular is a chatbot. [20] A chatbot is an AI software which can help to simulate conversations through chats with the users. It uses natural language through websites, mobile applications, messaging applications or just through the telephone. It is shown in Fig. 2. It is described as one of the most advanced interaction between humans and machines. It is based on returning responses on questions that users have asked. It analyses all the users' requests and after that it is trying to identify the users' intent. When the intent is identified it must provide the most appropriate response. In this way companies get new opportunities to improve the efficiency and to reduce typical costs that costumer services bring.

Chatbot is programmed to work independently and it can give the answer in natural language with a response the same as the human. Responses are combination of scripts and machine learning applications. It has a huge database. Sometimes happens that the answer cannot be found and then a chatbot just deflect the conversation.

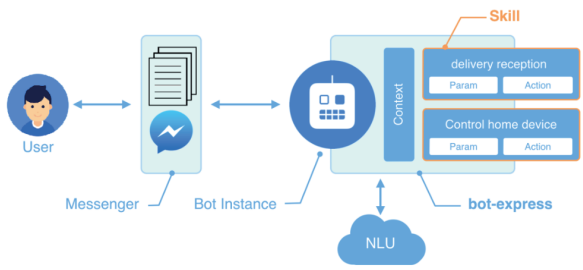


Fig. 2. Natural Language Understanding (NLU)

Digital Personal Assistant is also a software-based service which is designed to help users to complete

their tasks online. It means understanding voice by the computer and answering questions or managing their schedules, playing music… Acoustic model is created to take both audio recordings of speech and text transcription. Software with a speech recognition engine is used to transform sounds into words. Language model uses different applications and it has the aim to predict what will be next word in a speech sequence. The whole process is shown in Fig. 3.

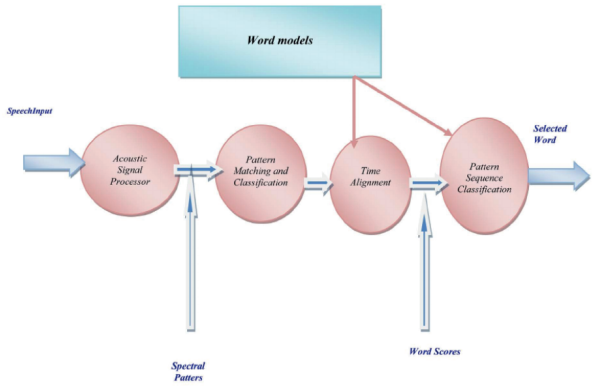


Fig. 3. Diagram of the processing of speech signals planning

Digital personal assistant leaders on the market are: Google Assistant, Siri (Apple), Amazon Alexa, Microsoft's Cortana. [21] When digital assistants have users permission they can collect different data and aggregate them all through search, mail, calendar, maps. They understand who the user is, what are his preferences, where is he, what is he doing, all of this just in order to predict what they really want. For speaker-dependent software new users first speak to the software and it is a kind of training for it because it is important for computer's ability to analyse how the person talks. On the other side, speaker-independent software can recognize anyone's voice, trainings are not necessary. And for better comprehension it is more useful to say simple sentences.

Digital assistants are the best helpers for making brands more popular. This is the best way to build a stronger relationship between brand and its customers. To help brands to become faster, Microsoft has created tools for helping marketers to embed Cortana into their devices and services and also improved Cortana's skills for better extension of their brands. They now have up to 145 million users per month. [22]

5. CONCLUSION

Applications of AI and ML in marketing have positive effect on customer satisfaction, and on revenue growth, in general. Marketers have better understanding on marketing, and sales qualified leads, have insight into customer preferences, can optimize marketing campaigns, improve the precision of pricing, and forecast the sales in more accurate, and faster way.

Marketing evidently evolved from traditional, via digital into intelligent. New terms such as marketing intelligence and neuromarketing appeared lately. With new versions of artificial neural network algorithms, smart applications in marketing become more personalized and even better reflect customer needs. Besides academic research in this field, the major benefits of AI application in marketing are also discussed in this paper. Google will soon become semantic search engine, IT companies are running in smart application development, (e.g. Siri, Cortana, Alexa), chatbots, robots and all the other AI applications have many advantages in marketing.

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THE ETHICS OF MACHINE LEARNING

Danica Simić*
Nebojša Bačanin Džakula

Singidunum University,
Belgrade, Serbia

Abstract:
Data science and machine learning are advancing at a fast pace, which is why tech industry needs to keep up with their latest trends. This paper illustrates how artificial intelligence and automation in particular can be used to enhance our lives, by improving our productivity and assisting us at our work. However, wrong comprehension and use of the aforementioned techniques could have catastrophic consequences. The paper will introduce readers to the terms of artificial intelligence, data science and machine learning and review one of the most recent language models developed by non-profit organization OpenAI. The review highlights both pros and cons of the language model, predicting measures humanity can take to present artificial intelligence and automatization as models of the future.

Keywords:
Data Science, Machine Learning, GPT-2, Artificial Intelligence, OpenAI.

1. INTRODUCTION

The rapid development of technology and artificial intelligence has allowed us to automate a lot of things on the internet to make our lives easier. With machine learning algorithms, technology can vastly contribute to different disciplines, such as marketing, medicine, sports, astronomy and physics and more. But, what if the advantages of machine learning and artificial intelligence in particular also carry some risks which could have severe consequences for humanity.

2. MACHINE LEARNING

Definition

Machine learning is a field of data science which uses algorithms to improve the analytical model building [1] Machine learning uses artificial intelligence (AI) to learn from great data sets and identify patterns which could support decision making parties, with minimal human intervention.

Thanks to machine learning, humans can communicate with different computer systems, including cars, phones, chat bots on the internet and much more as stated in [1]. Machine learning algorithms can be

Correspondence:
Danica Simić

e-mail:
danica.simic.17@singimail.rs

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used for predicting different medical conditions including cancer, for self-driving vehicles, sports journalism, detecting planets, and even beating professional gamers at some world popular video games.

Short History

The history of machine learning originates from 1943 when neurophysiologist Warren McCulloch and mathematician Walter Pitts conducted a study about neurons, explaining the way they work [2]. They used electrical circuits to model the way human neurons work, and that's how the first neural networks were born.

In 1950, Alan Turing created the famous Turing Test, which is designed for a computer to convince a human that it's also a human, rather than a machine. Two years later, Arthur Samuel wrote the first program which was able to learn while running – a game playing checkers [3]. The first neural network was designed in 1958 dubbed Perception, which could recognize different patterns and shapes.

Machine learning, and artificial intelligence saw a broad peak during the '80s, with researcher John Hopfield suggesting a network which had bidirectional lines which precisely resemble of how neurons work. Japan also played a significant role in machine learning development.

The highest peak in the 20th century was in 1997 when an IBM-built computer Deep Blue which could play chess beat the world champion.

The 21st century marked even more rapid development of artificial intelligence and machine learning. Some of the most popular projects include as stated in [2]:

- GoogleBrain (2012)
- AlexNet(2012)
- DeepFace(2014)
- DeepMind(2014)
- OpenAI(2015)
- U-Net
- ResNet

Types of Machine Learning

Machine learning can be sub-categorized into three types of learning [4].

- Supervised learning
- Unsupervised learning
- Reinforcement Learning (Hit & Trial)

Supervised Learning

Supervising learning is an instance of machine learning where algorithm can't independently conduct the learning process. Instead it's being mentored by its developer or researcher that works on its development, by being fed dataset. Once the training process is finished, machine can make predictions or decisions based on the data it was taught.

Popular Algorithms: Linear Regression, Support Vector Machines (SVM), Neural Networks, Decision Trees, Naive Bayes, Nearest Neighbor.

Unsupervised Learning

With unsupervised learning, once the inputs are given, the outcome is unknown. After being datasets, the model runs it. The term of unsupervised learning is not as widespread as supervised learning. However, it's worth saying that every supervised algorithm will become unsupervised eventually, once it is fed enough data. The main algorithms associated with unsupervised learning include clustering algorithms and learning algorithms.

There is an in-between scenario where supervised and unsupervised learning is used together to achieve desired goals. More importantly, a combination between the two is commonly used in real-world situations, where the algorithm contains both labelled and unlabelled data.

Reinforced Learning

Reinforced learning uses a more specific approach in order to answer specific questions. That said, the algorithm gets exposed to the environment where it learns using trial and error method. The algorithm uses its own mistakes made in the past for its personal improvement. Eventually, it is fed enough data to make accurate decisions based on the feedback it received from its errors.

Most commonly used algorithms

Below are the most popular and commonly used machine learning algorithms, as per [5].

Linear regression - equation that describes a line that best fits the relationship between the input variables (x) and the output variables (y), by finding specific weightings for the input variables called coefficients (B).

Linear Discriminant Analysis – Makes predictions that are made by calculating a discriminate value for each class and making a prediction for the class with the largest value.

Decision Trees - Decision trees learn from data to approximate a sine curve with a set of if-then-else decision rules. The deeper the tree, the more complex the decision rules, and the fitter the model.

Naïve Bayes - Naive Bayes classifiers are a collection of classification algorithms based on Bayes' Theorem, where every pair of features being classified is independent of each other.

Pros & cons of machine learning

Pros

- Trends and patterns are easily identified
- The overall algorithm improves over time
- Easy Adaptation

Cons

- The process of gathering data can be long and expensive
- Takes a lot of time
- Using bad data can craft a bad algorithm

3. OPENAI GPT-2 – ALGORITHM WITH BOTH PROS & CONS

On February 14, 2019, Elon Musk-backed organization OpenAI published a lengthy press release about a text-transforming machine learning algorithm that it developed [6]. The organization stressed that it couldn't release the trained model publicly, in fear of it being used for malicious purposes.

"Our model, called GPT-2 (a successor to GPT), was trained simply to predict the next word in 40GB of Internet text. Due to our concerns about malicious applications of the technology, we are not releasing the trained model. As an experiment in responsible disclosure, we are instead releasing a much smaller model for researchers to experiment with, as well as a technical paper."

The organization referred to AI GPT-2 as transformer-based language built with 1.5 billion parameters. The organization trained it on a huge dataset which consisted of 8 million web pages. The algorithm aims to deliver diverse content.

The algorithm is provided with a small sample of text written by a human and then it transforms it into series of paragraphs which seem both accurate and convincing, undoubtedly reminding of a tabloid-style or news article. The organization trained algorithm only with pages that were curated by humans, specifically outbound links from Reddit, which received three or more karma.

GPT-2 is equipped with additional capabilities, such as being able to create conditional synthetic text which greatly resembles of human-written text, excelling at surpassing other language models which were trained on domains such as Wikipedia, news or books.

It is also able to complete tasks such as question answering, reading comprehension, summarization, and translation. When trained, the algorithm uses raw text, without task-specific data. As it shows improvements in text prediction, it gets fed task-specific data.

About OpenAI

OpenAI was founded in December 2015, as part of a project that sees artificial intelligence development targeted towards "doing good" [7]. OpenAI is a non-profit organization with $1 billion in donations by names such as Tesla and SpaceX CEO Elon Musk and LinkedIn co-founder Reid Hoffman[5].

The company has several distinguished projects for the time it spent working on benefiting humanity with AI.

Its algorithms include a bot targeted towards the video game Dota which is capable of beating game professionals in August 2017. In February 2018 the organization released a report on "Malicious uses of AI," in which it highlights its mission and importance of using automatization for good.

On July 18, the organization announced a flexible Robot hand which is capable of handling physical objects with high accuracy and dexterity [8]. One month later, it praised on its Dota 2 bot which can defeat 99.95th percentile of professional DotA players [9].

Finally, in February 2019, the organization announced and reported on its text-transforming algorithm, GPT-2, which is sufficiently advanced to rather worrying the humanity than benefit it as mentioned in [6].

Here are some examples of GPT-2-generated text as opposed to the human-written text:

Sample 1:

SYSTEM PROMPT (HUMAN-WRITTEN)

In a shocking finding, scientist discovered a herd of unicorns living in a remote, previously unexplored valley, in the Andes Mountains. Even more surprising to the researchers was the fact that the unicorns spoke perfect English.

MODEL COMPLETION (MACHINE-WRITTEN, 10 TRIES)

The scientist named the population, after their distinctive horn, Ovid's Unicorn. These four-horned, silver-white unicorns were previously unknown to science.

Now, after almost two centuries, the mystery of what sparked this odd phenomenon is finally solved.

Dr Jorge Pérez, an evolutionary biologist from the University of La Paz, and several companions, were exploring the Andes Mountains when they found a small valley, with no other animals or humans. Pérez noticed that the valley had what appeared to be a natural fountain, surrounded by two peaks of rock and silver snow.

Pérez and the others then ventured further into the valley. "By the time we reached the top of one peak, the water looked blue, with some crystals on top," said Pérez.

Pérez and his friends were astonished to see the unicorn herd. These creatures could be seen from the air without having to move too much to see them – they were so close they could touch their horns.

While examining these bizarre creatures the scientists discovered that the creatures also spoke some fairly regular English. Pérez stated, "We can see, for example, that they have a common 'language,' something like a dialect or dialectic."

Dr. Pérez believes that the unicorns may have originated in Argentina, where the animals were believed to be descendants of a lost race of people who lived there before the arrival of humans in those parts of South America.

While their origins are still unclear, some believe that perhaps the creatures were created when a human and a unicorn met each other in a time before human civilization. According to Pérez, "In South America, such incidents seem to be quite common."

However, Pérez also pointed out that it is likely that the only way of knowing for sure if unicorns are indeed the descendants of a lost alien race is through DNA. "But they seem to be able to communicate in English quite well, which I believe is a sign of evolution, or at least a change in social organization," said the scientist.

Sample 2:

SYSTEM PROMPT (HUMAN-WRITTEN)

A train carriage containing controlled nuclear materials was stolen in Cincinnati today. Its whereabouts are unknown.

MODEL COMPLETION (MACHINE-WRITTEN, FIRST TRY)

The incident occurred on the downtown train line, which runs from Covington and Ashland stations.

In an email to Ohio news outlets, the U.S. Department of Energy said it is working with the Federal Railroad Administration to find the thief.

"The theft of this nuclear material will have significant negative consequences on public and environmental health, our workforce and the economy of our nation," said Tom Hicks, the U.S. Energy Secretary, in a statement. "Our top priority is to secure the theft and ensure it doesn't happen again."

The stolen material was taken from the University of Cincinnati's Research Triangle Park nuclear research site, according to a news release from Department officials.

The Nuclear Regulatory Commission did not immediately release any information.

According to the release, the U.S. Department of Energy's Office of Nuclear Material Safety and Security is leading that team's investigation.

"The safety of people, the environment and the nation's nuclear stockpile is our highest priority," Hicks said. "We will get to the bottom of this and make no excuses.

Sample from The Lord of The Rings trilogy:

SYSTEM PROMPT (HUMAN-WRITTEN)

Legolas and Gimli advanced on the orcs, raising their weapons with a harrowing war cry.

MODEL COMPLETION (MACHINE-WRITTEN, FIRST TRY)

The orcs' response was a deafening onslaught of claws, claws, and claws; even Elrond was forced to retreat. "You are in good hands, dwarf," said Gimli, who had been among the first to charge at the orcs; it took only two words before their opponents were reduced to a blood-soaked quagmire, and the dwarf took his first kill of the night.

The battle lasted for hours until two of the largest Orcs attempted to overwhelm Aragorn. When they finally stopped, they lay defeated and lifeless for miles and miles.

"I take nothing," said Aragorn. "But I give my word, at my peril and mine, that I will never forget this day of horror. None of us will forget. Ever!"

"I'll never forget it!" cried Gimli, who had been in the thick of the battle but hadn't taken part in it. One of the wounded orcs he had carried off, he was the only one of the survivors who remained uninjured. "We'll keep the memory of that day of evil, and the war with it, alive as long as we live, my friends!"

"Then we'll keep it alive as long as we live," added Legolas. "And we won't forget the first great battle of the night, even if we may have forgotten the final defeat."

"I agree," Gandalf said, "but we will all remember it as the last battle in Middle-earth, and the first great battle of the new day."

Aragorn drew his sword, and the Battle of Fangorn was won. As they marched out through the thicket the morning mist cleared, and the day turned to dusk.

The Two Rings were returned to Rivendell. Frodo and Sam woke up alone in their room, and Frodo found a note on his pillow. He opened it and read:

May the Power of the Ring be with you always, and may it's light never fade. I am not sure if it matters which of the two rings we accept this day but, as you asked me, I have chosen mine. I am sorry to leave you, Frodo, but know that we are very close to the end, and that you are with us forever.

May this letter find you safely in Rivendell; and if it does not, then I will accept the ring in your stead. If by any chance you find or give this letter to the enemy, may they learn the strength of the ring and may the Two Rings never be broken!

Although the company refrained from open-sourcing its original language model, researchers behind the project published a technical paper and a smaller model for researchers to experiment on [10]

Reaction to GPT-2 via Media

World-known and cited media outlets were quick to report on the capabilities of the GPT-2 language model.

Many publications stressed that the algorithm is too dangerous to be released publicly, which is something that OpenAI already announced. Due to the advanced capabilities of the algorithm, a fully trained system wasn't released publicly. Instead, the organization published a smaller model for researchers to study on it, as well as scientific paper which explains how it was developed.

Wired reported [11]:

A version of OpenAL's text generator trained on Amazon product reviews illustrates how a little extra training can adapt it to a specific task—or attack. Fake reviews trying to boost or drag down products or businesses are already a headache for companies such as Yelp, and they have been weaponized in political disputes.

Guardian reported [12]:

The creators of a revolutionary AI system that can write news stories and works of fiction – dubbed "deepfakes for the text" – have taken the unusual step of not releasing their research publicly, for fear of potential misuse.

TechCrunch reported [13]:

A storm is brewing over a new language model, built by non-profit artificial intelligence research company OpenAI, which it says is so good at generating convincing, well-written text c

Pros & Cons of OpenAI's GPT-2

It's no secret that GPT-2 can greatly contribute to both corporate and scientific world. Researchers and scientists around the world could use an extra hand

when it comes to writing lengthy scientific papers which involve a lot of measuring and calculations as per [6].

Additionally, programmers could use it for writing new programs, or train new machine learning algorithms.

As about the corporate world, a text-transforming algorithm could come in great handy in decision-supporting systems. At the same time, the algorithm would provide a reliable asset to journalists and authors around the world, who are often time-constrained in writing their articles, books or papers.

However, GPT-2 is far from perfect and it requires multiple changes before it can be labelled as safe. Just like everything innovative, there is the other side of the coin for this algorithm. If it fell into the wrong hands, it could be used for propaganda, the spread of falsely-written news and advertisements.

Using the model as such would result in vast uneasiness and disturbance, which could have catastrophic consequences for the society that we live in, per [6].

While the language model can't be labelled as destructive, it can be called delusive as written in the open letter in [14].. Destructive technologies operate in the physical world, and they include violence, wars, chemical, and nuclear weapons. On the other hand, delusive technologies can be used to mislead people. Unfortunately, misled people often take some measures which can become destructive if dealing with unsourced information.

4. CONCLUSION

AI & Automatization Making Life Easier

Despite humanity's fear of unprecedented text transforming algorithm's capabilities. Use of artificial intelligence and machine learning can be used for doing good, which is the initial mission of OpenAI.

Many modern inventions have both pros and cons, benefits and risks, but people still use them and experience the best of them. That said, OpenAI's GPT-2 language model can do wonders in the world where we live at a fast pace and exchange a tremendous amount of data per second [15].

In 2019, artificial intelligence, machine learning and data science particularly, are expected to be at their peak performance. Many companies demand solutions that can provide real answers and solutions in real time, while AI-powered robots are making the user experience a lot more pleasant, both in virtual and physical forms.

The virtual assistants that we use on our smartphones are trained to be much more intuitive, while robots perform much faster in the factories where humans are often exposed to risk by both machines and toxic substances.

Finally, all forms of the machine and deep learning can be further enhanced, which is their initial purpose, to learn just like the human brain and use their mistakes from past to learn even more.

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WIRELESS MICROPHONES INTERFERENCE DECREASING USING LTE FILTERS

Jovan Zlatanović[1,*],
Marina Marjanović[2],
Zoran Trivić[1]

[1]PE Transmitters and Communications,
Belgrade, Serbia
[2]Singidunum University,
Belgrade, Serbia

Abstract:
Strong signals from mobile phones can disturb and interfere with television signals making the channel impossible to receive the signal. In this paper, we measured the interference between wireless microphones and mobile phones that work in the same frequency Bandwidth from 750MHz to 850MHz. The measurements were performed on Košutnjak site from Radio Television Serbia (RTS) distribution main center. In this paper, we have two main contributions. First, we described the influence of existing Long Term Evolution (LTE) technology on wireless microphones which is used in Television stations. Second, it is described how this influence can be reduced using LTE filters searching for optimal filter response.

Keywords:
wireless microphones, LTE Technology, LTE filters, IEEE802.11.

1. INTRODUCTION

Mobile phones like other wireless devices radiate strong electromagnetic fields that might cause interference and noise in microphone signals. Efforts to correct interference problems are often complicated by the fact that a problem that has been solved usually returns later.

In a technique for improvement of the usage of wireless spectrum in the context of wireless local area networks (WLANs) by using new channel assignment methods among interfering Access Points (APs) was described. They tried to re-use the channel in the realistic interference scenarios in WLAN environments. Two efficient algorithms were proposed that achieved significantly better performance than the state-of-the-art methods. The obtained result was 45.5% and 56% reduction in interference for sparse and dense topologies respectively with 3 non-overlapping channels. Additionally, they showed that this approach effectively used partially overlapping channels in order to achieve an additional 42% reduction on average for moderately sized networks.

A straightforward extension to this work was to handle co-existing 802.11b/g APs in the same area of coverage. However, interference affected 802.11g APs more than 802.11b standard. In [1], the first location oblivious distributed unit disk graph coloring algorithm was proposed.

Correspondence:
Jovan Zlatanović

e-mail:
jovan.zlatanovic@etv.rs

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This was an improvement over the standard sequential coloring algorithm since they presented a new lower bound of 10/3 for the worst-case performance ratio of the sequential coloring algorithm with the greatest bound of 5/2. However, simulation results showed that this algorithm didn't provide a significant improvement over the previous algorithm which sequentially colored the nodes in an arbitrary order.

In this work, in Section I, we introduce SKM 300-865 G3 wireless microphone that we used in RTS. Section II describes LTE cellular technology that we consider for the purpose of our measurements [2]. In Section III, we analyze the consequences and the problems of interference of LTE systems and wireless microphones working in the same frequency band from 750MHz to 850MHz. In Section III we presented the measurement results and the results of measurements are concluded giving the issue of implementation and the solution of potential problem.

2. SKM 300-865 G3 WIRELESS MICROPHONE

SKM 300-865 G3 presents a super-cardioid handheld microphone/transmitter with condenser microphone capsule and excellent sound quality. Microphone SMK has enhanced frequency bank system up to 24 compatible frequencies and 42 MHz bandwidth. There are 1680 tunable UHF frequencies for interference-free reception, but part of frequency range is between 680MHz to 830MHz. In order to get all the functionalities that we needed, this wireless microphone was used together with microphone receiver EM3732 and microphone transmitter SK 3036. The EM 3732 is characterized by high transmission reliability, exceptional audio quality and simple operation, switching bandwidth of up to 184 MHz, more than double that of its predecessors. The integrated Ethernet connection means that the receivers can be linked into any network. The AES3/EBU digital audio interface facilitates a direct connection to digital mixing consoles. Sennheiser's "Wireless Systems Manager" (WSM) software allows monitoring and control all receiver operating statuses remotely. In addition, this versatile software enables the channel allocation reset at any time and stores it as a "Scene". The EM 3732 is available in 3 different frequency variants, such as: L: 470 - 638 MHz, N: 614 - 798 MHz, and P: 776 - 960 MHz.

The SK 3063 is a miniature, tunable bodypack transmitter that provides 30 mW output power, and 16 selectable frequencies in a 24 MHz micro range that operates within the UHF band of 450-960 MHz. The micro range can easily be retuned over a large portion (macro range) of the UHF band to ensure continuous operation regardless of DTV frequency allocations. The Hi-Dyn plus noise reduction system, optimizing attack and decay time, exhibits a signal-to-noise ratio of 108 dB(A). Frequency stability is ensured by the use of Phase Lock Loop (PLL) technology. Tunability, ruggedness, and reliability, along with Sennheiser's unsurpassed audio quality. A microphone's directionality or polar pattern indicates how sensitive it is to sounds arriving at different angles about its central axis. The polar patterns represent the locus of points that produce the same signal level output in the microphone if a given sound pressure level (SPL) is generated from that point. How the physical body of the microphone is oriented relative to the diagrams, depends on the microphone design. For large-membrane microphones such as in the Octave, the upward direction in the polar diagram is usually perpendicular to the microphone body, commonly known as "side fire" or "side address". For small size diaphragm microphones such as the Shure, it usually extends from the axis of the microphone commonly known as "end fire" or "top/end address". Super-cardioid microphone design combines several principles in creating the desired polar pattern as it is described in [3].

On the figure 1 super-cardioid wireless microphone is presented.

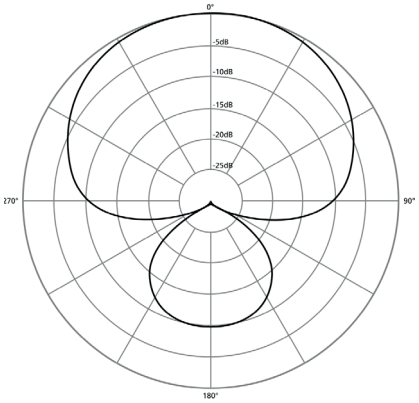


Figure 1. Super-cardioid wireless microphone

3. LTE TECHNOLOGY

LTE Technology

LTE represents a standard for high-speed wireless communication for mobile devices and data terminals,

based on the GSM/EDGE (Global System for Mobile Communications/ Enhanced Data Rates for GSM Evolution) and UMTS/HSPA (Universal Mobile Telecommunication System/ High Speed Packet Access) technology. The main objectives for LTE are: increased downlink and uplink peak data rates, scalable bandwidth, improved spectral efficiency, all IP network and A standard's based interface that can support a multitude of user types [4]. Serbian base stations are based on Huawei technology. Huawei's 3900 series multi-mode base stations offer a future oriented network solution integrating radio resources and multiple technologies. The design of the 3900 series multi-mode base stations is based on originality that encompasses the latest chip design, system architecture, Power Amplifier (PA) technology, and power consumption management. HUAWEI BTS 3900 is modular cabinet that consist of: RF (Radio Frequency) units (GSM modules, UMTS modules and LTE modules), BBU3900 - unit for digital signal processing, associated cables, DC power distribution unit, fans and ventilation system.

The main point is BBU3900, that can serve to any Radio Access Technologies RATs among GSM, UMTS, and LTE at the same time, thus enabling triple-mode application. Triple-mode is performed by control subsystem using different circuit boards modules [5].

In this work, we use LTE technology, that is able to utilize both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) to accommodate the uplink and downlink. It is essential that any cellular communications system must be able to transmit in both directions simultaneously. Additionally, when exchanging data, it is necessary to be able to undertake virtually simultaneous or completely simultaneous communications in both directions [6].

It is necessary to be able to specify the different direction of transmission, so that it is possible to easily identify in which direction the transmission is made. There is a variety of differences between the two links ranging from the amount of data carried to the transmission format, and the channels implemented. In order to be able to achieve the transmission in both directions, a user equipment or base station must have a duplex scheme.

The frame and subframe structure used within LTE provides the data synchronization and organization required to enable it to be transferred in a logical and ordered fashion. There are several forms of data that need to be sent over the LTE radio interface. LTE uses a series of data channels to provide effective management of the data: physical, logical and transport channels are used. Those LTE channels provide different interfaces into the higher layers of the protocol stack and in this way they are able to provide efficient management of the data. The physical, logical and transport channels all link to different areas of the stack. By organizing them in this way, the LTE system is able to route the data to the required area. This control channel number so it can be defined easily and its limits known. The LTE radio channels are also allocated numbers - these can be calculated from a simple defined formula. By having defined radio channels, they can be coordinated globally to facilitate roaming [7]. There is a large number of allocations or radio spectrum that has been reserved for FDD, frequency division duplex, and LTE use. The FDD LTE frequency bands are paired to allow simultaneous transmission on two frequencies. Part of FDD LTE Bands and Frequencies are presented In Table 1. The bands also have a sufficient separation to enable the transmitted signals not to unduly impair the receiver performance. If the signals are too close, then the receiver may be "blocked" and the sensitivity impaired. The separation must be sufficient to enable the roll-off of the antenna filtering to give sufficient attenuation of the transmitted signal within the receive band.

Table 1. Part of FDD LTE Bands & Frequencies

LTE Band Number	Frequency (MHz)		
	Uplink	Downlink	Width of Band
1	1920-1980	2110-2170	60
2	1850-1910	1930-1990	60
3	1710-1785	1805-1880	75
4	1710-1785	2110-2155	45
5	824-849	869-894	25
6	830-840	875-885	10
7	2550-2570	2620-2690	70
8	880-915	925-960	35
9	1749.9-1748.9	1844.9-1879.9	35
10	1710-1770	2110-2170	60
11	1427.9-1452.9	1475.9-1500.9	20
12	698-716	728-745	18
13	777-787	745-756	10
14	788-798	758-768	10
15	1900-1920	2600-2620	20

LTE Band Number	Frequency (MHz)		
	Uplink	Downlink	Width of Band
16	2010-2025	2585-2600	15
17	704-716	734-746	12
18	815-830	860-875	15
19	830-845	875-890	15
20	832-862	791-821	30
21	1447.9-1462.9	1495.5-1510.9	15
22	3410-3500	3510-3600	90
23	2000-2020	2180-2200	20
24	1625.5-1660.5	1525-1559	34
25	1850-1915	1930-1955	65
26	814-849	859-894	30/40
27	807-824	852-894	17
28	703-748	758-803	45
29	n/a	717-728	11
30	2305-2315	2350-2360	10
31	452.5-457.5	462.5-467.5	5
32	DL CA Only	1452-1496	44
65	1920-2100	2110-2200	90
66	1710-1780	2110-2200	90
67	DL CA Only	738-758	20

There are several unpaired frequency allocations that are being prepared for LTE TDD use. The TDD LTE bands are unpaired because the uplink and downlink share the same frequency, being time multiplexed. In Table 2. TDD LTE Bands and Frequencies are presented.

Table 2. TDD LTE Bands & Frequencies

LTE Band Number	Frequency (MHz)	
	Allocation	Width of Band
33	1900 - 1920	20
34	2010 - 2025	15
35	1850 - 1910	60
36	1930 - 1990	60
37	1910 - 1930	20
38	2570 - 2620	50
39	1880 - 1920	40
40	2300 - 2400	100
41	2496 - 2690	194
42	3400 - 3600	200
43	3600 - 3800	200
44	703 - 803	100
45	1447 - 1467	20
46	5150 - 5925	775
47	5855 - 5925	70

There are regular additions to the LTE frequency bands / LTE spectrum allocations as a result of negotiations at the ITU regulatory meetings. These LTE allocations are resulting in part from the digital dividend, and also from the pressure caused by the ever growing need for mobile communications. Many of the new LTE spectrum allocations are relatively small, often 10 - 20MHz in bandwidth, and this is a cause for concern. With LTE-Advanced needing bandwidths of 100 MHz, channel aggregation over a wide set of frequencies many be needed. LTE supports different channel bandwidths and as a result a different number of resource blocks can be supported. For all the channel bandwidths except 1.4 MHz, the resource blocks in the transmission bandwidth fill up 90% of the channel bandwidth.

4. LTE FILTER AND IMPLEMENTATION

When recording TV programs in RTS studios, wireless microphone signals and sound interruptions were approximate duration from 1s to 5s over an undetermined time interval. In the Figure 2. the transmission and the reflection parameters are presented.

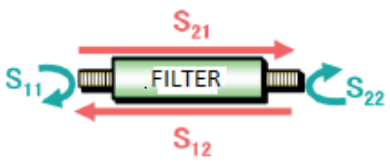


Figure 2. S-parameters

S-parameters are complex numbers that show Reflection/Tranmission characteristics (Amplitude/Phase) in frequency domain. Our LTE filter is two-port device with four S-parameters (). The numbering convention for S-parameters is that the first number following the "S" is the port where the signal emerges, and the second number is the port where the signal is applied [8].

With amplitude and phase information (shown in Figure 3), we can quantify the reflection and transmission characteristics of the devices. Some of the common measured terms are scalar (when the phase part is ignored or not measured), while others are vector (when both magnitude and phase are measured). Return loss is a scalar measurement of reflection, while impedance results from a vector reflection measurement. On the other hand, the group delays are purely phase-related measurements [9].

All parameters such as Reflections (Return loss), Impedance, Admittance, and Voltage Vawe Standing Wave Ratio (VSWR). are shown in Figure 3.

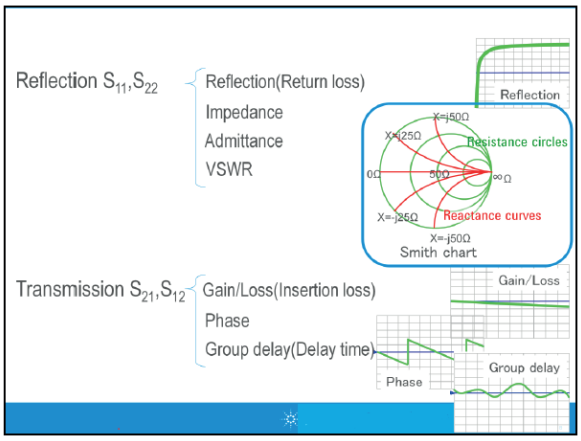


Figure 3. Reflection and transmission parameters

We analyzed the frequency spectrum with Kathrein's MSK 200 signal meter. An LTE filter is designed to stop interference by aggressively decreasing useful signals outside the broadcast band. LTE transmissions occur at several frequencies. In figure 4 and 5, the measurements result with and without implementation of LTE filter in studio Kosutnjak are presented.

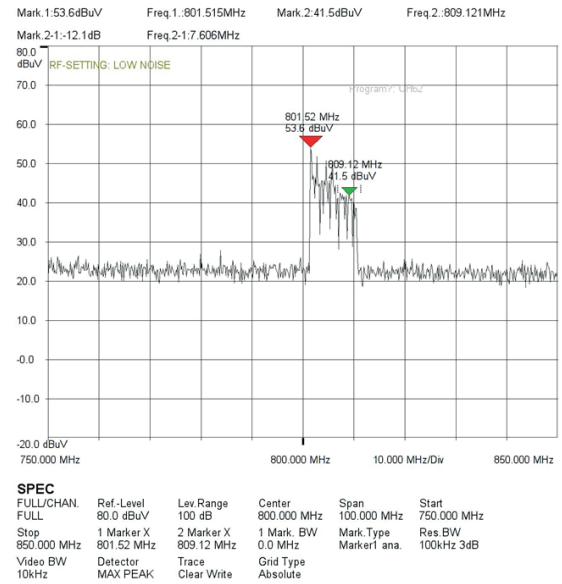


Figure 4. Bandwidth from 750MHz to 850MHz in site Kosutnjak

In figure 4 it is shown that LTE signal, in our case the interference signal is up to 40dB when wireless microphone up to 790MHz is used. As it is shown in figure 5, LTE interference signal is very strong and completely masks our wireless microphone signal. As a result, the useful signal on the output from the receiver is missing that resultins in silence.

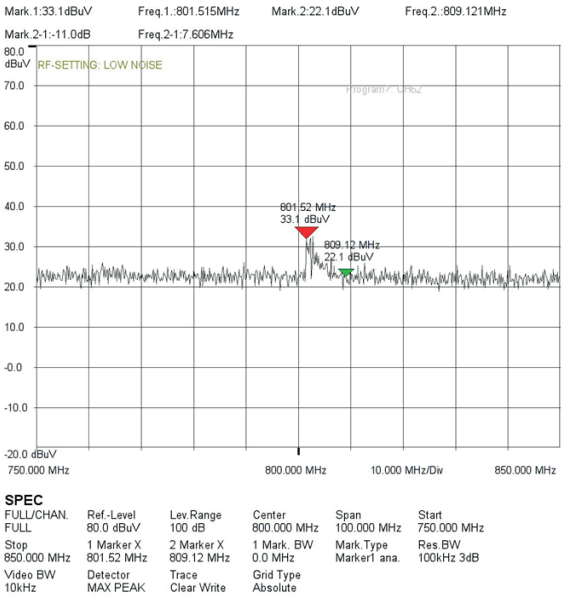


Figure 5. LTE filter implementation in site Kosutnjak

As it is shown on the Figure 5, we eliminate the LTE unused signal, but in bandwidths from 400MHz to 820MHz S12 parameter is too high, up to 20 db. That means that our wireless microphone signal will be attenuated up to 20 dB. Thus, we create the adapted filter (SLTE30) to the needs of a recording studio with a very small attenuation of the parameter S12 that is not to degrading the useful signal as it is shown on Figure 6. where S21 parameter is up to 3db.

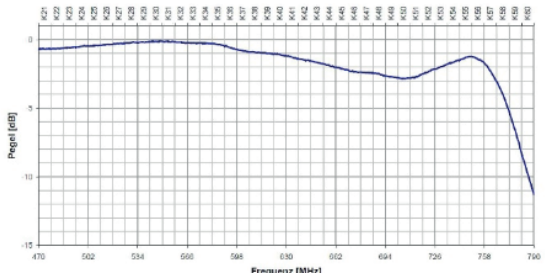


Figure 6. Insertion loss vs. frequency for SLTE30 filter

Therefore, microphone wireless signal in microphone receiver without LTE signal and attenuation microphone signal is very low and acceptable.

5. CONCLUSION

In this paper, the measured LTE interference between wireless microphone signal and the LTE 4G signal from mobile operator is presented. It is shown that interference wireless signal and LTE signal when recording a TV live show brings only silence. There is no music, and no votes. In cooperation with mobile operators, we determine the source of LTE signal. Additionally, we analyze the bandwidth (750-850MHz where our wireless microphone work and interference LTE signal occurs. Finally, we solve this problem and eliminate interference of LTE signal. In a first phase, we use the commercial LTE filters and we eliminate the interference. However, using the commercial LTE filters we also damage the useful wireless microphone signal. Thus, after the analysis of used filters, various adjustments, experiments modifications and we created a new LTE filter that eliminates the interference of LTE signal and transmits signal without any distortion.

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INVERSE FILTERING METHOD FOR SUPER-RESOLUTION DIGITAL IMAGING

Ratko Ivković[1, 3, *],
Mile Petrović[1],
Ivana Milošević[2],
Dejan Đukić[3],
Vladimir Maksimović[1]

[1]Faculty of Technical Sciences,
University of Pristina,
Kosovska Mitrovica, Serbia
[2]SP Audio and Video Technologies,
The School of Electrical and Computer
Engineering,
Belgrade, Serbia
[3]Faculty of Information Technology,
Alfa BK University,
Belgrade, Serbia

Abstract:
Super-resolution is a method of combining various techniques in digital image processing, in order to achieve higher resolution in certain image segments, which initially had insufficient resolution and quality. The principal idea in this work is the use of the analysis of the level of detail and of the standard deviation, which results in enhancing the resolution of the digital image, whilst maintaining the overall image quality. In the first part of this article, an experimental method for estimating the standard deviation and the level of detail in a digital image has been shown, together with the inferred facts that result from this analysis. The second part of this article uses these facts in the process of designing an inverse filter by applying the averages of pixel intensities. The proposed method has significant advantages over the heretofore used super-resolution techniques, as it achieves the enhancement of the resolution from a single image, whilst retaining the initial image potential.

Keywords:
Digital Image Processing, Super-Resolution, Inverse Filtering, Segments, Matrix.

1. INTRODUCTION

Resolution of an image describes the number of details that can be shown in this image. Resolution of a digital image is limited by the used digital image recording equipment such as the optics, the sensors (CCD, CMOS), or the electronics. The price of the equipment for producing high resolution digital images is extremely high, and it is prohibitive in the vast majority of imaging applications. On the other hand, it may be possible to use certain image processing algorithms in order to achieve the required enhancement in the image quality. Moreover, in some cases, even the digital images recorded using an expensive imaging equipment may be further enhanced by using some of those algorithms. All of the algorithms and their combinations [1, 2] that aim directly at the image resolution enhancement are summarily called the Super-Resolution (S-R) methods [3, 4]. Super-Resolution algorithms have been the subject of scientific interest since the inception of the digital image processing, and up until today. The main areas of the application of the S-R:

- Remote sensing - S-R achieves correct interpretation of remotely taken images of areas and regions that may be harmful for humans.

Correspondence:
Ratko Ivković

e-mail:
ratko.ivkovic@pr.ac.rs

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- Surveillance imaging and video - Surveillance cameras usually cover large areas, which implies that it is not possible to obtain high resolution imaging over the totality of the area under surveillance.
- Medical imaging - Usually, there are multiple images, taken using different methods and equipment. Hence, there is often a need for the application of S-R algorithms in order to obtain a correct interpretation.
- Image and video conversion - Methods for image and video format conversion often use some of S-R methods.

The principal aim of S-R methods is to obtain an image with enhanced resolution from one or multiple low-resolution images. There are two main kinds of S-R methods:

1. Classical S-R methods, or S-R methods based on the processing of multiple images (nowadays often seen in modern mobile handsets), and
2. Single image S-R methods.

Classical S-R methods (see [5, 6, 7]) use multiple images of the same scene. Each of these images is normally of limited quality and resolution, sometimes with unknown values of the image quality parameters. From these images, an image of high quality and enhanced resolution needs to be reconstructed. Classical S-R methods are mainly based on sub-pixel clustering. Single image S-R methods have had limited success in digital image resolution enhancement (see [8] and [9]). As may be seen in [10, 11, 12, 13, 14, 15, 16, 17], there are multiple ways to achieve resolution enhancement. In this article, the main idea is to design a resolution enhancement (S-R) algorithm by inverting the averaging filtering methods (blurring, median, or mean value filters), or the noise reduction filtering methods. By investigating image segments with visually similar colouring, it may be observed that the pixel values in these segments are not greatly different (see Figs. 1a, 1b, and 1c). The segment under observation in the image is marked by a circle, and the corresponding pixel values are shown in the top right corner of the figure. Although the selected segments are visually very similar, it is evident that the deviations in the pixel values in any of the three colour channels (R, G, B) within the marked segments may be up to 23% of the range of the values (0-255).

As has been seen in Fig. 1a, 1b, and 1c, pixel values in the same channel differ from each other. E.G. the selected pixel in Fig. 1b has RGB colour values (201, 88, 90), whereas the selected pixel in Fig. 1c has values (194, 69, 73). Within the selected segments in Fig. 1, there are no details, so it is not possible to consider the level of detail. However, it is reasonable to estimate the standard deviation for the image regions with visually similar uniform colour. Therefore, the principal idea for designing the S-R method presented in this article has been the variability in pixel values in the neighbourhood of the selected pixel.

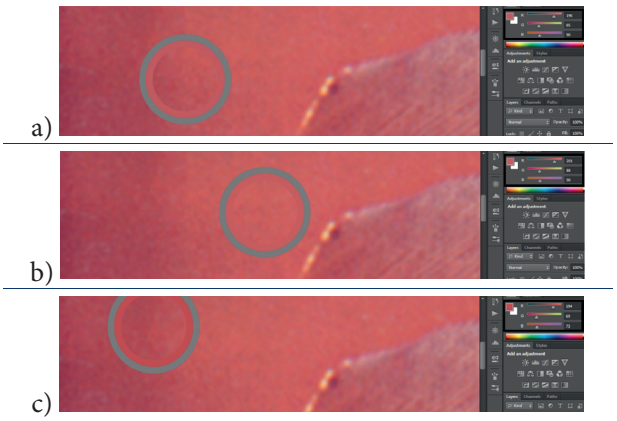


Fig. 1. Three regions selected within a single image segment

Three regions selected within a single image segment

So far, the methods for generating an image with enhanced resolution generally required the use of multiple low-resolution images. However, the algorithm proposed in this article uses only one low resolution image as the only source of data for analysis, and subsequently for creating an enhanced resolution image. Generating an image with enhanced resolution from images with low resolution may be viewed as the inverse of the process of image resolution reduction. Hence, the S-R method proposed in this article is being denoted an inverse filtering method.

2. THEORETICAL FRAMEWORK

The method proposed in this article is effectuated in two phases. In the first phase, the standard deviation of pixel values and the level of detail in the original low-resolution image are being estimated. In this process, it is not necessary to analyse the standard deviation using the whole image, as, in this estimate, the compression errors, image textures, edges, and noise would be taken into account, whilst these image details and artefacts, as

a rule, would have greatly different statistical descriptions. E.G. image segments that are preponderately red and that are preponderately blue, when taken together would have excessively large values of standard deviation. Therefore, the results of the analysis of standard deviation of pixel value distribution and of the level of detail in the whole image would not be valid. Thus, before the analysis of the standard deviation and of the level of detail, the image needs to be appropriately segmented into segments with approximately uniform colour. Then, for each segment, the standard deviation and the level of detail are being estimated. Further on, the estimation of image parameters is performed separately for each of the three colour channels: red, green, and blue. The estimated values obtained in this way are then being compared. As it has been shown in [18], the greatest value of the estimated standard deviation corresponds to the greatest level of image detail, that is, the greater the variability in the image, the greater the level of detail. This fact is being used in the S-R method described in this article. A problem may appear here as to how to segregate image segments with near but not quite the same colour values. The reasoning in this case leads to the use of the analysis of the presence of the edges in the image. Since edge is defined as the image coordinate at which there is an abrupt change of some of the image parameters (in this case, of the colour), the image regions surrounded by edges are considered to have pixels of the sufficiently similar values for the application of the proposed S-R method.

3. METHODOLOGICAL FRAMEWORK

Based on the theoretical framework described in the previous section, by which the standard deviation of the pixel values is clearly related to the level of image details, the segmented image will be used as a skeleton of the S-R enhanced image. It is therefore necessary firstly to detect the details in the original image, and then to estimate the standard deviation separately for each of the determined image segments.

The resolution enhancement is then performed as the image reconstruction by applying the inverted form of averaging filters. E.G. a 3 by 3 pixel region of the image has pixel values noted by Y1, Y2… Y9:

Table 1. Pixel values in the observed segment of the original image

Y1	Y2	Y3
Y4	Y5	Y6
Y7	Y8	Y9

The filter for image reconstruction is then defined by applying the following filter:

Table 2. Pixel values of the observed image segment of the reconstructed image

StD(-x,x)+Y1	StD(-x,x)+Y1	StD(-x,x)+Y1
StD(-x,x)+Y1	Y1	StD(-x,x)+Y1
StD(-x,x)+Y1	StD(-x,x)+Y1	StD(-x,x)+Y1

where StD(-x, x) is the standard deviation of the pixel values in the image segment being processed.

In the neighbourhood of pixel Y1, there are pixels that, statistically, have values within range from Y1 - StD to Y1 + StD. In this way, a filter is defined, that performs an operation which is the inverse of the pixel averaging in 3 by 3 subimages. Practically, the inverse averaging filter is designed by adding randomly generated values from the interval from -StD to +StD to the neighbouring pixels to pixel Y1. Pixel Y1 is thus being surrounded by 8 new values, as it has been shown in Table 2.

E.G. if StD is 5, the values added to the neighbouring pixels are generated randomly in the interval (-5, +5). If the value of pixel Y1 is 100, then the neighbouring pixels will obtain values from the interval (95,105). These values are not necessarily uniformly distributed, but will match the pixel value distribution of the original pixels in the image. In order to reduce drastic effects that may appear by performing the filtering near the segment edges, a mild form of weighted filter is being used here [19, 20].

4. RESULTS AND DISCUSSION

The proposed S-R method has been tried on 30 digital images, and also separately on 22 image segments, for the purposes of testing the method. Some of these images have been the images of physical objects and recorded using optical and image sensing equipment, whilst others have been synthetic images that have been generated by the computer. The results of the analysis of standard deviations have been presented graphically in Fig. 2.

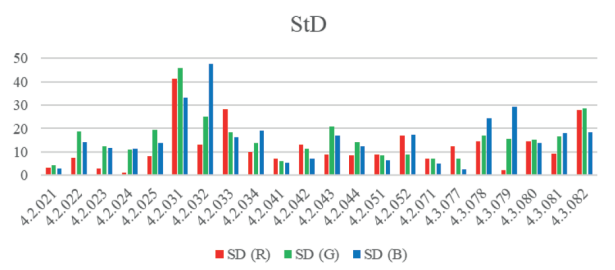


Fig. 2. Standard deviation of the image segments under investigation

Although the estimated standard deviation is not considered as a measure of image quality, it has been used as an indicator of pixel value variation of the neighbouring pixels. Here it needs to be underlined that there is not a single value of standard deviation in a segment, but there are three separate values, one for each colour channel. A justification of this approach is clearly visible in the results of standard deviation estimation for segments 4.2.32 and 4.3.079, in which there is a significant difference between the three estimates of the standard deviation. Such cases of different estimates of standard deviation in colour channels will be further compared with the estimate of the level of detail, in order to determine the quality of that digital image.

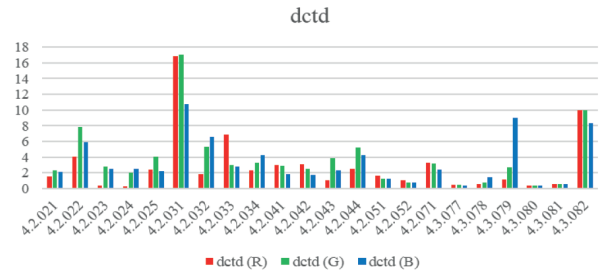


Fig. 3. Level of detail in the segments under investigation, obtained from the DCT

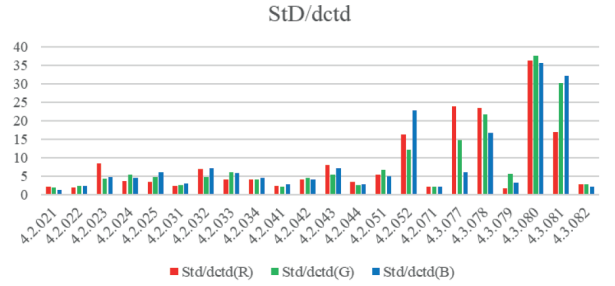


Fig. 4. Ratio between the estimated standard deviation and the level of details

As it has been shown in [18], the level of detail is not strongly correlated with the estimated standard deviation of the pixel values. Nevertheless, these two parameters show similar behaviour, except in case of images corrupted by the presence of noise. This observation is of utmost importance, as it offers a definite unique criterion as to which segments, and ultimately which images, are amenable to treatment using the S-R method described here. A convenient method for comparing these two image parameters is by computing the ratio between them. The conclusions of the observations presented in [21, 22] are further corroborated by observing the corresponding oscillations of the two parameters describing the image quality separately in each of the colour channels.

Despite the fact that the variations of these two parameters in an image segment may have high values in each of the colour channels, their ratio remains approximately constant, when the level of noise in the image is low [23]. However, as may be seen in segments 4.3.077 and 4.3.081, significant differences between these ratios indicate the existence of a high level of noise. It has been determined experimentally that the limiting level of noise for this S-R method is about 11%. In cases of images with higher level of noise, the results produced with this method deteriorate. When the level of noise is above 15%, and when the original image is of low resolution, the image resolution enhancement should be attempted by using one of the classical S-R methods, based on processing multiple images of the same scene. Inverse filtering method for image reconstruction may achieve the resolution enhancement up to three times per linear dimension, both horizontally and vertically, which has been shown in Fig. 5. Further assessment of the quality of the reconstructed image may be obtained by comparing the estimated level of details in these two images. Significant increase of the level of details in all of the segments of the reconstructed image is presented in Fig. 7. However, low level of details in images with initially low-resolution is a prohibiting condition for the presence of details in the corresponding reconstructed images. The quality of the reconstructed image when juxtaposed to the original image may be seen in Fig. 6, in which the original and the reconstructed images have been shown at the same resolution.



Fig. 5. Image reconstruction and resolution enhancement by using inverse filtering

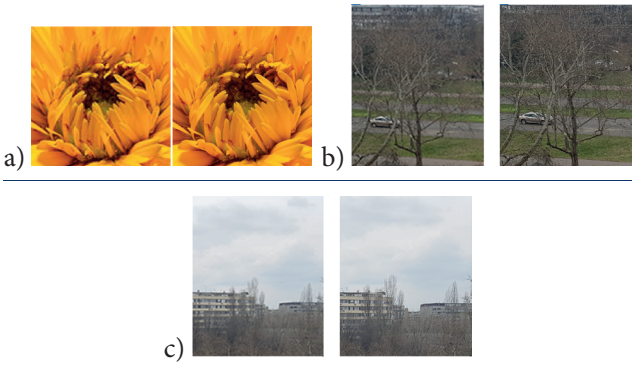


Fig. 6. Comparison of the original images and the reconstructed images with increased resolution obtained by using inverse filtering
(Note: images shown here have identical resolution)

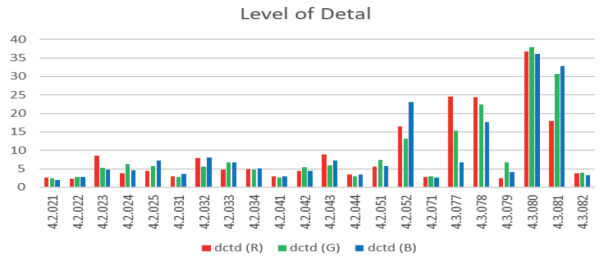


Fig. 7. Level of detail in reconstructed digital images

As has been shown in Fig. 7, relative increase of the level of detail in reconstructed images may attain high values, up to 46 % for segment 4.3.082. However, by comparing this increase with the values presented in Fig. 3. it may be observed that the increase in the level of details is the greatest in images which initially have low level of details. This is a beneficial property of the algorithm described here, as the images with a low level of details are perceived as visually most appealing. An example of this has been shown in Fig. 6. Standard deviation estimates in image segments in Fig 6b and 6c have values of up to 137, that is more than half of the available range (0-255). Therefore, each of these segments requires a different processing approach. Such high values of standard deviation are usually present in images of trees or buildings, but it is not the case with image segments with sky, or lawns, especially when these surfaces are sufficiently distant from the objective of the image recording camera.

Filtering images with typographic content, i.e. with black characters on white background, is an area of great interest in image processing. This type of images is characterised by low level of details, and by high contrast and clear transition between the objects, i.e. characters, letters, and the background i.e. the white surface (Fig. 9a). It has been considered that the images of this kind are most suitable for being processed by some of S-R methods. On the other hand, in the images with low resolution the transitions are not very clear, and a great loss of detail and contrast may be observed. Yet, it is exactly with the images of this kind that the S-R method described here attains a very high level of quality of reconstructed images. Application of the algorithm as described in section Methodological framework, i.e. with estimating standard deviation separately for each colour channel, and then generating 3 by 3 matrices with new pixel values, achieves preservation of the original information in the image. The results of comparison of the success of this method with other methods usually applied to this kind of images have been shown in Fig. 9b, 9c, and 9d, from which it is evident that visually the best reconstructed image is in Fig. 9d. It may be of interest to notice that, in this kind of images, the aim is to reduce the level of details in the image, which is achieved by increasing the sharpness of transition between the objects and the background, and which has been best achieved by the S-R method proposed in this article.

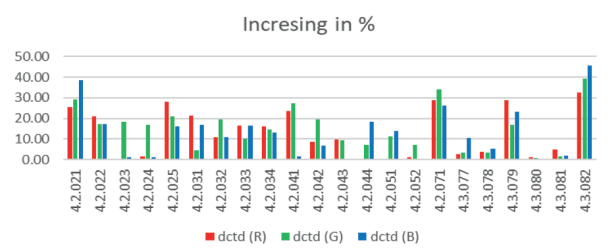


Fig. 8. Relative increase of the level of detail

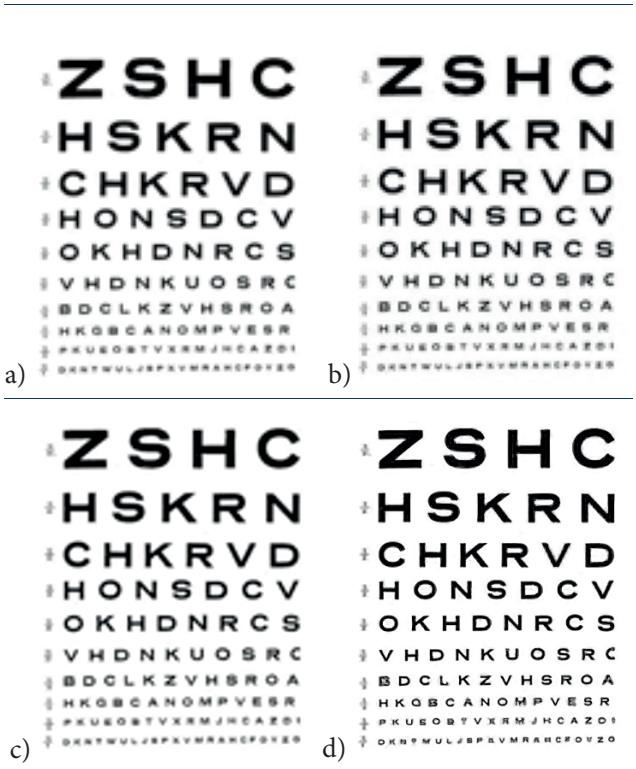


Fig. 9. Comparison of various S-R algorithms: a) original image, b) bicubic interpolation, c) Unified single-image S-R and d) Inverse filtering method

5. CONCLUSION

In this article, a novel algorithmic solution for Super-Resolution has been presented. The prominent quality of this solution is that it can reconstruct an enhanced resolution image from only one low resolution image. This solution is based on the analysis of standard deviation and on the weighted filter, and the essence of the method is the analysis of sensitivity of the neighbourhood of an image segment. The method is capable of enhancing the image resolution up to three times per dimension with respect to the original image. The results obtained on test images have demonstrated the effectiveness of the described method, and have shown that it compares favourably when compared to other S-R algorithms. This method has a wide area of application, but excellent results have been obtained by its application to the images with low level of details, such as images of human faces, images generated by computer animation, and, also, good results have been obtained by processing images with typographic content. A promising direction for future research will be in combining this algorithm with image segmentation methods, which will lead to even higher quality of reconstructed images.

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TERRESTRIAL DIGITAL RADIO SERVICES IN EUROPE

Branimir Jakšić[1,*],
Jelena Todorović[1],
Vladimir Maksimović[1],
Petar Spalević[2],
Ratko Ivković[1]

[1]Faculty of Technical Sciences,
University of Pristina,
Kosovska Mitrovica, Serbia
[2]Singidunum University,
Belgrade, Serbia

Abstract:
The paper presents an overview of terrestrial digital radio services in Europe. The first is presented the overview of the digital radio characteristics in Europe, which includes year of start experimental and regular broadcasting digital radio, the standards used for digital radio, the number of active multiplexes (national, regional and local) as well as the area coverage. After that is presented number of radio stations which emitting simulcast in the analog FM and digital DAB (DAB+) standard and number of radio stations which emitting exclusively in the DAB (DAB+) standard. In the end is presented comparison of data from 2014 and 2019 relating to the percentage of population covered by DAB/DAB+ signal, the total number of DAB and DAB+ services, services number in the DAB standard and the number of stations in the DAB+ standard.

Keywords:
Digital Audio Broadcasting, DAB, DAB+, digital radio.

1. INTRODUCTION

DAB (Digital Audio Broadcasting) is a family of digital standards for broadcasting digital audio and multimedia signals. DAB consists of DAB and DAB+ standards, which serve for digital broadcasting audio signals via radio and DMB (Digital Multimedia Broadcasting) standard, which represents the upgrade of DAB in the form of multimedia capabilities [1].

DAB began to develop in 1981, and since 2000 it has been under the authority of the independent international organization "World DAB Forum". This organization is concerned with the implementation and promotion of DAB, cooperates and coordinates with radio broadcasters, network service providers, equipment manufacturers, governments and competent state authorities.

Based on the RRC-06 (Regional Radio-communication Conference) held in Geneva in 2006 organized by the ITU (International Telecommunication Union), a new international agreement pf frequency planning for digital broadcasting radio and television programs has been established and adopted. On the basis of this agreement, a frequency plan for the realization of the digital radio was adopted, so that all European countries received the predicted frequencies for the broadcasting digital radio.

Correspondence:
Branimir Jakšić

e-mail:
branimir.jaksic@pr.ac.rs

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The transition from analog to digital broadcasting radio using DAB standards brings advantages, such as [1,2]:

- better use of the frequency spectrum (broadcasting multiple programs on one radio frequency, ie multiplex),
- broadcasting radio stations using same frequency on a large area using the Single Frequency Network (SFN);
- providing additional services,
- broader selection of radio stations, better sound quality (approximate to studio sound),
- interactivity,
- significant savings in transmission costs.

2. FEATURES AND DAB SERVICES

For the radio transmission of the DAB signal, two frequency bands are provided:

- VHF-III band, in the range of 174 - 230/240 MHz and
- L-band, in the range from 1452 to 1492 MHz, used in countries where the VHF-III band (Band III) is not yet available or as an additional distribution band, with the width of a single multiplex channel of 1.5 MHz [3].

The DAB standard is based on MPEG Audio Layer 2 coding, which is still used in broadcasting. An improved version of this encoding is MPEG Layer 3. The DAB+ standard is more efficient than the DAB standard. It uses the MPEG-4 High Efficiency AAC v2 profile (codec, known as HE-AAC v2) and it is the most efficient available audio compression scheme in the world and allows up to three times more multiplex services than the original DAB [1,4,5].

Geographical coverage area of radio services that use HE-AAC v2 is larger than the radio services that use MPEG Audio Layer 2. The multimedia information transmitted through the HE-AAC v2 radio service is much better protected against transmission errors than the radio service that use MPEG Audio Layer 3 codec. Audio bit rate range is from 32 kb/s to 384 kb/s [6,7].

Besides the basic function, the transmission of audio signals, DAB supports the following additional services:

- EPG (Electronic Program Guide) - is designed to offer similar services like TV EPG but for radio and related data transmission services.
- Slideshow - uses standard formats of Web images and standard Web publishing tools to enhance the radio program and visualize it. All standard formats such as JPEG, PNG or APNG (Animed PNG) can be broadcast by DAB without losing audio and video synchronization.
- TCM / TPEG (Traffic and Travel Information / Transport Protocol Experts Group) - was formed due to increased demand for more accurate and timely traffic and travel information) and serves to send information on traffic and roads. Regardless of the fact that the RDS / TMC (Radio Data System / Traffic Message Channel) technology has been quite successful in various European countries, it has certainly shown its limitations due to the limited RDS bandwidth. Implementation of the DAB, and later of the DMB standard offers enormous opportunities as a carrier for improved traffic and travel services, such as: traffic occasions/news, weather in traffic, driver assistance, parking information, local hazard alerts, traffic density, etc.
- Journaline, is a relatively new data transmission service, which is internationally standardized by the World DMB Forum. Basic functionality similar to electronic journal or teletext in TVs.
- Broadcast Website, serves for broadcasting Web site applications. Allows the transsmision of complete Web sites for offline use to a digital radio receiver, which should have Web browsing software. Besides to the related HTML pages, in the offer can be multimedia elements in the form of images, animated graphics, mp3 or video files.

A large percentage of radio listeners are still in cars and digital radio broadcasting industries around the world investing heavily in involving the automotive sector in their plans. Every year, WorldDAB holds annual European automotive manifestations. These events bring together distributors, manufacturers and automotive industries from different markets to share knowledge and look for the best practical solution for digital radio in cars, as well as drivers' expectations [8].

3. OVERVIEW OF THE MAIN DIGITAL RADIO CHARACTERISTICS

Table 1 shows an overview of the main digital radio characteristics in Europe that includes the year of start experimental and regular broadcasting digital radio, the

standards used for digital radio, the number of active multiplexes (national, regional and local) as well as the area coverage. Data refer to March 1, 2019. and were collected from the official websites of the national bodies responsible for the radio digitization and telecommunications regulations in [8-39].

Table 1. Overview of the main digital radio characteristics

Country	Experimental	Regular	Standard	MUX number			Coverage [%]
				N	R	L	
United Kingdom	1993	1999	DAB/DAB+	3	10	61	97.3
Norway	1995	1999	DAB/DAB+	1	7	7	99.7
Sweden	1995	2012	DAB/DAB+	1	1	-	41.8
Denmark	1995	2002	DAB/DAB+	2	-	1	98
Germany	1995	1999	DAB+	1	26	4	97
Poland	1996	2013	DAB+	-	17	6	56
Ireland	1998	2006	DAB	1	1	-	52
Belgium	1998	2012	DAB/DAB+	-	3	-	95
Spain	1998	2011	DAB/DAB+	3	-	-	20
Italy	1998	2012	DAB+	3	-	8	80
Austria	1999	2018	DAB+	-	1	-	29
Switzerland	1999	2009	DAB/DAB+	4	3	2	99.5
Netherlands	2004	2008	DAB+	2	5	-	95
Malta	2004	2006	DAB+	3	-	-	100
Slovenia	2006	2016	DAB+	1	-	-	73
Czech Republic	2007	2011	DAB+	-	1	3	62
France	2010	2015	DAB+	-	15	3	21.3
Hungary	2008	-	DAB+	1	-	-	30
Romania	2015	-	DAB	-	1	-	10.4
Slovakia	2015	-	DAB+	-	-	6	38
Croatia	2017	-	DAB+	1	-	-	70
Turkey	2017	-	DAB+	-	-	1	21.5
Ukraine	2018	-	DAB+	-	-	1	7.1
Greece	2018	-	DAB+	-	1	-	NA
Luxembourg	2018	-	DAB+	-	-	1	100
Serbia	2018	-	DAB+	-	1	-	28

[a]N - National, R- Regional, L - Local

The first tests of digital radio began in the 1990s. In some countries (Poland, Ireland, Belgium, Spain, Italy and Austria), the process from experimental to regular broadcasting included a longer time period (more than 15 years). In the last few years, some of countries that did not have digital radio services, they started broadcasting. Besides to the countries listed in Table 1, Bulgaria and Estonia occasionally experimentally broadcast digital radio services. Portugal, Bosnia and Herzegovina, North Macedonia, Montenegro, Albania, Finland, Moldova, Lithuania and Latvia are countries that do not currently broadcast digital terrestrial radio in Europe.

It is mainly applied DAB+ standard or in combination with the DAB standard. All countries that have started broadcasting in the DAB standard tend to switch to advanced DAB+. The DAB standard is currently exclusively represented in Romania and Ireland. The number and types of the multiplex are different. The most common are regional multiplexes, with the largest number of multiplexes being activated in United Kingdom, Germany, Poland and France.

The largest coverage of the population by DAB signal was achieved in Malta, Norway, Switzerland, Denmark, Germany and United Kingdom, which have almost 100% coverage of the population.

4. OVERVIEW OF DAB AND DAB+ SERVICES

Table 2 shows the number of DAB and DAB+ in European countries. The number of radio stations emitting simulcast in the analog FM and digital DAB (DAB+) standard and the number of radio stations emitting exclusively in the DAB (DAB+) standard is given [8-39].

From Table 2 it can be seen that most digital terrestrial radio station are broadcast in United Kingdom, as many as 495. Next are France, Norway, Denmark, Italy, Switzerland, which broadcast more than 100 digital radio channels. Also, it can be seen that broadcasting in the DAB standard is the most represented in United Kingdom, while other countries generally broadcast radio services in the DAB+ standard (the DAB standard is slightly or not at all included). Romania and Ireland broadcast services exclusively in the DAB system. The number of radio stations is directly related to the number of multiplexes shown in Table 1.

Table 2. Number of DAB and DAB+ services

Country	DAB			DAB+			Total DAB and DAB+
	simulcast FM and DAB	**exclusively DAB**	**Total**	**simulcast FM and DAB+**	**exclusively DAB+**	**Total**	
United Kingdom	329	158	**487**	1	7	**8**	**495**
Norway	1	1	**2**	20	193	**213**	**215**
Sweden	1	9	**10**	14	2	**16**	**26**
Denmark	7	7	**14**	11	3	**14**	**28**
Germany	-	-	-	110	40	**150**	**150**
Poland	-	-	-	21	7	**28**	**28**
Ireland	5	5	**10**	-	-	-	**10**
Belgium	12	4	**16**	11	1	**12**	**28**
Spain	18	0	**18**	1	0	**1**	**19**
Italy	-	-	-	116	20	**136**	**136**
Austria	-	-	-	4	11	**15**	**15**
Switzerland	6	9	**15**	80	41	**121**	**136**
Netherlands	-	-	-	94	18	**112**	**112**
Malta	-	-	-	53	0	**53**	**53**
Slovenia	-	-	-	14	2	**16**	**16**
Czech Republic	-	-	-	16	13	**29**	**29**
France	-	-	-	76	90	**166**	**166**
Hungary	-	-	-	7	0	**7**	**7**
Romania	5	1	**6**	-	-	-	**6**
Slovakia	-	-	-	36	21	**57**	**57**
Ukraine	-	-	-	9	5	**14**	**14**
Croatia	-	-	-	15	1	**16**	**16**
Turkey	-	-	-	8	0	**8**	**8**
Greece	-	-	-	7	0	**7**	**7**
Luxembourg	-	-	-	2	0	**2**	**2**
Serbia	-	-	-	3	0	**3**	**3**

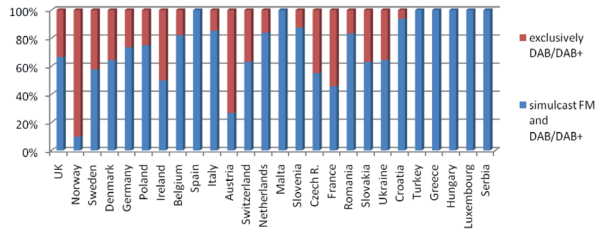


Fig. 1. Share of exclusively DAB/DAB+ and simulcast DAB/DAB+ services

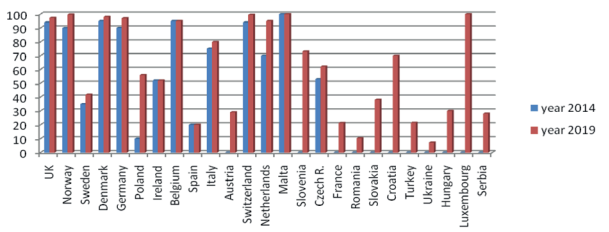


Fig. 2. DAB signals coverage in 2014 and 2019.

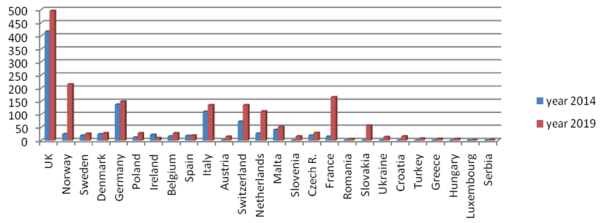


Fig. 3. Number of services (DAB and DAB+) in 2014 and 2019

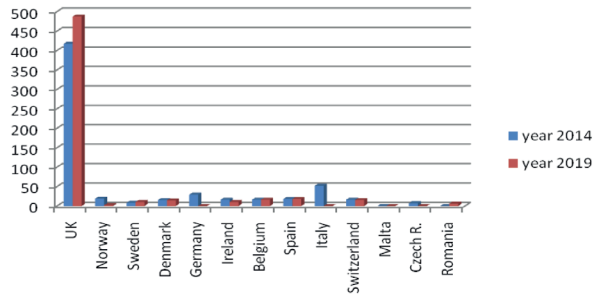


Fig. 4. Number of DAB service in 2014 and 2019

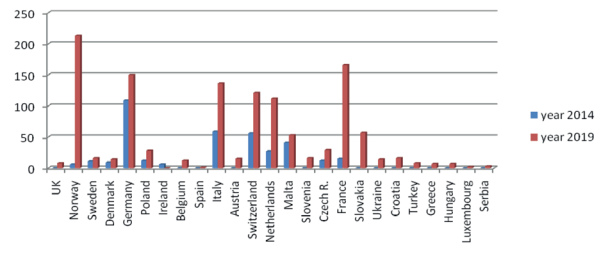


Fig. 5. Number of DAB+ service in 2014 and 2019

5. COMPARATION OF DAB AND DAB+ SERVICES

Fig. 2 shows a comparison of the % coverage of the population with the DAB/DAB+ signal at the beginning of 2014 and March 1, 2019 [8-40]. Increased coverage with digital terrestrial radio signal in all European countries is evident. The largest percentage increase in coverage is represented in countries where DAB broadcasting started in the given period.

In Fig. 3, Fig. 4 and Fig. 5, a comparison of the number of services is shown: total DAB and DAB+, only DAB and only DAB +, respectively, for 2014 and 2019. From the given figures can be seen increase of the number of digital radio services. The largest increase is in Norway, Netherlands, France and Slovakia.

From Fig. 4 it can be seen that the number of services using DAB standard has decreased in the last five years (the exception is United Kingdom), while from Fig. 5 it can be seen that in all countries there was an evident increase in the number of services in the DAB+ standard . The highest increse in the number of radio stations in the DAB + standard is in Norway, France and Slovakia. In the coming period, further increse of the more advanced DAB+ standard is expected, which will completely suppress its previous DAB version.

6. CONCLUSIONS

A large number of European countries are currently broadcasting a digital radio signal, either on a regular or experimental basis. According to the number of radio stations in digital form in front of all countries United Kingdom is leading, while in terms of coverage of the population with the digital signal at the very top are Malta, Norway, Switzerland, Denmark, Germany and United Kingdom where coverage is greater than 95%. Many countries are in transition from DAB to an upgraded DAB+ standard, which allows the broadcast up to 28 radio stations in one multiplex, as opposed to DAB which allows up to 15 radio stations. All countries have plans to expand the digital network to equalize the coverage of analog and digital radio signals. In recent years, there is increasing of radio programs that are broadcast exclusively in digital form.

The transition to digital radio broadcasting is closely linked with the transition from analogue to digital TV broadcasting, because part of the VHF-III range is designed for digital radio that is used for analog TV broadcasting

Although the advantages of digital radio lead to its popularization, for now there is not yet a specific date for completely switching off the analogue radio network, except for United Kingdom and Norway that are planning to completely switch to digital broadcasting in 2020.

ACKNOWLEDGMENT

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PRIMENA METODA VIŠEKRITERIJUMSKE ANALIZE U ODABIRU KANDIDATA ZA RAD U TURISTIČKOJ PRIVREDI

Anđelka Štilić[1, 2, *],
Angelina Njeguš[1]

[1]Singidunum University,
Belgrade, Serbia
[2]The College of Tourism,
Belgrade, Serbia

Rezime:

U ovom radu fokus je na primeni najzastupljenijih višekriterijumskih metoda odlučivanja (*Multi-Criteria Decision Making*, MCDM) u cilju rešavanja problema izbora kadrova. U okviru naučnih disciplina, kao što su Operaciona istraživanja i Teorija odlučivanja, razvijene su mnogobrojne metode i alati pomoću kojih se na validan i kvalitetan način, u mnoštvu podataka koji prate svako lice, a na osnovu višekriterijumskih zahteva koje ima poslovni subjekt, dolazi do optimalne selekcije i izbora kadrova. Jedan od takvih metoda je i MCDM metod koji ima svoje varijacije kao što su: višestruko objektivno odlučivanje (*Multi-Objective Decision Making*, MODM) i teorija višestrukih atributa (*Multi-Attribute Utility Theory*, MAUT) iz koje proističe donošenje odluke sa više atributa (*Multi-Attribute Decision Making*, MADM). Postoje razne implementacije MCDM modela kroz različite alate koji se mogu koristiti bilo pojedinačno ili kombinovati u mrežu hibridnog odlučivanja. Neki od tih alata su metod analitičkih hijerarhijskih procesa (*Analytic Hierarchical Process*, AHP), metod analitičkih mrežnih procesa (*Analytic Network Process*, ANP), metode rangiranja rezultata (npr. PROMHETEE i ELECTRE) i metode kompromisa (npr. TOPSIS i VIKOR).

Ključne reči:

Metode višekriterijumskog odlučivanja, AHP, ANP, Fuzzy teorija, selekcija kadrova.

1. UVOD

Upravljanje ljudskim resursima može se posmatrati kao strateški i koherentan pristup upravljanju najvrednijim sredstvima poslovnog subjekta – ljudima koji rade u njemu, radi ostvarenja ciljeva tog poslovnog subjekta. Pod upravljanjem ljudskim resursima ubrajaju se međusobno povezane aktivnosti od kojih su najvažnije: planiranje poslova i potrebnih ljudskih resursa, analiza poslova i poslovnog okruženja, regrutovanje potencijalnih kandidata za zapošljavanje, selekcija prijavljenih kandidata, socijalizacija novih zaposlenih, obuka i razvoj zaposlenih, upravljanje učinkom i ponašanjem, motivisanje, poštovanje zakonskih propisa iz oblasti radnog zakonodavstava, te otpuštanje – [1]. Budući da je kvalifikovano osoblje postalo jedno od neophodnih sredstava i ključni faktor uspeha za poslovne subjekte, HRM treba da utvrdi osnovne kompetencije za svako radno mesto kako bi zaposleni mogao da obavi svoj

Odgovorno lice:
Anđelka Štilić

e-pošta:
andjelka.stilic@gmail.com

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zadatak na najbolji način – [2], [3], [4]. Kako navode mnogi istraživači, proces selekcije kadrova usmeren je na izbor radnika (kandidata) s najvećim potencijalom, a na osnovu predefinisanih atributa za popunjavanje slobodnih radnih mesta – [5], [6]. Kvalifikovani izbor osoblja je glavni cilj procesa selekcije kadrova.

Problem izbora osoblja izuzetno je složen i multidimenzionalni problem koji zavisi od ljudskog suda, kognitivnih procesa, višestrukih i različitih atributa kao što su: promene u radnom okruženju, promene u radnom zakonodavstvu, promene u društvu, promene u marketingu i sve ovo utiče na selekciju i regrutovanje (novo) zaposlenih – [4], [7]. Usled složenosti, važnu ulogu u rešavanju problema izbora osoblja imaju novi analitički normativni metodi za razliku od ranije prakse koja je obilovala predrasudama pri donošenju takvih odluka.

2. IZBOR KADROVA KAO DEO TEORIJE ODLUČIVANJA

Višekriterijumska analiza (u izboru kandidata za rad u turističkoj privredi) pripada interdisciplinarnoj teoriji odlučivanja. Postoje različite klasifikacije teorija odlučivanja, a jedna od najčešće primenjivanih opisuje ih kao: deskriptivne, normativne i preskriptivne. Višekriterijumska analiza ima pre svega normativni pristup, ali su prisutni i deskriptivni i preskriptivni, čime rezultati njenog delovanja obogaćuju sve tri grane teorije odlučivanja.

Proces donošenja odluka interdisciplinarnog je karaktera, a teorijska izučavanja ove oblasti protežu se na nekoliko naučnih disciplina, kao što su matematika, statistika, operaciona istraživanja, ekonomija, psihologija i sociologija.

Odlučivanje predstavlja spregnut sistem koji čine: donosilac (donosioci) odluke, kriterijumi na osnovu kojih se donosi odluka, preferencijal tih kriterijuma i, na kraju, skup alternativa koji su zapravo informacije do kojih se došlo različitim vrstama obrade i analize izvornih podataka. Već na početku može se uočiti da odluku može donositi jedan ili više ljudi, da broj kriterijuma varira od jednog do prebrojivo mnogo, da se preferencijali razlikuju kada je u pitanju grupa donosilaca odluke, kao i da se razlikuje broj alternativa koje se uzimaju u razmatranje. Da bi se uopšte govorilo o odlučivanju, neophodno je imati bar dve alternative i mogućnost (mehanizam) da se napravi izbor između njih.

Personalni kriterijum je mentalni merni instrument i pripada zoni racionalnog, na osnovu kojeg procenjujemo neke karakteristike samog sebe, drugog bića, predmeta ili pojave u najširem smislu reči. On je baziran na sistemu vrednosti, ali sam po sebi to nije. Takođe se može razmatrati kao potreban i dovoljan skup svojstava koje ono što se procenjuje (treba da) poseduje kako bi se kvalifikovalo u dva osnovna stanja: zadovoljava ili ne zadovoljava, ili skalu stanja između ta dva. Na kriterijum se mogu primeniti atributi kao što su: strog, površan, nedovršen, ispravan... ali je to onda rezultat novog mentalnog merenja – ovog puta samog kriterijuma, tačnije to bi bili kriterijumi o kriterijumu. Jedna ista osoba ne poseduje uvek iste kriterijume za procenu (istog) posmatranog, niti posmatrano može u vremenskom intervalu biti istovetno. Posmatrano (procenjivano) i kriterijum (procene) utiču jedno na drugo. Svako novo uviđeno svojstvo posmatranog, može umnogome da redizajnira sam kriterijum procene, ali na redizajn utiču, pre svega, ukupni mentalni procesi procenitelja, kao što su nova znanja, društveni kontekst, uticaj marketinga... ali i psihički procesi, kao sto su stanje motivacije, usredsređenosti...

Za razliku od personalnog kriterijuma, postoje i tzv. objektivni kriterijumi. Objektivni kriterijum je norma, a norme su definisale ekspertske grupe kao naučna pravila izražena kroz postulate, tabele, skale..., kako bi proces ocenjivanja bio lišen subjektivne komponente, sem ako donosilac odluke zaobilazi propisane norme. A da li je ovde subjektivnost ukinuta? Nije nužno, samo je smanjena jer se novim naučnim saznanjima stvaraju nove norme, ali ne postoji obaveza da se stare izbrišu i zanemare, te će se kod donosioca odluke pojaviti izbor – koju od normi da primeni, dakle, subjektivnim odlučivanjem će izabrati određeni objektivni kriterijum ili skup kriterijuma, što proces vraća na nivo subjektivnosti.

Kada u procesu odlučivanja imamo više donosilaca odluka, lakše će se doći do zajedničke liste kriterijuma nego do zajedničkih preferencija. Otuda i kategorija težinskih faktora, kao i metoda na osnovu kojih se kod grupnog odlučivanja omogućava da se uzmu u obzir sve pojedinačne preferencije. Kod kompenzacionih metoda se, pri određivanju težine kriterijuma, u obzir uzima celokupan raspon važnosti (uticaja) svakog pojedinačnog kriterijuma. Dobijene težine nemaju apsolutno značenje i ne odražavaju generalne vrednosti, već samo preference i prioritete u odnosu na razmatrane varijante. Suprotno tome, u nekompenzacionim metodama prikazuju se globalne vrednosti važnosti kriterijuma.

Da bi se simulirala realnost i ponašanje donosilaca odluka, treba definisati pragove veta za svakog pojedinačnog donosioca odluka. U outranking metodama, prag veta ukazuje na situacije kada je razlika između dve

alternative, u odnosu na jedan određeni kriterijum, takva da tu alternativu suspenduje bez obzira na njen status u odnosu na ostale kriterijume. Ili, preciznije, kada postoji alternativa koja je po jednom kriterijumu znatno lošija u odnosu na drugu alternativu, ona je ne može nadmašiti bez obzira na njen učinak po osnovu drugih kriterijuma. U tom smislu, veto izražava mogućnost svakog donosioca odluka da negira izbor neke alternative kao rešenja, ako je ta alternativa ispod praga veta za odgovarajući postavljeni kriterijum [8].

Što se tiče kriterijuma za izbor zaposlenih u turističkom menadžmentu, u svojim istraživanjima [9] u evaluaciji koriste 107 kriterijuma koji se mogu svrstati u sledeće kategorije: 1) komunikacija, 2) upravljanje efikasnošću, 3) samostalno donošenje odluka, 4) liderstvo, 5) interpersonalno upravljanje, 6) međunarodna komunikacija i 7) upravljanje konfliktima. Kada je, međutim, reč o menadžerima koji rade u prodaji, kriterijumi su nešto drugačiji: 1) komunikacione veštine, 2) liderske veštine, 3) fleksibilnost, 4) odlučnost, 5) veštine pregovaranja, 6) analitičke veštine i 7) doslednost. Pomoću VASPAS metode, a na osnovu mišljenja tri eksperta, određeni su težinski faktori za svaku kategoriju: 1) komunikacione veštine – 0,23; 2) liderske veštine – 0,19; 3) fleksibilnost – 0,17; 4) odlučnost – 0,13; 5) veštine pregovaranja – 0,13; 6) analitičke veštine – 0,08 i 7) doslednost – 0,06 (Urosević et al, 2017).

Referenca [10] navodi sledeće kriterijume za izbor menadžera u oblasti turizma: energija, pokretljivost, samopouzdanje, originalnost i kreativnost, komunikacijske veštine i sposobnost postavljanja i praćenja ciljeva. Skorašnje zanimljivo istraživanje pokazalo je karakteristike menadžera koji nemaju uspeha u svom poslu ili funkcijama: nepristojnost, odsustvo empatije, arogantno ponašanje, neiskrenost, prevelika ambicioznost, pogrešno tumačenje problema, nemogućnost delegiranja odgovornosti, nesposobnost timskog rada, nesposobnost strateškog mišljenja, sebičnost. S druge strane, dobro znanje i informisanost pružaju sigurnost u radu, ali i čine menadžera privlačnim. Sveukupni izgled, ponašanje, dobri maniri, način govora, elokventnost... sve to doprinosi uspešnosti menadžera u javnosti. Istinski lideri su visoko motivisani ljudi sa težnjom ka postizanju uspeha, ambiciozni, snažni i originalni. Oni veruju u svoje lične vrednosti, sposobni su da prihvate, obrade i interpretiraju ogromne količine podataka. Sposobni su da se prilagode različitim ličnostima i situacijama, a takođe žele da uspeju kao lideri.

3. METODI VIŠEKRITERIJUMSKE ANALIZE

Analitički hijerarhijski proces (AHP) jeste jedan od najpopularnijih klasičnih MADM metoda čiji je arhitekt i primarni teoretičar THOMAS L. SAATY – T. L. Saaty (1980), profesor na Univerzitetu u Pitsburgu i predavač u postdiplomskoj školi Joseph M. Katz. Ovaj metod je moćan logičan pristup rešavanju složenih različitih vrsta odluka sa višestrukim kriterijumima. U AHP metodu, kompleksan problem se razlaže na nekoliko da bi se izgradila jednosmerna hijerarhija struktura koja pokazuje odnose između cilja, kriterijuma, podkriterijuma i alternativa. Glavni proces AHP je formiranje parova za poređenja kako bi njihov rezultat bio sumiran u „matricu uparivanja“. Za svaki par atributa, donosilac odluke određuje presudu o tome „koliko je važniji jedan atribut od drugih“. Upoređuju se parovi da bi se izračunala težina kardinalnog značaja atributa donosioca odluka – [11]. Da bi se zaposlilo medicinsko osoblje u opštoj bolnici u Ujedinjenim nacijama, [12] – predložili su metod grupne sistemske podrške (GDSS) u kojem su kombinovani AHP i Delphi principi. U studiji slučaja – [13] – korišćen je metod AHP za rešavanje problema procene osoblja, kako bi se odabrao dekan fakulteta u Univerzitetu Teksas A&M, u Sjedinjenim Američkim Državama. Korišćenjem AHP metoda utvrđene su težina kriterijuma i rejting kandidata. Odbor, kao donosilac odluka, identifikovao je četiri kriterijuma: objavljeni radovi, iskustvo u administrativnom poslu, iskustvo vezano za rukovodeći položaj i dokazane sposobnosti za obezbeđivanje sredstava, a značaj (težina) kriterijuma je utvrđen paralelnim poređenjem članova odbora.

Metod SAW se naziva i metodom ponderisane sume (VSM). SAW je najjednostavniji metod u kojem se svakom atributu daje težina i zbir svih težina mora biti jedan. Svaka alternativa se ocenjuje uzimajući u obzir svaki kriterijum. Zatim se kao rezultat dobija izabrana alternativa. Reference [14] sugerišu jednostavni pristup za ponderisanje radi rešavanje problema izbora osoblja. Oni su razmotrili sedam kriterijuma pri izboru jednog zaposlenog od njih pet i rangirali ih. Predloženi metod ilustruje studija slučaja u Telekomunikacionom sektoru u IRAN-u.

Analitički mrežni proces ANP jedan je od najnovijih metoda za višekriterijumsko odlučivanje. To je proces koji omogućava da se uključe svi faktori i kriterijumi koji utiču na donošenje najbolje odluke. ANP je koristan alat za predviđanje i prikazivanje uticaja različitih kriterijuma, s njihovim pretpostavljenim interakcijama i njihovim relativnim težinama na donošenja odluke.

Reference [15] predložili su za odabir osoblja korišćenje ANP metode, uključujući i međuzavisnost između kriterijuma. Model mreže je primenjen da bi se utvrdila težina faktora koji se koriste u problemu rešavanja izbora osoblja. Tim je odredio faktore prihvatljive kao kriterijume za selekciju osoblja, a ovi kriterijumi su odvojeni u tri glavne grupe faktora: kvalitativni faktori (kao što je samopouzdanje), faktori nula-jedan (kao što je vozačka dozvola) i kvantitativni faktori (dosadašnja iskustva).

TOPSIS metod (*Technique for Order Preference by Similarity to Ideal Solution*) zasniva se na konceptu da odabrana alternativa treba da ima najkraću udaljenost od pozitivnog idealnog rešenja i najdužu udaljenost od negativnog idealnog rešenja. Optimalna alternativa je ona koja je u geometrijskom smislu najbliža idealnom pozitivnom rešenju, odnosno najudaljenija od idealnog negativnog rešenja – [16]. Smatra se da je najveći nedostatak ovog metoda određivanje idealnih tačaka – [17]. Taj nedostatak rešava modifikovani TOPSIS metod. Reference [18] razvio je pristup zasnovan na TOPSIS metodi za istraživanje i razvoj (R&D) izbora osoblja u neizvesnom okruženju pomoću GREY teorije. Prvo, on je opisao rejting alternativa i odredio težinu kriterijuma po jezičkim varijablama koje mogu biti izražene u intervalima GREY brojeva. Onda su identifikovali relativnu bliskost (neku vrstu najmanjeg zajedničkog sadržaoca) kako bi se omogućilo poređenje svih alternativa izračunavanjem pomoću GREY relacione ocene (GRG) svake alternative. Oni su razmotrili osam kriterijuma koje bi trebalo da zadovolje kandidati za zaposlenje i koji su bili relevantni za istraživanje problema izbora. To su bili: radna sposobnost, obrazovanje, obuka za posao, radno iskustvo, nivo zvanja, starost, inovativnost i lojalnost.

PROMETHEE je metod delimičnog, odnosno parcijalnog rangiranja alternativa. Ovaj metod je višekriterijumska tehnika odlučivanja i razvili su ga Brans i Vincke i Mareschall – [19]. Dobro je prilagođen problemima u kojima se nalazi konačan broj alternativa i omogućava da se rangiraju iako postoji više, često konfliktnih kriterijuma – [20]. Reference [21] predstavljaju fleksibilni metod na osnovu različitih informacija o proceni (kvalitativnim i kvantitativnim) u cilju rešavanja problema izbora osoblja putem višestruke lingvističke PROMETHEE. Koristili su dvostepene lingvističke vrednosti za izražavanje kvalitativnih informacija i jasnu numeričku vrednost za izražavanje kvantitativnih informacija. Rešavanje problema izbora inostranog marketing menadžera primenom lingvističke PROMETHEE ilustrovana je izračunavanjem indeksa svake alternative i određivanjem redosleda kandidata.

Teoriju fuzzy skupova je 1965. godine postavio L. A. Zadeh u cilju boljeg tretmana kompleksnih sistema i formulisanja ljudskih aktivnosti u matematičkim okvirima. Iako se inicijalna primena fuzzy logike prvenstveno odnosila na oblasti automatizacije i industrijske kontrole, danas se sve veći broj fuzzy aplikacija koristi za rešavanje specifičnih problema u ekonomiji i menadžmentu i HRM-u. Koncept fuzzy brojeva je nastao posle pojma fuzzy skupa, a veliki doprinos razvoju i primeni ovog koncepta dali su: [22] i [23]. U skladu sa svojom namenom, fuzzy brojevi predstavljaju fizički svet znatno realističnije nego „obični" brojevi. Naime, subjektivna procena HR menadžera, kao npr. „troškovi evaluacije znanja ili sticanja posebnih komunikacionih veština... su oko 5.000" nije okarakterisana tačno određenom brojnom vrednošću. Brojevi tipa: „oko 100", „blizu 20.000" , „ne više od 10.000" mogu se predstaviti fuzzy skupovima koji se pod određenim uslovima i nakon određenih logičkih operacija tretiraju kao fuzzy brojevi. Osnovna prednost kvantifikacije faktora koji se odnose na HRM korišćenjem fuzzy analitičkih metoda, u odnosu na uobičajene kvantitativne pristupe, jeste u tome što fuzzy brojevi imaju mogućnost boljeg i adekvatnijeg opisa i lakšeg operisanja sa nejasnim i nepreciznim informacijama koje su u ovoj oblasti česte. Naime, u radu gde su prisutni neodređenost, višeznačnost, nejasnoća i nepreciznost koji karakterišu stanja i relacije faktora koji se odnose na HR, fuzzy logika predstavlja veoma pogodan i pouzdan matematički instrument. Takođe, za razliku od skala procena iz najčešće korišćenih metoda procene koje su stepenovane, u fuzzy modelu to nije slučaj već se može uzeti bilo koju vrednost iz definisanog (zadatog) intervala čime se bolje opisuje realno stanje. Postignuta je i potrebna osetljivost modela kao mernog instrumenta, jer je na osnovu dobijenih rezultata moguće ustanoviti manje razlike u mernoj pojavi.

GREY relacionu analizu metoda razvio je Deng, J. (1989) kao deo teorije GREY sistema. GRAY relaciona analiza je pogodna za rešavanje mnogih problema sa nepoznanicama koje uključuju diskretne podatke i nepotpune informacije, probleme iz oblasti optimizacije i višekriterijumske probleme. GREY relaciona analiza je do sada bila primenjivana za rešavanje najrazličitijih problema poput: rangiranja strategija rudarskog turizma – [24] ili za izbor dobavljača – [25]. Reference [26] predložili su GREY analitički mrežni proces (GANP) za rešavanje problema izbora osoblja koji je fokusiran na selekciju u neizvesno okruženje. Oni su, koristeći GANP, odredili procenu težine kriterijuma. U odnosu na GANP, suprotno konvencionalnom ANP-u, koristili

su GREY brojeve za formiranje matrica za upoređivanje. Lingvističke varijable su se koristile za opisivanje rejtinga atributa, a GREY broj za nijansiranje vrednosti. Takođe su predstavili mogućnost stepenovanja, poređenja i rangiranja GREY brojeva sa ciljem izbora najidealnije alternative. S numeričkim primerom za izbor osoblja, oni u svom radu ilustruju upotrebu sugerisane procedure.

Referenca [27] predlaže Fuzzy integrisani multifazni model evaluacije (FIMEM) sa višestrukim kriterijumima za poboljšanje izvršenja postupka izbora akademskog osoblja u pomorstvu. Predložena metodologija se sastoji od Fuzzy AHP, Fuzzy TOPSIS i SWOT analize. Fuzzy AHP se primenjuje za dodeljivanje težinskih faktora relevantnim atributima, a Fuzzy TOPSIS se primjenjuje za rangiranje i odabir alternativa. Dat je i primer za regrutovanje višeg predavača u instituciji za MET da bi se ilustrovao predloženi FIMEM pristup, a SWOT analiza je korišćena kako bi se omogućio kontinuirani razvoj dodeljenog akademskog osoblja. Kreator SWOT analize je A. S. Humphrey, a ime je dobila po početnim slovima četiri engleske reči koje opisuju njene principe: *Strengths, Weaknesses, Opportunities* i *Threats* (snage, slabosti, mogućnosti i opasnosti). SWOT analiza – [28] – krajnje je efikasan alat za sagledavanje, razumevanje i donošenje odluka u najrazličitijim situacijama u radu kompanije ili organizacije. SWOT analizom može da se sagleda sadašnji trenutak jednog privrednog subjekta, sa akcentom na prednostima kao i na slabostima, te da se napravi strategija zaobilaženja prediktovanih prepreka kako bi bili ostvareni planirani ciljevi u budućnosti. Na osnovu SWOT analize, menadžeri mogu da preciznije sagledaju ne samo sopstvenu organizaciju nego i njeno sadejstvo sa privrednim i društveno-političkim okruženjem, čime se targetiraju moguće pretnje, ali i moguće komparativne prednosti ili prednosti same po sebi. Na ovaj način se otvara mogućnost strateškog planiranja koje se bazira na SWOT principima – postići najveći uspeh maksimizacijom sopstvenih kapaciteta i potencijala, a istovremeno pravovremeno projektovanim akcijama reagovati na potencijalne opasnosti i minimizirati slabosti i gubitke. Sama suština je u permanentnoj analizi sva četiri SWOT elementa (snaga, slabost, mogućnost i opasnost) na relaciji privredni subjekt – okruženje i prilagođavanju strategije rezultatima te analize.

4. ZAKLJUČAK

Iako je problem sa selekcijom osoblja veoma stari, još uvek privlači interes mnogih praktičara i istraživača. Zbog nedovoljne tačnosti rezultata konvencionalnih tehnika kao što su intervjui ili testovi za zaposlenje, neki istraživači su se fokusirali na primenu metoda višekriterijumskog odlučivanja MCDM, metoda rangiranja rezultata kao što su PROMHETEE i ELECTRE, metode kompromisa kao što su TOPSIS i VIKOR, razvoj ekspertskih sistema, SWOT analizu koje se bave strategijom izbora i evaluacije kadrova. Neodređenost i nedovoljno poznati podaci prilikom formiranja kriterijuma za izbor, rešavaju se teorijum Fuzzy skupova ili Grey analizom.

Reference [29] ističu da postoji pozitivna povezanost između upravljanja ljudskim resursima i uspešnosti poslovanja. Iako se većina studija zasniva na presecima podataka, a samo nekoliko njih koristi kao metod panel ili longitudinalne skupove podataka, u ovom radu autori koriste tehnike meta-analize za procenu efekta odnosa između visokih performansi radne prakse HPVP i mere učinka zasnovane na dostupnim longitudinalnim studijama. Takođe se ispituje da li je povećan efekat kada je u pitanju kombinacija različitih HPVP-ova ili kod konkretne pojedinačne HPVP, a prati se dejstvo i na operativne performanse a ne samo finansijske. Rezultati pokazuju da set integrisanih HPVP-a koji se međusobno osnažuju ima jači uticaj na performanse preduzeća nego što je to slučaj kod pojedinačnih HRM praksi i da je ovaj efekat statistički invarijantan u odnosu na operativne i finansijske performanse firme.

Koristeći meta-analizu kako bi se smanjio uticaj greške u uzorkovanju i merenju, nalazi ove studije potvrđuju tvrdnje da HPVP pozitivno utiče na poslovanje firmi i, što je još važnije, nudi naučnicima osnovnu da koristeći longitudinalne studije dobiju predikciju povećanja performansi. Međutim, imajući u vidu ograničen broj postojećih longitudinalnih studija i poteškoće povezane sa neeksperimentalnim naučnim pristupom, istaživsnje uzročnih veza između praksi upravljanja ljudskim resursima performansi, i dalje ostaje izazov.

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MERENJE PARAMETARA I TESTIRANJE PERFORMANSI MODELA OTN MREŽE

Miloš Krstić[1],
Marina Marjanović[2,] *

[1]Vojska Srbije,
Beograd, Srbija
[2]Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Savremen način života korisnicima pruža nove telekomunikacione servise i usluge, što uslovljava njihove konstantne zahteve prema telekomunikacionim provajderima da obezbede sve veće informacione kapacitete. Ovaj zahtev nameće pitanje kako obezbediti veće kapacitete i brzine prenosa u uslovima ograničenog propusnog opsega postojećih optičkih transportnih mreža? Rešenje je primena OTN tehnologije u transportnim mrežama, a performanse ove tehnologije sagledane su kroz merenja karakterističnih parametra na optičkoj mreži kao i na testiranju mogućnosti OTN platformi.

U ovom radu, prikazani su rezultati merenja uradjenih u kompaniji „IRITEL" prilikom testiranja multiservisnih platformi baziranih na OTN/DWDM tehnologiji. Posebna pažnja data je na ugrađenom FEC mehanizmu koji obezbeđuje kvalitetan prenos siganala u uslovima velikog slabljenja, narušenog odnosa signal/šum ili izrazitog uticaja svih vrsta disperzija duž optičkog vlakna.

Ključne reči:

OTN/DWDM tehnologija, uređaj OTP10G IRITEL, merenje parametara (optičke snage, OSNR i disperzija) i testiranje performansi optičke transportne mreže.

1. UVOD

Povećanje brzine telekomunikacionog saobraćaja i povećanje kapaciteta prenosa stalni su zahtevi koji se postavljaju pred savremenim telekomunikacionim mrežama. Da bi se obezbedili ovi zahtevi potrebno je što efikasnije i fleksibilnije iskorišćenje postojećih resursa propusnog opsega i transportnih kapaciteta telekomunikacionih mreža.

Veoma brz razvoj telekomunikacija koji se desio krajem XX i početkom XXI veka rezultat je želja i potreba korisnika za pružanjem novih usluga i servisa sa malim kašnjenjem. Telekomunikacione mreže koje omogućavaju ove usluge, servise kao i dinamičko okruženje nazivaju se i širokopojasne mreže, a tehnologija prenosa naziva se "broadband" tehnologija.

Osnovni nosilac navedenog dinamičkog okruženja predstavljaju multiservisne optičke platforme. Multiservisne optičke platforme obezbeđuju bitske protoke do 10 Gbit/s po kanalu i kapacitete prenosa do 80 kanala, na rastojanjima koja prevazilaze nekoliko stotina kilometara, a uz to imaju i varijabilan propusni opseg u zavisnosti od potreba prenosa.

Odgovorno lice:
Marina Marjanović

e-pošta:
mmarjanovic@singidunum.ac.rs

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Multiservisne optičke platforme bazirane na OTN (Optical Transport Network) i DWDM (Dense Wavelength Division Multiplexing) tehnologiji obezbeđuju proširenje i nadogradnju postojećih optičkih transportnih mreža, baziranih na SDH (*Synchronous Digital Hierarchy*) tehnologiji, bez potrebe za infrastrukturnim ulaganjima koja se odnose na postavljanje novih optičkih kablova, jer je takva invensticija neekonomična sa gledišta telekomunikacionog provajdera.

U delu I ovog rada opisane su pojave degradacije signala pri velikim brzinama prenosa. U delu II, opisane su DWDM tehnologije, u delu III opisane su transportne mreže bazirane na OTN tehnologiji. Deo IV opisuje Multiservisnu platformu OTP10G IRITEL. U delu V, prikazani su rezultati merenja kao što su: merenje parametara i testiranje performansi OTN mreže, merenje optičke snage na trasi, raspodela OSNR duž optičke trase. Takodje, prikazana su merenja bitskih grešaka pri pojavama potkompenzacije/prekompenzacije uticaja hromatske disperzije.

2. POJAVE DEGRADACIJE SIGNALA PRI VELIKIM BRZINAMA PRENOSA

Osnovna komponenta svake optičke transporte mreže je optičko vlakno. Sa stanovišta prenosa kapaciteta njegove teoretske mogućnosti su beskonačne. Međutim povećanje kapaciteta uslovljava i povećanje brzine prenosa, ali povećanje brzine prenosa praćeno je pojavom degradacije signala usled nelinearnih efekata i intenzivnog uticaja disperzije, kako hromatske (CD) tako i disperzije polarizacionih modova (PMD) duž optičkog vlakna.

Ovi efekti degradacije signala su naročito izraženi pri brzinama prenosa većim od 2,5 Gbit/s i imaju kompleksne međusobne interakcije, a samim time i posledice koje se ne mogu zanemariti, jer direktno utiču na brzine prenosa i razdaljine na kojima se signal može preneti.

Efekat četvorotalasnog mešanja je nelinearna pojava koja takođe ima izrazit uticaj na prenos velikih protoka kroz optička vlakna. Ovaj efekat ograničava kapacitete kanala u optičkim transportnim sistemima i on se ne može ukloniti ni električnim ni optičkim filtrima, a raste sa porastom dužine optičkog vlakna.

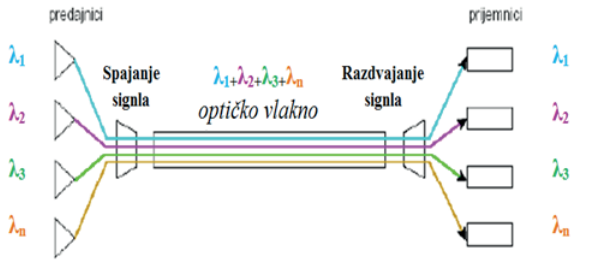
U prenosu signala sa protokom od 10 Gbit/s disperzija je važan ograničavajući faktor, često strožiji i od slabljenja. Hromatska disperzija može se predvideti i teoretski proračunati, a njen uticaj se može kompenzovati dodavanjem jedinica za kompenzaciju (DCM) na liniji.

Za razliku od hromatske disperzije, disperzija polarizacionih modova (PMD) je nepredvidiva, jer je statističke prirode, promenljivog je karaktera i vezana je za uslove sredine (npr. temperaturu, vibracije, naprezanje i razne vrste opterećenja) u kojoj se nalazi optičko vlakno, tako da može da dostigne velike vrednosti koje se ne mogu kompenzovati. Kada je na optičkoj linji izrazito velika PMD, telekomunikacioni provajderi imaju dve mogućnosti ili da ne koriste to optičko vlakno ili da ga jednostavno zamene, što često nije ekonomski isplatljivo.

3. DWDM TEHNOLOGIJA

Ključ napredka u pogledu prenosa velikih kapaciteta i brzina u optičkim transportnim mrežama donela je WDM tehnologija koja je omogućila da se u isto vreme više različitih optičkih signala na različitim talasnim dužinama prenose preko jednog optičkog vlakna, tako da više nije bilo potreba za menjanjem postojeće infrastrukture optičkih vlakana.

Multipleksiranje talasnih dužina WDM (*Wavelength Division Multiplexing*) predstavlja tehnologiju koja omogućuje da se u isto vreme više različitih optičkih signala na različitim talasnim dužinama prenose preko jednog optičkog vlakna. Svaki od signala koji se prenosi u WDM sistemu može biti sinhroni/asinhroni digitalni signal ili analogni signal, koji se može prenositi nezavisno od ostalih signala, bez obzira na njegovu strukturu. Princip multipleksiranja talasnih dužina u WDM sistemima ilustrovan je na slici 1.



Slika 1. Princip multipleksiranja talasnih dužina

Unapređenje ove tehnologije doneli su DWDM sistemi kojima je obezbeđena potpuna transparentnost u pogledu različitih brzina i formata signala koji se prenose, a zahvaljujući pre svega čisto optičkim funkcijama osnovnih komponenti ovog sistema.

4. TRANSPORTNE MREŽE BAZIRANE NA OTN TEHNOLOGIJI

Danas je OTN dominantna tehnologija u transportnim optičkim mrežama u kojima se vrši prenos signala velikog bitskog protoka kroz optičke mreže bazirane na DWDM. OTN tehnologija je definisana ITU-T G.872 preporukom [1] koja propisuje njenu arhitekturu, dok su struktura rama i multipleksiranje SDH, Ethernet i drugih signala definisani prema ITU-T G.709/Y.1331 preporuci.[2] Drugim rečima OTN tehnologija obezbeđuje standardni protokol nove generacije koji omogućava efikasan i prihvatljiv način multipleksiranja različitih servisa u signal koji je prilagođen transparentnom prenosu kroz optički spojni put.

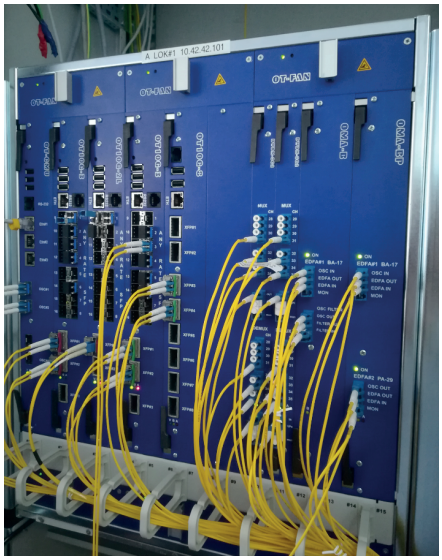
OTN tehnologiju karakteriše prilagođenost WDM mrežama, čime se postiže povećanje ukupnog kapaciteta linka, dok se povećanje dometa postiže korišćenjem zaštitnih kodova sa mogućnošću ispravljanja grešaka FEC (*Forward Error Correction*) mehanizma. Pozitivne karakteristike OTN tehnologije je i skalabilnost (osnovna granularnost od 1.25 Gbit/s) i transparentni prenos klijentskih signala, uključujući i transparetni prenos SDH signala sa očuvanim transportnim zaglavljem. Pored agregacije postojećeg SDH saobraćaja OTN platforma omogućava i prenos Ethernet paketskog saobraćaja u optičkom domenu.

Glavni ciljevi koji se postižu primenom OTN/DWDM tehnologije u transportnim platformama su kvalitet i pouzdanost (pružanje zahtevanog visokog nivoa servisa), skalabilnost (obezbeđivanje fleksibilnosti kapaciteta prenosa), prilagodljivost (razvijanje novih servisa, a da se pri tome ne ugrozi pružanje i kvalitet postojećih servisa) i upravljivost (obezbeđenje jedinstvenog funkcionisanja servisa i aplikacija, čime se telekomunikacionom provajderu omogućava efikasno upravljanje mrežom).

5. MULTISERVISNA PLATFORMA OTP10G IRITEL

OTP10G kompanije „IRITEL“ iz Beograda, predstavlja multiservisnu optičku transportnu platformu zasnovanu na OTN/DWDM tehnologiji, koja omogućava transport, mapiranje i multipleksiranje svih tipova korisničkih signala od 100 Mbit/s do 10 Gbit/s u jedinstveni linijski signal za prenos po optičkim vlaknima. Platforma podržava mapiranje i prenos: OTN, SDH, NG-SDH (*Next Generation SDH*), Ethernet (FE, GbE, 10GbE), SAN (*Storage Area Network*) i CBR (*Constant Bit Rate*) klijentskih signala.[3]

Platforma podržava DWDM optičko multipleksiranje saobraćaja po talasnim dužinama, odnosno prenos do 80 optičkih kanala po jednom paru optičkih vlakana sa mogućnošću odgranjavanja/dodavanja u čvorovima mreže. Ugrađeni optički pojačavači omogućavaju povećanje maksimalne dužine optičkih deonica, a time i ukupnog dometa. Funkcionalnost platfome ogleda se u spajanju OTN, standarne SDH, NG-SDH i Ethernet tehnologije u jedinstveni uređaj OTP10G koji je prikazan na slici 2.



Slika 2. Uređaj OTP10G u radu

Osnovne jedinice uređaja OTP10G su:

- Kontrolno upravljačka jedinica **OT-CMU**, namenjena je za monitoring svih alarma, konfigurisanje sistema, kontrolisanje softvera, nadzor performansi OTN i DWDM modula i nadgledanje sistema.
- Transponderska i muksponderska jedinica **OT-10G**, ima funkcije transpondera, muksponderа, prospajanja i zaštite saobraćaja. Ona obezbeđuje veliki broj linijskih i klijenskih interfejsa različitih brzina i protokola. Protokoli na svim interfejsima su OTN, SDH, Ethernet i bit transparentni protokoli.
- **10G XFP** optički primopredajnici - moduli, podržavaju sve bitske brzine od 9,95 do 11,3 Gbit/s.
- Optičke EDFA pojačavačke jedinice **OMA**, koje služe za pojačanje optičkog DWDM signala, a u zavisnosti od tipa pojačavača.

- **DWDM-8C2** - jedinica za de/multipleksiranje optičkih signala po talasnim dužinama.
- **DCM-DxDy** – jedinica za kompenzaciju hromatske disperzije, koje eliminišu uticaj hromatske disperzije na optičkim vlaknima na daljinama od 20, 40, 60, 80, 100 i 120 km.

Upravljanje i nadzor uređaja OTP10G u OTN mrežama vrši se softverom *"SUNCE + modul za OTN"*, koji omogućava i praćenje ispravnosti rada mreže, kvaliteta i pouzdanosti servisa, kao i promenu kapaciteta mreže.

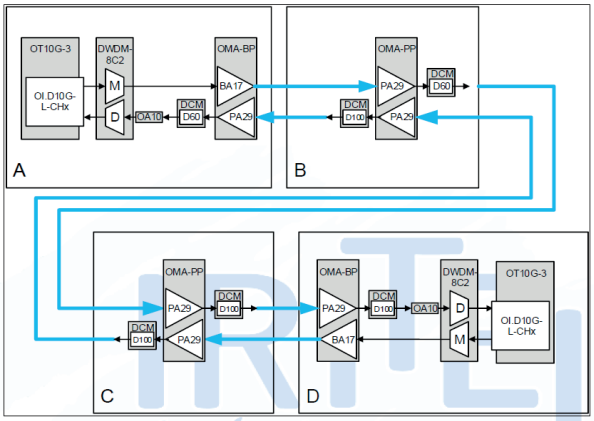
6. MERENJE PARAMETARA I TESTIRANJE PERFORMANSI MODELA OTN MREŽE

Sagledavanje uticaja negativnih faktora koji se javljaju pri prenosu signala velikih bitskih brzina kroz optičko vlakno i principi delovanja ugrađenih mehanizama kojima se eliminišu uticaji navedenih faktora, glavni je cilj ovih merenja.

Performanse mreže su sagledane kroz merenja vrednosti optičke snage i OSNR u referentnim tačkama na trasi (na izlazu primopredajnika, na izlazu MUX/DMUX, na izlazima pojačavača i na ulazu u prijemnik) u uslovima pojave veštački izazvanog slabljenja ili pojave disperzije. Poseban akcenat je dat na praćenju rada FEC mehanizma i njegovoj sposobnosti da omogući kvalitetan prenos signala u uslovima velikog slabljenja, narušenog OSNR ili izrazitog uticaja svih vrsta disperzija na optičkom vlaknu.

Realizovana su merenja optičke snage i OSNR duž optičke trase, merenja bitske greške (BER) pri prenosu SDH i Ethernet signala kroz optičku trasu sa i bez primene FEC mehanizma, merenja minimalnih vrednosti optičke snage i OSNR pri kojima je moguć prenos signala na optičkoj trasi, merenja vrednosti "džitera" pri prenosu SDH signala kroz OTN mreže i testiranje sistema pri pojavi potkompenzacije i prekompenzacije hromatske disperzije.

Za merenje i prikaz performansi korišćen je model optičke transportne mreže sa uređajima OTP10G kompanije „IRITEL" baziranim na OTN/DWDM tehnologiji. Optička trasa (A-B-C-D) se sastoji od tri optičke deonice: prva deonica A-B dužine 60 km, druga deonica B-C dužine 100 km i treća deonica C-D dužine 100 km. Ukupna dužina optičke trase u predajnom smeru je 260 km, a takođe tolika je i dužina drugog para optičkih vlakana u prijemnom smeru. Blok šema optičke trase na kojoj su izvršena merenja data je na slici 3.



Slika 3 Blok šema modela optičke trase

Klijentski SDH (*STM-4 i STM-16*) i Ethernet (*FE i GE*) signali dovode se na odgovarajuće SFP module odnosno na ulaze prvog uređaja OTP10G, a pomoću softvera "SUNCE+" vrši se mapiranje pritočnih signala i to STM-4 i FE u ODU0 strukturu, STM-16 u ODU1 strukturu i GE u ODU2e strukturu. Nakon izvršenog mapiranja STM-4/16 i FE signala i dodavanja odgovarajućih zaglavlja formira se 32-gi optički kanal (na talasnoj dužini 1551,72 nm i frekvenciji 193,20 GHz) i 35-ti optički kanal sa mapiranim GE signalom (na talasnoj dužini 1549,32 nm i frekvenciji 193,50 GHz).

Preko XFP modula OI.D10G-L-CHx prvog uređaja ova dva kanala se vode na ulaze jedinice za multipleksiranje DWDM-8C2, gde se multileksiraju u jedinstveni linijski DWDM signal koji se vodi na prvi optički pojačavač BA-17, gde se signal pojačava (lokacija A na trasi), a zatim se šalje na prvu optičku deonicu dužine 60 km.

Na kraju prve optičke deonice (lokacija B na trasi) nalazi se prvi predpojačavač PA-29 gde se signal pojačava i preko jedinice za kompenzaciju hromatske jedinice DCM60, vodi se na drugu optičku deonicu dužine 100 km. Na njenom kraju (lokacija C na trasi) nalazi se drugi predpojačavač PA-29 gde se ponovo pojačava oslabljen optički signal i vrši se ponovo kompenzacija jedinicom DCM100, a zatim se signal vodi na treću optičku deonicu dužine 100 km.

Na kraju treće optičke deonice (lokacija D trase) nalazi se treći optički predpojačavač PA-29 i preko jedinice za kompenzaciju hromatske disperzije DCM100 signal se preko optičkog atenuatora vodi na jedinicu za demultipleksiranje DWDM8C2 gde se vrši ponovno razdvajanje 32-og i 35-og kanala, a zatim se oba kanala vode na prijemnike odnosno XFP module.

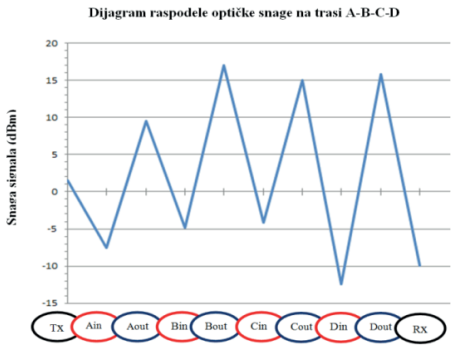
Isti postupak obrade signala vrši se i u smeru od lokacije D, preko lokacija C i B do lokacije A po drugom paru optičkih vlakana takođe dužine 260 km. U modelu optičke trase korišćeno je optičko vlakno tipa G.652D [4], a elementi optičke trase dati su na slici 4.

Локација	смер ↓	смер ↑
A	XFP OI.D10G-L-CHx(Tx) DWDM-8C2(mux) OMA-BP (BA17)	XFP OI.D10G-L-CHx(Rx) DWDM-8C2(demux) DCM(D60) OMA-BP (PA29)
оптичко влакно [km]	60	60
B	OMA-PP (PA29) DCM(D60)	DCM(D100) OMA-PP (PA29)
оптичко влакно [km]	100	100
C	OMA-PP (PA29) DCM(D100)	DCM(D100) OMA-PP (PA29)
оптичко влакно [km]	100	100
D	OMA-BP (PA29) DCM(D100) DWDM-8C2(demux) XFP OI.D10G-L-CHx(Rx)	OMA-BP (BA17) DWDM-8C2(mux) XFP OI.D10G-L-CHx(Tx)

Slika 4. Elementi optičke trase

Merenje optičke snage

Cilj merenja je izmeriti optičku snagu signala u referentnim tačkama na trasi i to: na izlazu iz XFP modula prvog uređaja (T_x), na ulazu/izlazu pojačavača BA-17 (A_{in}/A_{out}), na ulazu/izlazu svakog predpojačavača PA-29 na trasi (B_{in}/B_{out}, C_{in}/C_{out}, D_{in}/D_{out}) i na ulazu XFP prijemnika drugog uređaja (R_x). Merenja se vrše pomoću softvera „SUNCE+“, a izmerene vrednosti su predstavljne na dijagramu raspodele optičke snage na trasi A-B-C-D slika 5.



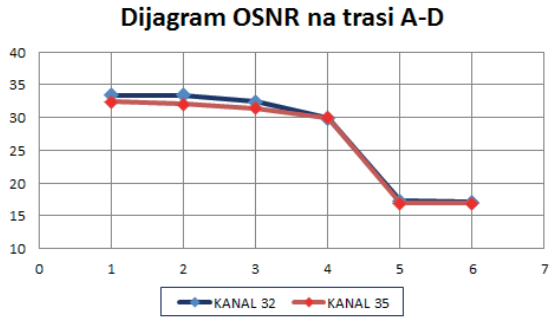
Slika 5. Dijagram raspodele optičke snage

Izmerena snaga na prijemu oba kanala u referentnoj tački (R_x) iznosi -10,73 dBm odnosno -9,24 dBm, što odgovara propisanom tehničkom zahtevu od strane kompanije „IRITEL“ (u rasponu od -7 dBm do -22 dBm).

Raspodela OSNR duž optičke trase

Cilj merenja je izmeriti odnos signal/šum (OSNR) u referentnim tačkama na trasi i to: na izlazu iz MUX i pojačavač BA-17 prvog uređaja, na izlazu svakog od 3 predpojačavača PA-29 na trasi i na izlazu iz DMUX drugog uređaja.

Merenja se vrše pomoću optičkog spektralnog analizatora EXFO FTB-500.[5] Izmerene vrednosti predstavljene su na dijagramu raspodele OSNR na trasi A-D slika 6.



Slika 6. Dijagram OSNR na trasi

Izmerene vrednosti OSNR oba kanala u tački 6 (DMUX) iznose 17,10 dBm odnosno 16,92 dBm, što odgovara propisanom tehničkom zahtevu IRITELA da iste budu veće od 16 dBm.

Analizirajući dobijene vrednosti OSNR za svaki kanal i posmatrajući dijagram možemo videti kako vrednost OSNR opada sa povećanjem dužine optičke trase. Smanjenje OSNR duž linka do njegove minimalne vrednosti koju mogu da podnesu prijemnici, određuju minimalnu početnu snagu koju mora da ima svaki kanal da bi se garantovale određene performanse sistema.

Testiranje graničnih vrednosti optičkih pojačavača na trasi

Cilj testiranja je utvrditi minimalne granične vrednosti signala pri kojima će sistem funkcionisati i pri kojima će biti očuvan zahtevan nivo OSNR.

Na ulaz svakog predpojačavača PA-29 dovodi se optički signal, a pomoću ateunatora vrši se slabljenje snage signala (čime se veštački simulira pojava velikog slabljenja na optičkoj trasi). Ovim se obezbeđuje da na svim ulazima predpojačavača PA-29 snaga bude približno – 27 dB, što predstavlja graničnu vrednost rada ovih pojačavača, odnosno pojačavač ne može da vrši svoju funkciju zbog velikog slabljenja ulaznog signala.

Merenje izlazne optičke snage signala na sva tri predpojačavača PA-29, vršimo pomoću softvera „SUNCE+". Navedenim softverom vršimo dodavanje ili oduzimanje određenog nivoa slabljenja na ulaze u predpojačavače PA-29, a na instrumentu EXFO FTB-500 posmatramo nivo odnosa signal/šum (OSNR) za svaki kanal posebno.

Uz približno isti nivo izlazne snage signala iz sva tri predpojačavača (5,30/5,34/5,42 dBm) obezbeđuje se da odnos signal/šum (OSNR) po svakom kanalu (32-om i 35-om) na celoj optičkoj trasi bude veći od 16 dBm, što predstavlja graničnu vrednost OSNR i tehnički zahtev u IRITEL-ovim optičkim sistemima, a izmerene vrednosti date su u tabeli 1.

Tabela 1. Izmerene vrednosti izlazne snage i osnr

Pojačavači PA-29 *(deonica)*	Ulazna snaga signala *(dBm)*	Slabljenje atenuatora *(dB)*	Ulazna snaga signala u pojačavač *(dBm)*	Izlazna snaga signala iz pojačavača *(dBm)*	Izmerena vrednost OSNR *(dBm)* za	
					32.kan.	35.kan
I pojačavač deonica A-B	-17,54	9,92	-27,46	5,30	24,89	24,86
pojačavač deonica B-C	-25,28	1,59	-26,87	5,34	17,10	16,92
III pojačavač deonica C-D	-20,10	7,03	-27,13	5,42	17,24	16,88

Merenje bitskih grešaka pri pojavama potkompenzacije i prekompenzacije hromatske disperzije

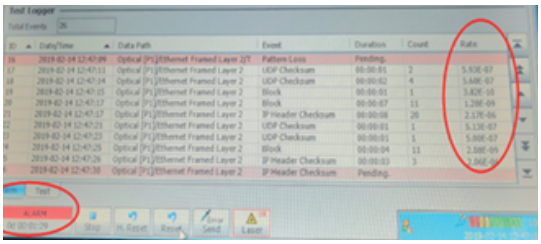
Ova merenja treba da pokažu princip delovanja ugrađenog FEC mehanizma u uređajima OTP10G, a koji obezbeđuje prenos kroz optičku trasu u slučajevima pojave potkompenzacije i prekompenzacije hromatske disperzije.

U funkcionisanju već opisanog modela optičke trase pomoću jedinica DCM vrši se kompenzacija uticaja hromatske disperzije na optički signal pri prenosu. U uređajim OTP10G su postavljenje ploče sa jedinicama za kompenzaciju i to DCM60 za kompenzaciju na deonici A-B, jedinica DCM100 za kompenzaciju na deonici B-C i jedinica DCM100 za kompenzaciju na deonici C-D.

a) Uticaj podkompenzacije na pojavu bitskih grešaka

Podkompenzaciju (povećanje vrednosti hromatske disperzije) simuliramo tako što iz uređaja OTP10G izvlačimo ploču sa jedinicom DCM60, a na instrumentu FTB-500 posmatramo vrednosti bitskih grešaka. U ovom slučaju sistem nastavlja da funkcioniše i nema pojave bitskih grešaka pri prenosu GE signala i pored toga što je FEC mehanizam isključen. Funkcionisanje sistema bez pojave BER se objašnjava time da sam XFP primopredajnik OI.D10G-L-CHx svojim karakteristikama može da toleriše uticaj hromatske disperzije u opsegu od -500 do 1600 ps/nm.

Nakon toga iz sistema se izvlači i ploča sa jedinicom DCM100 (dodatno se simulira povećanje uticaja hromatske dispezije). U ovom slučaju dolazi do povećanja bitske greške pri prenosu GE signala, što je prikazani na slici 7.



Slika 7. Pojava bitskih grešaka usled povećanja uticaja hromatske disperzije

Sama jedinica DCM100 vrši kompenzaciju hromatske disperzije u vrednosti oko 1700 ps/nm. U sledećem koraku uključujemo FEC mehanizam i sistem nastavlja da radi bez pojave bitskih grešaka. Ovo pokazuje praktični doprinos ugrađenog FEC mehanizma u eleminaciji bitskih grešaka pri prenosu signala kroz optičke mreže.

b) Uticaj prekompenzacije na pojavu bitskih greškaka

Podrazumeva da se povećava broj jedinica za kompenzaciju hromatske disperzije u sistemu, što takođe kao i podkompenzacija može da utiče na pojavu bitskih grešaka pri prenosu GE signala.

U prvom koraku pored već postojeće jedinice DCM60 u uređaju OTP10G dodajemo još jednu ploču sa jedinicom DCM60 i posmatra se prenos GE signala bez uključenog FEC mehanizma. U ovoj situaciji javljaju se bitske greške u prenosu GE signala, slično kao što je već prikazano na slici 7. U drugom koraku uključujemo FEC mehanizam i sistem ponovo uspostavalja prenos GE signala bez bitskih grešaka.

Merenje „džitera" pri prenosu SDH signala kroz OTN mrežu

Ova merenja treba da pokažu mogućnosti OTN uređaja da umanje vrednosti izlaznog "džitera" pri prenosu STM-4 signala kroz OTN mrežu u odnosu na isti taj prenos kroz SDH mrežu.

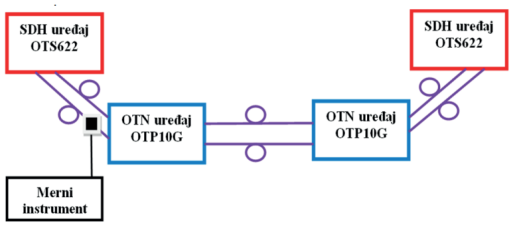
U prvom koraku koristimo dva SDH uređaja OTS622 IRITEL (multiservisna platforma bazirana na SDH tehnologiji sa bitskim protokom na linijskoj strani od 622 Mbit/s) [6] povezana sa dva optička vlakna (jedno za predaju, drugo za prijem).

Na prvom uređaju OTS622 dovodimo klijentski STM-4 signal iz generatora SDH signala, a na drugom uređaju OTS622 postavljanjem "petlje" vraćamo STM-4 signal po drugom optičkom vlaknu i instrumentom (ANRITSU MP-1590B Network Performance Tester) [7] merimo vrednosti izlaznog "džitera" signala STM-4, kao što je prikazano na slici 8.



Slika 8. Merenje izlaznog "džitera" STM-4 pri prenosu kroz SDH mrežu

U drugom koraku STM-4 signal dovodimo najpre na prvi uređaj OTS622, a zatim njegov linijski signal uvodimo kao klijentski signal u prvi OTN uređaj. Po jednom paru optičkih vlakana dužine 260 km signal se vodi na drugi OTN uređaj, a sa njega na drugi uređaj OTS622, gde se ponovo zatvara "petlja" za STM-4 signal, koji se sad vraća u suprotnom smeru po drugom paru optičkih vlakana. Preko "splitera" povezujemo instrument MP1590B i merimo vrednosti izlaznog „džitera", što je i prikazano na slici 9, a izmerene vrednosti date su u tabeli br. 2.



Slika 9 .Merenje džitera pri prenosu kroz OTN mrežu

Tabela 2. Izmerene vrednosti džitera pri prenosu stm-4

Signal	Primenjeni FILTRI *(frek.opseg)*	Dozvoljena vrednost **džitera** (UI_{pp}) u frekventnom opsegu	Izmerene vrednosti džitera (UI) u frekv.opsegu pri prenosu SDH-SDH	Izmerene vrednosti džitera (UI) u frek.opsegu pri prenosu SDH-OTN-OTN-SDH
STM4	**NP1-LP** *(1 KHz-5 MHz)*	1.5 UI*	oppm 0.364 UI (pri -10 ppm je 0,319 UI) (pri +10 ppm je 0,313 UI)	oppm 0.006 UI (pri −10 ppm je 0,05 UI) (pri +10 ppm je 0,06 UI)
	NP2-LP *(250KHz-5 MHz)*	0,15 UI	oppm 0.02 UI (pri −10 ppm je 0,023 UI) (pri + 10 ppm je 0,025 UI)	oppm 0.001 UI (pri −10 ppm je 0,02 UI) (pri+10ppm je 0,001 UI)
* Napomena: Prema ITU propisu G.825, za STM-4 1 UI = 1,61 ns				
Izmerene vrednosti džitera pri prenosu kroz OTN mrežu su znatno niže (0,006 UI i 0,001 UI) nego pri prenosu kroz SDH mrežu (0,364 UI i 0,02 UI), što potvrđuje izneti cilj na početku ovog merenja.				

7. ZAKLJUČAK

Svu superiornost OTN tehnologije mogli smo sagledati prilikom merenja i testiranja performasni na modelu optičke transportne mreže sa uređajima OTP10G, iz kojih smo mogli videti kako ugrađeni FEC mehanizam obezbeđuje zahtevani kvalitet prenosa u pogledu BER-a i OSNR u uslovima povećanog slabljenja na trasi i u uslovima pojave hromatske disperzije. Takođe merenjem vrednosti „džitera" mogli smo videti da je on značajno manji u OTN mrežama u odnosu na SDH mreže.

Integracija OTN/DWDN tehnologija u multiservisne optičke transportne platforme uz primenu čisto optičkih komponenti mreže (optičkih prekidača, „add-drop" multipleksera i "cross-conecta" na nivou talasnih dužina), uz primenu direktnih optičkih interfejsa i uz primenu novih servisa baziranih na QoS (stalni kvalitet usluga) omogućuje integraciju optičkih mreža različitih tehnologija u jednu tehničko-tehnološku celinu koja pruža transparentnost protoka i podržava primenu novih dinamičkih optičkih servisa.

Dalji pravci razvoja mreža baziranih na OTN/DWDM tehnologiji vode do sveoptičkih mreža (*All Optical Network*) u kojima se vrši prospajanje talasnih dužina GMPLS (*Generalized MPLS*) i koje se baziraju na komutaciji u fotonskom sloju. GMPLS vrši usmeravanje saobraćaja kroz optičku transportnu mrežu kreiranjem zajedničkog plana kontrole između IP-a i optičkog sloja, čime se obezbeđuje fleksibilna promena opsega u zavisnosti od potreba. Ove tehnologije neminovno će omogućiti prerastanje sadašnjih optičkih transportnih mreža u fotonske komunikacione mreže, odnosno mreže budućnosti.

ZAHVALNOST

Ističemo posebnu zahvalnost stručnim licima iz Sektora optičkih prenosnih sistema kompanije „IRITEL“ na pomoći i konstruktivnim savetima pri realizaciji merenja i testiranja performansi modela OTN mreže.

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MODEL POVEZIVANJA TELEVIZIJSKIH STUDIJA I MOBILNA UKLJUČENJA KORIŠĆENJEM RTP/TCP PROTOKOLA

Mirko Milošević[1],
Vladimir Maksimović[2,*],
Mile Petrović[2],
Branimir Jakšić[2],
Petar Spalević[3]

[1]Visoka škola elektrotehnike i računarstva,
Beograd, Srbija
[2]Fakultet tehničkih nauka,
Univerzitet u Prištini,
Kosovska Mitrovica, Srbija
[3]Univerzitet Singidunum,
Beograd, Srbija

Rezime:
U radu je prikazan jedan model za povezivanje više televizijskih studija i uključenja ekipe sa terena korišećnjem različitih protokola. Ovaj model je implementiran na Fakultetu tehničkih nauka u Kosovskoj Mitrovici. Strimovanje se vrši na serveru koji se nalazi u televiziji na kome je instalirana Wowza platforma i koja sadrži aplikacije za svaki studio sa kojim se vrši razmena i sa ekipom sa terena. Za strimovanje sa terena koristi se mobilni telefon gde se strimovanje obavlja pomoću 3G/4G mreže. Obzirom na to da je korisćenje mobilnih telefona veliko i da se koriste za razne vrste poslova, tako je i gledanje televizije na mobilnim telefonom postao neizbežni trend, sve više postoje aplikacije i softverska rešenja koje taj proces olakšavaju. Kako se prenos oslanja na internet vezu, strim je transkodovan u tri različite rezolucije i pri različitim bitskim protocima. U radu je prikazana ostvarena konekcija i analizirani paketi za sve tri rezolucije, odnosno grafički je prikazan broj paketa u jednoj sekundi za posmatrani određeni interval, kao i broj izgubljenih paketa.

Ključne reči:
striming, protokoli, digitalno emitovanje, mobilni prenos, televizija.

1. UVOD

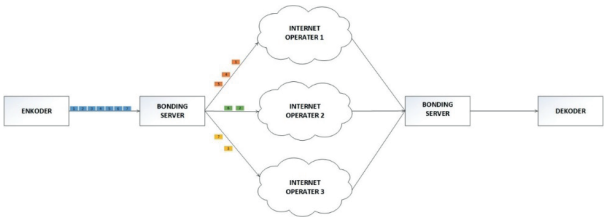
Internet je u mnogome doprineo razvoju tehnologija, pa je danas komunikacija moguća sa velikim brzinama prenosa. Razvojem interenta doveo je do znatne evolucije u televizijskim sistemima, naročito u delu kada je u pitanju uživo prenos sa terena. Na ovaj nčin je televizijskim stanicama koje nemaju budžet kao one "velike" televizijske kuće, omogućen prenos sa terena. Razvojem pametnih mobilnih telefona i njihovom dominacijom na tržistu, prenos uživo sa terena postao je jos dostupniji i jeftinij. Ako se uzme u obzir i činjenica da danas pametni mobilni telefon ima svaki građanin onda je i svako sa pametnim mobilnim telefonom potencijalni "enkoder" sa terena. Obzirom na veliki razvoj mobilnih mreža i njihovog pouzdanog prenosa, u televizijskim sistemima koriste se GSM liknovi za direktna uključenja putem interneta koji rad baziraju na Bonding tehnologiji, odnosno Bonding serverima koji se zasnivaju na principu obeležavanja paketa i slanje paketa po najoptimalnijim putanjama, kao što je prikazano na Sl. 1 [1,2].

Odgovorno lice:
Vladimir Maksimović

e-pošta:
vladimir.maksimovic@pr.ac.rs

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Međutim, jednostavniji i jeftiniji pricip ostvarivanja komunikacije sa terena i studija, korišćenjem 3G/4G mreže ili Ethernet mreže, kao što je pomenuto, realizuje se pametnim mobilnim telefonm. Na Fakultetu tehničkih nauka u Prištini sa privremenim sedištem u Kosovskoj Mitrovici nalazi se televizijski studio koji opremljen tehnikom koja može da ispuni sve produkcijske i postprodukcijske zahteve. Pored kreiranja sadržaja programa, ostvarane je fizička veza sa lokalnim kablovskim distributerom, a distribucija programa preko IP veze. U redu je predstavljen striming sistem koji koristi različite protokole uz odgovarajući hardver i softver koji je već implementiran na ovom fakultetu. U pomenutoj televiziji nalazi se server na kome je instalirama Wowza platforma koja omgućuje vezu i razmenu sadržaja sa drugim televizijama ali i mogućnost za uživo uključenja mobilnim telefonom korišćenjem protokola za strimovanje.



Sl. 1. Princip rada bonding servera

U Sekciji 1 dat je pregled korišćenih protokola za strimovanje, princip rada Wowza platforme, kao i šema implementirane veze sa ostalim televizijskim stanicama i uključivanje uživo sa terena korišćenjem mobilnih telefona. U Sekciji 2 prikazana je implementacija modela koji je realizovan u televiziji na Fakultetu tehničkih nauka. U Sekciji 3 prikazani su testovi i analize prilikom povezivanja drugih studija i prilikom uživo uključenja sa terena.

2. STRIMING PROTOKOLI

Striming (streaming) je termin koji označava emitovanje sadržaja preko Interneta krajnjem korisniku. Materijali koji su pripremljeni za striming se startuju automatski i ne zadržavaju se na računaru korisnika. Kvalitet emitovanog digitalnog programa najviše zavisi od kvaliteta Internet konekcije korisnika. Da bi se prenos realizovao koriste se različiti protokoli kao što su TCP (Transsmision Control Protocol) i UDP (User Datagram Protocol), što zavisi od načina željenog prenosa i opreme koja se koristi [3,4].

TCP protokol koji je najčešće korišćen protokol na internetu. Na početku konekcije uspostavlja se konekcija (vrši se rukovanje) između predajnika i prijemnika i predajnik je u svakom trenutku upoznat sa stanjem prijemnika. TCP radi sa Internet Prtokolom (IP – Internet Protocol), koji definiše kako će se paketi poslati između ostvarene konekcije. TCP uspostavlja vezu i održava sve dok prijemna i predajna strana ne razmene poruke tj. pakete. Određuje kako podatke poslati u pakete, odnosno u koja mreža može primiti pakete, upravlja kontrolom protoka. Namenjen je za prenos podataka bez greške, odnosno radi retransmisiju propalih paketa kao i potvrdu da su isti stigli. Na primer, kada server šalje HTML (Hypertext Markup Language) podatak do klijenta, on koristi HTTP (The Hypertext Transfer Protocol) protkol. HTTP traži dozvolu od TCP sloja da bi uspostavio konekciju i poslao fajl. TCP nakon toga deli podataka na pakete, broji i nakon toga ih prosleđuje IP sloju. TCP sloj na strain kijenta čeka sve dok svi paketi ne stiku, nakon toga šalje potvrdu da su paketi stigli i traži retransmisiju samo onih paketa koji nisu stigli. Nakon toga, sklapa sve pakete u jedan fajl i dostavlja klijentu. Retransmisija i promena redosleda paketa može dovesti do latencija u TCP strimu. Aplikacije koje su vremenski osetljive, kao što su VoIP (Voice over Internet Protocol) i strimovanje video signala, uglavnom se oslanjaju na UDP pretokol, koji znatno smanjuje latenciju i dziter [5].

UDP je protokol za prenos signala i osnovna karakteristika je “konekcija bez povezivanja” - predajnik nema informaciju o stanju na prijemu. Bez obzira da li je predajnik u stanju da primi i dekoduje pakete ili je došlo do zagušenja i prijemnik ne može da dekoduje signal - enkoder šalje pakete jer nema povratnu informaciju. Kada se pošalju podaci, nema načina da se sazna da li su stigli ili da li su stigli redosledom kojim su poslati. Međutim, podaci koji stižu, stižu brzo sto je bitno za neke vrste servisa tj. aplikacija kojima je brzina važnija od pouzdanosti isporuke podataka (npr. realtime audio i video). Zbog toga se veoma često koriste u takvim mrežama gde je bitno da veza postoji iako će biti gubitaka paketa. Međutim, u nekim slučajevima može se koristiti napredna tehnika korekcija greške kako bi se poboljšao kvalitet audia i videa. U drugim aplikacijama, mogu se implementirati testovi pouzdanosti u aplikacionom sloju. Na primer, ako klijent pošalje kratak UDP zahtev serveru, može pretpostaviti da je paket izgubljen ako ne dobije odgovor u dogovorenom periodu. To je jedan način na koji funkcioniše DNS (Domain Name Server). DNS takođe može raditi i preko TCP [6].

Postoji nekoliko slučajeva kada je bolje koristiti UDP umesto TCP protokola, kada je blok podataka koji treba poslati mali, veličine jednog paketa – jednostavnije je, brže i efikasnije prenositi samo podatke (uz zaglavlje UDP-a), pa u slučaju pogrešno primljene poruke ponoviti slanje, nego uspostavljati vezu i proveravati pouzdanost prenosa [7].

Prilikom stimovanja, u zavisnosti od aplikacije koja se želi primeniti, odnosno od projektovanog sistema i željenog načina prenosa koriste se i takozvani "protokoli za strimovanje" koji se baziraju na TCP i UDP protokolima, kao što su RTP (Real Time Protocol), RTSP (Real Time Streaming Protocol), RTMP (Real Time Messaging Protocol) i HLS (HTTP Live Streaming) [8].

RTP i RTSP su dva sasvim različita protokola koja se obično koriste zajedno. Iako se često pominje samo jedan obično se misli na oba protokola tj. RTP/RTSP (RTP može raditi bez RTSP). RTSP koristi za kontrolu i uspostavljanje sesije između predajne i prijemne strane. RTSP radi preko TCP a RTP se šalje preko UDP (video i audio se šalju preko par UDP portova). Ovo predstavlja dobru pogodnost ali je problematično kada se šalje preko javnih mreža, u tom slučaju se zahteva više portoava. RTP ima zadatak da šalje podatke u realnom vremenu, kao što je u ovom radu uživo uključenja i povezivanje više studija, odnosno transportni protokol iskorišćen za strimovanje putem internet protokola. RTP portokol može efikasno rešiti problem kašnjenja u mreži na štetu kvaliteta i može rešiti sinhronizaciju podataka različitih strimova. Enkodovanje podatak (audio i video) enkapsulirano je u RTP pakete, zaglavlje paketa pruža informaciju o rednom broju paketa pri čemu prijemnik može reorganizovati podatke paketa ali RTP ne može pružati pouzdan mehanizam za prenos paketa u sekvencu, niti pruža kontrolu protoka. Kontrola protoka se oslanja i zavisi od RTCP (Real Time Control Protocol) protokola [8,9].

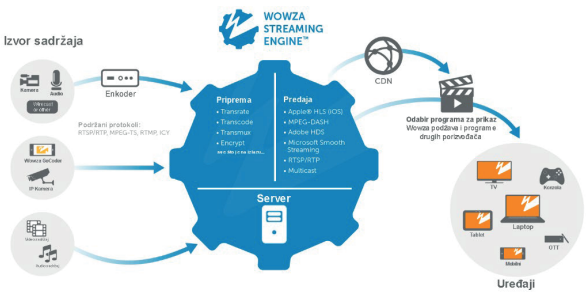
Razvojem i rastopm popularnosti Flash tehnike na internetu, za strimovanje se veoma često koristi RTMP (Real Time Message Protocol) porotkol. RTMP koristi TCP protokol na transportnom nivou što efikasno rešava problem gubitka paketa. RTMP je baziran na TCP protkolu za strimovanje audia, videa i podataka putem internet korišćenjem [10-12].

Još jedan od često korišćenih protokola za strimovanje jeste HLS (HTTP Live Streaming) protkol, koji je razvijen od strane Apple kompanije i baziran je na HTTP protokolu. Usmeren je uglavnom ka mobilnim uređajima zasnovanim na iOS operativnom sistemu kao što su iPhone, iPad, AppleTV ili personalnim računarima sa Apple-ovim operativnim sistemima. Karakteristika je kašnjenje od nekoliko sekundi ali veoma stabilana veza. Princip rada je da se preuzme jedan deo multimedijalnog sadržaja i uvek preuzme sledeći deo sadžaja pre nego što počne reprodukciju trenutnog dela. HLS se koristi za sisteme gde kašnjenje nije značajan faktor, ali polako ovaj standard počinje da se implementira u svim vodećim CDN (Content Delivery Network) serverima [13,14].

Mnogi današnji sistemi za strimovanje, počevši od onih kompleksnijih i skupljih do onih jednostavnijih i jeftinijih koriste se ovi protokoli za strimovanje. Takođe, koriste ih i popularni sistemi kao što su YouTube, Ustream, Twitch, Wowza itd. U imlementiranom sistemu na Fakultetu tehničkih nauka, na serveru je instaliran Wowza Streaming Engine [15].

Wowza Streaming Engine (poznat i kao Wowza Media Server) je striming server softver razvijen od strane Wowza Media Sistems. Server se koristi za uživo strimovanje (Live straming) i strimovanje na zahtev (VOD – Video on Demand) [16].

Za strimovanje je moguće koristiti kako hardverske enkodere, tako i softverske aplikacije instalirane na desktop, laptop, tablet računarima, smart telefonima a moguće je strimovanje i sa enkodera koji su fabrički ugrađeni u ENG (Electronic News Gathering) kamerama. Pomoću servera na kome se nalazi Wowza Engine, može se u isto vreme primati strimovi a u isto vreme i slati. Moguće je vezu bazirati i na TCP protokolu ali i na UDP. Za strimovanje koristi i podržava veliki broj striming protokola kao što su gore pomenuti a koji će biti korišćeni u ovom radu. Princip rada servera sa Wowza Streaming Engine prikazan je na Sl. 2 [16].



Sl. 2. Princip rada Wowza striming server-a

Wowza Streaming Engine se kao softverska aplikacija instalira na Server računar koji je preko mrežne kartice povezan na internet pri čemu je nephodno obezbediti

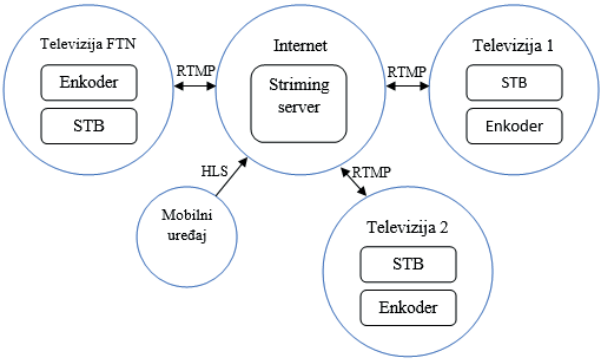
statičnu IP adresu sa odgovarajućim protokom (protok interneta download i upload zavisi od potreba korisnika, tj. koliko dolaznih strimova će biti u isto vreme slato ka Wowzi i koliko uređaja na prijemu reprodukuje u istom trenutku te strimove sa Wowze) [16].

3. IMPLEMENTACIJA MODELA

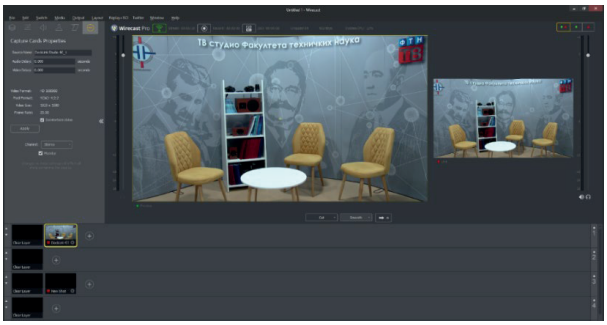
Struktura televizijskog sistema je projektovana tako da bude multifunkcionalna i zadovolji sve televizijske standardne i kriterijume. Kompletan televizijski sistem je adaptiran u prostorijama Fakulteta tehničkih nauka i projektovan je tako da služi za edukativne svrhe, ali i da ispuni sve produkcijske i tehničke zahteve. Pored distribucije signala ka kablovkoj (DVB-C) i zemaljskoj mreži (DVB-T2), moguće je distribuirati signal korišćenjem internet protokola, formirajući tako televizijski sistem baziran na internet protoklu (IPTV). Iako se IP protokol koristi za prenos video signala preko svih vrsta mreža, realizovani studio pruža mogućnost ostvarivanja konekcije sa drugim televizijskim sistemima u vidu razmene signala. Ta razmena se postiže tako što se u studiju nalazi server na kome je instaliran Wowza Streaming Engine platforma, dok se na prijemoj strani nalazi STB (Set Top Box) uređaj koji dekodira dolazne pakete stimovanog signala.

Na Sl. 3 prikazan je način realizacije konekcije TV sistema sa drugim TV sistemima i uređajima.

Najpre se na serveru, koji se nalazi u mašinskoj sobi, instalira Wowza Stremaing Engine na kojem se konfigurišu aplikacije koje će omogućiti razmenu signala sa drugim televizijskim studiom i mobilnim telefonom koji se nalazi na terenu. Za svaki strim se pravi nova aplikacija, na primer, pravi se aplikacija za strim od studija iz Kosovske Mitrovice ka strudiju Visoke škole elektrotehnike i računarstva u Beogradu, aplikacija za uključivanje mobilnim telefonom sa terena koju će moći da koriste oba studija i treća aplikacija iz studija u Beogradu ka studiju u Kosovskoj Mitrovici. Na tom istom serveru otvaraju se dva porta 8088 i 1935 kako bi se server mogao daljinski konfigurisati i omogućiti da se sa njega strimuje. Pomoću programa Wirecast [17], koji je instaliran na računaru u studiju i koji služi kao enkoder, konfigurišu se paramitri servera, odnosno javna IP adresa, port i naziv prethodno kreirane aplikacije u Wowzi. Na taj način formiran je strim koji drugi studio može prihvatiti pomoću STB uređaja ili testirati u VLC programu. Na Sl. 4 prikazan je strim koji se šalje iz studija iz Kosovske Mitrovice, a na Sl. 5 prikazan je stim koji se šalje iz studija iz Beograda.



Sl. 3. Pricip realizacije konekcija TV sistema



Sl. 4. Strimovanje signala iz studija u Kosovskoj Mitrovici



Sl. 5. Strimovanje signala iz studija u Beogradu

Slanje strima sa terena korišćenjem mobilnog telefona realizovano je pomoću GoCoder aplikacije [18], odnosno aplikacije koju je realizovala Wowza kompanija. U aplikaciji se unosi ista adresa servera i port, sa jedinom razlikom naziva aplikacije. Na Sl. 6 prikazano je slanje strima sa terena pomoću mobilnog telefona korišćenjem 4G mreže.

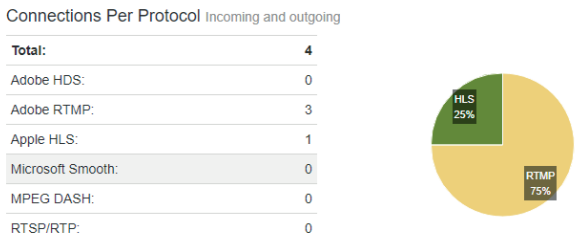


Sl. 6. Strimovanje signala mobilnim telefonom

Na ovaj način realizovan je prenos sa terena mobilnim telefonom i uspostava veze sa drugim studiom korišćenjem RTMP i HLS protokola. Prijem signala koji se šalje mobilnim telefonom u samom studiju konfirise se na STB uređaju tako što se unosu parametri strima (javna IP adresa, port i naziv aplikacije, u ovom slučaju to izgleda ovako: rtmp://147.91.144.107:1935/ftn/mLive ili ako se strimuje mobilnim telefonom sa iOS operativnim sistemom to izgleda ovako: http://147.91.144.107:1935/ftn/mLive/playlist.m3u8).

4. TESTIRANJE I ANALIZA

Na Sl. 7 dat je pregled aktivnih konekcija i iskorišćenih protokola. Sa Sl. 7 se može videti da je ukupan broj ostvarenih konekcija četiri, gde konekcije koje koriste RTMP protokol predstavljaju vezu između studija, dok HLS predstvalja vezu sa ekipom na terenu. U zavisnosti od situacije, za ostvarivanje veze, mogu se koristiti i ostali protokoli.



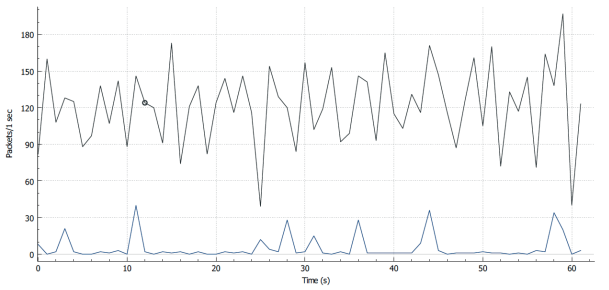
Sl. 7. Monitoring aktivnih konekcija i protokola

Obzirom na to da je uspostavljanje veze sa ekipom na terenu i razmena signala sa drugim televizijskim studijima preko internet veze, stabilnost i kvalitet, kako objektivni tako i subjketivni zavise upravo od brzine internet konekcije. Međtuim, da bi se video strim prilagodio svim korisnicima, na serveru na kome je instaliran Wowza Sreaming Engine prilikom strimovanja izvršeno je transkodovovanje strima gde se koriste različite rezolucije i različiti bitski protoci koji znatno više utiču na kvalitet. Analizirane su tri kategorije rezolucije video strima. U Tabeli 1 dati su parametri enkodera za primenjenu SD (Standard Definition) rezoluciju, HD (High Definition) rezoluciju i FullHD (Full High Definition) rezoluciju.

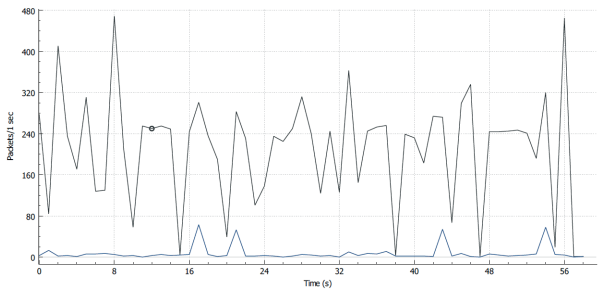
Tabela 1 . Parametri enkodera prilikom strimovanja

	SD	HD	FullHD
Rezolucija	720x576	1280x720	1920x1080
Broj frejmova u sekundi	25	25	25
Prosečni video bitski protok [kb/s]	1025	2252	4500
Audio bitski protok [kb/s]	128	128	128
Frekvencija odmeravanja audio signala [Hz]	44100	44100	44100

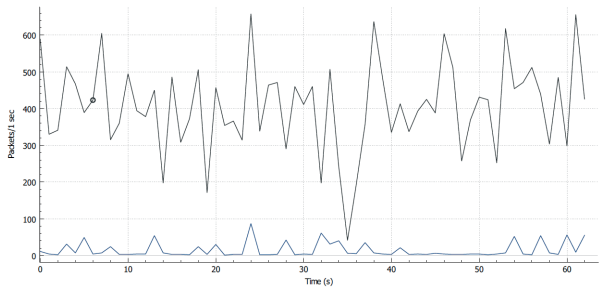
Na Sl. 8, Sl. 9 i Sl. 10 dat je prikaz broja primljenih paketa u jednoj sekundi u posmatranom interval strimovanja od 60 sekundi, kao i broj izgubljenih paketa prilikom strimovanja SD, HD i FullHD rezolucije, respektivno. Grafici su dobijeni korišćenjem softverskog paketa Wireshark [19] koji se koristi za analizu IP paketa. Gornji grafik se odnosi na broj primljenih paketa od strane servera ka korisniku, dok donji grafik predstavlja broj izgubljenih paketa.



Sl. 8. Broj prenetih i izgubljenih paketa i za posmtarani interval od 60s za SD rezoluciju



Sl. 9. Broj prenetih i izgubljenih paketa i za posmtarani interval od 60s za HD rezoluciju



Sl. 10. Broj prenetih i izgubljenih paketa i za posmtarani interval od 60s za FullHD rezoluciju

Sa datih slika se može videte da broj primljenih paketa raste sa porastom rezolucije, odnosno porastom bitskog protoka, jer je potreban prenos veće količine informacija. Takođe, povećava se i broj izgubljenih paketa ali ukoliko prijemnik (korisnik) raspolaže zahtevanim bitskim protokom (koji je veći ili jednak bitskom protoku strima koji se šalje), ovaj broj gubljenja paketa neće narušavati kvalitet prijema signala.

5. ZAKLJUČAK

U radu je prikazan jedan model za povezivanje više televizijskih studija korišćenjem internet veze. Prikazani model omogućava i ustpostavu veze sa mobilnih lokacija korišćenjem pametnih telefona. Model je implementiran na Fakultetu tehničkih nauka u Kosovskoj Mitrovici, a veza je testrana sa televizijskim studiom koji se nalazi na Visokoj školi elektrotehnike i računarstva u Beogradu, kao i sa mobilnim uređajem koji se nalazi na udaljenim lokacijama. Tom prilikom izvršena je analiza paketa za tri različite rezolucije (različitih bitskih protoka).

Predstavljeni model može se implementirati bez upotrebe mikrotalasnih veza ili drugih radio frekventnih veza (zemaljskih i satelitskih) čime se troškovi realizacije svode na minimum. Prednost ovog modela se ističe prilikom uključenja sa udaljenih lokacija, gde je samo potreban mobilni telefon sa internet vezom i odgovarajućom aplikacijom. Takođe, ističe se malim kašnjenjem signala čak i pri višim rezolucijama videa koje iznosi oko 3 sekunde i to ga čini pogodnom za implementaciju i u profesinalnim televizijskim kućama).

ZAHVALNOST

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[19] [Softverski paket Wireshark: https://www.wireshark.org/

KRIPTOGRAFSKI RADNI OKVIR ZA BEŽIČNE SENZORSKE MREŽE

Bogdan Brkić*,
Dejan Živković,
Mladen Veinović

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Bežične senzorske mreže doživjele su veliku ekspanziju u svim oblastima ljudskog života. Neke od primjena su komercijalne prirode, a neke su takvog karaktera da je gotovo nemoguće zamisliti bilo koju drugu tehnologiju koja bi mogla da ih zamijeni. Zbog sve niže cijene komponenti bežičnih senzorskih mreža i sve masovnije upotrebe one prikupljaju ogromne količine podataka koji bi, ukoliko bi bili nezaštićeni, mogli biti zloupotrebljeni. Predmet ovog rada je istražiti na koji način se štite podaci u bežičnim senzorskim mrežama uzimajući u obzir tehnološka i ograničenja u realizaciji koja su specifična za ovu vrstu uređaja.

Ključne reči:

simetrični i asimetrični kriptografski algoritmi, eliptične krive, programabilne logičke mreže.

1. UVOD

Bežične senzorske mreže (Wireless Sensor Networks - WSN) predstavljaju grupu umrežanih uređaja koje nazivamo nodovi ili čvorovi. Njihova osnovna karakteristika je da obavezno sadrže senzorsku komponentu. Najčešće se radi o malim, jeftinim, multifunkcionalnim i autonomnim uređajima koji pored senzora imaju: sklop za obradu i čuvanje podataka, vlastito napajanje, mogućnost komunikacije sa drugim uređajima najčešće bežičnom komunikacijom, a nerijetko posjeduju i aktuatore koji im omogućavaju upravljanje drugim uređajima. Informacije prikupljene sa nodova kao i upravljački signali za aktivaciju aktuatora čine skup podataka koji se prenosi bežičnim putem unutar oblasti koju mreža pokriva. Bez obzira na namjenu bežične senzorske mreže kao i na značaj podataka koji se unutar nje prenosi jasno je da ovakav protok informacija treba obezbijediti od neovlaštenog čitanja i modifikovanja. Kao i u većini današnjih komunikacionih uređaja kao logično rješenje zaštite podataka nameće se primjena kriptografskih tehnika. Poznato nam je da izvođenje kriptografskih algoritama može zahtijevati upotrebu značajnih resursa. Neke od osnovnih karakteristika bežičnih senzorskih mreža upravo su u suprotnosti sa zahtjevima koje postavljaju kriptografske tehnike - procesorski i memorijski resursi su skromni, a energetski resursi najčešće su ograničeni i za obavljanje bilo kakvih funkcija unutar nodova očekuje se što manja potrošnja energije.

Odgovorno lice:
Bogdan Brkić

e-pošta:
bogdan.brkic.08@singimail.rs

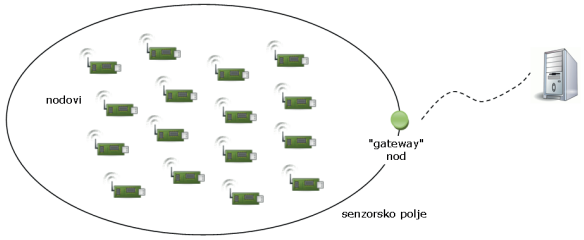
DOI: 10.15308/Sinteza-2019-526-533

2. BEŽIČNE SENZORSKE MREŽE

Nodovi

Osnovna namjena nodova je registrovanje i mjerenje različitih pojava iz okoline i slanje izmjerenih vrijednosti na neko centralno mjesto na kom će se vršiti obrada podataka. Nodovi su obično gusto raspoređeni u području koje se naziva senzorsko polje i prikupljaju i prosleđuju podatke iz okruženja u kom se nalaze. Ukoliko postoje aktuatori, sa centralnog mjesta za obradu podataka prema nodu se mogu slati i upravljački signali. Današnje tehnologije proizvodnje integrisanih kola omogućavaju dobijanje veoma minijaturnih nodova u kojima se nalaze sve pobrojane komponente. Jedna od važnih karakteristika ovih uređaja jeste mala potrošnja energije, tako da ako se radi o baterijskom napajanju mogu da rade veoma dugo sa jednim punjenjem. Mala potrošnja energije omogućava i napajanje „konstantnim“ izvorima energije kao što su npr. solarna ili energija kretanja.

Senzorsku mrežu čini grupa nodova od kojih svaki ima mogućnost komunikacije sa jednim ili više susjednih nodova. Najčešće se jedan od nodova tzv. “gateway nod” konfiguriše tako da ostvaruje i dodatnu funkciju - interkonekciju sa susjednom bežičnom mrežom ili nekim drugim informacionim sistemom. Oblast koju pokrivaju svi senzori jedne mreže u smislu registrovanja određene pojave na nekom prostoru predstavlja senzorsko polje.



Slika 1. Model bežične senzorske mreže

Senzori su konvertori koji jednu fizičku veličinu pretvaraju u drugu. Danas se najčešće vrši pretvaranje u digitalne električne impulse koje je poslije moguće obrađivati različitim uređajima.

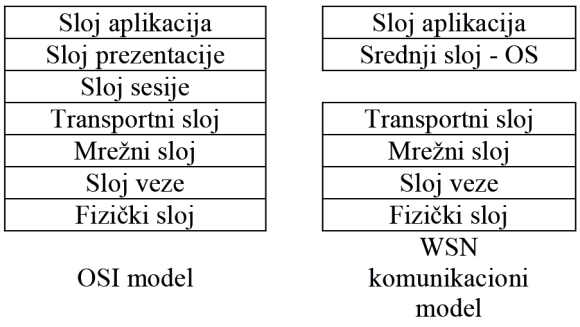
Oblasti primjene senzorskih mreža

Velika raznolikost pojava koji današnji vještački senzori mogu da detektuju, prate i izmjere naslućuje i široku oblast upotrebe ovih uređaja. Neke od oblasti primjene senzorskih mreža [1] su:

- industrija – praćenje stanja mašina i postrojenja, praćenje proizvodnih procesa, ...
- vojna industrija – detekcija pokretnih predmeta, neprijateljskih formacija i ciljeva, hemijskih i bioloških agenasa, nuklearnog zračenja, ...
- geolokacija
- javna bezbjednost – nadgledanje područja, praćenje različitih pojava, ...
- poljoprivreda – praćenje promjena u mikroklimi, praćenje kretanja štetočina i nametnika
- seizmologija – praćenje geoloških aktivnosti
- zdravstvo – praćenje zdravstvenog stanja pacijenta pomoću senzora koji se nalaze unutar i na organizmu, kretanje pacijenata unutar zdravstvene ustanove, pomoć hendikepiranim osobama, udaljeni monitoring pacijenta, ...
- saobraćaj i logistika – praćenje gužvi u saobraćaju, monitoring čvorova i parkinga, monitoring zaliha u skladištima, ...
- biološke i ekološke primjene – monitoring kvalitete vazduha i vode, praćenje šumskih požara, detekcija klizišta, sprečavanje prirodnih katastrofa, upozoravanje na poplave i cunamije, praćenje kretanja otpada i opasnih materija, ...
- kućna automatizacija – pametne kuće, upravljanje elektronskim uređajima na osnovu detektovanih promjena u okolini bez asistencije čovjeka, energetska efikasnost, upravljanje mikroklimatskim uslovima i privatnim i javnim prostorima

Komunikacioni model WSN

Komunikacioni model koji opisuje proces komuniciranja unutar WSN [2] sličan je OSI (Open Systems Interconnection) modelu i u odnosu na njega ne posjeduje jedino sloj sesije.



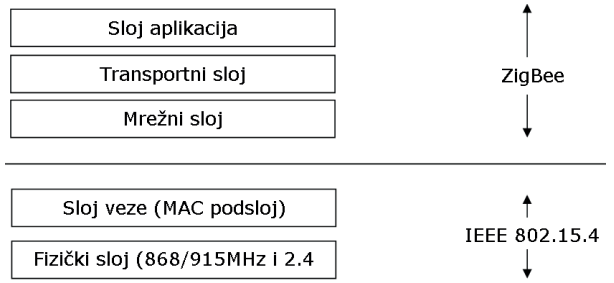
Slika 2. OSI i komunikacioni model WSN

Fizički sloj izvršava sledeće funkcije: odabir frekvencije, detekcija signala, zaštitu podataka, prenos podataka između čvorova, modulacija i briga o potrošnji energije. Sloj veze zadužen je za: formiranje zaglavlja i multipleksiranje paketa podataka, fizičko adresiranje i kontrolu toka paketa, kontrolu grešaka pri prenosu i kontrolu pristupa, osluškivanje medijuma, ponovljena slanja zbog nastalih kolizija, udvostručeni prijem kao i slanje podataka za kontrolu koji nisu neophodni. Mrežni sloj obezbjeđuje razmjenu podataka između transportnog, aplikacionog i MAC podsloja. Zadatak mrežnog sloja jeste da se pravilno formira mrežna topologija, konfigurišu i adresiraju uređaji, vodi računa o susjedstvu između čvorova, pronađe najbolji put da se poruka dostavi na odredište i da se uključivanjem i isključivanjem čvorova s mreže kontroliše potrošnja energije. Kako TCP kao transportni protokol ne garantuje pouzdan prenos zbog postojanja velikog broja čvorova i predajnika kao i potrebe pojedinih pristupnih uređaja da iniciraju multicast saobraćaj, na transportnom sloju koriste se protokoli: PFSQ (Pump Slow Fetch Quickly), RMST (Reliable Multi-Segment Transport), ESRT (Event to Sink Reliable Transport) i CODA (Congestion Detection and Avoidance). Operativni sistem utiče na potrošnju, responsivnost, kvalitet, bezbjednost i brzinu razmjene podataka. Shodno takvim potrebama pojedini operativni sistemi posebno su napravljeni za primjenu u WSM. Jedan od osnovnih zadataka operativnog sistema je optimizacija potrošnje energije noda koja se realizuje: uključivanjem ili isključivanjem dijelova senzorskog čvora, promjenom frekvencije sistemskog sata ili praćenjem upisivanja ili čitanja iz i u memoriju. Na aplikativnom sloju koriste se protokoli: SMP (eng. Sensor Management Protocol), TADP (eng. Task Assignment and Data Advertisement Protocol) i SQDDP (eng. Sensor Query and Data Dissemination Protocol).

Komunikacioni model je važno poznavati jer se na osnovu njega mogu klasifikovati i vrste napada na komunikaciju unutar mreže kao i mogućnosti primjene različitih kriptografskih tehnika na različitim slojevima.

Važniji standardi bežičnih senzorskih mreža

Najvažniji standard [1] koji se odnosi na WSN je IEEE 802.15.4. Ovo je standard koji definiše funkcionisanje "personalnih bežičnih mreža malog troška održavanja" (low-rate wireless personal area network LR-WPAN). Specificira fizički podsloj (868/915MHz i 2.4 GHz) i MAC podsloj sloja veze. Predstavlja osnovu i za sledeće specifikacije: ZigBee, ISA100.11a, WirelessHART, MiWi, SNAP i Thread . Svaka od ovih specifikacija razvija gornje slojeve komunikacionih modela koji nisu definisani u IEEE 802.15.4 standardu.



Slika 3. IEEE 802.15.4 i ZigBee standard u WSN komunikacionom modelu

Mada se u vezi sa bežičnim senzorskim mrežama nerijetko kao dodatni standard pominje i ZigBee, on je u stvari IEEE 802.15.4 bazirana specifikacija/nadgradnja za paket komunikacionih protokola višeg nivoa u mrežama u kojima se prenose manje količine podataka, manjim brzinama i na manjim udaljenostima (10-100m). Prenos podataka na veće udaljenosti postiže se ekstenzijom mreže tj. dodavanjem novih nodova. Neki standardi kao što su WirelessHART i ISA100.11a karakteristični su za industrijske aplikacije.

3. VRSTE PRIJETNJI I NAPADA NA BEŽIČNE SENZORSKE MREŽE

Bezbjednosni zahtjevi

Bezbjednosni principi [3][4] koji se javljaju u ostalim informacionim sistemima i koji pored ostalih generalno

nastoje da riješe i kriptografske tehnike pronalazimo i kod bežičnih senzorski mreža:

- povjerljivost podataka – Data Confidentiality – u kontekstu WSN znači da samo autorizovani nodovi imaju pristup podacima,
- povjerljivost izvora – Data Authentication – u kontekstu WSN znači da podaci potiču od autorizovanih nodova,
- integritet podataka – Data Integrity – podaci od izvora do odredišta nisu mijenjani od neautorizovanih nodova,
- vremenska validnost podataka – Data Freshness – stare poruke se ne ponavljaju i
- dostupnost – Availability – servisi koje nudi WSN ili pojedinačni nod su dostupni kada god je to potrebno.

Pored ovih principa značajni su i: sinhronizacija vremena, bezbjedno upravljanje nodovima (nodovi bi trebali biti fleksibilini, samoorganizujući, prilagodljivi i korektivni u odnosu na sigurnosne mjere) bezbjedna lokalizacija (očuvanje podataka o lokaciji tokom komunikacije sa susjednim nodovima).

Bezbjednosni izazovi u bežičnim senzorskim mrežama

Bezbjednosni izazovi [5] koji se javljaju u bežičnim senzorskim mrežama su:

- emitujuća priroda bežičnih komunikacija rezultuje time da su ove mreže podložne različitim napadima, od pasivnog prisluškivanja, reemitovanja lažnih poruka do izobličavanja signala,
- lokalizacija na teško dostupnom terenu kao što je šuma ili npr. bojno polje onemogućava kvalitetno fizičko obezbjeđenje mreže,
- ograničenja u procesorskoj i memorijskoj snazi kao i ograničeni energetski resursi,
- potencijalno velik broj nodova i ostalih uređaja u mreži,
- dinamička priroda ovih mreža može izazvati česte promjene u topologiji i autorizaciji ...

Protivnik je osoba ili entitet koji pokušava da naruši rad mreže neautorizovanim pristupom, uskraćivanjem servisa ili nekim drugim napadom ili prijetnjom.

Pasivni protivnik samo nadgleda komunikaciju i prijetnja je povjerljivosti podataka. *Aktivni protivnik* pokušava da briše, dodaje ili mijenja podatke koji se prenose kanalima. Prijetnja je integritetu podataka. *Mote-Class napadač* (mote=bubica; WSN nod veoma malih dimenzija) raspolaže resursima koji su slični resursima koje posjeduju nodovi u WSN. *Laptop-Class napadač* raspolaže moćnijim resursima nego što su to nodovi u mreži – veća procesorska i memorijska snaga, veći energetski resursi, jači komunikacioni resursi i dr. *Insajder* je napadač koji je kompromitovao neke autorizovane dijelove mreže npr. krađom ključeva ili pokretanjem malicioznog koda. *Autsajder* je napadač koji nema neki poseban nivo pristupa mreži.

Vrste prijetnji i napada na WSN

Sigurnosni problemi u bežičnim senzorskim mrežama [6] mogu se klasifikovati u 5 grupa:

- problemi koji se javljaju pri upotrebi kriptografskih tehnika (cryptography)
- upravljanje kriptološkim ključevima (key management)

Ključevi se koriste za obezbjeđivanje komunikacije u simetričnoj i asimetričnoj kriptografiji pri implementaciji različitih šema bezbjednosti. Distribucija ključeva nije tipična za bežične senzorske mreže, a ograničenja u resursima centralizovano upravljanje ključevima čini gotovo nemogućim. Direktna razmjena ključeva između svaka dva noda u WSN nije pogodna za mreže koje su rastuće. Bezbjednosna šema mora koristiti efikasnu i pouzdanu tehniku distribuciju ključeva kako bi se obezbijedila bezbjedna komunikacija među svim čvorovima.

- bezbjedno rutiranje (secure routing)

Protokoli regulišu na koji način nodovi šalju pakete drugim nodovima ili sinkovima. Najveći izazov sastoji se autentifikaciji komunikacije na strani sinka. Kriptografija javnog ključa zbog svojih resursnih zahtjeva je neisplativa u WSN u rješavanju ovih problema. Iz tog razloga uvode se protokoli koji u sebi uključuju i bezbjedno rutiranje i koji ujedno obezbjeđuju integritet podataka, autentikaciju i dostupnost poruka.

- bezbjedna agregacija podataka (secure data aggregation)

Agregacija podataka rješava problem duplih podataka koji se može pojaviti tokom prikupljanja podataka. Ovo je poseban problem u energetski-limitiranim mrežama. Agregatori su osjetljivi na napade kada dođe do injektiranja podmetnutih podataka preko kompromitovanog noda. Bez autentikacije napadač bi lako prevario agregator. Obezbjeđivanje agregacije tako uključuje:

autentikaciju, povjerljivost i integritet podataka kao i saradnju nodova u identifikaciji eventualno kompromitovanih nodova.

- detekcija upada (intrusion detection)

Uskraćivanje usluga (The Denial of Service - DoS) je bilo koji događaj koji umanjuje ili potpuno eliminiše sposobnost mreže da izvrši svoju osnovnu funkciju.

Napadi na fizičkom sloju

Na fizičkom sloju [7] postoje dvije vrste napada:

- "jamming" koji predstavlja ometanje interferencijom sa frekvencijama koje koristi WSN mreža i
- "tampering" koji označava fizičku kompromitaciju nodova.

Rješenja za uklanjanje ovih problema su:

- širenje komunikacionog spektra,
- redovan monitoring izvještaja o jamming-u

Napadi na sloju veze

Na sloju veze najčešći su napadi:

- namjerne kolizije („collision") – izmjena okteta koji se prenose kako bi se poremetili paketi i poremećaji u MAC protokolima,
- iscrpljivanje („exhaustion") – kolizija i poremećaji u MAC paketima rezultuju nepotrebnom retransmisijom paketa koji dovode do iscrpljivanja energetskih resursa,
- nekorektnost („unfairness") – degradacija servisa koja uzrokuje da korisnici real-time MAC protokola promaše rokove

Tehnike kojima se može preduprijediti nastajanje ovih problema su: upotreba kodova za korekciju greške, detekcija kolizije, multipleksiranje dijeljenjem vremena (time-division multiplexing – TDM), ograničavanje brzine prenosa, ...

Napadi na mrežnom sloju

Na mrežnom sloju možemo se susresti sa napadima:

- selektivno prosljeđivanje ("Selective Forwarding") – maliciozni nodovi odbijaju proslijediti poruke i jednostavno ih odbaciju,
- lažni sink ("Sinkhole") – napadač privlači nodove lažiranjem informacija o rutiranju,
- "Sybil" napad – jedan nod predstavlja više identiteta za druge nodove,
- "Wormhole" – napadač tuneliše saobraćaj iz jednog dijela mreže u drugi,
- "HELLO flood" – Laptop-Class napadač emituje informacije takvom transmisionom snagom da uvjerava svaki nod u mreži da mu je susjedni.

Rješenja za navedene probleme mogu se naći u enkripciji sloja veze i autentikaciji, rutiranjem po više putanja, verifikaciji identiteta ili autentikaciji emitovanja.

Napadi na transportnom sloju

Na transportnom sloju javljaju se napadi:

- plavljenje ("flooding") – napadač šalje veliki broj zahtjeva za uspostavljanjem konekcije što dovodi do iscrpljivanja memorije i ostalih resursa,
- desinhronizacija – napadač konstantno šalje poruke zahtjeva za retransmisiju navodno izgubljenih paketa

Ovi problemi se izbjegavaju upotrebom "connectionless" protokola i autentikacijom paketa ključujući i sva kontrolna polja u hederu transportnog protokola.

Preporuke za zaštitu WSN

Generalne preporuke za zaštitu bežičnih senzorskih mreža koje se mogu dati su:

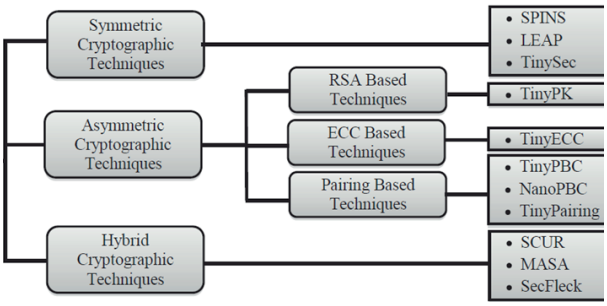
- ukoliko je moguće obezbijediti fizičku bezbjednost mreže,
- kriptografija može obezbijediti enkripciju na sloju veze i mehanizme autentikacije (MAC), ali to nije dovoljno,
- "end-to-end" mehanizmi zaštite nisu dovoljni,
- pažljivo dizajnirati protokole uz poštivanje bezbjednosnih principa i
- razmotriti probleme sa napajanjem kod usvajanja protivmjera.

4. KRIPTOGRAFSKE METODE ZAŠTITE BEŽIČNIH SENZORSKIH MREŽA

Mogućnost upotrebe kripto-algoritama u bežičnim senzorskim mrežama

Kriptografske tehnike su jedan od najčešćih i najkvalitetnijih načina obezbjeđivanja komunikacija pa tako i

komunikacija u bežičnim senzorskim mrežama. Kao i u drugim i ovdje se kriptografske metode zaštite mogu implementirati kroz: simetrične, asimetrične i heš algoritme. S obzirom na ograničenja u resursima, u odnosu na neke druge sisteme koji ih nemaju i koja lako implementiraju ove tehnike, potrebni su i posebni „resursnonezahtijevni“ algoritmi koje je moguće implementirati u praksi [8]. Na sledećoj slici prikazane su kriptografske tehnike, predloženi su neki od asimetričnih algoritama i navedene su realizacije u vidu “light-weight” protokola.



Slika 4. Tehnike i protokoli pogodni za zaštitu WSN

Hibridne tehnike kombinuju simetrične i asimetrične algoritme kako bi se iskoristile sve prednosti i jednog i drugog šifarskog sistema. U nekim od takvih rješenja simetrična kriptografija se koristi kod šifrovanja i autentikacije, a asimetrična za generisanje ključeva.

Primjena simetričnih algoritama

U simetričnim algoritmima koristi se jedan dijeljeni ključ za šifrovanje i dešifrovanje na obe strane komunikacije. Ključ treba biti tajan što je teško obezbijediti u izloženom okruženju kakvo je WSN. Mnoge bezbjednosne šeme za WSN koriste upravo samo simetrične algoritme zbog jednostavne implementacije i manjih hardverskih zahtjeva od drugih kripto-algoritama.

Iz grupe najčešće korištenih simetričnih algoritama (AES, Blowfish, DES, IDEA, MD5, RC4, RC5, SHA-1, SHA-256) algoritmi RC4 i MD5 su se pokazali kao najpogodniji za primjenu u WSN dok je za AES algoritam, na primjer, potrebno relativno veliko vrijeme za izvršavanje jedne AES operacije.

Primjena asimetričnih algoritama

Asimetrična kriptografija bazira se na dva ključa: privatnom i javnom. Javni se koristi za šifrovanje podataka, a privatni za dešifrovanje. Asimetrični kriptografski algoritmi najčešće se realizuju operacijama sa velikim brojevima, a to za posljedicu ima velike zahtjeve u pogledu hardverskih resursa i ovakvi algoritmi nisu baš najpodesniji za implementaciju u WSN.

Najveći broj predloženih rješenja koja koriste asimetrične algoritme zasniva se na upotrebi ECC (Elliptic Curve Cryptography) algoritma ili nekoj njegovoj adaptaciji u WSN okruženju. U odnosu na RSA algoritam ECC algoritam generalno operiše sa ključevima znatno manjih bitskih dužina, a u WSN okruženju ostvaruje manju potrošnju energije i angažovanje procesorskih i memorijskih resursa [9]. Većina rješenja bazirana na ECC algoritmu uključuje dodatni hardver u vidu ECC koprocesora male potrošnje energije. On uključuje i logičku jedinicu za modularnu aritmetiku koja se koristi za izvođenje operacija u odabranom “ECC polju”.

Postoje rješenja koja koriste i neke druge asimetrične algoritme kao što su Rabinova šema ili NtruEncrypt i drugi, ali podrazumijevaju upotrebu dodatnog hardvera za manipulaciju ključevima [10].

Kriptografski radni okviri za WSN

Kriptografski radni okviri (engl. *frameworks*) predstavljaju protokole i algoritme koji se izvršavaju u određenim slojevima sa ciljem uspostavljanja bezbjednog okruženja u bežičnoj senzorskoj mreži. Svaki radni okvir može obuhvatati algoritme za: šifrovanje i dešifrovanje, usaglašavanje ključeva i autentikaciju. Generalno ih možemo podijeliti [8] na okvire za:

- simetričnu kriptografiju (SPINS, LEAP, TinySec),
- asimetričnu kriptografiju (RSA bazirani kao TinyPK, ECC bazirani kao npr. TinyECC, „Pairing“ bazirani kao npr. TinyPBC, NanoPBC, TinyPairing i
- hibridne koji kombinuju simetričnu i asimetričnu kriptografiju (SCUR, MASA, SecFleck)

Framework	*Encryption*	*Cipher*	*Key Agreement*	*Code Requirement*
SPIN	CTR mode	RC5 (Block)	Master Key & Delayed Disclosure	2674B
LEAP	RC5	RC5 (Block)	Pre-deployed (Master Varaible)	ROM: 17.9KB RAM: no. of neighbours
TinySec	CBC mode (Optional)	Cipher independent	Any	RAM: 728B program space: 7146B
TinyPK	RSA	-	PK-RSA	13387B (512 bit key)
TinyECC	ECIES	-	ECDH	20818B (micaz)
TinyPBC	PBC	-	ID-NIKDS	Stack: 2,867B RAM: 368B ROM: 47,948B
NanoPBC	-	-	-	-
TinyPairing	PBC	-	-	RAM: 392B ROM: 21,742B
SCUR	Rabbit	Rabbit (Stream) (128bit)	Pre-Deployed key	-
MASA	-	-	-	-
SecFleck	RSA	RSA (Block) (2048 bit) & XTEA (128 bit)	-	RAM: 52B Program space: 1,082B

Framework	*Authentication*	*Cost (time/energy)*	*Support*
SPIN	CBC-MAC	7.24 ms	SmartDust
LEAP	CBC-MAC	Variable (No. of neighbours)	Mica2
TinySec	CBC-MAC	RC5(C): 0.90ms Skipjack(C): 0.38ms RC5(C, assembly): 0.26ms	Mica, Mica2, & Mica2Dot
TinyPK	CA-signed Diffie-Hellman public value	3.8 s	Mica1, Mica2
TinyECC	ECDSA	20266.47ms / 486.4 mJ (micaz)	Mica2/MicaZ, TelosB/Tmote Sky, BSNV3, & Imote2
TinyPBC	ID-NIKDS	5.45s (pairing computation)	Mica2 & MicaZ
NanoPBC	-	-	MicaZ
TinyPairing	-	21.95 s	MICA family, Telos, eyesIFX, Intel's Imote,
SCUR	-	-	-
MASA	-	-	-
SecFleck	RSA	RSA (s/w): 219,730 μs / 7,030.0 μJ RSA (h/w): 27 μs / 5.4 μJ XTEA (s/w): 18 μs / 0.6 μJ	Fleck sensor node

Slika 5. Kriptografski radni okviri za bežične senzorske mreže

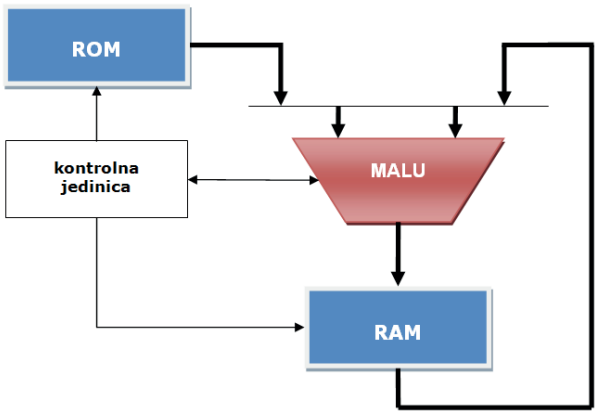
Prethodna tabela sadrži protokole u svakoj od navedenih podgrupa i može biti od koristi prilikom projektovanja bežičnih senzorskih mreža u fazi tokom koje se rješavaju pitanja zaštite podataka. Ova tabela sadrži uporedne podatke za svaki navedeni protokol kao što su: koji algoritmi se koriste za šifrovanje heširanje usaglašavanje ključeva i autentikaciju, kakvi su memorijski zahtjevi koje je neophodno obezbijediti za izvršavanje koda, koji su troškovi u vidu vremena izvršavanja i potrošnje energije i kakva je aplikabilnost na najvažnije familije senzorskih nodova.

5. PRIJEDLOZI MOGUĆIH UNAPREĐENJA MODELA ZAŠTITE BEŽIČNIH SENZORSKIH MREŽA

Na osnovu svega izloženog daćemo dva prijedloga [11] modela za zaštitu bežičnih senzorskih mreža. Poći ćemo od pretpostavke da želimo realizovati vlastite algoritme za šifrovanje, heširanje i usaglašavanje ključeva, te ih implementirati u hardveru, a zatim i u softveru.

Prijedlog 1 – hardverski pristup

Ovaj pristup zasniva se na upotrebi hardvera za obavljanje resursno kritičnih operacija. Kako se većina algoritama izvršava u modularnoj aritmetici naš kripto-hardverski dodatak biće opremljen procesorom koji umjesto aritmetičke logičke jedinice (ALU) ima modularnu aritmetičke logičke jedinice (MALU) sposobnu da obavlja aritmetičke operacije u modularnoj aritmetici.

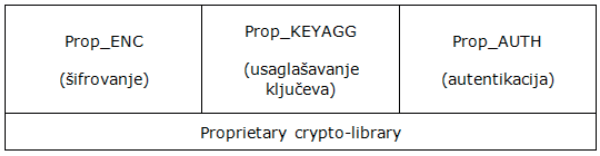


Slika 6. Koprocesor koji realizuje kriptooperacije vlastitog šifarskog sistema

Registre MALU možemo realizovati u npr. programabilnim logičkim mrežama (programmable logic array - PLA). Registre realizujemo tako što najprije postavimo neki matematički izraz koji određuje naš šifarski algoritam, a zatim vršimo programiranje PLA za izvršavanje modularnih operacija. Na primjer, u ECC algoritmu bismo kroz PLA mogli realizovati funkcije $f(z)=z^{163}+z^7+z^6+z^3+1$ ili $f(z)=z^{233}+z^{74}+1$.

Prijedlog 2 – softverski pristup

Drugo rješenje bazira se na kreiranju vlastitih softverskih biblioteka koje bi bile pridodate operativnom sistemu koji pokreće nodove naše bežične senzorske mreže. Ako pretpostavimo da imamo nodove na kojima se izvršava TinyOS onda je potrebno da u nekom od programskih jezika koje podržava operativni sistem (C, C++, Java) napišemo kod za kriptografske operacije šifrovanja, usaglašavanja ključeva i autentifikacije. Tokom pisanju koda treba voditi računa o resursnim ograničenjima koja nameće ciljana platforma.



Slika 7. Struktura vlastite biblioteke za kriptozaštitu WSN

6. ZAKLJUČAK

Bežične senzorske mreže su sve više upotrebi u različitim oblastima. Neke karakteristike njihovih gradivnih elemenata, nodova, kao što su niska potrošnja energije i ograničeni procesorski, memorijski i energetski resursi sa jedne strane omogućavaju njihovu minijaturizaciju što je poželjno, dok sa druge strane smanjuju mogućnost izvršavanja složenih kriptografskih operacija u cilju bolje zaštite podataka. Ovi problemi uslovili su razvoj mnogih inovativnih protokola i tehnika koje nastoje da riješe opisane probleme. Odabir odgovarajućih kriptografskih metoda za senzorske nodove je fundamentalan za pružanje bezbjednih servisa WSN. U ovom radu su opisani: bezbjednosni zahtjevi, vrste napada i prijetnji, načini za primjenu kriptografskih metoda zaštite bežičnih senzorskih mreža kao i kriptografski radni okviri dizajnirani namjenski za bežične senzorske mreže. Data su dva generalna prijedloga za realizaciju vlastitog modela bezbjednosti bežičnih senzorskih mreža.

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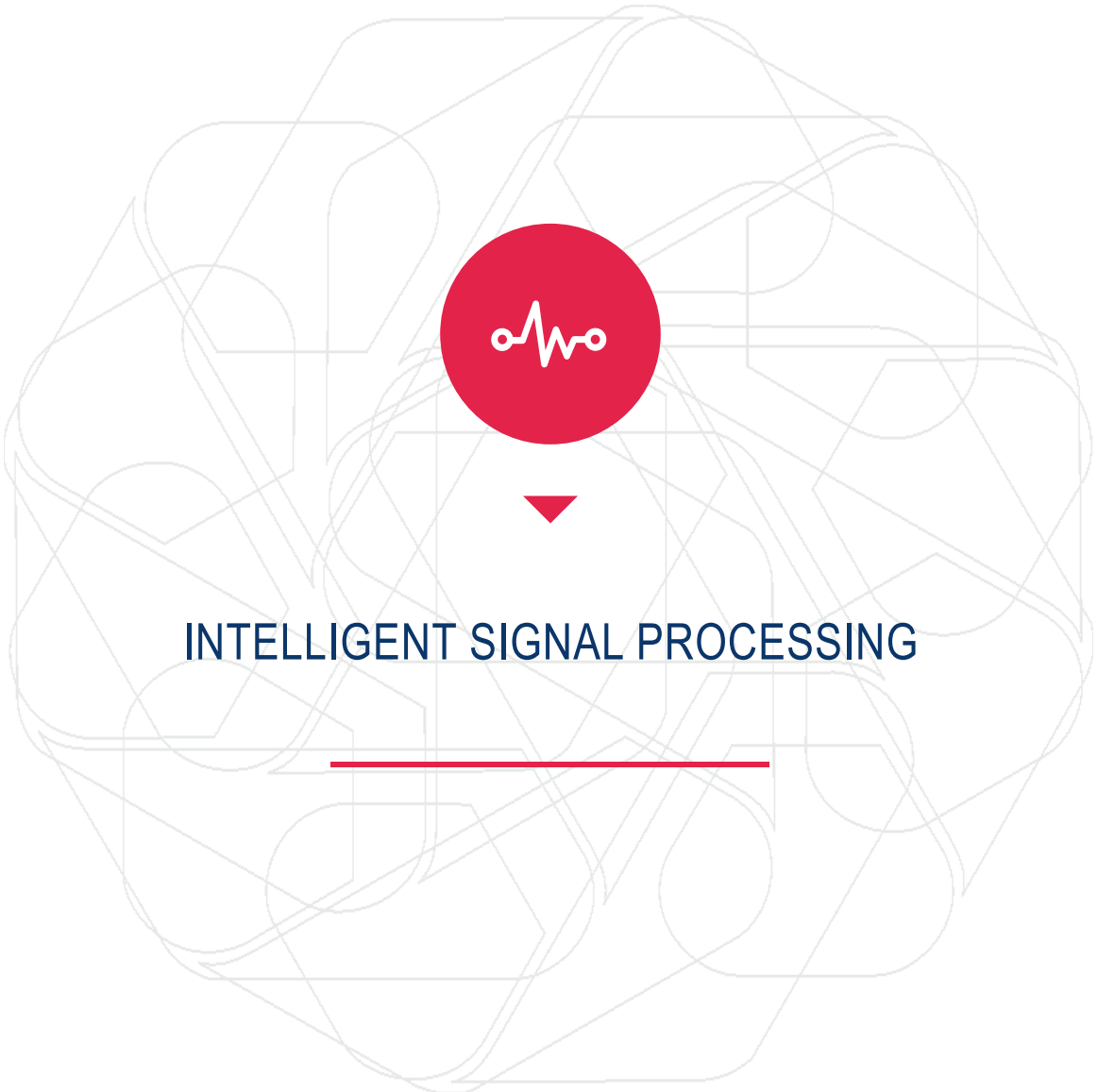
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INTELLIGENT SIGNAL PROCESSING

INTELLIGENT SIGNAL PROCESSING

OVERVIEW AND CLASSIFICATION OF DIGITAL WATERMARKING ALGORITHMS

Predrag Milosav[1, 2, *],
Zoran Banjac[2],
Milan Milosavljević[1],
Tomislav Unkašević[1, 2]
Medhat Abdelrahman
Mohamed Mostafa[3]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom Institute,
Belgrade, Serbia
[3]European University,
Belgrade, Serbia

Abstract:
This paper performs a comparative analysis of different watermarking techniques. Namely, in the last twenty-five years, a large number of algorithms for digital watermarking have been developed. In order to understand how different schemes can be applied it is important to define some criteria for classifying them. The algorithms are classified according to the characteristics of embedded watermarks and based on applications in which the watermark is built in. The robustness of the watermarks with respect to a different kind of attacks is also analyzed.

Keywords:
Watermark, Image Processing, Robustness, Data Embedding.

1. INTRODUCTION

Digital watermark is commonly used in the field of information security, copyright protection, data authentication, and broadcast control. The watermark is embedded in the carrier, which can be audio, video or other data, in such a way that the distortion caused by the embedding is too small to be noticed. At the same time, the embedded watermark must be sufficiently reliable and robust to withstand conventional degradation, alterations or deliberate attacks. In addition, for acceptable levels of distortion and robustness, the desire is to incorporate as much data as possible in a particular carrier and thus increase its capacity. Podilchuk and Delp presented a general framework for the embedding and detection / decoding of watermarks [1], taking into account their differences in their implementations and in different watermark algorithms and applications in the context of copyright. In the following section, the WM algorithm will be presented in the first chapter by basic characteristics and by the place of application. The second chapter will explain the basic techniques of embedding the watermark into different types of carriers. The third chapter is reserved for advanced watermarking techniques in order to solve the problems brought with the basic techniques mentioned in the second chapter. The last chapter is reserved for the conclusion of the complete work.

Correspondence:
Predrag Milosav

e-mail:
predrag.milosav@vlatacom.com

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2. CLASSIFICATION IN DIGITAL WATERMARKING

Digital watermarking technology has been developed as a convenient tool for identifying sources, creators, owners, distributors or an authorized consumer of the document or digital content. It can also be used to identify and track data illegally distributed. There are two main steps in the digital watermark process: (1) embedding the watermark in which the watermark is inserted into the content of the carrier, and (2) extracting the watermark, in which the watermark is extracted from the carrier. Nowadays there are a number of algorithms for imprinting watermarks. It is important to define some criteria for their description and classification in order to understand how different schemes can be applied.

Classification based on characteristics

This section categorizes digital watermarking technologies into five classes according to the behavior and characteristics of embedded watermarks.

Blind versus nonblind - The watermarking technique is considered to be *blind* if it does not require access to the original carriers, without watermark (video, images, sound, etc.), to restore the watermark. On the other hand, the watermark technique is considered *nonblind* if the original carrier is required to extract a watermark. Watermarks can be extracted using several different algorithms, Barni and Nikolaidis belong to the blind category, and on the other hand, Cox and Swanson algorithms belong to the nonblind [2-5]. Using of blind or nonblind algorithm are tradeoff robustness and complexity of use.

Perceptible versus imperceptible - A perceptible watermark is embedded and foreseen to be visible, usually by the author. A perceptible watermark is considered good if it is made so that it is difficult to remove and change by an unauthorized person, as well as that it can resist counterfeiting. On the other hand, imperceptible watermark is embedded with a sophisticated algorithm and made to be invisible to the user. However, it can be extracted using an inverse algorithm, only by the owner or authorized user.

Private versus public - A good quality watermark is considered *private* if only authorized users can detect and extract it, and such techniques have been developed to prevent unauthorized users to alter it or remove it (for example, using a private encryption key). This set of data stores information about the watermark location in the carrier, allowing the insertion or removal of a watermark if some of the links in that communication chain are compromised. On the other hand, public watermarks are embedded in a location that is well known to everyone and can be easily accessed and easily extracted. Basically, private watermark techniques are more robust than public, in which an attacker can easily remove, alter or damage data when the embedded code is known. A special type of public watermark is an asymmetric type in which each user can read a watermark without the ability to change, damage or remove it. Similar to asymmetric cryptography systems, the private key is used to incorporate a watermark and the public key is used for WM verification.

Robust versus fragile - The robustness of the watermark is reflected in the ability of a watermark to survive a legitimate daily use or manipulation by digital processing, such as intentional or unintentional attacks. The targets of the deliberate attack are to destroy or damage the watermark, while unintentional attacks do not explicitly intend to change it. According to the robust characteristics, watermarks can be categorized into three types: *Robust, Semifragile and Fragile.*

Robust watermarks have been designed to survive deliberate and unintentional modifications of the watermark carrier [3,4,6,7]. Inappropriate tendencial changes include the unauthorized removal or modification of the embedded watermark as well as the malicious insertion of any other information. Unintentional modifications include image processing operations such as scaling, cropping, filtering, and compression. In order to preserve information on ownership rights, robust watermarks are usually used to protect copyrights.

Semifragile watermarks have been developed to detect any attempt of unauthorized modification, while allowing some image processing operations [8]. This type of watermark technique can distinguish common image processing and content-preserving noise such as impulsive noise, lossy compression or bit error from malicious content modifications.

Fragile watermarks were developed to detect any unauthorized modifications [9-13]. This type of watermark refers to the complete verification of origin and integrity, so that the smallest intentional or accidental modification of the carrier with the watermark will change or destroy the watermark. It's mainly used for authentication purposes.

Spatial domain based versus frequency domain based - There are two image domains for embedding watermarks: spatial domain and frequency domain. In the

spatial domain [14], the watermark can be inserted into the carrier by changing the gray level of some pixels of the original gray-scale carriers or pixels values in each color (RGB) channel for full color carriers. This method has the advantages of low complexity, simple implementation and low processing power needed, but the inserted information can easily be detected by computer analysis or can be easily attacked and altered. The watermark can be embedded into the coefficient of transformed image in the frequency domain [4,15]. Transformations include *discrete cosine transformation*, discrete Fourier *transform*, and *discrete wavelet transformation*. If too much data is embedded into the carrier in the frequency domain, the image quality will be significantly decreased. Spatial domain watermark techniques are usually less resistant to attacks such as compression and additional noise. However, they have a much lower computational complexity and can usually survive a cropping attack, whose watermark technique often does not succeed in the frequency domain. Another technique is the combination of watermarking of the spatial domain and a watermark of the frequency domain to increase robustness and obtain less complexity.

Classification based on application

This section categorizes digital watermarking technologies into five sections according to the following usage and applications:

Copyright protection - The idea of this kind of protection is that watermarks are invisibly inserted into a carrier that can be detected when the product of the process (output file or stream) is compared with the original. They are designed to unambiguously identify the source of the carrier, origin and its authorized users. Identification of ownership and recipients by the technique of inserting an invisible watermark attracted great interest in the printing and publishing industry. The idea of copyright protection on a digital video is the incorporation of a watermark into a video stream that transmits information about the sender and receiver and the whole process is considered more critical when delivering digital content compared to the broadcasting of analogue signals. This watermark method can enable the identification and tracking of different copies of video data.

Data authentication - According to this scenario, the watermark can be considered a handwritten signature of a document and provides a high degree of protection. By comparing the two signed documents it can be ascertained whether they were created by the same person. The user signs the digital document using his private key, which is strictly intended for this need by his mathematical and cryptographic characteristics. Digital signatures can be checked using a public key according to the principles of asymmetric cryptography, in which two keys are used that are mutually related mathematically. To all who want to perform the verification, the public key as well as the verification methodology are available.

Fingerprinting - Checking digital documents requires some reliable methods that can undoubtedly prove the authenticity of the document. Following the uniqueness of biometric characteristics in the context of human distinction, a similar principle of fingerprinting was applied to digital documents. Digital fingerprints in the form of a watermark can be applied to protect digital content from malicious attacks, detect fake and counterfeit digital content and ensure secure transmission. This allows the copyright owner to track a pirate if the digital content is abused or distributed illegally. The content of a watermark that has the role of a fingerprint is an identification number that is unique to each content user, with the goal of establishing authenticity as well as a possible source of illegally distributed copies. Such watermarks must be additionally protected by cryptographic methods.

Copy control - The main idea was to protect copyright content in digital format from illegal copying and multiplication. In the case of DVD technology, it is clearly shown how the copy control information, indicating the copying level, is added to the main data, recorded on the digital recording medium, so that the master data comprises a first part containing the image and / or voice information, and the second part containing copy control information. The digital watermark is embedded in the second part of the master data and in combination with the first part of the data provides protection against illegal copying of digital content.

Device control - Device control watermarks are embedded control access to a resource using a special verification system. The watermark with the role of the authorization code is embedded in the signal and transmitted (for example, as a television or radio program) to the verification device. For the purposes of remote control of an apparatus such as a toy, computer or device, identical technique using watermarks may be applied. A device that has the role of recognizing the existence of a watermark is equipped with a suitable detector to identify hidden signals that can trigger an action or change the state of the device. An excellent example of the application of such a technology is a system that

automatically recognizes the broadcast of paid advertisements on the media, so that the ordinary listener does not notice the existence of a hidden watermark that is only visible to systems that are set to recognize it.

3. DIGITAL WATERMARKING FUNDAMENTALS

In accordance with the classification described in the previous chapter, the basic techniques of embedding of digital watermarks will be presented in detail below. Each of these techniques is based on the appropriate idea, then the mathematical basics, the modes of implementation, the complexity of the model, the challenges of successful watermark extraction, and the degree of resistance to different types of attacks. Depending on the aforementioned characteristics of each of the techniques, a suitable application will be mentioned and proposed.

Substitutive Watermarking in the Spatial Domain - The substitutive watermarking in the spatial domain is the basic and simplest watermark algorithm [11,17]. Locations for embedding, such as specific pixel bits, whether in gray-scale or in color image, are pre-defined before embedding a watermark. When the recipient receives a watermark image, they know the exact locations as well as the corresponding number of bits from which the watermark can be extracted.

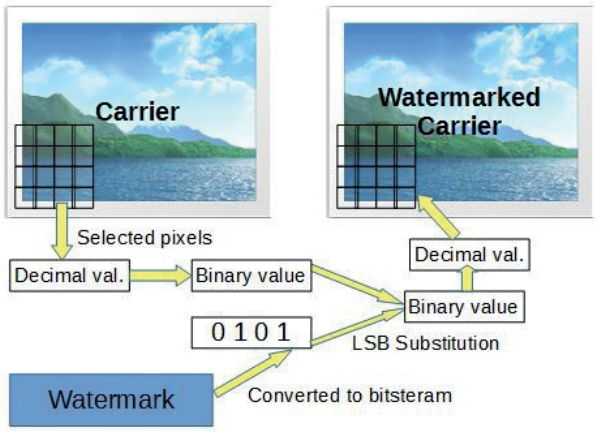


Fig 1. The substitutive watermarking embedding procedure in the spatial domain

Figure 1 shows the watermarking algorithm in the gray-scale carrier, while Figure 2 shows the reverse operation, in particular process of extracting the embedded watermark In general, the capacity of the watermark in the spatial domain is greater than the other watermark access. If the watermark is embedded in three LSBs, human beings usually can't distinguish the original image from a watermarked image. With the increase in the number of modified bits, the carrier capacity is increased, but also degrades carrier characteristics. The substitutive watermarking is easy to implement and does not require a high processing power or a large processing time. The embedded watermark is not robust against collage or lossy compression attack. For this reason, some improved spatial watermarking algorithms for enhancing robustness are proposed - for example, the hash function method and the bipolar M-sequence method [9, 11].

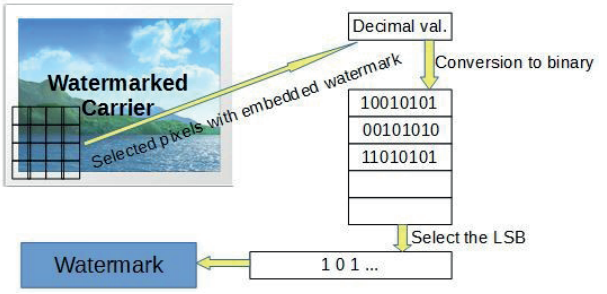


Fig 2. The watermark extracting procedure of substitutive watermarking in the spatial domain

Additive Watermarking in the Spatial Domain - Starting from the idea where the specific bits of certain pixels are not taken, the additive watermark technique has been developed. Instead of the precisely defined bits of certain pixels, only part of the watermark value in the pixel is added to perform the embedding process. If H is the original grayscale host image and W is the binary watermark image, then {h (i ,j)} and {w (i ,j)} denote their respective pixels. We can embed W into H to obtain the watermarked image H* as follows:

$$h^*(i,j) = h(i,j) + a(i,j) \cdot w(i,j) \quad (1)$$

where {a (i ,j)} denotes the scaling factor.

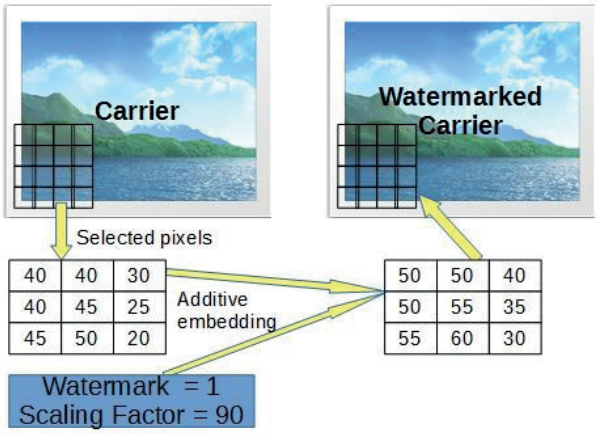


Fig 3. Method of block-based additive watermarking in the spatial domain

With the aim to enhance imperceptibility, a big value is not embedded to a single pixel, but into a dedicated block of pixels [18,19]. Figure 3. shows an example of the block-based additive watermarking. First, a 3 × 3 block is selected for embedding a watermark while the scaling factor will be 90. Second, the amount of scaling factor is divided by 9 (matrix size). Even the scaling factor is quite large, the decimal value of the pixels has not been changed too much so that when a recipient obtains the watermarked image, it is difficult to determine the embedded message since he does not know the location of the block for embedding. By this approach, we increased the robustness of the watermarked data, increased its resistance to different types of attacks and at the cost of reducing the capacity of the carrier. It is also important to select the proper value of the scaling factor according to the type of carrier and the used application of the additive watermarking.

Substitutive Watermarking in the Frequency Domain - In the frequency (or spectral) domain watermarking [6, 20], we can insert the watermark into the frequency coefficient of the image if it is previously transformed by discrete Fourier transform (DFT), discrete cosine transformation (DCT) or discrete wavelet transformation (DWT). The scheme of the substitution watermark in the frequency domain is basically similar to that of the spatial domain, except that the watermark is embedded in the frequency coefficients of the transformed carrier. The spatial coefficients of the watermarked image are obtained by inverse transformation as shown in Figure 4. By changing the specific coefficients in the frequency domain, we made a change in the corresponding number of decimal values of the pixels in the spatial domain. Such changes will adequately affect the quality and robustness of the watermarked image.

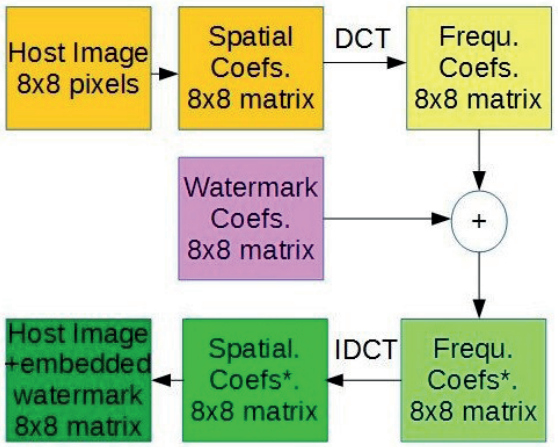


Fig 4. Algorithm of Substitutive Watermarking in the Frequency Domain

Multiplicative Watermarking in the Frequency Domain – The main idea of this method is that the watermark is scaled to the value of a specific frequency component of the transformed carrier. If H is the DCT coefficients of the carrier image and W is the random vector, then {h(m ,n)} and {w(i)} denote their respective pixels. We can embed W into H to become the watermarked image H* as follows:

$$h^*(m,n) = h(m,n)(1+\alpha(i)\cdot w(i)) \tag{2}$$

The magnitude of distortion of the watermarked image depends on the scaling factor *{α (i)}* value. It is usually set to be $0 < \alpha(i) < 1$ to provide a good trade-off between imperceptibility and robustness. An alternative embedding formula using the logarithm of the original coefficients is as follows:

$$h^*(m,n) = h(m,n)\cdot e^{\alpha(i)\cdot w(i)} \tag{3}$$

The watermark can be extracted using the inverse embedding formula, as follows:

$$w'(i) = \frac{h^*(m,n) - h(m,n)}{\alpha(i)\cdot h(m,n)} \tag{4}$$

Watermarking Based on Vector Quantization – Main idea is lossy block-based compression technique in which

vectors, instead of scalars, are quantized. Each partitioned, 2D block of pixels, maps to a final set of vectors that form a codebook that must be unique for the encoder and decoder. On the receiving side, calculation similar to cross-correlation of the vector is performed, and then the index of the vector that best fits the input block is sent to the decoder. A codebook is used to store all the vectors, their sizes and positions. For every input vector v, Euclidean distance is calculated in the search process to measure the distance between two vectors, as follows:

$$k = \arg\min_j \sqrt{\sum_i (v(i) - s_j(i))^2} \quad (5)$$

where $j = 0, 1, \ldots, N-1$. The closest Euclidean distance code word s_k is selected and transmitted to the decoder. With the same codebook, the decomposition procedure can easily extract the vector v via lookup table. Lu and Sun developed basics of the image-watermarking technique based on VQ [21]. During their proof of concept, codebook was divided into a few clusters of close code vectors with the Euclidean distance less than a given threshold. The model requires the original image for watermark extraction and the secret key was actually a part of the codebook. During the research they came to the conclusion that a tampering attack is detected if the received index is not in the same cluster as the best-match index.

Fragile Watermarks - Fragile watermarks represent a methodology and a means of ensuring that a received image can be trusted. Hidden fragile watermark will be evaluated by the recipient to see whether the image has been altered. Therefore, the fragile watermarking technique is used to detect any unauthorized modification. *Block-Based* fragile watermarks are very good described in Wong's watermarking insertion algorithm. Figure 5. shows the process of embedding a portion of the watermark W_r obtained by partitioning the watermark W, into a part of the carrier X_r obtained by dividing the carrier X. Figure 6. shows an inverse process, or the extraction of a part of the watermark E_r.

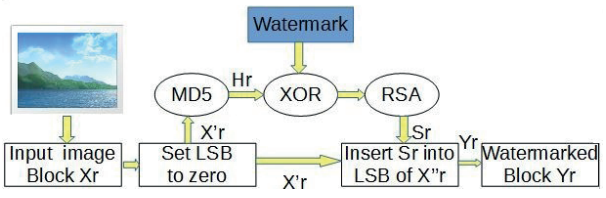


Fig 5. Wong's watermarking algorithm for data insertion

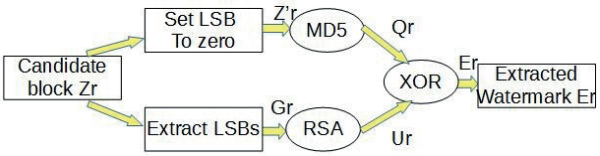


Fig 6. Wong's watermarking extraction algorithm

The idea of *Hierarchy-Based* watermarking approach is completely opposite to Wong's algorithm and it is based on breakdown of block independency. Because of the main idea of the method, it comes to the conclusion that the technique is good to defeat a VQ counterfeiting attack. Due to linking blocks to a larger entities, the embedded data not only include the information of the particular block but also possess the relative information of the higher-level blocks from the same entity. Just because of that, a VQ attack cannot estimate or recognize an image based on a codebook that only keep the information of each watermarked block.

Robust Watermarks - Robust watermarking is well chosen technique for providing security for copyright protection, which ensures that the embedded messages can survive attacks such as JPEG compression, Gaussian noise, and low-pass filtering. In order to advance robustness, *Redudant Embedding Approach* is one of the possible techniques and it's described by Epstein and McDermott patent for copy protection [22]. Cox algorithm have presented a *Spread Spectrum* – based robust watermarking algorithm in which the embedded messages are spread throughout the image [4,15]. Main idea is that the watermark is embedded in significant coefficients of host image, in frequency domain, transformed by DCT. In this way, the percent value of the significant coefficients will be the least affected.

4. ADVANCED TECHNIQUES OF DIGITAL WATERMARKING

Combinational Domain Digital Watermarking

The idea of high-capacity watermarks is minimizing image distortion while simultaneously increasing the amount of data that can be stored in the carrier. The presented technique involves combining the embedding of information in the spatial and frequency domain at the same time. The scenario is based on watermark splitting into two parts used for spatial and frequency

insertions, depending on the characteristics of the carrier, user preferences and the importance of the data. A carefully selected splitting strategy can be designed to be very complicated to make it unbeatable. Using random watermarking permutations increases robustness in order to better protect against image processing attacks such as cropping. The question is, how to insert more signals, but to keep the visual effects unperceivable? The main idea is to divide the watermark W into 2 parts, W1 and W2; to embed W1 into the spatial domain image H of the host and get H^S; then to embed W2 in the frequency domain of the host H^{DCT} domain to obtain the H^F; then execute IDCT in H^F and superpose it with H^S. The processing result will be a data of the carrier with an embedded watermark based on the combination algorithm for the watermark.

WM Based on Genetic Algorithms

Genetic algorithms, introduced by Hollard, are commonly used as adaptive approaches for providing randomized, parallel, and global search mechanisms based on natural selection and genetic principles in order to find solutions to the problem. The method is developed to improve retrieving of a noisy watermark from watermarked image if LSB substitution approach utilized as the embedding strategy and the watermark is embedded in frequency domain. Main challenge is prediction what the impacts will be in the frequency domain of a cover image if changes are made to the values of pixels in the spatial domain. GAs are considered to be the best method for solving the problem. By changing the pixel in the frequency domain, it is difficult to intuitively conclude what will happen to coefficients in a spatial domain. It is difficult to determine whether the embedded data in the frequency domain is of significance or not in the process of translating real numbers into integers. On the other hand, it's also difficult to predict how to change the corresponding pixels in order to avoid errors and to perform correct data embedding. It is therefore not only difficult to intuitively select the coefficients to be changed, but it is also very likely that such changes will lead to a very poor result. In order to solve previous problems, GA is used as an appropriate solution for rounding real numbers into integers instead of the traditional rounding approach. As GA is based on the chromosome model, reproduction, crossover and mutations, on similar principles, the theory applied in the process of embedding and extraction of watermarks.

Adjusted-Purpose Watermarking

Previous approaches have shown that all watermarking techniques are divided according two features: watermarking purpose (robust or fragile) and domain watermarking algorithm (spatial or frequency). Knowing this we are concerned with two primary issues:

1. How to adjust the approach to performing watermarking from the spatial to frequency domain?
2. How to adjust the purpose of watermarking from fragile to robust?

There are few different approaches in Adjusted Purpose Watermarking techniques:

A *morphological approach* to extracting the pixel-based (PB) features. Mathematical morphology, based on the theory of sets, can recognize the characteristics of the object by selecting a suitable structure and then perform an analysis of the selected structure and conclude on the success of a particular iteration. The analysis is of a geometric character and attempts to bring approach to the characteristics of human perception. Morphological operators deal with two images. The image being processed is referred to as the active image, and the other image, being a model. By designing and classifying different forms of structuring, it is possible to simplify the presentation of image data and explore the characteristics of shapes.

Some methods are based on selection and adjusting the variable-sized transform window (VSTW) and Quantity Factor (QF). According to two developed parameters VSTW and QF different techniques will be performed. Scenario consider watermarking in spatial domain when the VSWT=1x1 and in the frequency domain for other sizes. On the other hand, by adjusting the value of the QF, the embedded watermarks will become robust if the QF is large and become fragile if the QF is 1.

Reversibile Watermarking

Previous chapters shows that most existing fragile watermarking schemes usually makes some permanent distortions in the original image for embedding the watermark information. However, for some multimedia specific applications, such as medical diagnosis, law enforcement, and fine art, the generated distortions are not allowed. For solving that problem there are two kind of reversible data-hiding schemes proposed.

First proposed scheme is based on chaotic fragile watermarking technique. This approach consider difference of two neighboring pixels, their average values are calculated and the secret data that have to be embedded are appended to a difference value and represented as a binary number. Further, using the histogram of the pixels in the carrier image to design a reversible hiding scheme, where the pixels between the peak and zero are modified in the embedding process and the pixel in the peak point of histogram is used to carry a piece of the secret message. Proposed algorithm obtain the chaotic hash value of each image block that is computed as the watermark, which ensures that complicated nonlinear and sensitive dependence within the image' s gray features, secret key, and watermark - exists. The huge size of the key space is very important and beneficial for image authentication. Moreover, after the authentication message has been extracted, reversible watermark embedding allows the exact recovery of the original image.

Second proposed scheme is based on techniques using multiple scan difference-value histogram modification. Two metrics parameters that describe performance are important to consider with a reversible data-hiding technique. The first is the maximum payload, which is the maximum amount of data that can be embedded into an image. The second is visual quality, which is measured using the PSNR (peak signal to noise rations) between the original image and the image with embedded watermark. Three different scanning techniques are used for the construction of the difference histograms in order to maximize the payload capacity. The scanning techniques that we use are horizontal, vertical, and diagonal. Adjacent pixels are more likely to have similar values and according to this the scanning order is very important, so the result in a difference histogram that has most of its values near zero.

5. CONCLUSION

By classifying and reviewing the digital watermarking techniques, their mathematical and implementation models, as well as reviewing their specific purposes and suitable sites for use, a clear picture is obtained of the application possibilities as well as a better basic position for further analysis and improvement of implementation. It is clear that there is no universal watermark technique that will satisfy all application needs while being both simple to implement, quick to perform and resistant to various types of attacks. On the other hand, the good quality knowledge and understanding of the digital watermarking technique provides an opportunity for infinite research and improvement of existing methods of embedding, extraction and application of watermarks as well as techniques of steganography as a related scientific discipline.

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VISUALISATION TOOLS FOR DESIGN OF MARITIME SURVEILLANCE SYSTEM

Bojan Džolić[1, 2, *],
Nikola Tošić[2, 3],
Vladimir Orlić[2],
Mladen Veinović[1]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom Institute,
Belgrade, Serbia
[3]Faculty of Transport and Traffic Engineering,
University of Belgrade,
Belgrade, Serbia

Abstract:
The aim of this paper is to describe the application of Matlab for the design of the sensor network within a real-world Maritime Surveillance System. In the phase of planning and solution preparation of new Maritime Surveillance System project, it is necessary to analyse the zones of monitoring, sensors arrangement, and spatial distribution in order to make the best decision. With a goal to define the observation zone of interest, a software solution is made in Matlab using built-in functions for location computing in World Geodetic System, a graphical representation in Google Earth and a library that supports working with Google Earth formats for export. The sensors supported in this Maritime Surveillance System are Electro-Optical systems – multi-sensor cameras, X-band and Ku-band microwave radars and High Frequency Over The Horizon Radars. With this software solution, a particular sensor's observation zones, along with global coverage zone are determined at the real location. Coverage diagrams are plotted as Google Earth objects, generating a KML export file. In this way, easy manipulation over potential solutions is provided, with high flexibility and portability, leading to a more detailed assessment and decision making in Maritime Surveillance System design.

Keywords:
Maritime Surveillance System, High Frequency Over The Horizon Radar, Electro-Optical systems, MW radars, KML.

1. INTRODUCTION

Nowadays it becomes clear that control of territorial waters is not enough to ensure secure flow of goods from Exclusive Economic Zone (EEZ) [1]. More and more efforts are being made to protect the complete EEZ: a sea area stretched from territorial waters up to 200 NM in direction of open sea in which countries have exclusive rights regarding the exploration and use of marine resources of the sea. Controlling this zone represents technological, financial and organizational challenge [2]. In order to achieve better coverage of such a large area the observation zone is divided into several smaller subzones. Critical areas are ports, oil platforms, territorial waters and EEZ. According to the functionality of the sensors themselves for each of the above mentioned zones, a different type of sensor is used. The sensors typically supported in this Maritime Surveillance System are Electro-Optical systems – multi-sensor

Correspondence:
Bojan Džolić

e-mail:
bojan.dzolic@vlatacom.com

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cameras (EO), X-band and Ku-band microwave radars and High Frequency Over The Horizon Radars (HF-OTHR). The data collected from all sensors are integrated into a unique software platform. From that software platform the operators are able to monitor and track all vessels detected from the all above mentioned sensors. It is very important that integration of the sensors does not deteriorate the continuity of tracking ships.

In the first phase of MSS design, it is necessary to determine the positions of the sensors themselves in relation to the client's requirements and to make the coverage areas of all the sensors individually. The main goal is to define complete observation zone of interest using a software tool. With these software solutions, a particular sensor's observation zones, along with global coverage zone are determined at the real location. In this way, easy manipulation over potential sites is provided, with high flexibility and portability. After this phase of MSS design the field survey is coming in order to find the most favorable location for the installation of sensors. Automated approach in design phase of MSS based on HF-OTHR technology is of crucial importance, since these systems are very complex and sophisticated resolving of practical issues is more than necessary ([3] – [7]).

2. MARITIME SURVEILLANCE SYSTEM CONCEPT

The main goal of MSS is to support a large number of sensors in order to achieve effective coverage of zones of different sizes: from local zones (ports, corridors) to the complete EEZ – which logically mean a multitude of sensors.

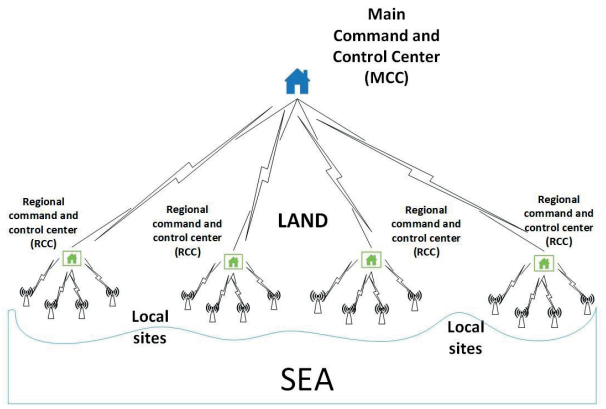


Fig. 1. Maritime Surveillance System concept

The solution is based on integration of several types of sensors into unique surveillance network that includes one main control centres (MCC) and several regional control centres (RCC), as shown on Fig. 1.

All sensors are divided in regions with Regional Command and Control centers - RCC and all RCC's are integrated in national network with the Main Command and Control center – MCC. In this way, the territorial hierarchy is achieved from the MCC down to the local site level.

In the phase of planning and solution preparation of new Maritime Surveillance System project, it is necessary to analyse the zones of monitoring, sensors arrangement, and spatial distribution in order to make the best decision. Each sensor has its own defined coverage zone, depending on type and particular model.

The following sensors are supported within our solution:

- Vlatacom Over The Horizon Radar – vHF-OTHR,
- Maritime MW X band radars – SEAFALCON,
- Electro Optical multi-sensor cameras - vMSIS3-CHD-C1200.

A MW radar type SEAFALCON [8] is a sensor with very high resolution and because of that feature it can detest very small objects, Fig. 2. Disadvantage of this radar is because this is the line of sight radar and needs to have optical visibility with the target. Because of the curve of the earth this sensor has huge limitation according to the coverage range [9], e.g. if MW radar antenna is installed on the standard telecommunication tower with the height of 50 m above the see level the maximum detection range should be around 45 km. The area that needs to be reserved for installation of the tower, generators and equipment shelter is around (30 x 30) m.

In order to achieve coverage of complete coast line the radar network of MW radars should be used.



Fig. 2. MW X-band radar - GEM LD 2325 RK, [8]

The vMSIS is a state of the art monitoring and surveillance system that integrates various high definition imaging sensors and provides long range target detection, recognition and identification based on superior sensors, optics and image processing [10]. System comprises a cooled MWIR high definition thermal imager, a color low light day/night high definition imager, and an optional SWIR imager, each of them with long range optics and a system hybrid real-time image stabilization, Fig. 3.



Fig. 3. EO camera - vMSIS3-CHD-C1200, [10]

The vMSIS camera is installed together with MW radar on a shared tower. The cameras are fully synchronized with MW radars and once the MW radar detects the object located on the see the camera will visualize that object displaying it on the screen located in MCC. Maximum coverage range for the camera is around 20 km in diameter.

The HF-OTHR is based on surface wave propagation, provides a unique capability to detect targets far beyond the conventional microwave radar coverage [2]. HF-OTHR radars use the frequency band of 3-30 MHz to provide a large coverage that could extend up to 200 NM in range [11]. It has the ability to scan the area in angle width of ±60°. A typical configuration is given in Fig. 4. The radar consists of 2 subsystems: a transmitting (Tx) antenna array, receiving (Rx) antenna array and transceiver. Dimension of the sites directly depends on working frequency [12][13], e.g. if working frequency is 7 MHz total length of the site, transmit and receive part, is around 800m.

According to the client's requests in the phase of planning the coverage zone should be calculated in advance. The maximum coverage range depends on frequency, day/night time, sea state, radiated power... In order to achieve coverage of complete EEZ the network of the sensors with overlapped coverage zones should be used [14].

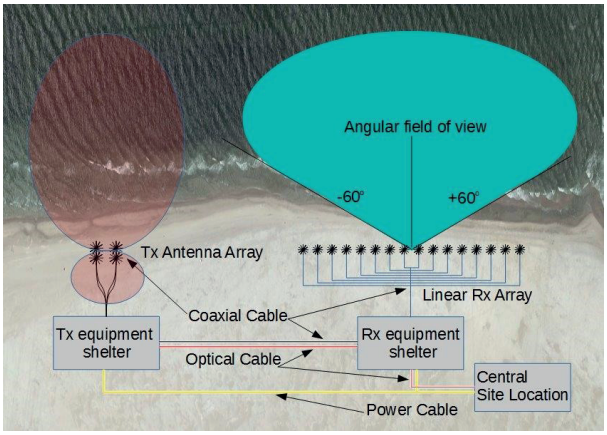


Fig. 4. Site configuration of HF-OTHR

Manual drawing polygons in the form of coverage area for all sensors for complex systems is a difficult and complicated task, so this solution provides possibility of automatically generating polygon for each sensor using the software tool.

3. APPLICATION OF THE SOFTWARE TOOL GOOGLE EARTH FOR VISUALISATION OF MSS DESIGN

In the early phase of the design of MSS is necessary to initially conduct an analysis of the coastline where the potential sensors will be installed. The analysis is done through one of the software tool for visualization of the Earth's surface.

Currently free on the market and the most represented version of this software tool is Google Earth (GE) [15]. Google Earth is a virtual globe, a map and geographic information software. This software maps the Earth through the superimposition of images obtained from satellite imaging, aerial photography and the Geographic Information System (GIS) 3D Globes. The file formats that can be displayed in GE are KML or KMZ.

A software tool that is used to automatically generate polygons for all above mentioned sensors is Matlab. It has built-in functions for location computing in World Geodetic System (WGS) [16]. A purpose of this solution is to automatically calculate and draw the observation zones of all sensors individually generating a unique KML file [15]. For a graphical representation of KML file software tool Google Earth (GE) is easily used.

Algorithm for design of MSS is shown on the Fig. 5. Using GE, it is possible to notice the free space near the

coast suitable for installing the sensors. A very useful option provided by GE is usage of measuring tools by means of obtaining information about the distance between potential locations and thereby obtaining awareness of sensors arrangement and spatial distribution in order to make the best decision. After placing the placemark for the potential sites, on the basis of the previous analysis of the coast, it is necessary to export all of those potential sites with the geographical coordinates in one unique Comma-Separated Values (CSV) file. CSV is a "text-based" format. It is two dimensional structures consisting of rows of data, each row containing multiple cells [17]. Each row carries information about sensors. Cells, from each row, carry information about name of the sensors, maximum range, latitude, longitude, and true north, respectively. Fig. 6 shows an example of CSV file.

For calculating the coverage area of the HF-OTH radar is necessary to use predefined CSV file which carries information about name of the sensors, maximum range, geographic position of the receiving (Rx) antenna array and angle relative to the north (true north), Fig. 4. A program defines a distance to the TX array, as well as a position of the TX array. After compiling the code, a program automatically draw the polygon with the coordinates of the circular sector of the angle of 120° for each potential HF-OTHR site.

For calculating the coverage area of the MW radar and the EO camera is necessary to use predefined CSV file which carries information about name of the sensors, maximum range and geographic position of potential site. A program defines a distance to the HF-OTHR (if the HF-OTHR site is planned to be installed at the same area), as well as a position of the tower which carries the sensors itself. After compiling the code, a program automatically draws the polygon which presents covering area of the sensors.

Next step is to define a path of the CSV file into Matlab code. After running Matlab code, the code draws coverage areas of all sensors in the form of a polygon and generates a KML file suitable for re-display in software tool for the visualization of these polygons. The KML file specifies a set of features (place marks, images, polygons, 3D models, textual descriptions, etc.) that can be displayed on maps in geospatial software implementing the KML encoding. After loading the KML file generated by the Matlab code, GE displays the complete coverage area.

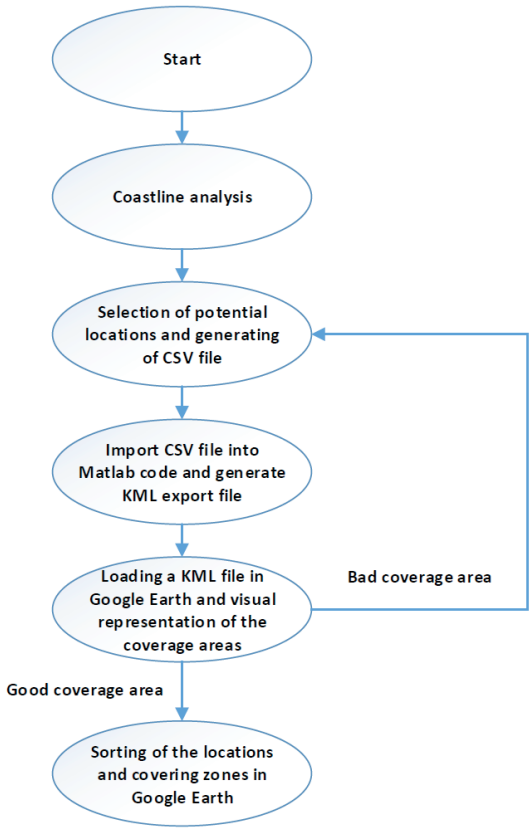


Fig. 5. Algorithm for design of MSS

othr1	200	-35.4673	-57.1432	193
othr2	200	-36.8675	-56.6671	170.76
othr3	360	-37.3801	-57.0488	201.44
othr4	360	-38.3078	-57.8906	244.25
othr5	360	-38.7874	-59.6397	253.92
othr6	200	-39.6224	-62.1089	200.84

Fig. 6. CSV file format

If global coverage is homogeneous, without interruptions and "holes" in the area of coverage of the EEZ, this KML file is adopted as a potential solution and goes to the next phase of the design of the solution, Fig. 5. That phase is the field survey and search for the best permanent location in the vicinity of the predefined potential location from GE.

If global coverage is not homogeneous and has interruptions and "holes" in the coverage area of the EEZ is necessary to do the rearrangement of the sensor In GE and repeat procedure from point in algorithm showed on Fig. 5-Selection of potential locations, until the covering area is fully covered by all installed sensors.

4. VISUAL REPRESENTATION OF THE ACHIEVED RESULTS

The required data for calculating the archived coverage area for all sensors used in MSS are the geographical location of potential locations where sensors would be installed, coverage range and true north. Following three figures show through examples how the polygons, generated by our code in Matlab, look for each sensor individually. In the Fig. 7 a polygon generated in Mablab and displayed in GE for HF-OTHR is presented. In the Fig. 8 a polygon generated in Mablab and displayed in GE for MW radar is presented. In the Fig. 9 a polygon generated in Mablab and displayed in GE for EO system is presented.

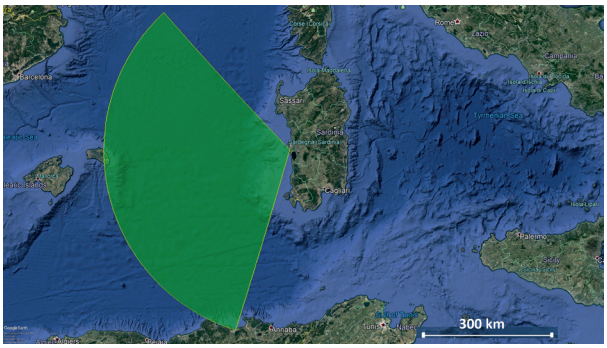


Fig. 7. HF-OTHR polygon generated in Matlab and displayed in GE

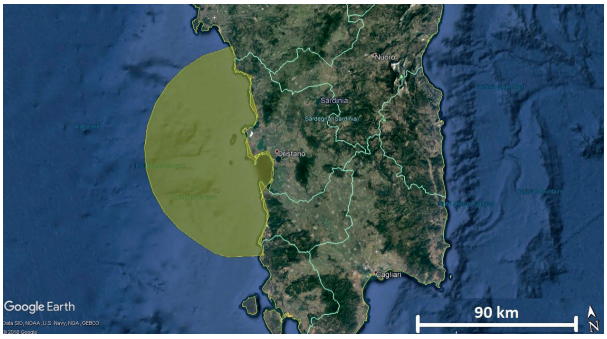


Fig. 8. MW radar polygon generated in Matlab and displayed in GE

In order to present a complete sensors network Sardinia island was used for demonstration, Fig. 10. From the Fig. 10 can be noticed all the coverage areas for the following sensors: Over the Horizon Radar (OTHR) – green color, MW radar – yellow color, EO camera – blue color. Also, compleate sea area is fully covered by the sensors. The global coverage is homogeneous, without interruptions and "holes" in the area of coverage of the EEZ, so this would represent an example of successive MSS design.

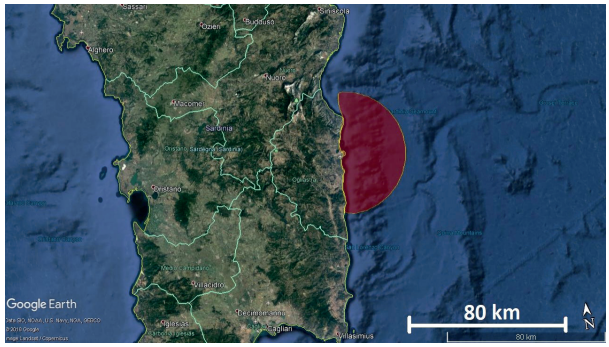


Fig. 9. EO camera polygon generated in Matlab and displayed in GE

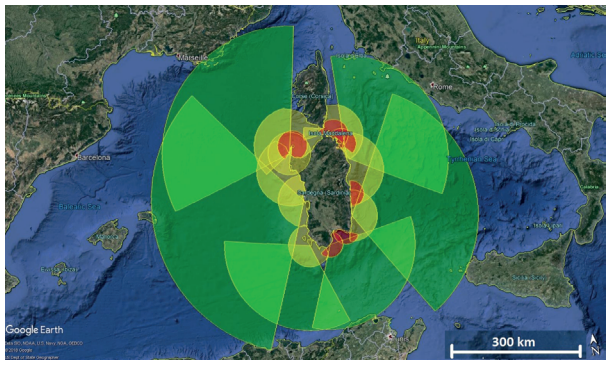


Fig. 10. Total coverage area polygons generated in Matlab and displayed in GE

In the Fig. 11 GE structure of the imported polygons and position of the sensors is presented. The structure of graphic elements is complex and includes a large number of individual polygons. Polygons are loaded in the layers, so for the analysis purpose only one type of the sensors can be displayed, or all sensors from only one site can be displayed, etc.

Easy manipulation with particular elements, editing and importing on various maps in just a few steps represents the obvious advantage of implemented solution over any manual design and hand-made manipulations over a number of objects.

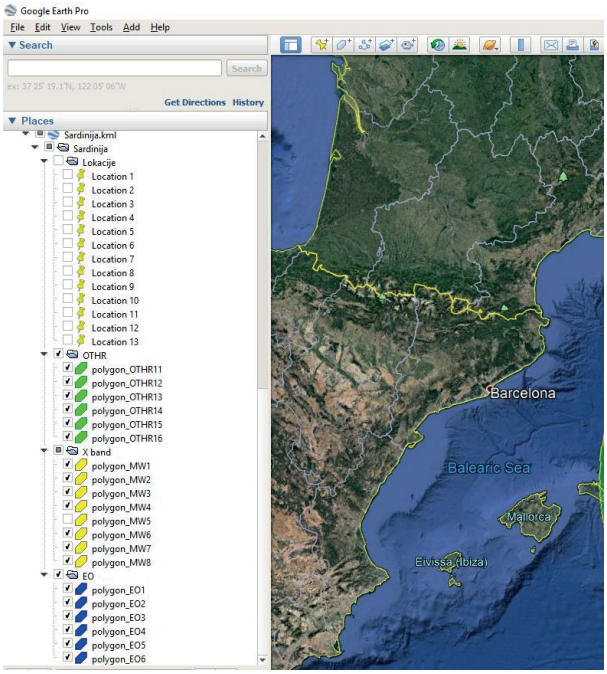


Fig. 11. Google Earth structure of the imported polygons

5. CONCLUSIONS

We are all witnesses to changes in the society and entangled paradigms. Over the past few decades we have seen increased threats of terrorism, smuggling, theft of national wealth, etc. With all those global events monitoring of the EEZ becomes almost mandatory. It is safe to assume that this type of MSS, which can provide monitoring of complete EEZ, will find the place in global use in the near future.

In this paper main focus is given to provide solution which is completely automated, fully reconfigurable and easy to import in software tool for the visual representation, such as GE. Taking into account all these aspects, together with careful system design of each sensor in the network leads to complete EEZ monitoring. This solution found place in practical application. It is used to make solutions for the Vlatacom Institute, also applied to already operational MSS around the world.

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DEEP LEARNING APPLICATIONS IN MOBILE NETWORKS

Dejan Dašić[1, 2, *],
Miljan Vučetić[2],
Gardelito Hew A Kee[3],
Miloš Stanković[1, 2]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom Institute,
Belgrade, Serbia
[3]European University,
Belgrade, Serbia

Abstract:
The expected deployment of 5G networks, growing percentages of mobile networks' market penetration levels and increasing popularity of mobile applications induce new challenges and requirements for mobile network operators. One of the ways of tackling these new challenges is the deployment of advanced machine learning techniques in hopes of handling expected traffic volumes, performing real-time analytics and managing network resources. The paper presents the aspects of mobile networking in which deep learning methods can be implemented. After presenting the basic background and modern deep learning techniques and related technologies, paper presents an overview of the current advances made in these research areas. The paper also identifies the fields within the realm of mobile networking that show particular potential for new exploration.

Keywords:
Deep learning, mobile networks, mobile data analysis, network security, signal processing.

1. INTRODUCTION

Modern day and upcoming mobile networks generate immense volumes of various heterogeneous data. Implementation of deep learning structures and algorithms, as opposed to traditional machine learning (ML), is advised as the performance of deep learning increases significantly with the growth of size of training data sets. Furthermore, training deep NNs with big data sets prevents model over-fitting. On the other hand, application of Stochastic Gradient Descent (SGD) training method to NNs requires only sub-sets of data at each training step, guarantying scalability of deep learning with big data [1].

Data generated in mobile networks is heterogeneous and noisy in nature and exhibits complex spatial and temporal patterns [2]. These features only amplify another advantage of deep learning over traditional ML algorithms, which is the ability of extraction of high-level features from the data of complex structure and with inner correlations. Labeling of such data would otherwise require significant human effort, which is costly [3].

Correspondence:
Dejan Dašić

e-mail:
dejan.dasic@vlatacom.com

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Another advantage of implementation of deep learning over traditional machine learning in the area of mobile networking comes from the fact that deep learning provides several methods which enable use of unlabeled data for the purposes of extraction of useful patterns through unsupervised learning. This is important as most current mobile systems generate semi-labeled or unlabeled data [2].

In the following section (section II) the paper introduces the basics of deep learning, giving the explanation of the neural network (NN) and briefly presenting the deep learning architectures referenced in the sections to follow. In section III we name the areas within mobile networking in which implementations of deep learning have been investigated by the researchers. A brief overview of the advances in these application areas is also presented. Section IV concludes the paper, summarizes some of the challenges and sheds light on future research directions.

2. DEEP LEARNING BASICS

Deep Learning is a subfield of Machine Learning dealing with structures and algorithms meant to mimic the operation of the human brain. The best-known model to serve as the basis for deep learning is an artificial neural network. Neural network, imitating the brain structure, is comprised of layers of neurons, interconnected by weighted connections. For the purposes of modeling such structures the neurons can be considered as variables and the weights assigned to connections between them can be regarded as parameters. The purpose of network training is to configure the network parameters is such a way so as to ensure that the desired set of inputs causes the desired set of outputs [4]. The term "deep" neural network refers only to neural networks with sufficient number of hidden layers. Implementation of deep learning models enables making predictions, classifications or decisions based on the input set of data without explicitly programming, but rather learning the network. Other structures, beside deep neural networks, comprising of multiple layers, such as deep random forests [5] or deep Gaussian processes [6] can also be considered deep learning structures.

One of the structures widely used in deep learning applications is the Multilayer Perceptron (MLP). It represents a network of several layers of operations whose outputs depend on the inputs applied with weights and biases [7]. Being the original artificial neural network it was also the most popular one in the past. But due to its fully-connected units between layers contributing to its complexity, this architecture is growing less popular. It is, however, used in more complex structures like Convolutional Neural Networks (CNNs).

Unlike MLPs that employ full set of connections between the layers, CNNs use a set of locally connected filters in order to extract correlations between data regions. This gives CNNs extraordinary performance in imaging applications[8].

Another widely used architecture in machine learning is a Restricted Boltzmann Machine (RBM). RBMs are structures made of two layers – a, so called, visible and a hidden layer – in which units can take binary values with certain probabilities. Hidden units are fully connected to visible ones with weights, but unlike in MLPs where the hidden layers are affected by the inputs (visible layer) – here the hidden layer affects the visible layer as well. Several RBMs stacked together form a structure called a Deep Belief Network (DBN) [9].

Auto-Encoders (AE) are unsupervised learning structures that attempt to copy their inputs to their outputs over several hidden layers between them, while performing dimensionality reduction in the process [10].

Recurrent Neural Networks (RNN) is a structure whose current state depends on the inputs as well as the previous states of the network. As such, these networks are well suited for modelling sequential data [11].

An idea of remembering the state of the network in order to use it in the future is maybe best implemented in Long Short-Term Memory (LSTM) networks in which each unit has three gates (input, output, forget) by which to control the information flow to itself [12].

Generative Adversarial Network (GAN) is a framework in which two models, i.e. neural networks, are trained simultaneously. One model is a generative one and it tries to approximate the target data distribution from the training set data, whereas the other model is a discriminative one trying to guess if the sample at its input comes from the real training data or the output of a "counter-part" generative network [13].

All of the structures named previously can be trained using one or more of the three machine learning training approaches: unsupervised learning, supervised learning and reinforcement learning.

Supervised learning is the teaching method in which the network is fed with labeled data pairs (input-output) in order to produce a desired output for a given input. Unsupervised learning is a learning method without the labeled data in which the network is expected to perform

some classification of the input data based on the existence of commonalities within the data samples. Reinforcement learning is a paradigm which introduces an idea of a reward, whereas the actions of certain agent influence the environment to a new state and bring about the reward for that action. The reward and the new state form basis for a new action of the agent. Reinforcement learning is an attempt to approximate the environment so as to maximize the rewards [14] .

3. DEEP LEARNING APPLICATIONS IN MOBILE NETWORKS

In the following subsections we describe the areas of mobile networking in which deep learning has made significant advances:

Mobile Data Analysis

Sources of data within the mobile network include infrastructure elements' metadata, performance indicators, call records, radio information, end user devices, user profiles, applications and sensors on end devices. This makes mobile networks a true big data source with the data storage being partly cloud-based and partly edge-based. Authors in [15] categorize mobile network data into a group of *network-level* data and *application-level* data based on the data source localization.

Network-level data

Part of the reason for spatial and temporal variations in *network-level* data is users' varying behavior [16]. This fact makes this data good basis for user mobility analysis and public transportation planning [17], as well as network diagnosis and management.

Part of the efforts employing network-level data goes to the aim of *network state prediction*. These activities relate to prediction of network traffic or performance indicators while considering historical measurements or related data. Authors in [18] demonstrate high accuracy of prediction of Quality of Experience (QoE) by employing MLPs and using objective metrics such as average user throughput, number of active users in a cell, average data volume per user, and channel quality indicators as their inputs. Part of the efforts goes into implementation of deep learning with the idea of city-scale mobile traffic forecasting, by using spatio-temporal correlations of geographic mobile traffic measurements. A time sequence of mobile traffic data measurements taken over a region is used to predict mobile traffic in future time instances. Authors in [19] implement AEs for extraction of spatial feature and dimension reduction and then process the extracted representations by LSTMs in order to perform the final forecasting. This arrangement applied to real-world datasets shows performance superior to Support-Vector Machines (SVM) and the Autoregressive Integrated Moving Average (ARIMA) model. Some authors ([20], [21], [22] and [23]) employ deep learning to CNNs and LSTMs for the purpose of mobile traffic forecasting. They also show accuracy higher than traditional methods such as ARIMA. Some authors inspired by techniques of image super resolution [17] investigate the possibility of employing dedicated CNNs in combination with GAN in order to predict with fine resolution the network-wide mobile traffic consumption by using coarse-grained measurements. This is done in hopes of reducing measurement overhead. Read-world dataset experiments show improvement in measurement granularity of up to 100 times.

Another area of research interest of using network-level data in deep learning implementation is *mobile traffic classification*. Deep AEs have been used by authors in [24] to identify protocols in TCP flow datasets with great precision. For the purposes of encrypted traffic classification authors in [25] used MLPs, CNNs and LSTMs. For the same purpose authors in [26] propose a 1D CNN which seems to be a promising architecture due to its reduced complexity. CNN structures are also used for the purpose of identification of malware traffic in [27] where mobile data are regarded as images. Representation learning is then used to classify unusual patterns which represent malware traffic.

Part of the network-level data resides in the Call Data Register (CDR) and *mining of CDR data* can provide useful information. As RNNs are well suited for sequential data analysis, in [28] user trajectories from streaming CDR data are considered as sequence of locations and RNNs are used to estimate metro density. CDR data are also used in [29] where CNNs are employed for the purposes of users' gender and age predictions.

Application-level data

Application-level data is sourced from various mobile devices. The devices act as local sensor hubs used for

data collection and preprocessing [30]. This heterogeneous data, from sources such as GPS sensors, accelerometers, mobile cameras and video recorders, even portable medical monitors can be collected through crowd-sourcing schemes for further analysis. This data is highly related to user's profile and thus reflects users' behavior, such as mobility, preferences and personal communication patterns [31]. Extraction of this data can be used in recommender systems and user targeted advertising. Some of this data is private. Extraction of useful patterns from end-user multi-modal sensing devices without raising privacy issues is still a challenge.

Two approaches are implemented in application-level mobile data analysis. One is cloud-based computing and the other is edge-based computing; difference between the two being the localization of the actual computing object. In cloud-based computing the inference is done in a cloud and the results are sent to edge devices, whereas in edge-based computing models are deployed on edge devices themselves which perform local calculations.

One popular use of application-level data is in the area of *mobile health* where wearable sensors capture physical condition data of or around their users. In one such application sensory devices are used to warn disabled persons (deaf) of the various recognized emergency situations [32]. In other works deep learning networks are used to classify lifestyle of users based on wearable devices sensory information or to perform edge-computing health monitoring.

Significant interest and use of application-level mobile data is seen in the area of *pattern recognition*, be it for object classification or activity recognition. Some research is this area [33] investigates the possibility of employing CNNs on mobile devices for the purpose of object recognition. Authors compare task performance on CPU, GPU and mobile platforms and show the possibility of successful implementation of such platform on a mobile device. Efforts in the field of activity recognition range from recognition of human activity by analysis of offline smart phone datasets gathered by accelerometers and gyroscopes [34] or the analysis of sensory data collected by a smart watch by using RBM [35] to designing a virtual "X-ray" machine to recognize human poses based on radio frequency signals analyzed by a proposed 4D CNN framework [36].

Application-level mobile data is also used in the area of *Automatic Speech Recognition (ASR)*. Work in [37] presents a specific architecture in a CNN model which facilitates ASR using mobile multi-microphone devices in noisy environments. In [38] authors propose and evaluate a new deep learning framework for the purpose of multi-task audio sensing. They test on a smartphone performing the tasks of speaker identification, emotion recognition, stress detection, and ambient scene analysis and show great accuracy while achieving high runtime, memory and energy efficiency.

Mobility Analysis

Movement patterns of individuals groups that can be extracted from mobile network data can be a highly useful resource in the processes of urban planning or public service provisioning, or network resource management. Due to its ability to extract spatial dependencies in sequential data deep learning is well suited for mobility analysis. Authors in [39] employ LSTM networks to model the joint movement patterns of a large group of people and vehicles city-wide. In [40] authors use RNNs to perform short-term mobility forecasting on a real-world deployment dataset and show accuracy superior to traditional, non-deep approaches.

User Localization

Location based applications and services in mobile network environment require knowledge of individual user positioning. Some work of implementing deep learning to this end is presented in [41] where the authors use crowd-sensed geo-tagged received signal strength information to learn an MLP of the correlation between the cellular signals and the location of the users.

Network Control

Advances made by deep learning, based on its powerful function approximation mechanism, in improving traditional reinforcement learning and imitation learning gave rise to efforts of tackling network control problem known for their complexity. Besides reinforcement learning and imitation learning the approach implemented in network control is analysis-based control. Analysis-based control does not output actions directly, as do the reinforcement and imitation learning approaches, but rather extracts the useful information and provides it to an agent for further action.

One form of network control is *network optimization* which means management of network resources in

order to improve network performance. Utilization of mobile data analytics enables prediction of spatial and temporal changes in the requirements for network resources [31]. This means that the network operators can allocate radio resources in the manner required so as to optimally fulfil the user demand. Authors in [42] use LSTMs to predict traffic load at base station in ultra-dense networks. Based on these predictions they change resource allocation policy so as to avoid congestion. Authors in [43] make use of the RNN for traffic prediction with the idea to help dynamic spectrum assignment in a mobile network. Some research investigates network operation under adversarial circumstances. Authors in [43-14] address the issue of anti-jamming communication in unknown and dynamic environments with a deep reinforcement learning agent. They combine deep Q-network with CNN and take raw spectrum information as the input. With limited prior knowledge of the environment they improve the network throughput.

Network Security

Network security deals with the protection of network resources and entities from unauthorized access, information leakage and malicious attacks. This function is achieved by implementation of firewalls, anti-virus software and intrusion detection systems. Modern day cyber security systems implement deep learning both in the forms of supervised and unsupervised learning. Application of supervised learning enables recognition of undesired signatures and patterns from previous experience and their generalization applied to future intrusions. Application of unsupervised learning enables identification of patterns clearly different from normal behavior. One thing of importance to consider is that besides the protection perspective, deep learning can also be used from the attack perspective.

On the *infrastructure level* research goes in the direction of identification of network events that fall out of expected behavior, thus indicating a possible attack. Stacked AE is used to categorize network traffic with high accuracy [44] or in combination with MLP for feature selection and extraction [45]. AEs are also used in [46] to detect abnormal spectrum usage.

Security on a *software level* addresses mainly the issues of smartphone malware and botnets in modern mobile networks. Deep learning is implemented for analysis and detection of these threats.

RBMs are used in [47] to classify Android malware by training on both labeled and unlabeled mobile applications. Other approaches to tackling the malware detection go the way of analysis of essential application features, where the malware features are extracted by DBNs and SVMs are used for classification. CNNs are also used in malware detection. In [48] detection of malware is done by employing CNNs to detect sequences of opcodes indicative of malware from a disassembled byte-code of an application used as text for analysis.

MLPs or LSTMs can be used for the purpose of detection of botnets through feature extraction from mobile botnet behaviors.

Security implementations of deep learning on a level of *user privacy* are in good part concerned with preservation of user private data in the process training and evaluating a deep neural network. In several studies researchers implement a deep learning framework partitioned across the cloud and mobile devices, where the feature extraction actions are performed on the mobile devices and classification is performed in the cloud. Local processing of input data ensures strong privacy guarantees.

Another implementation of deep learning networks in research has been for performing cyber-attacks with the purpose of compromising private user information or predicting, i.e. guessing passwords. GAN architectures are mostly used for these purposes. Various deep learning architectures are used in [49] in order to perform side channel key recovery attacks. Compared to other template machine learning attacks, deep learning based methods show better performance in breaking unprotected or protected implementations of Advanced Encryption Standard. Research in [50] shows that CNNs can guess with high accuracy the list of active applications run on a smartphone using only data on orientation and data from a magnetometer. Should data from motion sensors be added to the list of used data, the accuracy levels would reach 98% which could pose a threat to user privacy. Research also shows that injection of Gaussian noise to the used data significantly reduces inference accuracy, thus mitigating the threat to user privacy.

Signal Processing

Deep learning techniques are finding their ground in signal processing application, mostly in the areas of Multiple-Input-Multiple-Output (MIMO) processing and modulation.

Deep learning helps optimize MIMO performance based on environmental conditions. MLP based networks

are investigated as possible estimators of transmitted vectors in a MIMO channel in [51] where simulations show that this architecture achieves high accuracy with light computation requirement.

For the purposes of channel estimation and signal detection researchers use CNNs as well as MLPs.

Researchers in [52] suggest implementation of non-iterative neural networks for the purpose of control of transmit power of base stations with the aim of preventing inter-cell interference. Neural network estimates the optimal transmit power at every packet transmission. Simulations show performance better than that of a currently used belief propagation algorithm.

Researchers in [53] bring deep learning to physical layer design. Authors observe and treat a single-user end-to-end MIMO system as an unsupervised deep AE in which MLP followed by a normalization layer forms the transmitter. The receiver is formed of another MLP and a Gaussian noise layer acts as the channel. Experiments show that such an AE system performs considerably better than the Space Time Block Code approach.

Tests of deep learning platforms regarding modulation recognition show that LSTMs are the best candidates for performing this task. However, it has been proven that CNNs can also provide satisfying accuracy in modulation classification.

4. CONCLUSION

In this paper, current and future applications of deep learning techniques to mobile networking have been discussed. Advantages of using these techniques in several areas of mobile networks have been stressed.

Certain drawbacks of deep learning do, however, restrict its applicability in mobile networking. Deep learning is, generally speaking, vulnerable to adversarial examples. It is also known low interpretability and requires massive volumes of data to training.

One direction of future efforts in the mobile networking applications of deep learning can be expected to be creation of massive high-quality datasets for the purposes of networks' training. Because of the rising importance of location based services, advances in the field of application of deep learning for the purposes of spatio-temporal data mining can also be expected [54]. Due to large amounts of unlabeled data created by the networks, future research efforts can also be expected in the field of unsupervised learning with the goal of labeling and classifying said data. For the purposes of network control, developments in the field of (deep) reinforcement learning applications are foreseen.

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MULTISENSOR IMAGING SYSTEM VIDEO INTERFACE IMPLEMENTATION IN FPGA

Nikola Latinović[1,*],
Ilija Popadić[2],
Petar Milanović[2],
Miroslav Perić[2],
Mladen Veinović[1]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom Institute,
Belgrade, Serbia

Abstract:
In this paper we describe practical implementation of FPGA based solution for converting signal from cameras with HD-SDI, analogue and camera link interfaces to common HDMI format. Main challenges like: frame rate equalization, image resolution adaptation and acts in case of camera connection loss are described in details. As a practical example we gave details about system with HD-SDI visible light camera, HD MWIR camera and analogue SWIR camera. In order to achieve target visibility in different day/night and meteorological conditions a multi-sensor imaging system combines signals from visible light camera, short wave infrared (SWIR) camera and medium (MWIR) or long (LWIR) wave infrared camera. Usually cameras originate from different vendor, with different interfaces, resolutions and frame rate. In order to enable further processing like image stabilization, enhancement, target tracking and image fusion, formats from all cameras should be converted to the same format.

Keywords:
Video, Multi-sensor, FPGA, Digital Signal Processing, Electro-Optical System.

1. INTRODUCTION

Multi-sensor imaging surveillance systems are under constant development and upgrade and have the large application in both civil and military defence [1]. The basic idea of Multi-sensor system is to combine data from different types of sensors (thermal sensors [2], colour cameras, low light cameras [3], SWIR cameras [4], laser range finders [5], etc.), process them for better situational awareness.

One example of multi-sensor system can be found in Figure 1, VMSIS3-C1200T [6] with courtesy of Vlatacom Institute. In most of these systems we can find a main multi-core CPU dedicated for Digital Video Signal Processing. It is usually a powerful hardware processor in which one can apply most of the Signal Processing Algorithms. Usually, the main CPU has to have unique video source input, but cameras originate from different vendors and have different types of interface, resolution and frame rate.

Our approach is to achieve a unified interfacing solution and implement it on an FPGA [7] architecture to convert any kind of input camera

Correspondence:
Nikola Latinović

e-mail:
nikola.latinovic@vlatacom.com

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interface to common HDMI [8] interface of any resolution and frame rate, according to input camera synchronization signals. In our particular case, it has also been developed a dedicated hardware platform which main parts are interface board, FPGA carrier board and main processor carrier board. For main processor we have decided to use Nvidia Jetson TX2 [9], which has a powerful hardware structure dedicated for Video Signal Processing. The main accent in this paper is on FPGA implementation for collecting video input data from interface board (with different types of connectors and interfaces) and converting that data into HDMI parallel data.

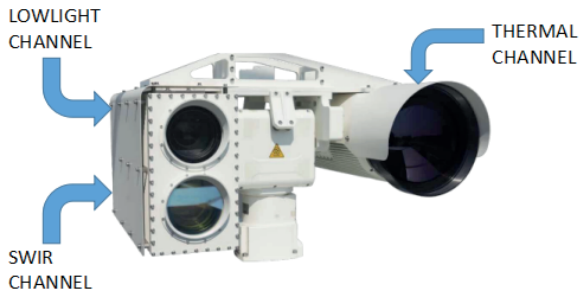


Figure 1. Multi-Sensor Imaging System - VMSIS3-C1200T

2. SYSTEM ARCHITECTURE

Entire system block design is shown in Figure 2. The main idea is to create a unified video signal processing platform which takes an input from various camera interface, prepares the data for main processor, which is in this case, NVIDIA Jetson TX2, and outputs the live stream via Ethernet interface. This applies for single channel camera streams.

For multi-sensor platform, these modules can be multiplied, with one main processor as a master channel, which controls the other channels. NVIDIA Jetson TX2 is capable to provide multiple stream views via Ethernet interface. The main operator PC should be used in this case with console application that sends and receive commands to/from master channel controller. All Video Signal Processing like image fusion, tracking, motion detection, pseudo-colouring, etc. Can be implemented on NVIDIA Jetson TX2, which is multicore platform with 256 parallel GPU CUDA [10] cores.

In the input stage, chipset for input pipeline is dedicated to convert data from any camera interface to parallel data that represents an input for FPGA processing. FPGA then converts input parallel data to HDMI parallel data and outputs it towards the output chipset pipeline which then converts this data into HDMI stream in first stage and to MIPI-CSI2 in the second stage. MIPI-CSI2 [11] lines are input for main Video Processing Unit (NVIDIA Jetson TX2).

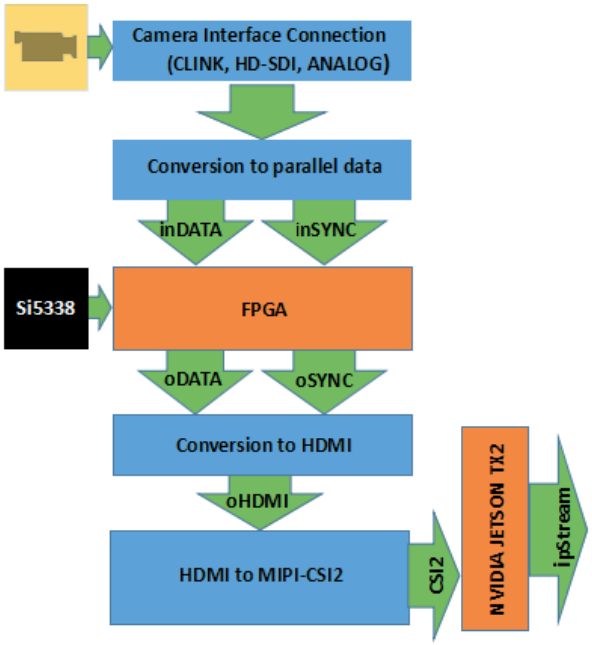


Figure 2. System Block Design

3. FPGA SIGNAL PROCESSING ARCHITECTURE

FPGA System Architecture is shown in Figure 3. The purpose of this design is to detect the presence of input camera, converts its format to appropriate format for the main CPU and outputs that format towards the CPU.

Signals from Camera interface are being converted to parallel data stream in the input stage pipeline and that represents the input for FPGA design. After the processing is done, the FPGA outputs processed data stream, according to HDMI standard towards the output pipeline, which converts parallel HDMI data to common HDMI video signal.

When Camera is present and powered on, the input stage pipeline delivers the parallel data from camera input interface. These parallel data can be divided into two sections:

- Synchronization signals (4 lines)
- Data signals (up to 24 lines)

Synchronization signals are Frame Valid, Line Valid, Data Valid and Pixel Clock. Those signals serve as an input to **Dual Port RAM** module. When Data Valid signal is active, pixel data from Data signals are been written to memory, synchronous to Camera Clock (Pixel Clock). When Frame Valid Signal is active, the Memory Address for writing data has been reset so the entire frame is written to Memory.

HDMI Driver module produces the four synchronization signals according to HDMI standard. Those signals are input for the reading side of the Dual Port RAM module. When Data Valid Signal is active, data is been read from Memory and outputted toward the main processor, synchronous to Camera Clock. When Frame Valid Signal is active, the read address has been reset, so that we read from beginning of the frame.

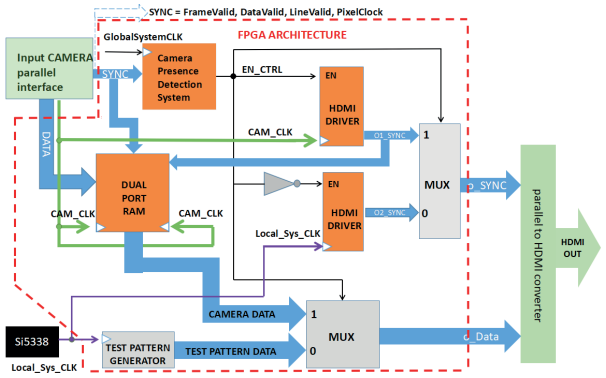


Figure 3. FPGA System Architecture

The **Camera Presence Detection System** module is designed to monitor the input synchronization signals from camera interface. If the synchronization signals are in expected values (defined by constants inside the module), the **Camera Presence Detection System** outputs a logical 1 and enables the HDMI Driver which is driven by Camera Clock, so the live stream from camera is outputted to main CPU. If the synchronization signals are not in expected values, the **Camera Presence Detection System** outputs a logical 0, which enables the HDMI Driver that is driven by Local System Clock and Test Pattern image is outputted to main CPU.

Test Pattern Generator is a VHDL module designed to output Greyscale pixel data driven by Local System Clock, so that, in case of absence or malfunction of camera, the test pattern image is streamed.

The FPGA projects for various input camera interfaces are designed to work in 3 different clock domains: Camera Clock (13.5 - 74.25MHz), Global System Clock (100MHz) and Local System Clock (13.5 - 74.25MHz) based on Si5338 IC [12], which configuration depends on input camera clock. Si5338 is a precise quad clock generator and it is configurable by I2C interface via main processor.

Camera Input Clock is used for live streaming picture from input camera.

Local System Clock is used to stream test pattern image when input camera is not plugged or malfunctioning.

Global System Clock is used to monitor all processes in project design and to trigger resynchronization between input and output image streams in case when switching from Test Pattern to live stream and vice versa.

4. PRACTICAL IMPLEMENTATION

For practical implementation, on Figures 4 and 5 we can see an example of design of printed circuit board (PCB) - an FPGA Carrier Board (FCB). On the figures below are displayed top and bottom layer design.

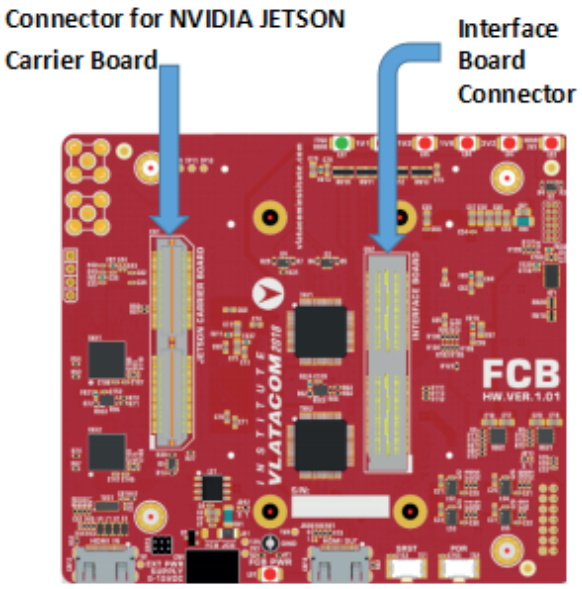


Figure 4. Top Layer View of PCB - FCB

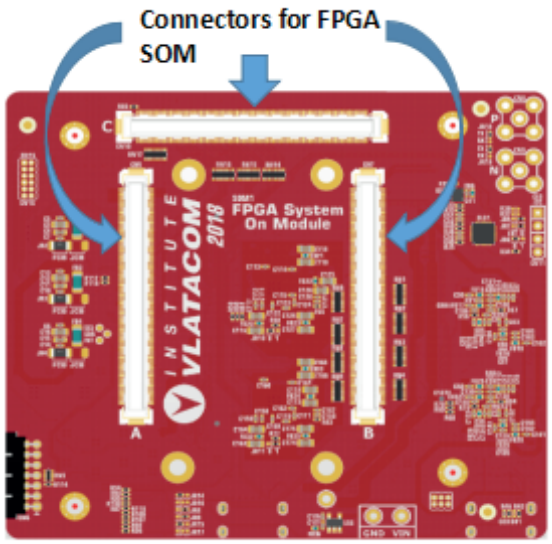


Figure 5. Bottom Layer View of PCB - FCB

As it is shown in the figures above, the PCB is designed to be modular, so it has a few connectors for interfacing a main processor board, camera interface boards (Camera Link [13], Analog [14], HD-SDI [15]) and FPGA System on Module (SOM). FPGA SOM and main processor board can be a custom board, according to requirements. Camera interface board is connected to FCB according to the input camera interface type and appropriate FPGA bitstream is downloaded to FPGA SOM.

For Multi-sensor imaging system shown on Figure 1, the described hardware is present on every channel. Characteristics of each channel and parameter settings can be seen in Table 1.

The parameters from table describe input camera sensor characteristics as well as some core settings for FPGA projects, for each camera. It is important to notice configuration for Local System Clock, which is configurable by I2C interface via main processor. For each channel there is a clock setting for transferring 30 frames per second or 60 frames per second, depending on project needs and applied video processing algorithms on main CPU. The Functional block design of Si5338 Clock generator can be found in Figure 6. The input internal oscillator has a base frequency of 24MHz.

As we can see in the Table 1, for Lowlight Channel size of FIFO buffer is quarter from full resolution. That is because in particular FPGA module there is not enough block RAMs for entire frame to store. Because of lack of memory resources, the synchronization between input and output Frame Valid signal is implemented, so we can read entire frame from beginning. This lack of memory can be avoided by adding one DDR4 external RAM module. FPGA used for this project is from Xilinx Kintex 7 Ultrascale plus series [16].

Table 1. Implemented version of fpga architecture in VMSIS3-C1200T

Resolution	1920x1080	720x576	1280x720
FPS	30/60	25/50	30/60
Data Type	YCbCr	YCbCr	RGB - Mono
Interface	HD-SDI	Analog	Camera Link
Scanning Type	Progressive	Interlaced	Progressive
Pixel Clock	74.25MHz	27MHz	74.25MHz
Local System Clock	37.125/74.25MHz	13.5/27MHz	37.125/74.25MHz
Global System Clock	100MHz	100MHz	100MHz
Dual Port RAM FIFO size	480x1080x20bit	720x576x20bit	1280x720x8bit
HDMI frame size	1920x1080	720x576	1280x720
HDMI extended frame size	2200x1125	864x625	1650x750

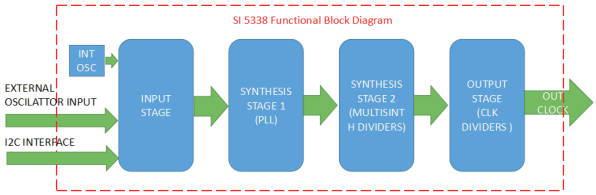


Figure 6. Functional Block Design of Si5338 Clock generator

Figure 7 shows a test pattern image displayed on live stream when camera is absent or malfunctioning.

The System was on the field test in Abu Dhabi, United Arab Emirates. The shown target, Hyatt Capitol Gate hotel was on the distance of 7.5 kilometres. Climate conditions were 43 degrees of Celsius outer temperature, sunny and clear.

Figures 8, 9 and 10 show a live stream from the system shown on figure 1, on all three channels: Low Light, SWIR and MWIR Thermal, respectively.



Figure 7. Test Pattern Live Stream

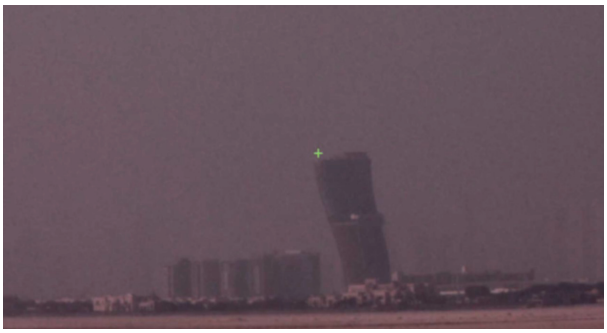


Figure 8. LowLight Channel Live Stream



Figure 9. SWIR Channel Live Stream



Figure 10. MWIR Thermal Channel Live Stream

5. CONCLUSION

The described and implemented unified solution for interfacing cameras with video processing units has proven to have a lot of advantages in comparison to most platforms currently available on the market. First of all is its modular design and reprogrammable hardware, so for any type of camera input interface, only the interface board should change. One interface board is present per one camera interface. Also, a hardware PCB is designed so that processing blocks can be easily changed (main signal processing processor and FPGA can be a matter of choice).

The System was on the field test in Abu Dhabi, United Arab Emirates. The shown target, Hyatt Capitol Gate hotel was on the distance of 7.5 kilometres. Climate conditions were 43 degrees of Celsius outer temperature, sunny and clear.

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IMAGING SYSTEM PERFORMANCE ANALYSIS USING MODULATION TRANSFER FUNCTION

Nedeljko Pađen[1, 2, *],
Dragana Perić[2],
Milan Milosavljević[1]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom institute,
Belgrade, Serbia

Abstract:
Modulation Transfer Function (MTF) is a useful tool for imaging system performance analysis. It can be used as engineering approach for verification of main system parameters, or for optimization task of the system under test. This methodology is based on linear systems theory and allows performance analysis to be divided into subsystems. In this paper, MTF methodology will be presented and explained, as an analytical model and as a testing tool which is implemented in electro-optical laboratory. According to MTF model, calculations are done to provide theoretical limit for the imaging systems. After tests in electro-optical laboratory have been done, we compared model expectations with measurements results and discussed achieved relations. The measurement has shown that the calculated cutoff frequencies correspond to the measured ones, in majority of cases. The calculated MTF curve has proven to be limit for the real measured system performance. Therefore, this study has shown that MTF can be convenient for finding system limitations, bottlenecks and increasing the overall performance of the system. Guidelines for further optimization of the imaging systems are derived.

Keywords:
Modulation Transfer Function, infrared, visible, multi-sensor imaging system.

1. INTRODUCTION

Today's modern society is facing many challenges in the field of border security, such as the cross-border criminal, smuggling of contraband, illegal immigration, human trafficking, and many others [1]. The protection of these vast areas is usually requiring the integration and centralized control of many type of sensors, giving very different type of data (textual data streams, video, audio, imaging, etc..), which are gathered with different type of devices, such as cameras, radars, motion sensors on smart fences, and similar. One of the key roles in these systems are Multi-Sensor Imaging Systems (MSIS), which are the sets of different cameras covering visible spectral band - VIS (0.4-0.7 μm), but also Near InfraRed – NIR (0.7-1.1 μm), Shortwave infrared - SWIR (1.1-2.5 μm), Midwave Infrared – MWIR (2.5-7 μm) and Longwave Infrared - LWIR (7-15 μm). By integrating high quality detectors and powerful lenses, these systems can provide 24 hours visibility, even in the scenarios of degraded

Correspondence:
Nedeljko Pađen

e-mail:
nedeljko.padjen@vlatacom.com

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atmospheric conditions. Based on their main role in the system, MSIS can be designed for various tasks, such as detection, recognition and identification of different type of objects (vehicles, truck, pedestrians, etc.).

This paper will analyze one such multi-sensor imaging system, consisting of visible camera and SWIR camera with lenses, whose specifications will be listed in chapter IV of this paper. This particular system was tested in the electro-optical laboratory, where the performance analysis was done using Modulation Transfer Function (MTF).

In chapter II we will describe the basics of electro-optical (EO) imaging system performance, followed by Chapter III with an overview of the theory behind the MTF analysis and its contribution in the overall performance analysis of one imaging system. In Chapter IV we will describe the electro-optical laboratory, equipment used for the measurements and the procedures and methods used in this process. Chapter V will present the results of the measurements for both visible and SWIR camera, with different focal lengths, and discuss the results in relation to the theoretical expectation. In Chapter VI we will present the result of the outdoor camera performance, where we have choose a scene at distance of 12 km from the camera position, to demonstrate the system ability to perform detection, recognition and identification of the objects. Finally, in Chapter VII we summarize the conclusions on the conducted testing and propose some possible guidelines for further optimization of the electro-optical imaging system.

2. EO IMAGING SYSTEM PERFORMANCE

Performance analysis of an electro-optical imaging system is a complex process where the real system optimization can be achieved only if an end-to-end analysis of the whole system is done, from the scene, to the observer [2]. Figure 1 illustrates one such system, by presenting standard elements involved in the final creation of the image of the object, to be presented to the observer.

The resulting image quality is affected by various effects, such as [2]:

- The scene content - background, target and background characteristics, motion, clutter,
- Intervening atmosphere - transmittance, rain, haze/fog, dust,
- Electro-optical system - resolution, sensitivity, noise, Minimum Resolvable Temperature (for infrared systems), Minimum resolvable Contrast (for visible systems),
- Display - luminance, contrast, distance for observer, glare and finally,
- Observer - his experience, training, fatigue, workload.

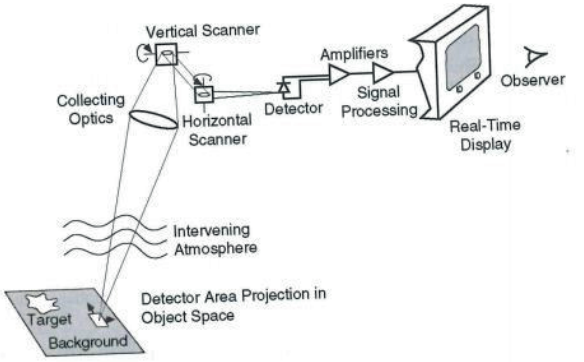


Figure 1. Electro-optical system [2]

With all these variables, different models are developed for the electro-optical systems, with the task to relate measurable system design parameters, with their operational performance. Three levels of models are fulfilling these requirements [3], [4]:

- Component/phenomenology models – These models are based on finding the MTF of the individual elements, which will give us the MTF of the whole system (MTF_{SYS}). MTF_{SYS} will then be used as the input for the next-level system modeling
- System performance models – Built on component models, they describe the total system performance for some controlled tasks
- Operational models – These models characterize the overall operational system functionality, where they are used to calculate detection, recognition and identification ranges

The focus of our analysis will be restricted to the component model, where the Modulation Transfer Function will help us describe the signal transfer characteristics of our multi-sensor imaging system. The MTF will be described in more detail in the following chapter.

3. MTF ANALYSIS

The creation of an image can be mathematically described as a convolution operation (denoted by *) of an ideal image f(x,y), convolved with the total impulse response of the electro-optical systems h(x,y).

$$g(x,y) = f(x,y) * h(x,y) \quad (1)$$

where the total impulse response is the summation of weighted impulse responses of different elements [5]. Thus, the systems can be analyzed directly in the spatial (time) domain, which is involving a complex mathematics. The alternative to this is the analysis in the frequency-domain, by means of Fourier analysis, where the irradiance distribution in the object or image plane of a time-domain electrical signal is transferred to a "spatial frequencies" in the frequency domain. In that way, we will have:

$$G(x,y)=F(x,y) \times H(x,y) \quad (2)$$

representing the Fourier transform of the elements of the equation (1). This movement from time to spectral domain is allowing much effective analysis of spectral response of the system, where the H(x,y) is referred as the Optical Transfer Function (OTF) [5].

The Modulation Transfer Function represents the modulo of OTF, i.e. the magnitude response of our optical system to the sinusoidal input signals of various frequencies.

This kind of analysis can be performed only for linear, shift-invariant systems [2]. Although these conditions are not always fulfilled, the MTF analysis is very useful tool in a system performance analysis and comparison and, as such, very much in use in the system design and choice of the adequate optical elements [6].

Modulation in optical system terminology refers to the contrast between the bright and dark regions of an image – high spatial frequencies relates to good contrast, low spatial frequency are referring to degraded contrast [5]. The MTF are basically plotting the modulation (contrast) versus spatial frequency. The following figure depicts the degradation of the MTF function as the result of increased spatial frequency:

By moving to the spectral domain, instead of convoluting the independent impulse responses of the system components, we will simply multiply their separately calculated MTFs, resulting in the overall system modulation transfer function (MTF_{SYS}). The Figure 3 is illustrating typical MTF shapes of some components.

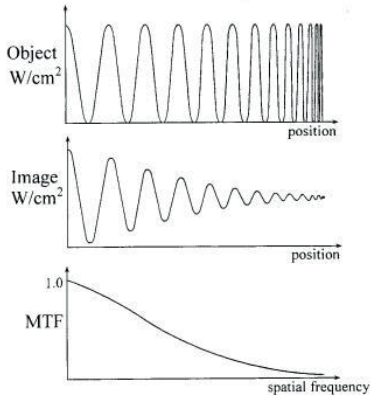


Figure 2. MTF as a function of spatial frequency [5]

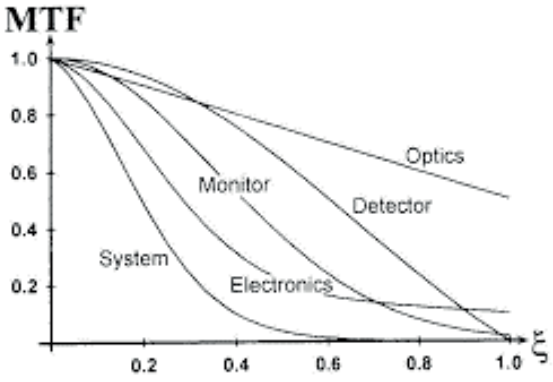


Figure 3. System MTF as a result of components MTFs [5]

The MTFs presented on figure 3 do not conclude the list of the elements affecting the final shape of the MTF system graph, where the jitter, defocus and noise are also influencing the final result. The more components are taken under the analysis, the better result (result closer to real measurements) will be achieved. As a rule of the thumb, it can be considered that the quality of the optical system is better, if the area below the curve is greater. None the less, there is no ultimate way to evaluate which MTF shape is the best [5], due to non-linearity of the human eye which does the task of reconstruction filtering. For that reason, the results from the laboratory should be accompanied with the tests performed in the real environment, which should enhance the evaluation procedure.

Our analysis will focus on the MTF for detector (determined by the size of the pixel and the focal length of the lens) and MTF for the optical system (which is limited by the optical diffraction). The description of the laboratory and the methodology used in this process will be described in the following chapter.

4. MTF MEASUREMENT SETUP

The measurements of the MTF characteristics were done in an electro-optical laboratory equipped with collimator station, illustrated on the following figure:

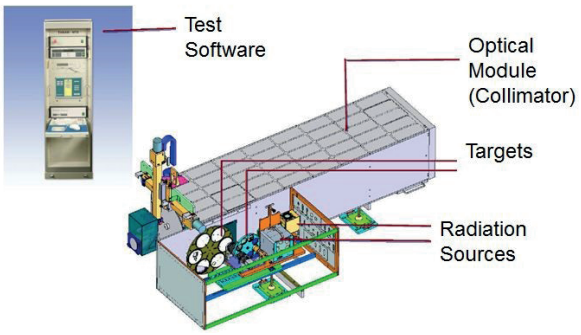


Figure 4. Electro-optical modular test station [7]

The test system has the following characteristics [7]: Collimator's effective focal length (EFL) is 120 inch, with the clear aperture of 14 inch. The field of view is 1.0° and the radiation source is VIS/SWIR integration sphere 0.44-2.2 μm.

The characteristics of the cameras under the test are as follows:

- SWIR – resolution 640 x512 pixels, detector pixel size 15 μm. Lens has declared waveband 0.9-1.7 μm, and variable focal length (f_l) of up to 1500mm. The measurements were made on f_l = 500mm, with F#4, and FL = 2500mm, with F#16
- Visible camera – resolution 1920x1080 pixels, detector pixel size 5 μm. Lens has declared waveband 0.4–0.7 μm, and the variable focal length of up to 2000mm (with extender). The measurements were made on f_l = 1000mm, with F#7.2, and f_l = 2000mm, with F#16

The target used for the MTF measurement is step-target, depicted in the figure 5. The MTF measurement procedure with step target is described in [8].



Figure 5. Step-target, used in MTF measurement

While the target has almost perfect edge, its image gets distorted as a result of the system imperfection, resulting in the line spread function (LSF).

The measurement process begins by placing (and selecting) the step target in the target wheel and switching on the integration sphere and setting the intensity. Images in the number of consecutive frames are taken, and averaging is done over all recorded frames. After that the edges are aligned, to do the averaging over the lines from where the above mentioned LSF is calculated. From LSF, by means of Fast Fourier transformation (FFT) the MTF graph is derived, presenting all the frequencies, up to cut-off frequency.

The MTF curve for the detector is the magnitude of the following formula

$$OTF_{detector}(f_x)=\mathrm{sinc}(\alpha f_x)=\frac{\sin(\pi\alpha f_x)}{\pi\alpha f_x}, where \quad (3)$$

$$\alpha=\frac{1}{fdco}=\frac{d}{f_l} \quad (4)$$

Diffraction (optical) MTF was calculated by the following formula:

$$OTF_{diff}=\frac{2}{\pi}\left[cos^{-1}\left(\frac{f_x}{f_{oco}}\right)-\left(\frac{f_x}{f_{oco}}\right)\sqrt{1-\left(\frac{f_x}{f_{oco}}\right)^2}\right], for\ f_x \le f_{oco} \quad (5)$$

$$OTF_{diff}=0\ , for\ f_x > f_{oco} \qquad , where \quad (6)$$

$$f_{oco}=\frac{1}{\lambda F_{\#}}\ and\ F_{\#}=\frac{f_l}{D} \quad (7)$$

The parameters used in the formulas (and in the tables in the following chapter) are

- **λ** – central wavelength
- **d** – detector pixel size
- **f_l** – focal length
- **D** – Diameter of the lens aperture
- **F#** - function of focal length and lens aperture

- **f_dco** – detector cutoff frequency
- **f_oco** – optical (diffraction) cutoff frequency, due to lens diffraction [1]

Prior to the measurement process the MTF calibration was performed, with the analysis of dominating limitation effects for the electro-optical system. These limitations are pixel size and lens focal length , for the detector-limited systems and lens numerical aperture (NA) and working imager spectral band, for diffraction limited systems.

The results of the conducted measurements, with the discussion of the results in relation to the theoretical calculation are given in the following chapter.

5. MEASUREMENT RESULTS

The measurement parameters and the calculated cut-off frequencies are summarized in Table I, for visible camera, and Table II, for short-wave infrared camera.

Table 1. Calculated cut-off frequencies for visible camera

λ [um]	d_det [µm]	fl [mm]	F#	f_dco [cy/mRad]	f_oco [cy/mRad]
0.50	5.00	1,000.00	7.20	100.00	277.78
0.50	5.00	2,000.00	16.00	200.00	125.00

Table 2. Calculated cut-off frequencies for swir camera

λ [um]	d_det [µm]	fl [mm]	F#	f_dco [cy/mRad]	f_oco [cy/mRad]
1.50	15.00	500.00	4.00	16.67	166.67
1.50	15.00	2,500.00	16.00	83.33	41.67

These values were then used to calculate and plot the graphs for the MTF of detector, MTF of diffraction, and the resulted MTF of the system (MTF product) using the formulas (3-7) given in previous chapter.

Figure 6 is presenting the graphs of the calculated MTFs and the measured MTF for visible camera without extender (f_l =1000mm), while the figure 7 is depicting the results for visible camera with extender (f_l =2000mm).

Figure 8 is presenting the graphs of the calculated MTFs and the measured MTF for SWIR camera with focal length of 500mm, and finally figure 9 is giving the graphs of SWIR with f_l=2500mm.

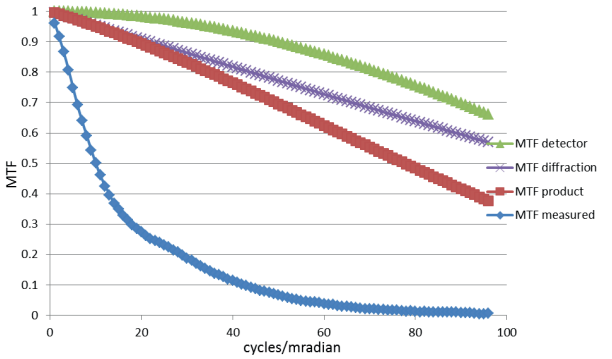


Figure 6. MTF for visible camera, f_l =1000mm

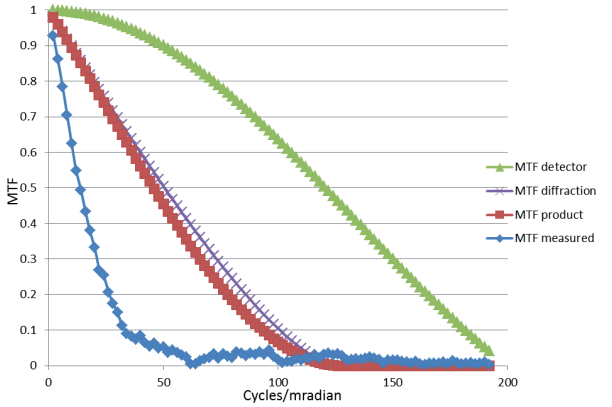


Figure 7. MTF for visible camera, f_l =2000mm

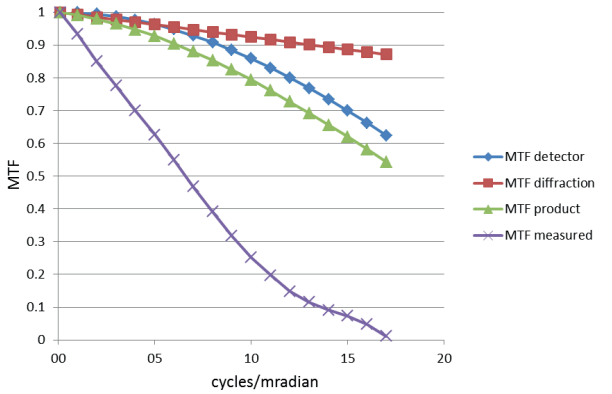


Figure 8. MTF for SWIR camera, f_l =500mm

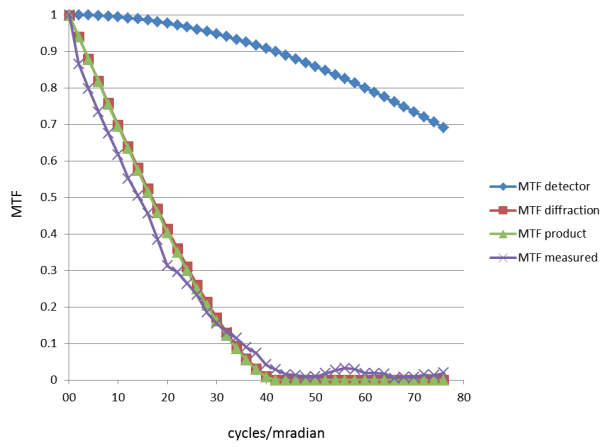


Figure 9. MTF for SWIR camera, f_l =2500mm

What follows is the discussion of these results.

A. Visible camera, without extender (fl =1000mm)

By analyzing results presented in Figure 6, we can conclude that the measured Modular Transfer Function has the expected cut-off frequency, which is in this case limited by the detector pixel size. The deviation of the measured MTF from the theoretical one, reflected in the steeper decline of the MTF curve, can be explained by the effect of the elements which were not measured in this case, such as focus, electronics for video processing, display, etc. We can notice that MTF drops below 50% at approximately tenth of the cut-off frequency.

B. Visible camera, with extender (fl =2000mm)

In the case of visible camera with the extender, depicted in Figure 7, we can see that the measured result (MTF measured curve) has the lower cut-off frequency than the one expected by the theory (MTF product curve). We can also conclude that limiting factor in this case is the diffraction of the lens system. Calculated cutoff frequency as a result of the lens diffraction is 125 cycles/mrad, while the values of the measured MTF are falling below 0.02 already for the spatial frequencies around 60 cycles/mrad. As in this scenario we have use the optical extender (to achieve the targeted focal length), this deviation can be explained by the aberrations (imperfection) of the optical extender elements.

C. SWIR camera, focal length 500mm

In this case the measured MTF has the expected cutoff frequency, which is limited by the detector pixel size. The same as for the visible camera without extender (measurement *A*), the deviation of the measured MTF from the theoretical one, reflected in the steeper decline of the MTF curve, can be explained by the effect of the elements which were not measured, such as focus, electronics for video processing, display, etc. However, in this case we can notice that MTF drops below 50% at approximately half of the cut-off frequency. Comparing this result with the one discussed in section A, we conclude that SWIR lens has better optical characteristics that the one used with visible camera. Having this in mind, we expect better identification in SWIR images, which will be tested with images taken from real scenario.

D. SWIR camera, focal length 2500mm

This final measurement, for the short-wave infrared camera with the narrow field of view (NFOV), gave us the best results in terms of matching of the shape of the measured and theoretical MTF curve, which are in this case almost identical. The limitation in this case is optical diffraction of the lens, the MTF curve reaches zero for the spatial frequencies around 40 cycles/mrad, while the diffraction cut-off frequency is round 41cycles/mrad.

6. REAL SCENARIO IMAGES

In order to illustrate image performance of the multi-sensor imaging system (MSIS) in real scenario, the system tested in the laboratory was installed outdoor and set to monitor the scene approximately 12 kilometers apart from the MSIS position.



Figure 10. Visible camera image

What is clearly distinguishable on the pictures are the vehicles, buses, pedestrians and the general background characteristics (buildings, trees, etc..). Since this type of system is generally designed to perform detection, recognition and identification of the objects, it is safe to say that the system is performing well, for the

purpose it was built for. Comparing images in VIS and SWIR, we can conclude that SWIR image is richer in details, which is expectable regarding the comment stated in section C. During the tests we also noticed remarkable advantage of the SWIR image in presence of fog.



Figure 11. SWIR camera image

7. CONCLUSIONS

The theoretical analysis and laboratory measurements of electro-optical system performance have demonstrated that MTF can be an effective analytical tool.

Theoretical calculations have shown that the increase of focal length results in the increase of f-number (F#), and for that reason the diffraction of the lens system becomes the dominant limitation factor (7), compare to the detector limitation. In that way, we have identified the maximal frequency for our system. On the other side, when the focal length is small, the system limitation is imposed by the detector pixel size, which indicates how the system can be further improved.

MTF measurements in the electro-optical laboratory have also given some valuable information. They have confirmed that by increasing the focal length, the system is moving from detector-limited, to diffraction limited system. For lower frequencies, the steeper curve of the measured MTF can be explained by the effects of the elements not measured in this case. The comparison of these curves for VIS and SWIR camera has shown that SWIR lens has better optical characteristics, which is another valuable result of the MTF analysis.

With the real scenario images we have confirmed the expectation from the laboratory measurements that SWIR camera gives better (richer in detail) image. This was especially obvious for the tests conducted in the degraded environmental conditions (fog).

Taking into account the considerable distance, it can also be concluded that the whole EO system is performing well, for the purpose it was built for (detection, recognition and identification of the objects). This leads to the general guideline in the design and optimization of EO systems – the key of the success is to fully understand the system requirements and the use-cases [9], since no system can be designed to provide perfect resolution, contrast, brightness and color fidelity, for any object distance, in any environmental condition. Therefore, the best systems are the ones designed for the exact purpose. Then, through the careful selection of system elements (lens, detector, etc..) and the system parameter optimization we can influence on the system performance.

To further prove the value of MTF analysis, future efforts will be made to include in the calculations the effects of the other system elements, such as focus, jitter and image processing MTFs. It is expected to provide better matching of measured and calculated MTF results, but also to give some additional direction for further EO system optimization.

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INTELLIGENT SIGNAL PROCESSING

ENERGY AND COMMUNICATION REQUIREMENTS FOR NETWORK OF E-BAND RADARS AS SENSORS

Marko Pajić[1, 2, *],
Bojan Džolić[1, 2],
Miroslav Perić[2],
Mladen Veinovic[1]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom Institute,
Belgrade, Serbia

Abstract:
E-band radars EBR are very promising short distance high-resolution sensors for safety and smart city solutions. In order to achieve larger scale coverage, we have investigated possibility of gaining raw signal from multiple EBRs for purpose of centralized data processing and fusion. Based on publicly available data about EBR ranges, resolution and data formats, we have considered requirements for implementation of communication and power network for them. We have presented data for both static and dynamic scenario. In static scenario EBR positions are fixed, while in dynamic scenario some of EBRs are located on vehicles with known position obtained by GPS.

Keywords:
radar, smart city, communication, energy efficiency.

1. INTRODUCTION

For traffic monitoring in smart city usually a set of cameras are used [1]. In typical installation camera transmits compressed video image over internet protocol - IP based network [2] to control center where video storage is performed [3]. IP traffic throughput generated by single camera depends on its resolution, frame rate and used compression. The analysis of required IP communication bandwidth is given in [4] we can assume values from about 1Mbps to 10Mbps per camera, which yields to huge requirements in both communication bandwidth - CBF and storage capacity - SC.

In order to reduce CBF and SC, in modern surveillance systems only significant events are transmitted in full image quality and stored if needed, while insignificant video is recorded in lower quality. The decision about significance is obtained either by operator or video analytic subsystem [5]. Usage of smart sensor technologies for vehicle and human detection [6] could be additionally exploited for more accurate detection of significant events. The main drawback of its usage in larger scale is their low resolution, installation problems and necessity of communication with control center or cameras themselves. In this paper we analyze possibility to replace these sensors by E-band radars - EBR [7] as a vehicle [8], pedestrian [9] and other events sensors with higher resolution and range compared to conventional smart sensors. Similar approach for lower bands is given in [10].

Correspondence:
Marko Pajić

e-mail:
marko.pajic@vlatacom.com

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EBR operates in frequency range from 76 to 81 GHz and its usage is regulated by ITU-R recommendations M.2057 [11] and M.1452 [12]. These recommendations define radio parameters that minimize possibility of interference with other system and also give indication about expected performance.

Thanks to EBR main application as driving assistance sensors, there are commercially available low-cost solutions [13] which justify technical feasibility of this approach. Besides this new application, EBRs are traditionally used for airport security applications [14][15][16].

The paper is structured as follows. In section II we describe main EBR operation theory and define basic parameters. In chapter III we analyze one typical urban use case with static radars. In chapter IV we analyze cooperative vehicle radars scenario and finally in chapter V we gave the conclusions.

2. E-BAND RADAR BASIC OPERATION

Block diagram of one frequency-modulated continuous wave (FMCW) radar system is shown in Figure 1. Basic operating principles of FMCW radar are:

- A local oscillator (LO) generates a chirp, linear frequency-modulated continuous wave signal.
- The chirp is amplified by the PA and transmitted by a transmit antenna.
- Receive antenna receives any reflection of the chirp.
- LNA amplifies the received signal.
- Mixer combines received and LO signal to produce intermediate (or beat) frequency (IF) signal.
- This signal is subsequently digitalized in ADC and processed in DSP.

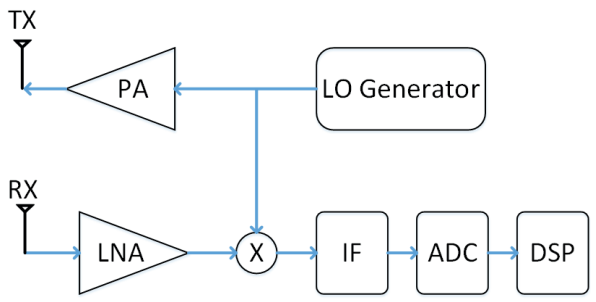


Fig. 1. FMCW radar block diagram

Chirp is a tone whose frequency is linearly increased with time. Figure 2 shows typical FMCW chirp pattern, with frequency as a function of time. The chirp is characterized by bandwidth (B) and sweep time (T_S).

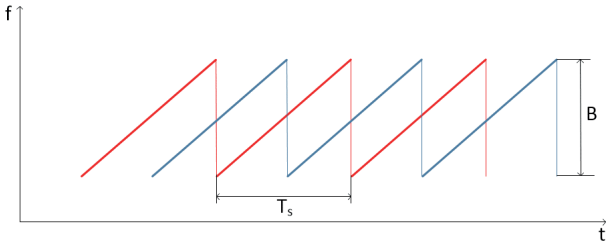


Fig. 2. Typical FMCW chirp pattern

FMCW radar can successfully measure range, angle and velocity of the target. This paper will focus on range and angle of arrival of the target.

Maximum range

Maximum range of a radar is directly related either to supported IF bandwidth or to signal to noise ratio (SNR) of received signal.

Maximum range related to supported IF bandwidth is given in Equation 1:

$$Range_{\max} = \frac{\mathbf{F}_{\max}\, c}{2S} \tag{1}$$

IF_{max} – Maximum supported IF bandwidth

c – Speed of light

S – Chirp slope ($S=B/T_S$)

From the previous equation, it is clear that maximum range is depending on chirp characteristics and supported IF bandwidth which is on the other hand dependent on ADC requirements, specifically ADC sampling frequency and sampling mode.

Maximum range related to SNR of received signal is derived from radar equation [17] and it is depending on radar's RF performance (transmit power, receiver sensitivity, antenna gains, chirp characteristics) and target characteristics (Radar Cross Section – RCS):

$$Range_{\max\,(SNR)} = \sqrt[4]{\frac{P_T\, G_{RX}\, G_{TX}\, c^2\, \sigma\, NT_S}{f_c^2\, (4\pi)\, kT_{\det}\, N_F\, SNR_{\det}}} \tag{2}$$

P_T – Transmit power

G_{RX}, G_{TX} – Antenna gain (receiver and transmitter)

c – Speed of light

σ – Target Radar Cross Section – RCS

N – Number of chirps

T_S – Chirp time

K – Boltzman constant

T_{det} – Temperature

N_F – Noise figure

SNR_{det} – Minimum required SNR

For range calculation based on signal to noise ratio we have assumed values for radar cross-section reported in [8] as +12 dBsm for vehicle and -10 dBsm for pedestrian.

Range resolution

Important parameter of FMCW radar is range resolution. This defines the minimum distance between two targets that allows the radar to detect them as separate objects. Range resolution is calculated from the following equation:

$$Range_{res} = \frac{c}{2B} \tag{3}$$

c – Speed of light

B – Chirp bandwidth

Range resolution is directly dependent of chirp bandwidth, the larger the chirp bandwidth, the better the range resolution. For E-band radars that operate in frequency range of 76 to 81 GHz, approximate range resolution is 4cm.

Angular range

In order to exactly determine the position of the target in front of the radar, apart from its range, the exact angle of arrival of the target needs to be known. To estimate the angle of arrival, radar is using multiple receivers. Figure 3 is showing the basics of radar's angle estimation.

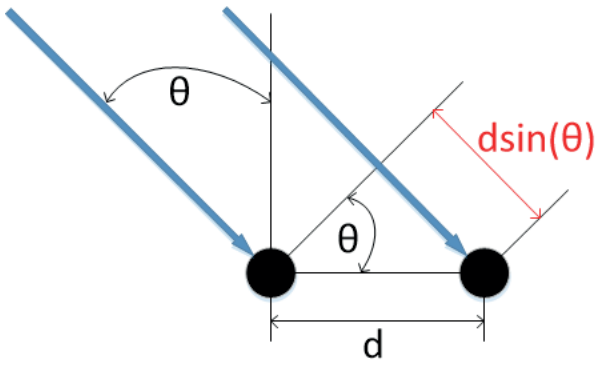


Fig. 3. Angle estimation

Maximum angular range or radar field of view is depending on the distance between receiver antennas and wavelength:

$$\theta_{\max} = \sin^{-1}\left(\frac{\lambda}{2d}\right) \tag{4}$$

λ – Wavelength

d – Distance between two receiver antennas

Maximum angular range is ±90° for spacing between two antennas of λ/2.

Angular resolution

While range resolution defines the minimum distance between two targets, angular resolution defines minimum angle of arrival of two targets that allows the radar to detect them as separate objects. Angular resolution is directly related to the number of transmit and receive antennas, meaning the larger the number of antennas, the better the resolution. Angular resolution is described by the following equation:

$$\theta_{res} = \frac{\lambda}{dN_{RX}\ N_{TX}\cos\theta}\frac{180}{\pi} \tag{5}$$

λ – Wavelength

θ – Angle of arrival

N_{RX} – Number of receiver antennas

N_{TX} – Number of transmitter antennas

Radar parameters examples

Based on publicly available data about EBR ranges, resolution and data formats, we have presented Table I as a comparison of performances of some radars.

Table 1. E-band Radar parameters

	Radar 1	**Radar 2**	**Radar 2**
Company	ELVA-1	TI AVR 1243	
Radar type	Fault object detection (FOD)	Automotive	
Central frequency	76 GHz	76 GHz	
Modulation type	FMCW	FMCW	
Bandwidth	500 MHz	300 MHz	540 MHz
Sweep time	1- 10 ms	30 us	50 us
Ramp slope	< 0.5 MHz/us	10	12
Samples per chirp	8192	500	500
Resolution	14 bits	12 bits, complex IQ	
Transmitter power	24.8 dBm	12 dBm	
Antenna type	Parabolic on pan-tilt platform	Printed frequency scanning	
Antenna gain	50 dB	10.5 dBi	
Antenna beam width	0.4 deg	30 deg	
EIRP	74.8 dBi	24 dBi	
Noise figure	n.a.	14 dB	
Range (vehicle)	n.a.	150 m	70 m
Range (pedestrian)	n.a.	80m	40 m
Range (other object)	1000 m*	225 m	125 m
Azimuth angular resolution	0.4 deg	1 deg	1 deg
Range resolution	0.3 m	0.5 m	0.28 m
Pan-tilt speed	0.1 deg	n.a.	n.a.
Raw image throughput	15-131 Mbps	150-600 Mbps	150-600 Mbps
Power consumption estimation	500 W*	17 W total 2 W radar front end 15 W signal processing	

*Manufacturer data

For further calculations we would assume values for radar 2 with chirp parameters set up to successfully detect vehicles at the distance of 150 meters.

3. URBAN USE CASE

We have analyzed typical urban use case of static radar installation along a busy two directional city street.



Fig. 4. Urban use case map view

We have found that to cover this area we need to position the radars at approximate distance of 100-150 meters. Since these radars are small in size, existing utility poles used for city lighting can be used as installation points. Figure 5 depicts idealistic case of radar network layout, taking into account the parameters from Table I in regards to vehicle range measurements and antennas beam width. The radars are placed alternately on both sides of the street in a way that two adjacent radars on the same side of the street are at the maximum distance of 200 meters.

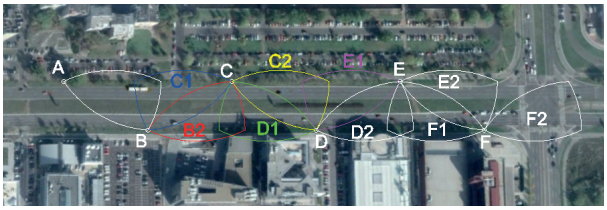


Fig. 5. Urban use case system topology

Figure 6 illustrates coverage zones of radars installed in radar nodes B, C and D. It is clear that the coverage zone of radar B2, marked red in the Figure 6, is overlapping with coverage zones of radars C1 (blue) and D1 (green).

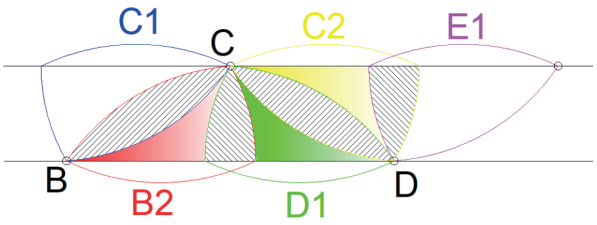


Fig. 6. Overlapping radar coverage zones

Raw data taken from radars with overlapping radar zones is processed in control nodes. Control nodes are collocated with the radars and installed on the same utility poles. Signals from control nodes are then transferred further to the Command and Control Center (C2 Center). Block diagram of signal flow from the radar to C2 Center is shown in Figure 7 on the following page.

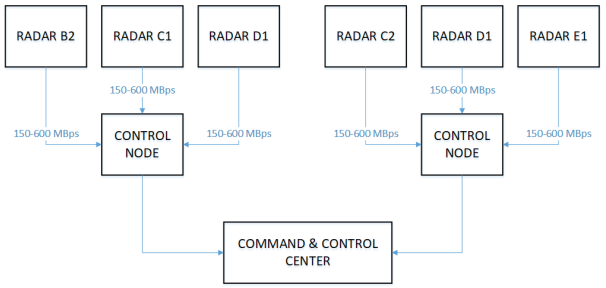


Fig. 7. Signal flow from radar to C2 Center

Taking into account that raw image throughput from radar to control node is 150-600 Mbps, communication requirements are very strict. Communication network that can sustain such capacity and is suitable for infrastructure installation between utility poles is either fiber-optic network or visible light communication network.

In terms of energy requirements, since power consumption of each radar is 17 W and it is intended to be installed on utility pole used for city lighting, needed power requirements can be obtained from city grid. Alternatively, as a backup and in case city grid is unavailable, small solar panels installed also on top of utility poles can be used.

4. COOPERATIVE VEHICLES SCENARIO

In previous chapter we have analyzed static scenario where EBR positions are fixed. In this chapter we will focus on dynamic scenario where additional data is being obtained from cooperative vehicles equipped with EBR radars.

General network concept remains the same in terms of control nodes that gather, process and transfer the information to C2 center (Figure 8).

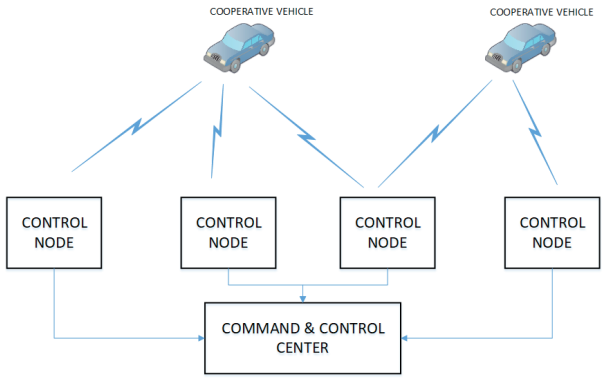


Fig. 8. Cooperative vehicles scenario

The difference is that in this case control nodes receive information from moving vehicles. Information about cooperative vehicle's position and radar orientation is obtained from GPS receiver, IMU sensor and digital magnetic compass installed in the vehicle.

Taking into account huge amount of raw data provided by the radar, it is clear that raw data from the radar installed on the moving cooperative vehicle cannot be transferred to control node. Limitations of radio communication network between cooperative vehicle and control node defines the amount of data that can be transferred between them. Unlike static scenario where communication network is sufficient for throughputs in range of 150-600 Mbps, in dynamic scenario cooperative vehicles can only send information about the positions of detected objects. In this case, radio communication network between cooperative vehicle and control node can either be mobile network (3G or LTE) or vehicular ad-hoc network (VANET).

5. CONCLUSION

Traffic monitoring in smart city is usually performed using cameras, which implies huge requirements

in communication bandwidth. Depending on video quality, required communication bandwidth for a single camera is usually in range from about 1Mbps to 10Mbps. This paper analyzed the possibility to replace these cameras with EBR radars and its impact on requirements for communication and power network for them. We have analyzed two scenarios – static scenario with fixed position of radars and dynamic scenario with radars installed in cooperative vehicles.

The analysis of urban use case with fixed position of radars showed that fusion of raw data taken from radars with overlapping radar coverage zones is performed in control nodes. Typically, one control node processes raw signals from three adjacent radars with overlapping coverage zones. Taking into account that raw image throughput from radar to control node is 150-600 Mbps and that the radars are intended to be installed on utility poles used for city lighting, fiber-optic communication is the first choice for communication network.

The analysis of dynamic scenario with radars installed in cooperative vehicles showed that available radio technologies do not allow the transmission of huge amounts of raw data between cooperative vehicle and control node. Cooperative vehicle can only send information about the positions of detected objects.

In terms of power requirements, since power consumption is less then 20W per radar and in case of radar installation on utility poles used for city lighting, first choice would be city grid. As a backup or alternative, solar panels could provide sufficient power supply.

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BIG DATA AND DEVELOPMENT OF SMART CITY

Mirko Simić[1, 2, *],
Miljan Vučetić[2],
Gardelito Hew A Kee[3],
Miloš Stanković[1, 2]

[1]Singidunum University,
Belgrade, Serbia
[2]Vlatacom Institute,
Belgrade, Serbia
[3]European University,
Belgrade, Serbia

Abstract:
Phenomenon of Smart City had its around-twenty-year development path influenced by changes in technological, social and business environment. Big Data, together with Internet of Things and Cloud Computing, has tremendous and profound impact on the changes of Smart City, transforming its shape and achievable goals and redefining its requirements and challenges. The aim of this paper is to study the aspects of Big Data within the Smart City concept. We analyze the past and present Smart City pilot projects, giving special attention to the evolution of its traditional applications (traffic, healthcare, power grid, water & waste treatment and public safety) in the context of present technological maturity. We also describe feasible Smart City applications based on Big Data, followed by summary of benefits and main challenges, especially the growing ones, such as security of infrastructure or security of private data. The final result of the study is comprehensive two-dimensional chart (technological maturity of environment vs. stage of adoption of Smart City) with identification of typical development states. The chart may help city planners selecting or creating optimized development plans of their communities.

Keywords:
Smart City, Big Data, Timeline.

1. INTRODUCTION

Broad definition of Smart City includes monitoring and integration of the critical infrastructure, optimization of resources, planning of maintenance activities, monitoring of security while maximizing services to the citizens [1]. The critical infrastructure may involve physical infrastructure (roads, bridges, tunnels, rails, subways, airports, seaports, water, power), IT infrastructure (telecom networks, data centres, access points, terminal devices, available IT services), social infrastructure (schools, hospitals, theatres, media, social clubs, social networks) and business infrastructure (companies, campuses, clusters) [2].

Physical and IT infrastructure is having dominant stake in Smart City agenda from its early age, while social and business infrastructure gain more attention in the recent years. Originating from more than 20 years ago, Smart City applications evolved from SCADA-like solutions to applications covering broad range of aspects of life.

Correspondence:
Mirko Simić

e-mail:
mirko.simic@vlatacom.com

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The four technological layers of Smart City architecture are: 1) sensing layer - sensors or terminal devices, 2) network layer - telecommunication medium and associated services, 3) Operation, Administration, Maintenance and Provisioning, and Security (OAM&P&S) layer - centralized processing or management platform[1] and 4) application layer [3]. All technological layers were subject to dynamic changes and transformation. One of the key drivers of this process is appearance of *Big Data*.

Big Data is a popular term used to describe the exponential growth, availability, and use of information, both structured and unstructured [4]. Smart sensor devices, the primary source of Big Data, became ever-present and affordable both for institutions and individuals. It is considered that 90% of world`s digitized data was captured (or generated) in the last two years. Per Intel and United Nations estimations, the number of connected smart devices will rise from respectful 6 billion in 2006 to astonishing 200 billion in 2020, which will be 26 devices per each human being on Earth [5].

Some characteristics of Big Data are referenced to as the Vs of Big Data management. These include the main 3 Vs (1, 2 and 3) and two additional Vs: 1) Volume: amount of data that has been created from all the sources; 2) Velocity: speed at which data is generated, stored, analyzed and processed, with emphasis on supporting real time Big Data analysis; 3) Variety: various types of data being generated – structured or unstructured; 4) Variability: constant changes of data structure and 5) Value: possible advantage that Big Data can offer to businesses [6].

Big Data, together with Cloud Computing and Internet of Things (IoT), are seen as pillars of future Smart Cities.

2. TIMELINE

Historically, the toddler age of Smart City may be considered in late 80`s with innovations in centralized management over power generation, water processing, first steps in video monitoring and real-time data exchange over those-days telecommunication networks. The earlier appearance of ATMs (in the 70`s) cannot really be related to Smart City phenomenon, although its technical aspects correlate to the essence of Smart City. Situation with traffic lights introduction in the same era is somewhat different: they fit the frame of Smart City applications, but technically they were not really integrated and interconnected.

Development of Smart City was further driven in the 90`s by the progress in available computing power, introduction of web services and roll out of mobile radio networks. Although sensors were still not ``plug-and-play`` and telecom networks were still typically narrowband, it becomes clear that it is possible to connect and integrate remote devices with central processing platform in almost any place and in any time. Smart City starts to grow as feasible and sustainable concept.

Late 2000`s see broadband mobility, initial steps of cloud computing and ever-present and ever-affordable sensors in smart devices. Data centres become critical public and private infrastructure. People and devices get fully connected. Wide population start to benefit from its smart environment and smart applications become everyone`s need.

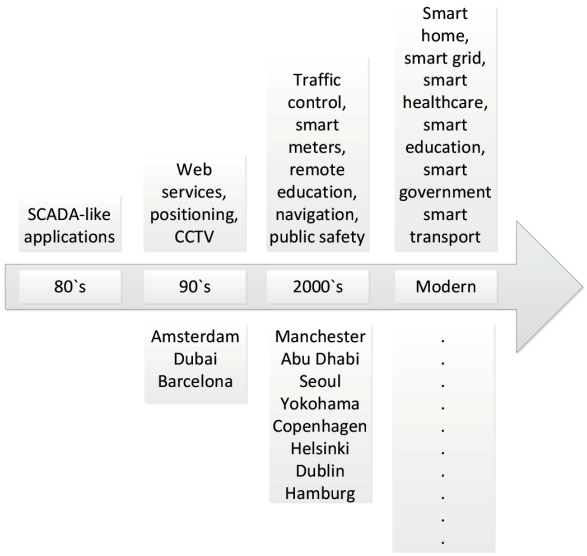


Fig. 1. Smart City Evolution Timeline

As shown in Fig. 1, today almost all cities claim to be more or less smart *with an underlying self-congratulatory tendency, obviously with regard to a different level of technological embeddedness or due to the existing intelligent capacity that a city holds* [7].

The proliferation of digital data usually referred to as Big Data, and flood of processing improvements based on artificial intelligence dictate the ambitious plans and futuristic vision of Smart City. Applications with Big Data analytics in various domains of Smart City enable data storage for large amounts of data and processing of such data for building advanced Smart City services. Big Data platforms, usually hosted on clouds, may perform parallel processing and analysis of such large volume

1 decentralized model is subject of recent research

of data. The results of this process are beyond results of traditional applications in terms of very existence, response speed and certainty. All mentioned illustrate how Big Data and accompanying phenomena has tremendous and profound impact on the changes of Smart City, transforming its shape and achievable goals and redefining its requirements and challenges.

Some historical aspects of the evolution of technological layers of Smart Cities are shown in Table I.

Table 1. Evolution of Smart City technological layers

	Centralized platform	***Telecommunication medium***	***Smart devices***	***Application***
80`s	Mainframes, dedicated SW	Narrowband, restricted for public use	Expensive sensors, restricted for public use	SCADA, industry
90`s	Server farms, first public interfaces	More bandwidth, access available	More affordable, market driven	Web services, positioning, CCTV
2000`s	Data centres, more processing power	Fixed broadband, mobile	Very affordable, ``plug-and-play`` type	Traffic control, smart meters, remote education, navigation, public safety
Modern	Cloud computing, artificial intelligence, Big Data, IoT, ideas about decentralization	Fixed and mobile broadband	Smart and autonomous, everpresent	Smart: home, grid, health, education, government, transport, neighborhoods…

3. SMART CITY APPLICATIONS AND CHALLENGES

We will analyse the traditional Smart City applications: traffic management, healthcare, power grid, water & waste management and public safety.

Traffic Management

Traffic Management is one of the first Smart City applications which set foot on ground. Traffic flow, congestion detection, parking availability, real time traffic monitoring, accident prevention and accident response were early seen as sustainable objectives of Smart City. Potential of return-of-investment in traffic applications sparked long ago the interest of city governments, decision makers and solution providers.

The applications are ranging from simple traffic lights control and CCTV to intelligent traffic routing, assisted parking, integrated multi-modal transport and smart video analytics. Challenges related to traffic management are numerous – they are mostly driven by the trend of increase of number of vehicles in urban environment. Enabling traffic flow even in peak hours, keeping traffic participants safe during heavy traffic periods, fitting the stringent and developing ecological demands without compromising traffic efficiency are present challenges that every city in the world has to deal with. Furthermore, traffic management includes interaction with citizens – therefore those applications need to be tailored with human nature taken in to account.

Appearance of smart self-driven cars will have profound impact on the form of traffic in urban environment, partly solving some of the existing problems (traffic security, traffic control), while creating some others (cyber security in traffic, readiness of traditional infrastructure and processes).

Examples:[2]

Zaragoza traffic monitoring system (Spain) [8],
Dublin Road Congestion System (Ireland) [8],
Eindhoven Traffic Flow System (the Netherlands) [8],
Enschede Vehicle Inductive Profile (the Netherlands) [8],
Thessaloniki Mobility Project (Greece) [8],
Toulouse Social Media Analytics (France) [9],
Singapore CityMIND Platform (Singapore) [9],
LA Merge Platform (Los Angeles, USA) [9],
Zhejiang City (China) [9].

Healthcare

Healthcare is the area where Smart City is yet to prove its potential. Medical call centres and networked medical institutions with unified patient records were seen in the past decade. More efficient work of field emergency medical teams is consequence of usage of

2 some cities – Dubai, Tianjin, Brisbane, Amsterdam, Barcelona correspond to almost all applications, so they are not usually mentioned

Geographic Information Systems (GIS) and navigation services, supported with availability of mobile broadband telecommunication. Smart health and telecare services offer remote telematic support to citizens, typically elderly people. However, jump to the foreseen healthcare application is yet to be seen.

Deployment of home-based diagnostics solutions, artificial intelligence based diagnostics, robot assisted surgeries is ahead. However, human-related aspect of healthcare may cause significant delays in deployment of those solutions.

Challenges of smart healthcare are related to: 1) availability to all citizens – the issue of finances, social justification, government type; 2) responsibility for the results of treatment shared between medical staff and Smart City services and infrastructure and 3) education of medical staff and citizens to deploy and use futuristic healthcare services.

Examples:
Amsterdam Health Lab (the Netherlands) [8],
Forum Virium Helsinki (Finland) [8].

Power Grid

Smart power Grid applications attract lot of attention as all stakeholders benefit from their deployment: electricity companies optimize their operation and attain more control over the system; citizens get better and cheaper energy with opportunity to actively tailor and control their consumer profiles; society in general get cost-efficient and reliable infrastructure; environmentalist achieve higher ecological standards etc. Hence power grid may develop itself within or without Smart City initiatives. Also smart power grid may easily be deployed in the area larger than the city - regional level, for example.

Smart power grid application may range from smart metering and smart lighting to smart energy management.

Typical challenge of the smart power grid is handling the unprecedented quantity of data in real time. Every successful smart power grid project is actually also the successful Big Data case.

Examples:
Ontario Smart Metering (Canada) [9],
Power matching city (Denmark) [9],
GRID4EU (Reken -Germany, Uppsala -Sweden, Castellon -Spain, Forli Cezena -Italy, Virchlabi -Czech Republic, Carros -France) [9],
Smart electric Lyon (France) [9],
Korea Electric Power Corp (Korea) [9],
Pacific Northwest Smart Grid (USA) [9],
Smart Meter by Tata, Delhi (India) [9],
Barcelona Smart Grid (Spain) [8],
Smart Power Hamburg (Germany) [8],
Copenhagen wind power and Smart grid system (Denmark) [8],
Mannheim E Energy (Germany) [8],
Gothenburg managed Celsius project (Germany) [8].

Water & Waste Management

Water & Waste Management attract lot of attention as well, but the attention comes mostly from city governments, responsible for the reliable services and from environmental organizations, interested in ecological aspects of using water resources and management of waste.

Challenges in this field are mostly related to the pace of growth of cities` population and the pace of growth of waste generated per capita.

Examples:
Dongtan (South Korea) [9],
Tianjin (China) [9],
Cape Town (South Africa) [9],
Copenhagen waste water management (Denmark) [8],
Aarhus City Water Balance (Denmark) [8].

Public Safety

Public Safety due to its nature and *raison d'être* is one of the first spheres to use the technological benefits within Smart City framework. Urban areas are most common target of terrorist attacks or attempts of attacks. Prevention of security incidents or enabling first responders to better handle problematic situations by using modern communication methods and databases is fitting nicely into Smart City agenda. Video surveillance is ever-present system in all the cities of the world; however those systems became only recently upgradeable to use smart video analytics and processing in real time. Empowering citizens to report security problems in real-time (with photo/video sharing), controlling potential spread of diseases or enhancing food security are some of the additional applications related to the public safety aspects of Smart City. Smart City seen through the eyes of public safety professionals becomes Safe City.

Some studies showed that security technology is seen as the most important and essential part of Smart City

technology roadmap [10].

Challenges of public safety applications are typically handling of massive amount of data and keeping citizen privacy. Sensitivity of those challenges is defining a bit different ambience for deployment of public safety applications.

4. BIG DATA BENEFITS AND CHALLENGES WITHIN SMART CITY FRAMEWORK

Data mass in Smart City arena will grow rapidly (exponentially) in all areas, from personal and municipal level to global. The data will come from plethora of devices and sources available in the market and it will have various forms: structured, semi-structured and unstructured. We may witness the shift from the realm of traditional desktop computing to an increasingly sophisticated computing [11]. It is already utterly important to understand data sets and organize them carefully.

Benefits of Big Data

Foreseen quantity of sensor or smart devices in all Smart City applications drives the necessity of aligning with Big Data principles. Congestion management systems will not be able to operate through conditions of unprecedented sizes of cities, where dozens of millions of people live, work and commute, without using Big Data for analytics. Europe with its 240 million smart meters in 2020 will be an excellent example of networked and optimized Smart Grid which everybody will benefit from, but only in case it will be capable of digesting the Big Data created. Face recognition and tracking of the suspects via urban video surveillance is the dream of the public safety professionals – the dream that can only became reality if the challenges of Big Data are handled.

Big Data is offering and bringing immense advances to applications of urban life. Actually, it is *conditio sine qua non* for Smart City of the future.

Big Data Challenges

Big data will enable new data-driven services to upgrade processes and enable innovation of products and business models. In the era of advanced digitization of the society, the potential benefits and challenges associated with big data are important topics for decision-makers [12].

Challenges related to Big Data may be grouped in the following way, as given in [13]:

1. Data sources and characteristics – related to the format of data; to be tackled by technological improvements.
2. Data and information sharing – related to the ``ownership`` of data and protocols of sharing; to be tackled by hierarchical organization of sharing with strict rules and procedures.
3. Data quality – related to the heterogeneity of data and its subsequent (un)certainty; to be tackled by technological improvements.
4. Cost – related to whether the citizens should pay for deployment of advanced application based on Big Data or not;
5. Smart City population – related to growth of population and growth of generated data per capita; to be tackled by technological improvements.
6. Security and Privacy – related to security policies and mechanisms to protect the data against unauthorized use and malicious attacks. There is a great amount of danger which originates from the process of digitization and exchange of data, especially in the Big Data environment. Small scale and large scale cyber-attacks are becoming reality and the potential resulting damage is rapidly growing. Even well-planned Big Data applications, such as Cassandra and Hadoop suffer from a lack of cyber security mechanisms. The way to tackle this issue is: 1) establishing and following strict security procedures and 2) establishing and operating cyber emergency response teams (CERTs).

5. DEVELOPMENT OF SMART CITY VS MATURITY OF ENVIRONMENT

Anthopoulos and Fitsilis in [14][15] did an analysis of the types of Smart City services and came out with nine smart service groups (SG):

- SG1: e-Government services
- SG2: e-democracy services
- SG3: smart business services
- SG4: smart health and tele-care services
- SG5: smart security services
- SG6: smart environmental services
- SG7: intelligent transportation
- SG8: typical telecommunication services

- SG9: smart education services.

They observed when a shift from a service group to another happened, which drives a shift to a different smart city class. Technology roadmapping for these smart service groups shows that the smart city evolution did not pass through all classes, neither cities have evolved from all classes to all the others. The authors Anthopoulos and Fitsilis tried to explain the results with a theory that a *smart city evolves in order to sustain against radical changes, coming both from internal (e.g., service demand, political willing etc.) and external sources (e.g., city competition, climate change etc.)* [14].

On the other hand, Park, del Pobil and Kwon studied Smart City technology roadmapping related to IoT [10]. They analyzed and classified Smart City applications based on importance and essentiality. One of their conclusions was that the sustainable urban environment may be feasible only with a data-oriented smart city infrastructure in place.

In this paper we have analyzed Smart City development over different axis compared to Anthopoulos and Fitsilis, with simplified states in order to achieve a clearer picture. We were not addressing importance and essentiality.

The horizontal axis is the timeline represented by five quasi-historical stages related to Smart City: 1) *no* (corresponding to rare cities with almost no smart applications), 2) *early* (cities with smart city application in its early stage, such as those from 80`s and 90`s), 3) *developing* (cities with developing smart city infrastructure, such as those from late 2000`s), 4) *mature* (modern cities, disposing several Smart City applications) and 5) *future* (a few cities with futuristic state of Smart City).

The vertical axis is the technological maturity of environment, represented by three simple states: 1) *low,* 2) *medium* and 3) *high*. The technological maturity of environment can be defined in many ways – here for the cause of simplicity the following criteria has been adopted: *low* means that the power supply system within urban area is not of high quality (variation of voltage, frequency) or not of high availability (not rare power cuts); *medium* means that broadband connectivity (4G, fiber optics) is not available in every corner of the urban area; *high* means that power supply is very stable, 4G and fiber optics is available everywhere within the city limits. The last criterion may be considered a precondition for Big Data applications.

Initial chart layout, with all theoretically possible system states, is shown in Fig.2.

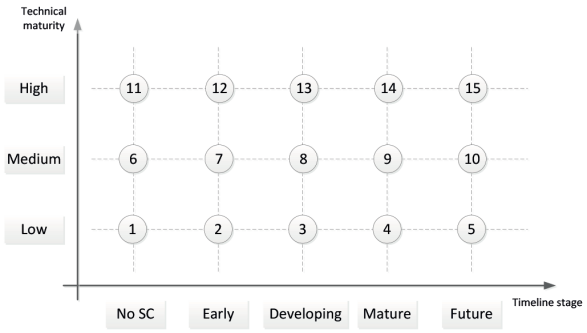


Fig. 2. Initial chart layout

Considering Timeline stages and Technical maturity, it is obvious that only system states 14 and 15 may have conditions for real Big Data applications.

Chart optimization is performed by eliminating system states 4, 5, 6, 10, 11 and 12. States 4, 5 and 10 are not technically possible, while states 6, 11 and 12 are considered rare exemptions, if existing at all.

The remaining states and possible (feasible, sustainable) state shifts are shown in Fig. 3. Horizontal shifts indicate efforts of Smart City planners to improve or broaden Smart City services. Vertical shifts indicate efforts of the whole society to improve overall technical environment in the city (simplified herein to telecommunication environment). Finally, diagonal shifts indicate ambitious efforts of all relevant institutions to enhance both general conditions and Smart City status.

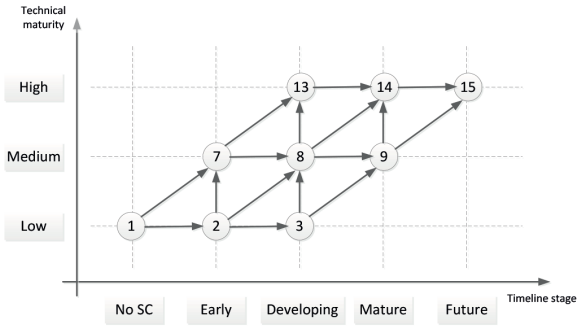


Fig. 3. Optimized chart layout with possible state shifts

The optimized chart may be used to detect a city`s status and indicate realistic perspective, thus assisting the Smart City development planning.

Example of Belgrade

City of Belgrade has very turbulent past, including the recent period. Certain city aspects (geographical and operational) are underdeveloped, while some others (public safety, culture) are in a relatively good shape.

Deployment of Smart City applications may help with bridging the problems the city has. Since Belgrade has already got some Smart City applications in place (e.g. traffic control, public safety, e-government apps), the current Smart City state may be tagged *Developing* on the horizontal axis. On the other hand, having the stable power grid and not having broadband connectivity everywhere, it may be tagged *Medium* on the vertical axis, taking state 8 as its current point.

Shifts to states 9, 13 and 14 are possible depending on the following considerations:

1. If it is considered that the overall technical environment will not progress (due to lack of initiatives or due to economical limitations or for some other reason), the planners may pursue shift to state 9. The shift might be done with initiatives on the Belgrade City level that could introduce realm of field-proven Smart City applications.
2. If it is considered that the Smart City state in Belgrade will not progress (due to lack of support or due to economical limitations), the planners may follow the shift to state 13. The shift might be done with initiatives on the country level only (Serbian Government). In this simplified model, those initiatives would be related to improvement of telecommunication infrastructure and services.
3. If it is considered that both the overall technical environment and Smart City state may progress simultaneously, the planners may pursue shift to state 14. The shift might be done only with initiatives on both Belgrade City and country level (Serbian Government). The shift would bring Belgrade to Big Data age.

6. CONCLUSIONS

The aim of this paper was to study the aspects of impact of Big Data on the Smart City concept. We presented the past and present Smart City projects, especially their traditional applications (traffic, healthcare, power grid, water & waste treatment and public safety). We described main challenges of traditional and advanced Smart City applications, especially the growing ones, such as data sharing or security of private data. The final result of the study is comprehensive two-dimensional chart (technological maturity of environment vs. stage of adoption of Smart City) with identification of typical development states and potential shifts. The chart may be used by the city or government planners to select or create optimized development plans of their communities.

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CONTRIBUTION TO THE THEORY AND PRACTICE OF GENERATING RSA ALGORITHM KEYS

Tomislav Unkašević[1, 2, *],
Zoran Banjac[2],
Milan Milosavljević[1],
Predrag Milosav[1, 2],
Medhat Abdelrahman Mohamed Mostafa[3]

[1]Singidunum University, Belgrade, Serbia
[2]Vlatacom Institute, Belgrade, Serbia
[3]European University, Belgrade, Serbia

Abstract:
The RSA cryptographic algorithm is widely used in data protection and electronic business. One of the most important parameter of the achieved level of security is the quality of the generated cryptographic keys with which the algorithm is applied. In this paper a few cases in which poorly generated RSA cryptographic keys caused dis-accreditation of the system are described. The recommendations and checks that must be fulfilled during generation of RSA algorithm cryptographic keys are formulated in order that keys were considered safe for implement on.

Keywords:
RSA algorithm, RSA keys, random number generation.

1. INTRODUCTION

The level of data protection achieved by the application of cryptographic algorithm in data protection mostly depends, on the quality of the cryptographic algorithm and the quality of the applied cryptographic key. The significance and role of the applied cryptographic algorithm is indisputable and clear. The role and significance of the applied cryptographic key is often overlooked. In the case of using the RSA cryptographic algorithm, we will show the role and significance of the quality of the applied cryptographic key to the security of data that are protected.

The cryptographic algorithm RSA, [1], is one of the cryptographic cornerstones of protection in information systems and e-commerce. It belongs to the class of computationally secure cryptographic algorithms based on the complexity of the problem of factorization of natural numbers.

The RSA algorithm is defined by natural numbers n, p, q, e and d which meet the following requirements:

- $n = p \cdot q$ where p, q are prime numbers
- e and d meet the following requirements

$$gcd\left(e, \varphi(n)\right) = 1, \quad ed = 1 \bmod \left(\varphi(n)\right),$$
$$\varphi(n) = \left(p-1\right)\left(q-1\right),$$

Correspondence:
Tomislav Unkašević

e-mail:
tomislav.unkasevic@vlatacom.com

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Wherein $\varphi(n)$ is Euler's function, $gcd(a,b)$ is the greatest common divisor of *a, b,* and $a \bmod n$ is remainder of the division of the number *a* by *n.* Then $k_e = (n,e)$ is the encryption key and it is called the public key. Decryption key is $k_d = (n,d)$ and it is called a secret key.

Messages m are represented by numbers from the interval $0 \le m < n$ and their enciphered form *c* is obtained as

$$c = E_{k_e}(m) = m^e \bmod n \tag{1}$$

Decryption takes place as follows

$$D_{k_d}(c) = c^d \bmod n = m \tag{2}$$

The RSA algorithm belongs to the class of computationally secure cryptographic algorithms, which means that its parameters must have appropriate characteristics so that messages protected by this algorithm have the desired level of security. The RSA algorithm's security rests on ignorance of efficient ways to factorize large natural numbers, and in order to achieve security in practical terms its parameters must have appropriate characteristics. Bearing in mind that in order to achieve a minimum security level, when applying the RSA algorithm, it is required that the length of parameters *p* and *q*, marked with $|p|$ and $|q|$, respectively, $|p| = |q| = 1024$ bits and $|n| = 2048$ bits.

The cryptographic algorithm RSA is most often used to create an electronic signature and an electronic envelope.

From the point of view of the safety of the generic RSA algorithm, the primary role is played by attacks that reconstruct the secret key (n,d). In this context; attacks can be grouped according to the methods used to achieve this goal:

- Algorithms for factorization of the RSA algorithm module
- Characteristics of the applied public and secret key
- Properties induced by the method of implementing the RSA algorithm

Details can be founded in [2], [3], [4], [5], [6].

2. IMPACT OF CRYPTOGRAPHIC KEYS

The importance of cryptographic keys for safe use of cryptographic algorithms was detected at the end of the nineteenth century and formulated as the Kerckhoff's principle. According to Kerckhoff's principle, [7] the security of each cryptographic system rests with a good cryptographic algorithm on the assumption that its keys are generated in a random way and are unknown to the opponent. The following examples illustrate what can happen in data protection systems when this principle is not respected.

Non random values from certified true random number generator

The first example concerns the system for access to electronic state and commercial services in Taiwan, the analysis presented in [8].

Each user has a smart card called the "Citizen Digital Certificate card" with his electronic certificate issued by the appropriate accredited certification body and which is used for identification, authentication and authorization when using electronic services. As an algorithm for creating an electronic signature, the RSA is used and its keys are generated on a smart card with a built-in random number generator that has a FIPS 140-2 certificate level 2. In [8], the authors analyzed the quality of the generated modules, number n in the description of the RSA algorithm, on a sample of two million issued electronic certificates. Module size in the analyzed cases is 1024 bits. The authors said that in a given sample they successfully factored 184 modules. A number of modules, 103 of them, are factorized due to the fact that some of them had a common prime factor, and the remaining detection of repetition forms that occur when generating prime numbers in this system.

The two most common factors detected in the analysis are given in the following equations.

$$\begin{aligned} p = c&0000000000000000000000000000000\\ &0000000000000000000000000000000\\ &0000000000000000000000000000000\\ &000000000000000000000000000002f9 \end{aligned} \tag{3}$$

$$\begin{aligned} q = c&92424922492924992494924492424922\\ &49292499249492449242492249299249\\ &92494924492424922492924992494924\\ &49242492249292499249492442 4e5 \end{aligned} \tag{4}$$

The factor (3) indicated by *p* appears forty-six times, and the factor (4) indicated by *q* appears seven times in the one hundred and three cases.

The presented results of the conducted analysis indicate the possibility of identity theft and phishing in electronic commerce. A rough estimate is that in the analyzed system, one identity can be stolen on every ten thousand issued electronic identities, which is not at all harmless and incomparably greater than the probability that the theory recognizes as a danger in the case of good random generators. Similar analyzes for other environments and their results are given in papers [9], [10].

These results indicate that the probable cause of the problem is the generator of random numbers on the smart cards as the theoretical analysis shows that the probability of the event is negligible. Namely, probability that two randomly generated modules n_1, n_2 of the RSA algorithm have a common factor, $gcd(n_1, n_2) \neq 1$ provided that it is $n = pq, |p| = |q| = k$, is approximately equal

$$P\left(gcd(n_1, n_2) \neq 1\right) \approx \frac{k(k-1)}{(k-2)2^k} \to 0 \quad when \quad k \to \infty \quad (5)$$

On the other hand, the appearance of the bit pattern in the generated prime numbers, the numbers *p* and *q*, points to the possible multiple use of the random sequence generated for prime number candidates.

Non random prime number generation from pseudoraandom number generator

In the paper [11], the authors analyzed the statistical properties of the RSA algorithm key generated by various software libraries for this purpose. The result of their analysis showed that it is possible to detect with high probability the library by which the sample of RSA public keys is generated. That analysis showed that the keys generated by the Infineon RSA Library version v1.02.013 have significant deviation from the uniform distribution for events $(p \mod x)$ and $(n \mod x)$ when *x* is a small prime number. This result was intrigued by another group of researchers who came up with the idea of trying to factor RSA keys obtained in this way.

In the first step they found that all the prime numbers generated by this library have a form

$$p = k \cdot M + \left(65537^a \bmod M\right) \quad (6)$$

Wherein *M* is a product of the first *N* prime numbers, i.e.

$$M = \prod_{i=1}^{N} P_i = 2 \cdot 3 \cdot \ldots \cdot P_N \quad (7)$$

and *k, a* are unknown random numbers. So,

$$n = \left(k \cdot M + \left(65537^a \bmod M\right)\right) \cdot \left(l \cdot M + \left(65537^b \bmod M\right)\right) \quad (8)$$

Coppersmith method, [12], is used for factorization. The method can be used for factoring RSA modules when one number of the high bits of one factor is known, [11].

In this case, the idea is as following.

Denote the order of the element 65537 in the group Z_M^* by $ord(65537)$.

Since the system is designed for factorization of the modules in the form (8), the first step is to determine are the modules of desired shape. This is achieved by the following analysis

$$n = \left(k \cdot M + \left(65537^a \bmod M\right)\right) \cdot \left(l \cdot M + \left(65537^b \bmod M\right)\right) = \\ = 65537^{a+b} \bmod M = 65537^c \bmod M \quad (9)$$

So, *n* is good candidate if there is c such that it is $n = 65537^c \bmod M$

Then for each number $a \leq ord(65537)$ using the Coppersmith's algorithm obtains number *k* and checks if the obtained number is a factor of *n*. If answer is yes, *n* is factorized, $q = n / p$ but if it is not the next *a* is chosen.

Using this algorithm, the RSA keys obtained by Infineon RSA Library version v1.02.013, it is possible to factorize efficiently modules of lengths 512 and 1024 bits, and special cases of keys 2048 and 4096 bits long.

Details and more efficient algorithms can be found in the [11].

Special properties of the prime numbers usage

In this case, we will consider one feature of RSA algorithm.

We call the message *m* fixed point relative to the RSA algorithm with parameters n, p, q, e and d if it is satisfied that

$$m^e = m \bmod n \quad (10)$$

i.e. encryption does not change message. For each selection of parameters n, p, q, e and d there are fixed

point messages but their number varies depending on the selected p, q and e. This can be a problem when implementing a digital envelope system

Digital envelope is a key distribution technique for symmetric cryptographic algorithms in which the data are encrypted by symmetric cryptographic algorithm, for example AES, and the key used is encrypted by the RSA algorithm public key of the recipient. Both cipher texts are sent to the recipient and he first decrypts the key with the secret RSA key and the RSA algorithm, then decrypts the received message with the AES algorithm.

For RSA algorithm with parameters n, p, q, e and d the number of fixed point messages, *NP*, is given by the term

$$NP = \left(gcd\left((e-1),(p-1)\right)+1\right)\cdot\left(gcd\left((e-1),(q-1)\right)+1\right) \quad (11)$$

This results in the one who implements the system and controls the procedures for generating keys for the RSA algorithm can control the number of fixed point messages and thus compromise the system, for example according to [13], by stating that the generated parameters satisfy the following relations:

- $p = 2^m p_1 + 1,\ q = 2^n q_1 + 1,\ e = 2^{\max\{m,n\}} p_1 q_1 + 1, p_1$ and are prime numbers, then all the messages are fixed point messages.
- $p = 2^m p_1 + 1,\ q = 2^n q_1 + 1,\ e = 2^{\min\{m,n\}} p_1 q_1 + 1, p_1$ and q_1 are prime numbers, then randomly selected message is fixed point message with probability approximately $1/2^{|m-n|}$

Controlling the size of the numbers m and n the attacker can adjust the security of the system with its attacking capabilities.

If one uses a digital envelope technique by combining, for example, a 256-bit AES algorithm and RSA algorithm with a 2048-bit key, its security would, at first glance, be respectable. However, if the parameters for RSA generated as in the previous examples, it would practically not be protected.

In case of the parameters p, q, e are randomly chosen, the probability that the randomly selected message is fixed point message is approximately $(\ln n)^3 / n$ which is negligible considering the size of the number n .

3. GENERATING RSA KEY

In part I the RSA algorithm definition is given. As we mentioned in introduction the RSA algorithm's security rests on the fact that there is no efficient ways to factorize large natural numbers, and in order to achieve security in practical terms its parameters must have appropriate size. So, selection of parameters must ensure that the modulus of specific RSA algorithm has a size that prevents efficient factoring.

Module size $n = p \cdot q$ satisfies $|p|+|q|-1 \le |n| \le |p|+|q|$.

Have a security parameter k given, and $k = |p| = |q|$ then the number *2k* represents the level of security of the RSA algorithm.

Practical algorithms for generating RSA keys and their consequences

Having in mind the description given in I parameters p, q are randomly selected from a set of prime numbers. This choice is most often carried out in three steps:

1. A random number of length k is generated using a random number generator
2. Check its length (zeroes which are not significant digits are not counted) which must be k.
3. Check that the generated number is prime number.

Each of these steps takes some time.

If a good random generator is used to be a random choice of k bits get the number of length k is $1/2$

The probability of randomly selected number from the interval $(1, 2^k)$ is prime number is about $1/(k \ln 2)$. Therefore, the likelihood that the number whose representation makes randomly selected k bits has a length k and it's prime number is $1/(2k \ln 2)$ what in the case when it is $k = 1024$ roughly speaking means more than a thousand and four hundred attempts to make one successful. What further aggravates the situation is the fact that deterministic algorithms to determine if the number is prime takes long time, and, in the previous example, this type of check will occur with more than one thousand and four candidates.

Such a purely theoretical approach is inefficient for mass application, and in practice, various modifications are used to increase efficiency.

If with $b_0 b_1 \ldots b_{k-2} b_{k-1}$ denote the generated random bits, b_0, b_{k-1} to be the smallest and greatest weight respectively, the usual modifications are:

1. Set $b_0 = b_{k-1} = 1$ and bits $b_1, \ldots, b_{k-2}$ are generated randomly. This eliminates the generation of candidates who do not have length k $(b_{k-1} = 0)$ and which are certainly not prime $(b_0 = 0)$

2. It is known that the product is two k bit numbers can have a length $2k$ or $2k-1$. To reduce the chances of selecting numbers p,q which give the RSA modulo length $2k-1$ in the product an analysis is performed showing the numbers p,q should be selected from the interval $\left[\sqrt{2}\cdot 2^{k-1}, 2^{k}-1\right]$. A more efficient approach, which induces a non-significant reduction in entropy, is by putting $b_0 = b_{k-2} = b_{k-1} = 1$.

Items 1. and 2. do not distort the randomness of the selection because the selection process is such that candidates who do not meet the requirements of those items were certainly rejected.

Therefore, the basic, potential source of problems with RSA keys originates from generating random sequences on two grounds:

- The quality of the random generator
- How to use generated random sequences in the process of generating RSA keys.

In part II, we saw examples of both situations.

Instructions for generating RSA keys

In accordance with the previous one, regarding the level of security that RSA offers, the first factor in order is the quality and length of the generated keys. We have seen in that some of the properties of the generated elements can be such as to dis-accredit the system in which they are used. In order to avoid such situations in the process of generating keys for the RSA algorithm, a standard representation, it is necessary to adhere to certain rules:

1. The random number generator generating candidates for prime numbers must be thoroughly tested and reliable. Sequences representing candidates must be selected independently.
2. Every prime number p length k can be used up to a maximum of once.
3. For every prime number p length k numbers $p\pm 1$ they must have at least one large prime factor
4. For prime numbers p,q it must be valid $|p-q| \geq n^{0.25}$, [14]
5. For the secret key (n,d) it must be valid $d \geq n^{0.292}$, [15].

The above-mentioned rules are technically more detailed in international standards. Recommendations related to random and pseudo- random generators can be found in [16], [17] and [18].

Recommendations on the method of forming candidates for random numbers, checks of their properties and recommended algorithms for this purpose are given in [19], [20] and [21]. These recommendations deal with requests related to items with item numbers 3, 4, and 5. Item number 2 is not recorded as necessary due to the insignificant probability of occurrence in ideal conditions. As shown in practice, [8], [10], [9] and [12], that this property can be the cause of significant security weaknesses in some situations. The authors of the [8] root of this unexpected behavior attributed the inadequate entropy of the applied sources of randomness, although the causes could be covered in the way of implementing the defined recommendations.

4. CONCLUSION

Although by its description and mathematical basics, the RSA algorithm does not require deep mathematical knowledge, it represents one of the cornerstones of security in the computer and networking world. Despite its simplicity, it is not easy to implement it reliably. The previous presentation shows the potential weaknesses of the RSA algorithm keys that lead to system discreditation. The theory shows that in the case of randomly generating parameters the probability of occurrence of some of these characteristics is negligible, but practice, [8], [12] shows that even in seemingly verified situations this does not have to be the case.

In addition to the previous choice of parameters, the security of the systems in which the RSA algorithm is applied is significantly influenced by the way in which it is implemented and interaction with the rest of the system. This can be seen more in [2], [4] and [6].

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BLOCKCHAIN AND DISTRIBUTED SYSTEMS

USING SMART CONTRACTS IN SMART ENERGY GRID APPLICATIONS

Panagiotis Giannakaris,
Panagiotis Trakadas*,
Theodore Zahariadis,
Panagiotis Gkonis,
Konstantinos Papadopoulos

Technological Educational Institute of Sterea Ellada,
Department of Electrical Engineering,
Chalkis, Greece

Abstract:
The evolution of the energy production and distribution towards innovative decentralized models, dictates the introduction of emerging technologies to transform the conventional energy sector into smart. In this paper, blockchain technology is introduced, in the concept of utilization and associated benefits in smart grid sector. Moreover, potential applications of smart contracts in the smart metering environment are discussed as well. Blockchain-based technology including smart contracts, is an ideal candidate for matching energy demand and production at smart grid level. As such, consumers will have the ability to become prosumers with a significant role in the continuous smart grid stabilization, since in a smart metering environment, all the contracting nodes will be able to streamline their energy consumption according to the grid demand. In addition to that, by the introduction of smart contracts within the smart grid landscape, smart meters can go one step further, allowing customers to pay as they go, rather than relying on monthly assessments.

Keywords:
blockchain; smart contract; smart energy grid.

1. INTRODUCTION

During the last decade, a revolution has started that transformed the way that demand and supply of electricity is organized and offered to the prosumers. The large-scale transition towards renewable and decentralized energy brought a plethora of unforeseen changes in the energy sector. In order to cope with the associated challenges, energy industry is actively examining new business models and technological mechanisms for delivering new and better services to customers. Likewise, customers are seeking new ways to purchase energy at the lowest price and are willing to consume energy, generated from renewable sources. As such, relevant stakeholders are increasingly promoting new peer-to-peer trading mechanisms based on decentralized technologies. Blockchain is the most innovative, promising and popular technology to address these issues. It can be considered as an IT platform connecting energy producers and consumers in a decentralized manner, the so-called prosumers, that not only consume but also produce energy from several sources, such as rooftop photovoltaic panels, that can be inserted in the energy grid

Correspondence:
Panagiotis Trakadas

e-mail:
ptrakadas@teiste.gr

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and consumed from other neighbors. In this decentralized concept, blockchain technology has the potential to widen the range of opportunities for market entrants to expand their businesses into the energy market [1].

This paper is the first step towards the realization of an M.Sc. thesis related to the introduction of smart contracts within the smart grid ecosystem and provides an overview of the solutions that blockchain-based technologies can offer to this new era of smart grid.

The rest of the paper is organized as follows: In section II, the main principles of blockchain technology are provided. In section III, the concept of smart contracts as well as the way that can be customized and utilized in the blockchain technology is described. Section IV analyzes the use of the smart contracts in a smart metering environment, while the benefits and drawbacks of the blockchain technology in the energy sector are clarified. Finally, section V concludes this position paper and explains future work.

2. PRINCIPLES OF BLOCKCHAIN TECHNOLOGY

While blockchain technology was originally devoted to digital currency applications, the research community soon realized that its usability can be advantageous to many societal, market and business sectors, including energy sector [2], [3], [4]. By storing blocks of information that are identical across the nodes that comprise a network, the blockchain is not be controlled by any single entity, but rather depends on the majority of the nodes participating in the network. Due to this decentralized approach, a blockchain-based network has no single point of failure.

Companies, worldwide, have started to explore the ways that blockchain technology could be used to provide new services to the market and enhance the existing ones. As it becomes apparent, blockchain technology is an ideal candidate for decentralized processes that require large networks and trust relationships between all parties, as the case of smart grid sector.

One of the main components of a smart grid is smart meters. Smart meters are the communication devices used as gateways between households and the electricity grid. Smart meters allow for the exchange of information both in terms of electricity consumption flows as well as information flows with respect to billing, prices and other related information. Moreover, in the current realization of a smart grid, a centralized marketplace for monitoring and balancing the supply and demand is needed. Instead of this centralized approach, smart contracts can be used to balance demand and supply in a decentralized approach without the need for a trusted third party.

In principle, a blockchain network consists of a number of computing nodes, where each node is using a client to validate and relay transactions between the users of the network, and store the latest copy of the digital ledger that is created from the validated transactions among the users of the blockchain. Fig. 1, depicts nodes comprising a simple blockchain network.

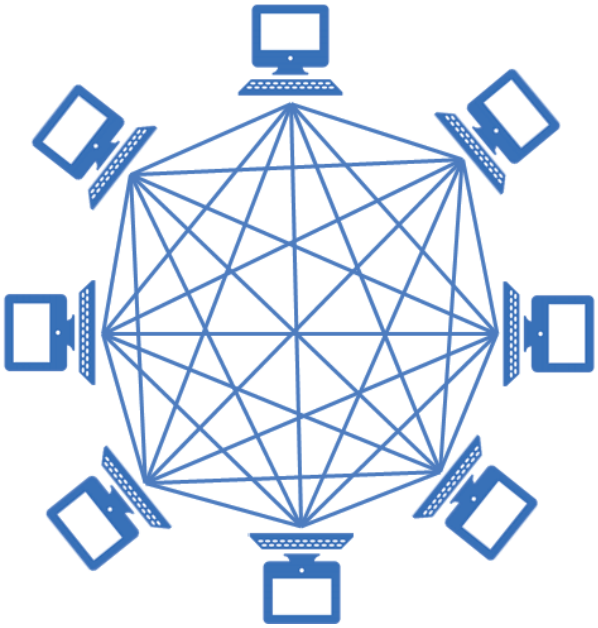


Figure 1. A blockchain-based network consisting of several nodes

The content of each block of the ledger is an aggregated set of data or, equivalently, an append-only list of records. Data are collected and processed to fit in a block, through a process called mining and each block could be identified using a cryptographic hash (digital fingerprint). The formed block will contain newly inserted information of the transaction, along with a hash of the previous block. Thus, the blocks can form a chain from the first block (Genesis Block) to the last one. In this way, all the data could be connected via a linked list structure. Fig. 2, depicts how hash of the blocks within a blockchain is calculated.

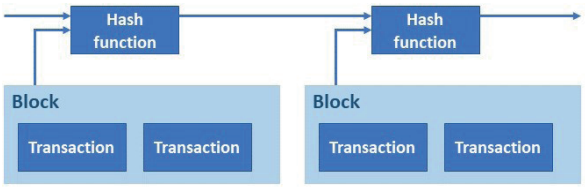


Figure 2. Illustration of blockchain hashing function

In the case of the Bitcoin blockchain, the block contains a header and relevant transaction data. A hash tree (or Merkle tree) of transactions is created and the hash of the root is included in the header. A hash tree is a full binary tree of a hash values. At the bottom level of the tree, each transaction has a node containing its hash value. After that, the tree is constructed in a way such that the parent node has a value of the hash of the data contained in its children concatenating together. In this way, a hash tree allows efficient and secure validation by constructing a Merkle tree path from the bottom level of the tree up to the root node. Fig. 3, illustrates a hash tree. In a blockchain, the block header has a field for previous block hash. Hence, each block will contain a reference of its previous block, and this could build up a chain of blocks. As it becomes obvious from its inception, a blockchain is resistant to modification of the data.

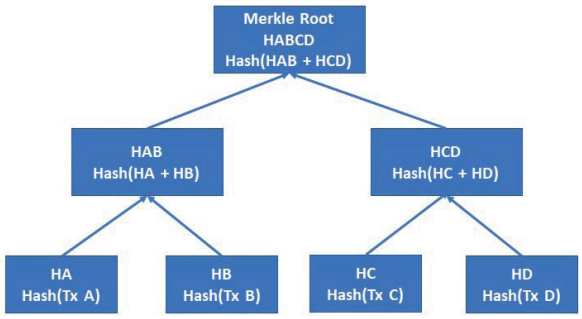


Figure 3. Illustration of a Hash Merkle tree

A blockchain is a type of a distributed ledger. The common characteristic between blockchain and distributed ledger technology is that the blocks are not maintained by any central authority. However, important differences may exist among the blockchain and distributed ledger technologies. In concrete terms, a distributed ledger is a database spread across all nodes of the network, where each node processes and stores an identical copy of the latest version of the ledger. Any updates to the ledger are performed independently and recorded by every node in the network. Afterwards, the nodes execute a voting process on these updates to ensure that the majority agrees with the conclusion reached. This voting and agreement methodology on the ledger is called consensus and is conducted by a consensus algorithm. Once consensus is reached, the distributed ledger updates itself and the latest, majority-agreed version of the ledger is saved on each node separately [5].

Given the former analysis, blockchain is one form of distributed ledger technology, but its structure differentiates it from other types of distributed ledgers. Data on a blockchain are grouped together and organized in blocks. The blocks are then linked to one another and secured using cryptographic algorithms. The structure of a blockchain allows data only to be appended to the database. Altering or deleting previously entered data on earlier blocks is impossible. Thus, given its unique characteristics, blockchain technology is well-suited for recording events, managing records, processing transactions, tracing assets, and voting without the need for the existence of a trusted third party.

Therefore, every blockchain is a distributed ledger, but not every distributed ledger is a blockchain. Each of these concepts requires decentralization and consensus among nodes. However, the blockchain organizes data in blocks, and updates the entries using an append-only structure.

3. PRINCIPLES OF SMART CONTRACTS

A few years after the introduction of blockchain concept, it became apparent that a decentralized ledger could be used for smart contracts (otherwise called self-executing contracts, or digital contracts). In this concept, contracts are independent pieces of software code (scripts) that are stored and replicated on the system and supervised by the network of computer nodes that comprise the blockchain. This mechanism is able to automatically activate terms of the contract (e.g. transferring money if and only if specific conditions and met). Thus, the exchange of any product or service can be facilitated by the use of smart contracts, in a transparent, unconflicted and immutable way while avoiding the inclusion of a trusted third party. In other words, smart contract is a computer code that runs on top of a distributed ledger and includes rules that the involved parties have agreed upon in order to interact with each other. In the case that these rules are satisfied, the smart contract agreement is automatically

activated. In this way, the smart contract code verifies and executes the terms of the smart contract, providing a simple form of decentralized automation. More specifically, a smart contract can be considered as a mechanism that involves digital assets of the users that participate in the smart contract and these assets are exchanged among the participants when the rules of the smart contract are satisfied in a way that it is declaratively described within the smart contract code. In brief, the smart contracts have the ability to turn legal obligations into automated processes, guarantee a greater degree of security, reduce reliance on trusted intermediaries and lower the transaction costs.

In particular, energy industries provide real-world use cases to demonstrate the value of blockchain-based smart contract technology. In the energy industry, blockchain-based smart contracts can enable smart grids, microgrids, and other types of innovative grid management technologies by both providing the mechanism for automating value transmission and the means to streamline transaction administration.

4. BLOCKCHAIN-BASED SMART CONTRACTS IN SMART GRID

Energy industries provide real-world use cases to demonstrate the value of blockchain-based smart contract technology. In the energy industry, blockchain-based smart contracts can enable smart grids, microgrids, and other types of innovative grid management technologies by both providing the mechanism for automating value transmission and the means to streamline transaction administration.

Blockchain-based smart contracts, support the "as you go" pay smart meter concept. However, even in this case, certain vulnerabilities exist. For example, the smart meters' security is insufficient, due to their probably outdated protocols or the inability of the costumers to visit a payment machine in order to reload their payment cards. By contrast, smart contracts can augment the security of smart meters on a blockchain-based system, as well as to enhance the process of payment in a smart metering environment [6], [7]. Blockchain-based smart contracts, makes it possible for customers to arrange their payments on their phones, tablets or PCs, using blockchain-based smart contracts that execute when their remaining electrical power is reduced below a certain amount. In the near future, blockchain-based smart contracts could also be structured to be executed according to weather conditions, adjusting accordingly the credit amount of a specified consumer.

With a blockchain-based system, consumers would have direct access to an immutable record of their consumed energy, which could be compared with their historical usage. Therefore, consumers would be able to make the appropriate adjustments in specific parameters of the smart contracts, according to the current energy demands in a range of a few days. The immediate feedback of the energy usage at costumers, gives them the benefit to manage their energy assets with high accuracy.

In this approach, a blockchain based distributed ledger stores in a tamper proof manner the collected data of the energy consumption from smart metering devices, while self-enforcing smart contracts programmatically define the expected energy flexibility at the level of each prosumer. Blockchain demand side management is able to match demand and production at smart grid level.

In the case of the demand-response model of a smart grid, a smart contract can be observed as a piece of code that defines the appropriate actions of each producer in order to participate in such demand-response programs, accompanied by the rules for assuring the grid level balance between energy demand and energy production. These contracts are registered in the blockchain and are triggered by new energy transactions, which make each blockchain node to update its state, based on the results obtained after executing the smart contract. The involvement of each entity in a demand-response event takes place by the use of self-enforcing smart contracts. Such contracts, are defined and used to implement in a programmatic manner the levels of energy demand flexibility where energy providers may provide during demand-response events, associated with incentive and/or penalty rates, as well as rules for balancing the energy demand with the energy production. The self-enforcing smart contracts are defined in a distributed fashion at the level of each energy provider voluntarily enrolled with the demand-response event and specify the expected energy demand and adjustments to its energy baseline. For each value provided and stored to a specific block by the smart metering device associated with the energy provider, the corresponding smart contract evaluates, by estimating the difference between the expected energy curve and actual monitored energy values.

In the case of significant variations, the appropriate actions are taken to rebalance the energy demand with the energy production. Thus, smart contracts act as a decentralized control mechanism. Based on the registered deviations in the local grid, new demand-response events are defined in a decentralized manner, providing

also the rates for penalizing the entities that violate the smart contract and for rewarding those that handle their energy production with flexibility.

Moreover, blockchain distributed consensus, is used for verification of consumption and financial settlement, using the information gathered from the smart meters. This information is aggregated in blockchain blocks, and afterwards it is permanently registered and further replicated across the distributed ledger. Since the data structures offered by blockchain are based on hash pointers, the resulting benefit is that the entire ledger is entered in a tamper proof environment, that can be modified only by re-computing the hashes for all the following blocks, which is infeasible. Thus, one of the most important operations within the blockchain approach is that the majority of the network nodes must agree on the contents of the ledger, which in this case reflects the energy state of the smart grid.

In conclusion, compared with a traditional energy consumption contract, the blockchain based management of the smart energy grids, provides many solutions to a set of already identified problems that currently exist in this domain. The adoption of the Blockchain concepts will transform the smart grid into a democratic community, that no longer relies on a central authority but can take any decision through smart contract rules enforced and verified by each node of the grid. Moreover, it will provide transparency with respect to pricing models.

5. VULNERABILITIES IN SMART METERING ENVIRONMENT

As a transparent and decentralized transaction technology, blockchain may be able to provide the security that is missing in the design of many smart meters today. But is blockchain ready to be used as a communication protocol in the electrical grid? As it is mentioned below, smart meters rollout, reveals several vulnerabilities which may occur during the deployment of the smart grid.

- Communication protocols between smart meters and home appliances, are possible to be exposed to attacks by hackers.
- In the case, where the utilities follow an adverse incentive system that focuses on cost-savings rather than security, they may lack the personnel to properly assess the risks and mitigate the attacks.
- Detaching smart meter operations from the accountability of the grid operator, as it happens in some European countries, including Germany and the United Kingdom, may augment the lack of security.
- If an attack occurs, it is still unclear who is liable for it.

6. CONCLUSIONS

Blockchain technology and its derivatives, such as smart contracts and distributed ledger technologies, in general, is a promising technology that provides several opportunities across the market sectors but in particular in the smart grid domain. Blockchain smart contracts in energy management, will bring resilience and flexibility in the sale and purchase of electricity with clear benefits for both the industrial stakeholders and the customers. In particular, customers will have in hand plenty of useful information with respect to their daily energy usage and related costs. They will also be capable of planning their energy consumption and predict their payment accordingly.

On the downside, there are still open issues prior to the wide acceptance and implementation of smart contracts in the energy market. Blockchain based technology in energy sector, is still in an initial stage worldwide and lacking a pan-European regulatory framework that would allow this technology to show its full potentials. The changeover from the traditional way of energy payment to an ecosystem including new trading mechanisms, is something that it will need time for familiarity, not so much from young age persons but from older ones. The familiarity with smart phones which has taken place a decade ago, can definitely help the well establishment of blockchain smart contract technology, since the transactions and settles which have to do with the energy management, will be mostly held through smart phones or tablets. Nevertheless, with the pass of time, blockchain technology in energy sector as every other new one, will become a piece of our daily life.

This paper is categorizing the issues related to the inclusion of the smart contracts in the smart grid application domain in order to provide innovative security solutions and traceability on energy consumption.

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IMPORTANCE OF A LEGAL FRAMEWORK IN SMART CONTRACTS

Guillermo Martínez Cons*,
Alondra Guadalupe Mora Hernández

University Center of Economic and Administrative Sciences,
University of Guadalajara,
Jalisco, Mexico

Abstract:
Technological advances have resulted in better strategic business planning and new and innovative ways of doing business. However, not all industries adapt immediately to these transformations that, even when they have innovated with the disruptive technologies that they introduce, they have also brought with them irreversible consequences in the way in which we relate. The fourth industrial revolution that we are witnessing today shows a panorama where scientific advances are increasingly challenging traditional jobs and careers to adapt and the social sciences are no exception. In the particular case of law, new challenges are presented in those that it is essential to frame in a normative all those conducts that derive in a human connection including those that are carried out by means until recently considered unconventional, such as digital platforms and electronic encryptions that nowadays are practiced in innumerable areas, one of the most relevant ones: economic transactions.

Keywords:
Blockchain, Ethereum, Scripts, Solidity, Legislation.

1. INTRODUCTION

The smart contracts created by Nick Zsabo in 1994, are computer codes that replace the writing of a contract and have the ability to be fulfilled automatically once the contracting parties have agreed their terms through clauses registered in a virtual code on a Specific address of the Blockchain, these scripts allow the automation of processes in several steps. [1] The Blockchain technology works as a universal database with the hash combination for the PKI integrity (public and private key) that serves to chain the blocks and the decentralization of the records at the node scale (distributed ledger). [2] Two types of smart contracts are distinguished: the so-called smart code contracts that allude to code sequences that are stored and executed in a chain of blocks and the smart legal contracts which are not registered in it. Both have in common the existence of agreements implemented by means of codes that are executed automatically once the pre-established requirements are fulfilled through a Boolean logic in the if / then / else structure. [3]

Correspondence:
Guillermo Martínez Cons

e-mail:
gmcons@hotmail.com

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2. OPERATION OF SMART CONTRACTS

The smart contracts scripts are apt to be programmed in series and stored in the Blockchain or in protocols shared by computer networks such as Ethereum and Corda. In the case of the Bitcoin Blockchain, it supports very specific smart contracts, where the technological base lies in the combination of the Peer to Peer communication systems, with the signature or mutual trust accreditation systems that appear in the PGP system (Pretty Good Privacy). [3]

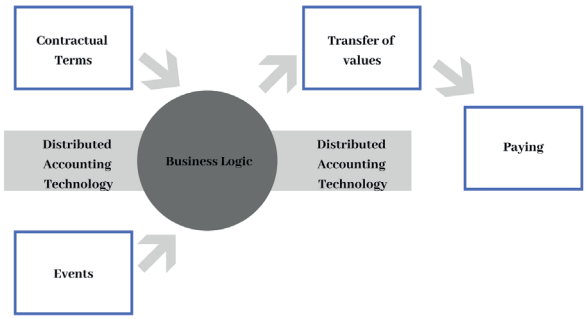


Fig. 1. Scheme of the operation of a Smart Contract

Source BBVA Research

Ethereum works as a platform with Distributed Accounting Technology (DLD) with Touring programming language that emerges as an improved version of Bitcoin cryptocurrency operations to overcome the limitations of its previous programming language, such as custody Blockchain, withdrawal limits, financial contracts, gambling market and similar ones through a very advanced programming language. [4] Ethereum employs a proprietary programming language called Solidity, a language similar to high-level Javascript that is able to interact with the Ethereum Virtual Machine (EVM), which is considered a Universal Turing Machine, a term that refers to the complete software that executes any code defined by the developer, the program written in Solidity is compiled and deployed to a node in the network in which the nodes implement the Ghost protocol (Greedy Heaviest Observed Subtree), this language allows the creation of ĐApps, ICO and smart contracts, the latter classified in algorithms programmed in decentralized applications. [5] (Fig. 1) These contracts are stored in the chain of blocks in information nodes, as it is the case with operations carried out with cryptocurrency, except that in these cases, the information instead of referring to cryptocurrency operations, includes the content in an encrypted contract. According to the World Economic Forum, Ethereum reached its highest level in January 2018 with 136,000 million euros, rising to 13,886.84 million dollars at the end of 2018. [6].

While Corda, unlike the Blockchain of Bitcoin and Ethereum is an authorized solution, that is, it is a private Blockchain, an example of this is the R3 Consortium that brings together large banks and companies with a Corda design, where these platforms are designed specifically for the requirements of the banks through a distributed accounting book prototype where, unlike the Blockchain, in the contracts registered in Corda the search for the general consensus is not one of its characteristics and although it has a structure of distributed records, access is not public and can only be accessed when two parties carry out the agreement. [5].

3. APPLICATIONS OF SMART CONTRACTS

The application of a smart contract arises when there is a need to manage a certain work flow defined by rules or when it is intended to ensure compliance of previously agreed conditions. [7] The effect is that, once the agreement is concluded and the triggering events are indicated, the production of these scheduled events is executed automatically, with no possibility of modification, blocking or non-execution of the benefit. [8].

Table 1. Uses of the Smart Contracts

Action	Description
Payment automation	The required amount arrives at the specified time.
Registration and change of ownership	The documents are registered in the platform to establish a property and change the ownership.
Intellectual property	Facilitation and automation of income.
Insurance	The automated incident payment process between the insurer and the user.
Betting	A smart contract can ensure that conditions are met.
Automatic purchases	Set up the contract for the purchase of shares, cryptocurrencies or any product at a fixed price for a limited time.
Votes	Verification of the exact results and establish an immediate consequence based on them

These functionalities intend to establish an accounting system that avoids double payment in a deal, when there is a central authority that oversees this process, the control is simple, however when performed in a medium where this figure does not exist, the development is complex, since no entity provides review and guarantee in the development. Being able to manage digital assets backed by an economic value, smart contracts can be considered as money managers, so they should be emphasized in the correct programming of them.

4. NEED TO ESTABLISH A PROPER LEGAL FRAMEWORK FOR SMART CONTRACTS

Contracts can be considered as agreements in which two or more involved parties agree to comply with a series of conditions. Whatever the form, they must have in mind the fundamental elements of: voluntary consent of the parties, object of the contract and a fair cause that is true and lawful. They only differ in the way of writing, its legal implication and the way of compliance. [1] That is why, in spite of being codes registered in a programmed platform, they are equally valid when complying with the minimum requirements established for these agreements.

Smart contracts protect information in an encrypted network eliminating intermediaries and providing advantages such as autonomy, security and trust, in the field of law, this type of innovation is called a suspension condition. However, among its disadvantages are the technologies that it uses: IoT and Blockchain. The first allows a link with real assets, but the devices it employs are easily hackable, the Blockchain for its part, is more secure, but it is immutable, although platforms such as Accenture are working on an editable Blockchain. [1] Similarly, we cannot talk about the total elimination of intermediaries, since in the case of poorly scheduled contracts or whose execution has not occurred as expected, it will also be necessary to go to court to resolve the arbitrariness.

In the approval of a smart contract nobody must expressly give consent, but everything works automatically and the system itself is in charge of corroborating the validity of each interaction. [9] This type of contracts does not admit clauses that need interpretation to be verified, nor do they include the concepts of "fortuitous event" and "force majeure". [3] Some tools such as Oracle allow the status of intelligent contracts to be updated with external information, while the multi-signature function allows the contract to be configured so that all parties have the duty to approve a transaction and thus a single party cannot dispose of the funds. [1].

In some cases, legal regimes are seamlessly integrated into this contracting format, but achieving a fully automated process involves resorting to online payment mechanisms that are not always adapted to the contractual type, the use of electronic money and virtual currencies make it difficult to functionality and legal security in standardized and automated forms of contracting and its use due to its scarce or null regulation and its double character of value unit and unit of account. [8] The main reason why the automatic contracting platforms do not always use digital money is due to the scarcity of the commercial offer. The money issuance sector is highly banked and credit institutions have not yet culminated with the launch and promotion of this payment instrument in the dimension that its potential provides. [8]

The novelty and at the same time difficulty in the system is that there is no intermediary-supervisor, but rather the system users themselves supervise and admit the operations, each of them through a diffuse system of mutual accreditation. A point that represents both positive and negative variables is regarding the anonymity of a subject within the Blockchain, since it provides the possibility and facility to carry out trust transactions between people from anywhere in the world without the need for an intermediary or authority. Nevertheless, in the case of a possible litigation, the knowledge of just a digital identification of the subject hinders any attempt at judicialization to resolve the misfortune. One of the discrepancies in terms of physical contracts is the exceptio non adimpleti contractus clause, that is, the exception of breach of a contract, which functions as a means of defense established in the substantive right by which it seeks to maintain contractual balance in the bilateral and onerous contracts and the central axis is the proper correlation between the reciprocal obligations of the contracting parties. Therefore, if one of the parties does not comply with its provision, the other one is not obliged to comply with its own. [10]

The business partner of Roca Junyent, a prominent firm of lawyers specializing in business law in Europe and Asia, Xavier Foz refers in this regard that "the role of lawyers is key, since on the one hand affects multiple disciplines of law; on the other hand, like any innovation, it generates situations of doubt due to the lack of specific regulation of many of its facets, which poses a challenge for jurists and opens questions regarding issues such as the liability regime of the parties involved in the process ". [11]

Table 2. Main ĐApps in Ethereum

ĐApps in Ethereum	Description
Golem	It is considered a supercomputer that combines the power of users' computers. Transactions are made through the cryptocurrency of the same platform, the GNTs (Golem Network Tokens).
Augur	It combines the concepts of decentralization and prediction markets with the commercialization of virtual actions, the transactions are made in real money or in cryptocurrencies.
Aragon	It aims to eliminate intermediaries in the process of creation and maintenance of organizational structures that is possible through the use of the Blockchain.
Crypto Kitties	It is one of the first games in the world that has been created based on Blockchain technology, the cryptocurrency it uses are its "virtual kittens" that can be bought and sold.

The important thing is that today, there are around 12 million smart contracts only in Ethereum, the main creation platform. However, it is currently contemplated that they can be developed directly in the ĐApps, decentralized applications that allow any interaction between individuals from the web or through a mobile app without the need of a central agent to manage this service.

The State Of The ĐApps portal already collects about 1200 projects around these apps. [12] Among the advantages presented by these decentralized applications are: it provides security because the sensitive information of the users is protected against theft, manipulation or computer attacks, the information published in ĐApp format networks cannot be tracked by any central entity and failure of the service cannot happen because everything is distributed in nodes.

5. REGULATORY INITIATIVES

There has been little dynamism regarding the regulation of this type of activities in Latin America, among the projects contemplated by the States are the Fintech Law in Mexico that establishes the applicable regulation for the Financial Technology Institutions (ITFs) that are those of electronic payment and collective financing (crowdfunding). [8] Article 8 of this law allows the applicant company to act temporarily under a flexible regulatory framework to be able to develop new business models through the use of technological tools that do not exist in the market of financial services that it is desired to cover, this includes smart contracts. Likewise, this regulation stipulates that the Bank of Mexico, the central bank of the country, can administratively sanction anyone who carries out transactions with virtual assets or currencies without prior authorization. [13]

In Colombia, there is no rule that establishes or regulates the Blockchain, there is no restriction to do so since the principle of technological neutrality, enshrined in Law 1341 of 2009 stipulates that any type of technology can be used for any purpose legitimate you have. [4] The statute applicable to these tools in the country is the Electronic Commerce Law, adopted in 1999 as a Uniform Law model of the United Nations CNUDMI, since it is taken when considering electronic documents as data messages.[2]

The Argentinian law firm Derito launched the country's first smart contracts service for services that operate on the Blockchain, being the first platform of this type developed by lawyers in the country. Its objective aims to bring lawyers together with the technological part and search a faster and more efficient solution for contracts ending with intermediaries. Thus, the legal validity before a judicial presentation is given when issuing the contract by the office itself, even when it is intended that the conflicts are resolved in the same platform, which is expected to be ready in March 2019, and in the first stage of launching this type of software development, supply, temporary rent and deferred payment. This shall remain available for the use of people, companies and public entities. [15]

In the United States, it is the federal states and not the central government that have addressed the issue, the first state was Vermont, where after passing a law in 2016, stipulates that the documents written in the block chain are authentic as long as can obtain a verification of the date and time of registration of that information in said chain. Subsequently Arizona, in 2017 issues a law granting legal status to smart contracts. [16] While in other countries such as China the regulations on this matter are barely consolidating, the Cyberspace Administration of China (CAC) published the so-called "Regulation for the management of information services Blockchain", this document, according to local South China Morning Post, it would be the first document that contains rules that specifically regulate the Blockchain industry. Among its postulates are the mandatory registration that all Blockchain service providers must do before the CAC, in the same way users are required to

register their real names on the platforms, thereby eliminating the privacy that these transactions provided. [17]

In Brazil, despite the form, the smart contract is legally valid when considering the principle of Article 107 of the Civil Code that ensures freedom in a contractual manner. In this way, regardless of whether a contract is written in a programming language, the legal system gives it validity since the formal requirements are subjective or objective for the effects to be produced, as far as these instruments are concerned so far. There are proposals to include and regulate the concept in the Brazilian legal system. [18]

In the European Union, in Malta, there has been an initiation of regulation that consumes many of the variants that this type of activities entails. In June 2018 Joseph Muscat, Prime Minister of this nation declared: "Malta is officially the first country in the world in having a holistic legislative framework regulating the Blockchain and DLT technology. We will be the global center for market leaders in this new sector ... "So Malta becomes the first jurisdiction to provide full legal certainty in this ecosystem with the Digital Innovation Law that allows the creation of the Digital Innovation Authority of Malta (MDIA), entity that will work autonomously and independently and will be in charge of everything concerning technological innovation and its forms of use, initially regulating only Blockchain technology and smart contracts, although it also provides government policies, education, promotion, design and use of innovative technology; while with the Law of Arrangements and Services of Innovative Technology is intended to be responsible for establishing regulations required by the MDIA to operate with cryptocurrencies. The Law of Virtual Financial Assets establishes a regulatory regime of the market in order to comply with the fundamental principles of financial regulation, protect the investor and provide integrity and financial solidity. [19]

6. CONCLUSION

Since the individual lives in a society, all activities have been governed in one way or another by rules, laws have served as the precepts that regulate the relationships between these subjects ensuring compliance with the rights of each one. However, advances in technology in the current era have caused many of the human actions to be subject to a controversy over its order, as new forms of interaction leave the law with many gaps in its coverage given the fact that there is no established delimitation that allows to regulate the jurisdiction.

The use of science in business is not something new, in the commercial area there are new methods every day that facilitate making operations thousands of miles away. What is surprising is that, despite the fact that a large part of the population uses these technologies in this type of transactions, such as the use of smart contracts, many legislations do not yet stipulate a legal framework that regulates commercial matters carried out in this means that allow legal certainty by assuming that those with whom it is treated will respect their commitments as in conventional agreements. Although this type of instruments have multiple advantages such as cost reduction, the elimination of intermediaries and the protection of data by being in an encrypted code, we cannot ignore that being a legitimate tool, necessarily in its creation, as throughout its validity and at the end of it must have legal supervision that allows users to have full certainty that the agreed agreement will have compliance and otherwise must trust that there will be mechanisms to restore arbitrariness. Since the language of smart contracts is unconventional to the one usually employed by lawyers, they should be directly involved in its creation to ensure that they have the conditions that provide tools in the event of a legal conflict, since it is not only about establishing conditions of use of the assets that support these operations, as has been discussed from the increase in transactions with cryptocurrencies, the entire executing system must be articulated, where the different variants involved as the transmission of personal data, the use of financial assets in the programming language and the binding of contractual law in the terms established, provide certainty to users and service providers of this type of platforms.

More and more countries are taking part in this area, some governments consider that it is nothing more than a new form of writing in the agreements, which is why they should be governed by the same regulations as the traditional ones, as in the case of Brazil, while in other countries such as Mexico, the United States and China. special laws have been specified for their ordering based on user protection, mainly with the establishment of rules of use and operation. Countries such as Argentina and Colombia do not explicitly include legislation for this type of activity, however we realize that in practice little by little they are conferring control and supervision through private entities. Nevertheless, only Malta has provided a complete and flexible legislative environment so far that has caused many Fintech companies and exchange houses to choose this country as an operation site, considering its regulatory system as one of the most accessible ones.

What is clear without a doubt is that the ways in which we do business involve more and more technology, where it can not be assumed that everything will be fulfilled under the principle of good faith, it is essential to establish rules that are adapted to human needs that appear day by day.

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SIMULACIONA ANALIZA EPIDEMIČNIH KONSENZUS ALGORITAMA

Nenad Milošević[1],
Ana Milošević[1, *],
Jelica Protić[2],
Marko Mišić[2]

[1]Univerzitet Singidunum,
Beograd, Srbija,
[2]Elektrotehnički fakultet,
Univerzitet u Beogradu,
Beograd, Srbija,

Rezime:
Cilj ovog rada je simulaciona analiza jednog epidemičnog (engleski **epidemic** ili **gossip**) sistema na primeru Tendermint konsenzus tehnologije. Prednosti simulacija u odnosu na eksperimentalnu analizu su relativno jednostavna analiza performansi sistema u LAN i WAN uslovima, kao i za različit broj procesa i za različit nivo povezanosti komunikacione mreže između procesa. Za potrebe simulacione analize u okviru ovog rada implementiran je samo podskup Tendermint konsenzus algoritma koji se odnosi na ponašanje u odsustvu otkaza (engleski **failure-free case**) i kada je komunikaciona mreža sinhrona i pouzdana (nema gubitaka poruka, **engleski message loss**), što odgovara normalnom ili uobičajenom radu algoritma (engleski **normal case**). Fukcionalnosti algoritma za tolerisanje otkaza procesa i periode nepouzdane mrežne komunikacije, kao i odgovarajuća analiza su van obima ovog rada, i planirani su kao budući rad.

Ključne reči:
blokčejn, simulacija, konsenzus, epidemični sistemi.

1. UVOD

Konsenzus je verovatno jedan od najbazičnijih problema u kontekstu distribuiranih sistema tolerantnih na otkaze (engleski **fault-tolerant distributed computing**). U akademskoj literaturi postoji veliki broj naučnih radova koji analiziraju konsenzus algoritme, iz teorijskog ali i praktičnog ugla. Važnost konzensus problema je povezana sa njegovom ulogom u postupku ”Repliciranja determinističkih konačnih automata” (engleski **State Machine Replication**), skraćeno **SMR**; generičkoj metodi za repliciranje servisa (programa) koji se mogu modelovati kao deterministički konačni automati [1], [2]. Uloga konsenzusa u **SMR** postupku je da omogući da više replika istog programa izvršava zahteve (od klijenata) u istom redosledu. Na taj način distribuirane replike programa ostaju sinhronizovane i prolaze logički kroz ista stanja. Ovaj pristup garantuje ispravno i kontinuirano izvršavanje programa i usled otkaza (engleski **fault**) podskupa replika.

Najveći broj teorijskih analiza i praktičnih instalacija sistema baziranih na konsenzus algoritmima su za **LAN** (**Local area network**) mreže i sadrže mali broj replika (tri do sedam) [3], [4]. Replike su direktno

Odgovorno lice:
Ana Milošević

e-pošta:
amilosevic@singidunum.ac.rs

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povezane i predstavljaju deo jednog administrativnog domena. Upotreba konsenzus algoritama u kontekstu blokčejn sistema i kriptovaluta donosi nove izazove u dizajnu i analizi konsenzus algoritama. Blokčejn aplikacije kao decentralizovani sistemi ne predstavljaju deo jednog administrativnog domena tako da nije moguće obezbediti potpunu mrežnu povezanost između procesa. Procesi su deo **WAN** (**Wide area network**) mreže i jedan proces je najčešće povezan samo sa podskupom svih procesa u sistemu. Iz tog razloga ovakvi sistemi su najčešće bazirani na epidemičnim protokolima komunikacija [5]. Takođe, broj procesa koji učestvuju u ovakvim sistemima je najčešće znatno veći nego u tradicionalnim **LAN** instalacijama (podrazumeva stotine ili čak hiljade procesa) [6], [7].

Dobre strane epidemičnih algoritama su tolerancija otkaza podskupa procesa kao i mogućnost adaptiranja prilikom izmene broja procesa i strukture komunikacione mreže između procesa. Sa druge strane, vreme propagacije poruka između procesa (engleski **end-to-end communication delay**) kao i broj dupliciranih poruka su znatno veći nego kod sličnih sistema kod kojih su procesi direktno povezani.

2. TENDERMINT KONSENZUS I GOSIP ALGORITMI

O Tendermintu

Tendermint je softver razvijan metodologijom otvorenog koda (engleski **open source**) [8] koji omogućava pisanje blokčejn aplikacija u bilo kom programskom jeziku koristeći **ABCI** (**Application Blockchain Interface**) blokčejn interfejs. Za razliku od blokčejn sistema poput Bitkoina [6] (engleski **Bitcoin**) i Itirijuma [7] (engleski **Ethereum**) gde se redosled transakcija i blokova u blokčejnu određuje "rudarenjem" (engleski **Proof of Work**), Tendermint je baziran na distribuiranom konsenzusu (engleski **Proof of Stake**). Konsenzus algoritam koji se koristi u Tendermintu je adaptacija klasičnih konsenzus algoritama poput **PBFT** (**Practical Byzantine Fault Tolerance**) [10] i **DLS** (**Dwork Lynch Stockmeyer**) [11] za blokčejn kontekst [9]. Radi se o **BFT** (**Byzantine Fault Tolerant**) konsenzus algoritmu, što znači da Tendermint toleriše otkaze podskupa procesa, i to sve tipove otkaza (engleski **arbitrary**). To uključuje klasične otkaze (na primer diska) kao i maliciozno ponašanje (hakerski napadi, softver zaražen virusom ili administratorske greške). Tendermint algoritam nastavlja normalno funkcionisanje ukoliko manje od jedne trećine procesa otkaže; drugim rečima, kažemo da Tendermint pretpostavlja da je $n > 3f$, gde je n ukupan broj procesa a f maksimalan broj neispravnih (engleski **fault**) procesa. Procesi koji učestvuju u Tendermint konsenzus algoritmu razmenjuju poruke preko epidemičnog ili gosip protokola, i svaki proces uspostavlja komunikaciju samo sa podskupom svih procesa. Uloga Tendermint gosip algoritma je da omogući komunikaciju između svih procesa u sistemu uprkos tome što procesi nisu direktno povezani jedni sa drugima. U okviru Tendermint sistema može se reći da konsenzus algoritam kreira poruke koje se onda prosleđuju svim procesima preko Tendermint gosip protokola. Radi veće efikasnosti Tendermint gosip algoritam koristi "aplikativno" znanje konsenzus algoritma koji "opslužuje", tako da možemo reći da se radi o specifičnom gosip algoritmu (što nije slučaj sa klasičnim gosip algoritmima u literaturi).

Tendermint konsenzus algoritam

Uloga konsenzus algoritma u Tendermintu je da odredi sledeći blok transakcija u blokčejnu. Nakon što procesi donesu odluku (engleski **decide**) u trenutnoj konsenzus instanci počinju narednu instancu. U Tendermint terminologiji broj konsenzus instance se još naziva i visina (engleski **height**). Svaka pojedinačna konsenzus instanca se sastoji od rundi (engleski **round**), gde svaka runda predstavlja sekvencu razmene poruka između procesa u pokušaju da donesu odluku. U svakoj rundi jedan od procesa ima specijalnu ulogu **predlagača** (engleski **proposer**). Predlagač ima zadatak da predloži vrednost oko koje treba da se postigne konsenzus u toj rundi. Predlagači se u Tendermintu određuju deterministički na osnovu vrednosti trenutne konsenzus instance i runde, **round robin** formulom.

Na slici 1 prikazane su poruke koje procesi ramenjuju kao i stanja kroz koja prolaze u toku svake runde Tendermint konsenzus algoritma. Procesi razmenjuju sledeće poruke u okviru Tendermint konsenzus algoritma:

- ***Proposal*** – ovom porukom se šalje predlog bloka transakcija oko koga treba da se postigne konsenzus.
- ***Prevote*** - ovom porukom procesi glasaju za predlog dobijen preko ***Proposal*** poruke.
- ***Precommit*** – ovom porukom procesi informišu ostale procese da li su primili (ili ne) ***Prevote*** poruku za predloženu vrednost.

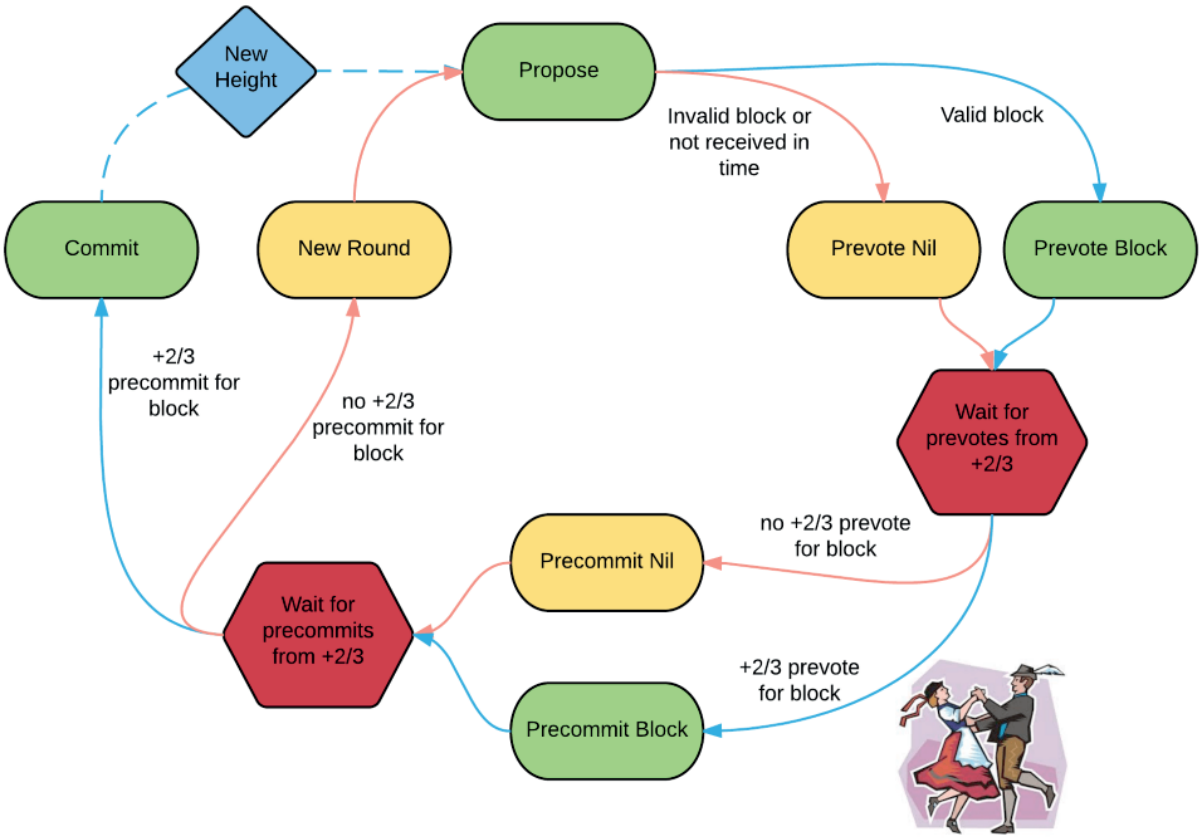
Stanja kroz koja proces prolazi u toku jedne runde su:

- ***ProposalWait*** – u ovome stanju se nalazi proces sve dok ne dobije ***Proposal*** poruku za trenutnu rundu.

- ***PrevoteWait*** – u ovo stanje proces prelazi kada dobije ***Proposal*** poruku, i on je u ovome stanju sve dok ne dobije ***2f+1 Prevote*** poruka za predloženu vrednost za tekuću rundu, nakon toga prelazi u ***PrecommitWait*** stanje
- ***PrecommitWait*** – u ovome stanju proces čeka sve dok ne dobije ***2f+1 Precommit*** poruka za predloženu vrednost za tekuću rundu, nakon toga smatramo da je odluka donesena.

Glavne strukture podataka

Pre nego što opišemo konsenzus i gosip algoritme korišćene u ovom radu definisaćemo dve strukture podataka u kojima se čuvaju sve informacije neophodne za njihovo funkcionisanje. Za čuvanje informacija o trenutnoj konsenzus instanci, svaki proces koristi objekat tipa ***RoundState***. U ovom objektu čuvaju se informacije o trenutnoj konsenzus instanci (visini) i rundi u kojoj se proces trenutno nalazi, kao i u kom konsenzus stanju za tu rundu je proces. Takođe čuva se ***Proposal*** poruka za tekuću instancu i rundu, kao i sve ***Prevote*** i ***Precommit*** poruke koje je proces primio u kontekstu trenutne visine (to uključuje i poruke za sve runde te visine u kojima je proces bio). Ključna struktura podataka za funkcionisanje gosip algoritma je ***PeerRoundState***. Naime, Tendermint kreira jednu instancu ovog objekta za svaki proces sa kojim je uspostavljena direktna mrežna komunikacija. Te procese nazivamo još i susedima (engleski **peer**).



Slika 1. Tendermint konsenzus algoritam

Filozofija Tendermint gosip algoritma je da proces susedu prosleđuje one informacije koje mu omogućavaju najbrži napredak. Iz tog razloga ***PeerRoundState*** struktura sadrži informacije o trenutnoj visini i rundi u kojoj se sused nalazi, kao i njegovo trenutno konsenzus stanje. Osim ovih informacija, za svakog suseda se čuva i informacija o tome da li je sused već primio od nekog procesa ***Proposal*** poruku za njegovu trenutnu rundu, kao i informacije koje ***Prevote*** i ***Precommit*** poruke je sused do sada primio. Ukoliko se sused nalazi u manjoj visini, tj. proces već zna koja je odluka donesena u susedovoj trenutnoj instanci, proces šalje susedu ***Decision***

poruku sa odlukom. U ovom slučaju u ***PeerRoundState*** strukturi beleži se informacija da smo mu poslali ***Decision*** poruku za njegovu trenutnu konsenzus instancu, da bi se izbeglo ponovno slanje ove poruke. U nastavku rada će se objektu ***RoundState*** pristupati preko reference *roundState*. Referenca *peerRoundState* će se odnositi na objekat suseda, koji je tipa ***PeerRoundState***, i to na objekat onog suseda od koga smo primili poruku koju obrađujemo u tom trenutku.

Tendermint konsenzus algoritam

Konsenzus algoritam koji je implementiran u ovom radu će ovde biti prikazan u vidu četiri rutine koje se pozivaju iz gosip protokola. Svaka od rutina se odnosi na konsenzus poruku koju je proces primio i koja bi trebalo na adekvatan način da se obradi.

Rutine koje predstavljaju konsenzus algoritam su:

- ***ProposalConsensusRoutine***
- ***PrevoteConsensusRoutine***
- ***PrecommitConsensusRoutine***
- ***DecisionConsensusRoutine***

Svaka će detaljno biti objašnjena u narednim odeljcima.

ProposalConsensusRoutine

Kada proces primi ***Proposal*** poruku prelazi u ***PrevoteWait*** stanje i to je potrebno ažurirati i kreirati poruku koja će susedima na to ukazati. Nakon toga proces kreira ***Prevote*** poruku. Sve poruke koje se kreiraju tokom konsenzusa će pomoću gosipa biti prosleđene susedima. Kako je proces mogao da prima ***Prevote*** poruke bez obzira što još uvek nije prešao u ***PrevoteWait*** stanje potrebno je pokrenuti i ***PrevoteConsensusRoutine*** jer možda zajedno sa njegovom ***Prevote*** porukom on ima dovoljno poruka da pređe u ***PrecommitWait*** stanje.

PrevoteConsensusRoutine

Ova rutina bi trebalo da proveri da li je broj primljenih ***Prevote*** poruka dovoljan da se pređe u ***PrecommitWait*** stanje. U slučaju da jeste menja se stanje i to je potrebno zabeležiti i kreirati poruku kojom će se ta informacija preneti susedima. U slučaju da se radi o procesu validatoru kreira se ***Precommit*** poruka. Nakon toga, potrebno je pokrenuti i ***PrevoteProposalRoutine*** jer se ***Precommit*** poruke mogu primati i u ***PrevoteWait*** stanju, tako da je moguće da je dovoljna još jedna ***Precommit*** poruka da se završi tekuća konsenzus iteracija.

PrecommitConsensusRoutine

U ovoj rutini se proverava da li su ispunjeni svi uslovi da bi konsenzus bio donesen. Uslovi koje je potrebno ispuniti jesu da smo primili ***Proposal*** poruku za tu rundu i da smo primili ***2f+1 Precommit*** poruka za tu predloženu vrednost. U slučaju da su uslovi ispunjeni kreće se u novu iteraciju konsenzus algoritma.

DecisionConsensusRoutine

Ova rutina se poziva kada se dobije ***Decision*** poruka od suseda za visinu i rundu u kojoj se trenutno nalazi proces. Proces treba da zapamti vrednost i da završi konsenzus bez obzira u kom se stanju nalazio i da pređe na sledeću visinu, to jest da krene sa izvršavanjem nove iteracije konsenzus algoritma.

Tendermint gosip algoritam

U okviru ovog rada se analizira malo jednostavnija varijanta gosip algoritma koja je dovoljna za analizu performansi.

Gosip algoritam se može podeliti na dva ključna dela:

- ***ReceiveRoutine***
- ***GossipRoutine***

Gosip - ReceiveRoutine

ReceiveRoutine je zadužena da prima poruke od suseda, i da ih na adekvatan način obrađuje. Način na koji se obrađuje poruka zavisi od tipa poruke. Gosip kod Tendermint-a razmenjuje poruke specifične za Tendermint konsenzus i još neke poruke koje olakšavaju i optimiziju sam gosip protokol, kako ne bi došlo do slanja redudantnih poruka.

Poruke koje se razmenjuju putem gosipa su:

- Poruke specifične za konsenzus:
  - ***Proposal***
  - ***Prevote***
  - ***Precommit***
  - ***Decision***
- Poruke specifične za gosip:
  - ***HasVote***
  - ***NewStepRound***

U narednom delu teksta biće prikazano detaljnije koje informacije nosi i kako se obrađuje svaka od ovih poruka. Pri tome osim gosip dela, pokazaćemo i u kom trenutku se pozivaju rutine koje bi trebalo da obave konsenzus logiku.

1. ***Proposal*** *poruka*

Ona sadrži visinu i rundu na koju se odnosi poruka i predloženu vrednost.

Prilikom prijema ove poruke potrebno je proveriti da li je visina na koju se odnosi poruka veća ili jednaka od visine suseda od koga smo primili poruku, u slučaju da jeste potrebno je ažurirati visinu suseda i označiti da sused ima ***Proposal*** poruku.

Zatim je potrebno ažurirati i interno stanje procesa. Prvo je potrebno proveriti da li proces čeka na ***Proposal*** poruku i da li se poruka odnosi na istu visinu i rundu u kojoj se proces nalazi, ako je to slučaj poruku bi trebalo sačuvati. Nakon što smo sačuvali poruku potrebno je pokrenuti konsenzus rutinu koja se odnosi na prijem ***Proposal*** poruke.

2. ***Prevote*** *i* ***Precommit*** *poruka*

Ove poruke su u gosip algoritmu predstavljene jednom porukom koja se naziva ***VoteMessage***. Ona sadrži visinu i rundu poruke. Pored toga deo ove poruke su identifikator validatora koji je generisao ovu poruku i oznaku koja ukazuje na to da li se radi o ***Precommit*** ili ***Prevote*** poruci.

Sa strane gosip protokola ove dve poruke se obrađuju na identičan način. Obrada se sastoji u tome da se zabeleži da sused ima tu poruku. Nakon toga bi trebalo da se proveri da li se poruka odnosi na našu visinu i rundu, u tom slučaju bi je trebalo zapamtiti. Svaki put kada sačuvamo novu ***Prevote*** ili ***Precommit*** poruku potrebno je kreirati novu ***HasVote*** poruku koja će biti poslata susedima prilikom izvršavanja ***GossipRoutine*** gosip protkola. Isto tako, svaki put kada smo primili do tada nepoznatu ***Prevote*** ili ***Precommit*** poruku potrebno je pokrenuti konsenzus logiku vezanu za prijem tog tipa poruke.

3. ***Decision*** *poruka*

Pored standardnih polja koja se odnose na rundu i visinu, ova poruka sadrži i vrednost oko koje je postignut konsenzus.

Prijem ove poruke je potpuno transparentan za gosip protokol jer njena obrada se samo odnosi na konsenzus deo Tendermint-a. Potrebno je samo pokrenuti rutinu konsenzusa koja je odgovorna za prijem ove poruke.

4. ***HasVote*** *poruka*

Telo ***HasVote*** poruke sadrži ista polja kao ***VoteMessage***. Ovo je jedna od poruka koje su specifične za gosip deo. Ovom porukom nas sused obaveštava da on ima neku ***Prevote*** ili ***Precommit*** poruku. Na nama je samo da to zabeležimo da mu kasnije ne bismo slali poruku koju već ima. Ova poruka se kreira i šalje susedima kad god primimo neku novu ***Prevote*** ili ***Precommit*** poruku.

5. ***NewRoundStep*** *poruka*

NewRoundStep poruka u sebi nosi informaciju o novom stanju konsenzus algoritma. Ovom porukom sused nas obaveštava da je promenio konsenzus stanje. Na nama je samo da to zabeležimo kako bismo mu slali one poruke koje mu mogu pomoći da dalje napreduje. Treba obratiti pažnju na to da se pri promeni stanja suseda može saznati i to da je on prešao u novu rundu ili došao do konsenzusa, tako da bi i to trebalo da bude zabeleženo. Za kreiranje ove poruke je zadužen konsenzus deo Tendermint-a.

Gosip - GossipRoutine

Ova rutina gosip protokla je zadužena da na osnovu internog stanja procesa i informacija koje proces ima o susedima odluči koje poruke treba da pošalje kom susedu i da to i uradi.

GossipRoutine se sastoji od četiri dela:

- ***InfoMessagesSender***
- ***DecisionMessagesSender***
- ***ProposalMessagesSender***
- ***VoteMessagesSender***

U narednim pododeljcima biće detaljno opisan svaki od njih. Takođe, važno je napomenuti da redosled ovih rutina mora biti ovakav kako bi se postigle najbolje performanse i najmanja redudantnost poruka.

1. ***InfoMessagesSender***

Ovaj deo ***GossipRoutine*** ima zadatak da svim susedima pošalje sve poruke koje su nastale pri obradi poruka u ***ReceiveRoutine***. Poruke koje se ovde šalju su poruke koje nisu vezane za konsenzus već imaju zadatak da ubrzaju rad gosip protokola, tako što će obezbediti da svaki proces ima što bolji uvid u stanje svog suseda i da samim tim proces šalje susedu samo one poruke koje su mu zaista potrebne. Ovde se govori o ***HasVote*** i ***NewRoundStep*** porukama. Takođe, treba napomenuti da svaku od poruka šaljemo samo jednom svakom od suseda.

2. ***DecisionMessagesSender***

U slučaju da je proces napredovao više od svog suseda i da je visina na kojoj se on nalazi veća nego visina njegovog suseda, on svom susedu šalje ***Decision*** poruku. Ovime on želi da ubrza susedov napredak, jer je u interesu konsenzus algoritma da svi procesi napreduju. Takođe, ovo je validan postupak zato što ako smo mi već doneli odluku za visinu u kojoj se nalazi sused to znači da je ***2f+1*** korektnih procesa poslalo ***Precommit***

poruku i samo je pitanje vremena kada bi i naš sused doneo odluku, tako da mi ovime samo ubrzavamo njegov napredak.

Još je potrebno ažurirati u stanju suseda da smo mu poslali ***DecisionMessage*** kako mu je ne bismo u sledećoj iteraciji opet slali.

3. ***ProposalMessagesSender***

U okviru ovog dela potrebno je da, onom susedu koji se prema informacijama koje mi imamo o njemu nalazi u ***ProposalWait*** stanju i koji se nalazi na istoj visini i rundi kao i mi, pošaljemo ***Proposal*** poruku.

Nakon slanja poruke potrebno je ažurirati da smo mu poslali poruku kako mu je više ne bismo slali.

4. ***VoteMessagesSender***

Ako smo došli do ovog dela ***GossipRoutine*** to znači da ni ***Decision*** ni ***Proposal*** poruka nije poslata i da sused od nas očekuje da mu pošaljemo ***Prevote*** ili ***Precommit*** poruku.

Prvo što treba da uradimo jeste da proverimo da li se sused nalazi na istoj visini kao i mi jer jedino u tom slučaju mi mu šaljemo poruku. Ako se nalazi na manjoj visini onda ćemo mu slati ***Decision***, a ako se nalazi na većoj visini onda mu mi ne možemo nikako pomoći. Zadatak ovog dela rutine jeste da pošalje neku od ***Prevote*** ili ***Precommit*** poruka. ***Prevote*** poruka se šalje ako je njegovo konsenzus stanje ***ProposalWait*** ili ***PrevoteWait*** i ako mi imamo neku ***Prevote*** poruku koju naš sused nema. ***Precommit*** poruka se šalje u slučaju da je stanje suseda ***PrecommitWait*** ili u slučaju da sused ima sve ***Prevote*** poruke kao i mi i da nemamo nijednu ***Prevote*** poruku koju bismo mogli da mu pošaljemo. Naravno u oba slučaja je potrebno da imamo ***Precommit*** poruku koju naš sused nema. Kada smo poslali susedu neku od poruka potrebno je da to zabeležimo kako mu ne bismo slali istu poruku dva puta.

3. SIMULATOR

Simulator simulira jedan distribuirani sistem koji se sastoji od velikog broja procesa koji su nasumično povezani. Svaki proces se sastoji od dve niti, jedna nit predstavlja ***ReceiveRoutine*** gosip protokola, a druga nit predstavlja ***GossipRoutine*** gosip protokola. One se ponašaju u skladu sa opisom koji je dat u prethodnim poglavljima.

Glavne dve apstrakcije koje su simulirane u okviru simulatora jesu mreža i vreme pristizanja poruka. Obe će biti detaljno opisane u narednim potpoglavljima.

Mreža procesa u simulatoru

Kao parametri simulacije unose se broj procesa i broj izlaznih konekcija svakog procesa. Kada se kaže izlaznih konekcija misli se na broj konekcija koje će svaki proces pokušati da uspostavi, a sami linkovi između procesa suseda su bidirekcioni. Veze između suseda mogu biti **LAN** i **WAN** tipa, za potrebe simulacija uzeto je da se između dva suseda u 80% slučajeva uspostavlja veza **WAN** tipa, a u 20% slučajeva veza **LAN** tipa. Sama razmena poruka između procesa je simulirana tako što kada proces A želi da pošalje poruku procesu B, on će u okviru poruke naznačiti kome šalje poruku i naznačiće u kom trenutku bi ta poruka trebalo da stigne procesu B. O načinu izračunavanja vremena pristizanja poruke biće reči u narednom potpoglavlju.

Kada je proces upisao u poruku kome je poruka namenjena i vreme isporučenja on poruku šalje u mrežu, koja je ovde implementirana kao jedan bafer koje je neopadajuće uređen po vremenu pristizanja poruka. Poruka će biti u tom baferu sve dok joj ne istekne vreme; nakon toga će biti poslata procesu kome je namenjena. O prosleđivanju poruka odgovarajućim procesima zadužena je zasebna nit. Ona ima zadatak da uzima prvu poruku iz bafera sa porukama i u slučaju da joj je isteklo vreme, trebalo bi da je prosledi procesu kojem je namenjena.

Kako je svaki proces u mreži jedinstveno označen, u simulaciji postoji jedna heš mapa koja kao ključ ima jedinstveni identifikator procesa, a kao vrednost ima bafer sa porukama. Iz toga sledi, da se prosleđivanje poruke određenom procesu B sa identifikatorom *id* sastoji u tome da iz heš mape uzmemo bafer sačuvan pod ključem *id* i da u njega stavimo odgovarajuću poruku. Prikaz kretanja poruka kroz mrežu dat je na slici 2.

Vreme pristizanja poruke

Kako je jedan od glavnih ciljeva ovog simulatora merenje vremena koje protekne dok veliki broj procesa u distribuiranom sistemu donese konsenzus, bilo je potrebno na neki način simulirati vreme koje protekne od trenutka kada neki proces pošalje poruku do tenutka kada ta poruka stigne do procesa primaoca. Za potrebe simulacije uzeta je aproksimacija da vreme koje prođe između trenutka slanja i trenutka pristizanja poruke zavisi od tipa link-a koji se nalazi između dva suseda. Kako je ranije napomenuto da linkovi mogu biti **LAN** i **WAN** tipa, uzeto je da to vreme u slučaju **LAN** linka iznosi od 1 do 5 ms, a u slučaju **WAN** linka ono iznosi od 70 do

100 ms. Svaki proces pre nego što pošalje poruku svom susedu on treba da na osnovu tipa veze između suseda i njega izgeneriše slučajan broj u opsezima od 1 do 5 ili od 70 do 100 i da na trenutno vreme simulacije doda taj broj. Nit koja prosleđuje poruke će testirati vreme simulacije i kada ono bude veće od vremena pristizanja poruke, ona će proslediti poruku onom procesu kome je poruka namenjena

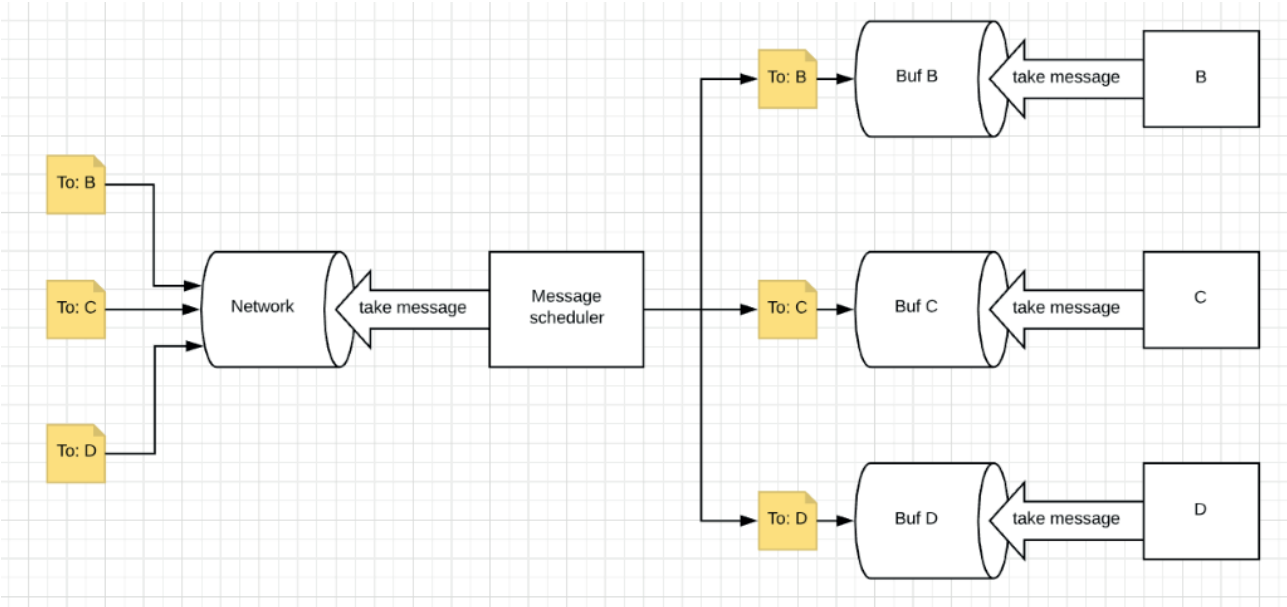
4. REZULTATI SIMULACIONE ANALIZE

Rezultati simulacione analize pokazuju prosečno vreme koje protekne da proces postigne konsenzus, prosečan broj dupliranih ***Prevote*** poruka koje proces dobije i prosečan broj dupliranih ***Precommit*** poruka. Parametar koji se menja prilikom simulacija je broj procesa. Svi rezultati su nastali kao prosečni rezultat od rezultata dobijenih iz 100 iteracija konsenzus-a. Na graficima koji se nalaze na slikama 3, 4 i 5 prikazani su rezultati za simulacije gde se broj procesa menjao u opsegu od 10 do 100, a broj izlaznih konekcija je 10.

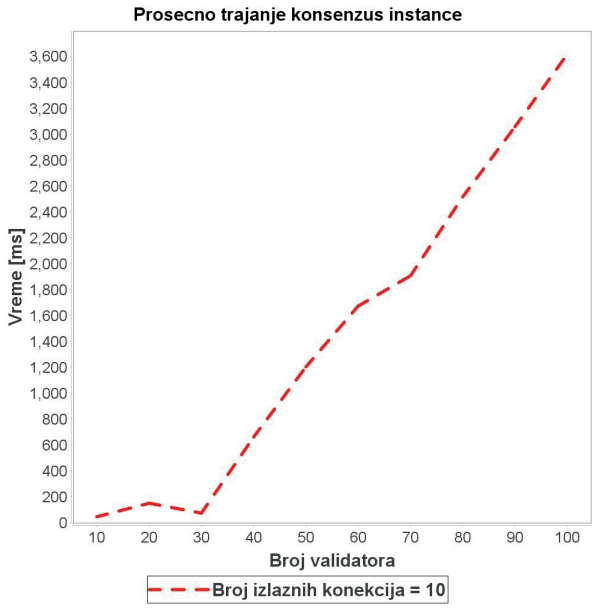
Na grafiku na slici 3 primećuje se da se vreme konsenzus instance povećava sa povećanjem broja procesa. Ovo su rezultati koje smo i očekivali ali zanimljivo je što ovom simulacijom dobijamo vreme u ms koje protekne dok se ne dođe do konsenzusa i vidimo da ono ne prelazi 3, 4 sekunde. Objašnjenje zašto je došlo skoka između 30 i 40 procesa je to što u proseku svaki proces ima oko 20 suseda i u slučaju kada imamo 30 procesa dovoljno je da proces dobije poruke samo od svojih suseda i da postigne konsenzus jer oni čine dve trećine svih procesa.

Na grafiku prikazanom na slici 4 možemo videti da se broj dupliranih ***Prevote*** poruka procesa naglo povećava do granice od 40 procesa. Nakon toga i dalje raste ali manjim intenzitetom. Jedno od objašnjenja za nagli skok se oslanja na to da je i porast u vremenu postizanja konsenzusa bio u tom predelu najveći pa je samim tim i vreme za koje je proces mogao da primi duplikate najveće.

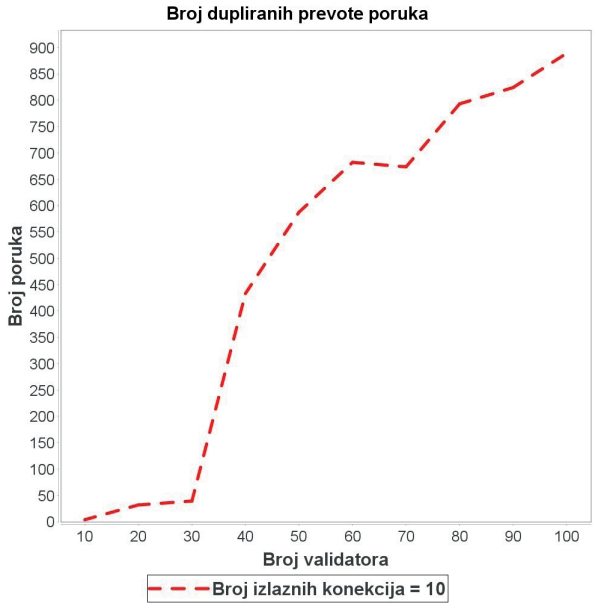
Na grafiku sa slike 5 vidimo da je i broj dupliranih ***Precommit*** poruka porastao sa porastom broja procesa. Može se primetiti da je taj broj daleko manji od broja ***Prevote*** poruka. Razlog za to leži u samoj implementaciji gosipa koji daje prednost ***Prevote*** porukama u odnosu na ***Precommit*** poruke kada se proces nalazi u nekom od ***ProposalWait*** ili ***PrevoteWait*** stanju.



Slika 2. Tok poruka kroz mrežu

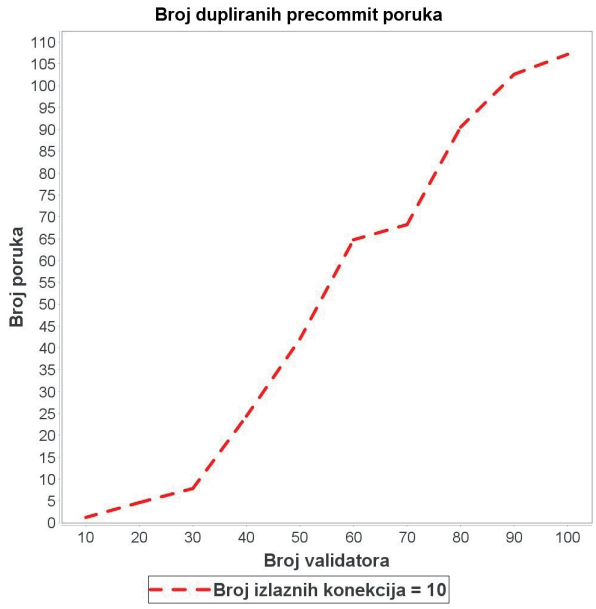


Slika 3. Prosečno trajanje konsenzus instance



Slika 4. Prikaz odnosa dupliranih Prevote poruka

Simulacija nam takođe omogućava da testiramo i uporedimo koliko se razlikuju prethodni parametri u zavisnosti od toga koliko je procesa povezano **LAN** linkom, a koliko je procesa povezano **WAN** linkom. U prethodnim graficima odnos je bio 80-20 u korist **WAN** linkova. Ovi procenti se mogu lako menjati, ali je ovaj odnos uzet jer je to najrealniji slučaj.



Slika 5. Prikaz odnosa dupliranih Precommit poruka

5. ZAKLJUČAK

Rad predstavlja simulacionu analizu epidemičnog konsenzus algoritma koji se koristi u Tendermint blokčejn sistemu. Analiziran je uticaj broja procesa na prosečno trajanje konsenzus instanci, kao i prosečan broj dupliciranih ***Prevote*** i ***Precommit*** poruka.

Rezultati simulacija pokazuju da se prosečno trajanje konsenzus instanci linearno povećava sa povećanjem broja procesa. U smislu apsolutnih brojeva, prosečno trajanje konsenzus instance za 100 procesa je 3, 4 sekunde, što omogućava korišćenje Tenderminta i u aplikacijama koje zahtevaju obradu zahteva u realnom vremenu. S druge strane broj dupliciranih poruka koje svaki proces primi je dosta veliki i povećava se skoro eksponencijalno sa brojem procesa. Ovo je aspekt Tendermint konsenzus algoritma koji je daleko od optimalnog i gde postoji dosta prostora za poboljšanje.

Kao sledeći korak u istraživanju planirana je uporedna eksperimentalna i simulaciona analiza koja će poslužiti za validaciju i dodatne korekcije simulacionog modela. Osim toga ideja budućeg istraživanja je proširenje analize na scenarija koja uključuju različite tipove otkaza i nepouzdanosti mreže.

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MODERN TECHNOLOGIES IN LANGUAGE TEACHING

SECOND LANGUAGE VOCABULARY ACQUISITION ENHANCED BY THE USE OF TECHNOLOGY

Valentina Gavranović

Singidunum University,
Belgrade, Serbia

Abstract:
This paper focuses on the possibilities technology offers in the area of second language teaching and learning, with the emphasis on its use for the purpose of enhancing learners' vocabulary. With the introduction of computer-assisted foreign language learning instruction, new strategies and approaches to foreign language teaching and learning have also been proposed. The aim of this work is to review effective approaches to teaching and learning vocabulary, and to analyse how these can be supported and improved by the use of various technological advances. The purpose of this paper is to promote technology-assisted vocabulary learning with the emphasis on pedagogical implications and principles guiding the use of various technological options.

Keywords:
technology-assisted learning, vocabulary acquisition, reading strategies, web tools/ apps.

1. INTRODUCTION

An ongoing process of change in foreign language teaching and learning paradigm has been brought about not only by the introduction of new theories and approaches in applied linguistics but also by continuous and complex social and cultural changes. The potential which technology offers has made researchers and language instructors investigate how to improve learners' language skills and enhance their language competence. These tendencies and endeavours are contributing to new developments and courses in foreign language teaching and learning.

For the last couple of decades not only has the use of technology become advantageous in promoting and improving the quality of education, but also the imperative in creating reformed curricula across the world [1]. Ever since technology was introduced in education in 1960s, it has been applied in different forms and for various purposes, but with the same goal – to facilitate and enhance the language learning process. With the advancement of technological tools, which are getting more and more sophisticated, new methods and techniques have also been introduced [2].

Technology plays a significant role in our lives, and it is an inevitable component which needs to be taken into consideration in redefining

Correspondence:
Valentina Gavranović

e-mail:
vgavranovic@singidunum.ac.rs

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pedagogical principles so that the needs of the 21st century language learner could be met. Chapelle asserts that 'technology-based language teaching and research is not a departure from applied linguistics – it is a continuation – the 21st century version of what applied linguists do' [3].

When technology was introduced in foreign language teaching, it was primarily used to enhance students' vocabulary and grammar through the method called 'drill-and-practice', which prevailed for a long time [1]. However, the last two decades have been marked by the growing interest of researchers in the use of technology for the purpose of developing primary language skills, and the focus on second language vocabulary acquisition combined with enhancing reading skills has got a special place in applied linguistics. Comprehension-based approaches to language development considerably contributed to the research related to vocabulary acquisition and retention [4].

2. CALL AND ITS BACKGROUND

The second half of the 20th century was facing the unprecedented changes in all areas of human existence which were caused by technology and its various courses of development. Education and foreign language teaching and learning were no exception. In the 1960s a new foreign language teaching concept was introduced and it relied on the use of computers in the classroom. Firstly, computer-assisted language learning (CALL) was proposed and implemented at several universities throughout the world, and it was supported by different computer programmes used for the purpose of teaching a foreign language. The most widespread types of tools and programmes were, and still are, those which support behaviourist approach to teaching, containing computer-assisted gap-fill and cloze exercises [5].

The name of CALL was officially agreed upon by a group of language instructors at TESOL convention in Toronto, in 1983 [5]. This time was marked by intensive activities related to the use of technology in applied linguistics. The possibilities which technology offered encouraged various investigations and research, and these affected practical and pedagogical implications in teaching – new curricula were designed, the market was swamped by books, programmes and coursebooks supporting and explaining the principles and ideas promoted in CALL.

The way technology was used in applied linguistics in the first decades of CALL development supported language learning rather than acquisition. However, over the years, new theories and approaches in applied linguistics were proposed, and the creation of numerous applications, programmes, multimedia tools and resources designed to facilitate language learning influenced the perception of the opposing principles of language learning and language acquisition. One of the proponents of this view was Chapelle, who claimed that CALL could promote acquisition rather than learning [5].

3. SECOND LANGUAGE VOCABULARY ACQUISITION

One of the primary skills a second language learner needs to develop is the knowledge of vocabulary, the skill emphasised by many researchers as a crucial feature of language learning. The process of vocabulary learning is complex and must be dealt with a systematic approach in order to help learners reach a higher level of vocabulary acquisition, retention and production. Teaching vocabulary implies having a deeper understanding of the differences between receptive and productive vocabulary, breadth and depth of vocabulary knowledge and direct teaching and contextual inference [6].

There have been different, often opposing views related to the nature of vocabulary acquisition, defended and supported by numerous investigations and research. Their main concern was to explain when a vocabulary item is considered to be learned and when to be acquired. Many linguists and researchers claimed that the best environment for vocabulary acquisition is a real one, when learners are exposed to real life situations outside the classroom, in the environment where the language is used in an authentic way, spontaneously and with no prior filtering or modifications to suit learner's needs and level of knowledge. On the other hand, formal and controlled language learning environment, as provided by the classroom and the teacher as the language instructor, is also believed to be beneficial for language learners.

In order to solve these opposing views, Krashen hypothesised the theory of comprehensible input, emphasising the importance of the input learners receive. If the classroom provides meaningful input, then this learning environment is beneficial for language learners, just like the rich resource of language material learners receive outside the classroom, in real interactions with people. Although the classroom has its limitations, it can be a resourceful environment for language learning, where students get sufficient amount of comprehensible input,

and become equipped with necessary tools to develop their language skills further in the world outside the classroom. Among the factors which influence the efficacy of the learning environment are also the age and the language level of the learner.

Krashen claims that 'The real advantage of the informal environment is that it supplies comprehensible input. If, however, we fill our second language classrooms with input that is optimal for acquisition, it is quite possible that we can actually do better than the informal environment, at least up to the intermediate level' [7].

The last statement illustrates another complex vocabulary issue and it relates to the acquisition of vocabulary at a higher level which implies more academic register and a considerably larger set of words required for the proper understanding and use of a foreign language.

Another issue which provoked opposing opinions refers to the understanding and perception of two cognitive processes – acquisition and learning. Some authors believe that these two processes are completely opposed and separated. However, this view has been challenged by many researchers who claim that 'once learning becomes automatised, it may become acquisition' [7].

Krashen also points out that second language instructors should focus on creating learning environment which provides meaningful comprehensible input, which will, consequently, encourage acquisition. This learning environment should stimulate subconscious learning which becomes automatised and with features characteristic for language acquisition. Although conscious learning plays an important part, Krashen believes that 'conscious learning does have a role, but it is no longer the lead actor in the play', and investigates 'how we can put conscious learning, or 'grammar' in its proper place in the second language programme [7].

4. SECOND LANGUAGE VOCABULARY ACQUISITION ENHANCED BY READING

Due to the increased interest in vocabulary teaching and learning and the influence of comprehension-based approaches to language development, researchers are focusing on the ways how to support the growth of learners' vocabulary [4]. There is a growing interest in the study of vocabulary acquisition and its relation to reading comprehension. Many linguistic investigations and research have pointed out that there is a close connection between reading proficiency and vocabulary knowledge.

Nagy and Herman, the proponents of the incidental vocabulary learning hypothesis, suggest that the exposure to the target language is very important if acquisition is to take place, and that it is necessary to be exposed to the aimed word 10 to 12 times [8]. Extensive reading has been promoted as an efficient way of expanding learners' vocabulary. One of the proponents of the positive impact of extensive reading on vocabulary acquisition was Krashen who claimed that learners can acquire vocabulary in this way because they are exposed to comprehensible input.

Even though theorists believed that reading, without special emphasis on vocabulary instruction, contributed to the growth of learners' vocabulary, there were no documented studies to support this claim for a long time [9]. Falcon reviews the results of the studies which investigated the impact of reading on incidental vocabulary learning, and makes the conclusion that all the cited studies confirmed the close connection between vocabulary acquisition and reading comprehension, and that there is a positive impact of the latter [10].

In order to understand a text, a leaner needs to have not only the linguistic knowledge, but also the background knowledge, developed reading strategies and motivation [8]. All these are closely interdependent and can support each other in the process of reading comprehension and vocabulary acquisition.

The focus of current research is also on developing strategies for promoting incidental vocabulary learning, and one of the suggested strategies includes the use of marginal glosses.

5. CALL AND ITS EFFECTS ON READING COMPREHENSION AND SECOND LANGUAGE VOCABULARY ACQUISITION

With the introduction of CALL in the 1960s, theorists believed that it supported language learning rather than acquisition. However, its developments and the view that in the learner's cognitive behaviour unconscious acquisition precedes conscious learning made many researchers reexamine and redefine these two processes. One of the proponents of the theory that CALL may promote acquisition rather than learning was Chapelle [5].

In recent years many researchers have investigated the effects of CALL on reading comprehension and second language vocabulary acquisition. The results of their studies contributed to a better understanding of this issue, and without exception they proved that

technology-mediated language instruction can be greatly beneficial for learner's vocabulary growth.

It has been argued that computer technologies can support learning in a number of ways, one of which is the use of multimedia to enhance vocabulary development and reading comprehension. Multimedia relies on computer-based systems that use various types of content, such as text, audio, video, graphics, animation, translation and interactivity. Various studies in their conclusion stated that multimedia glosses are beneficial for students' reading comprehension skills, and since these are closely related to vocabulary acquisition, glosses are also proved to enhance vocabulary [4].

In his study Uno came to the conclusion that if learners want to memorise new words effectively and achieve retention, it is necessary to provide repeated exposure to these words. He also came to the results that previous student's experience and background knowledge play an important role in memorising even harder and longer words [11].

Relying on the view that it is easier to learn a word if it is associate with actual objects or images, Chun in his research investigated the impact of multimedia applications on vocabulary acquisition. The results of the research he conducted pointed out to the higher scores for words which were annotated with pictures and texts [12].

Starting from the premise that glossing is advantageous over non-glossed texts in enhancing incidental vocabulary learning, Makoto Yoshii in his research investigates which glosses are the most effective. However, even though the results pointed out to the positive impact of glosses on reading comprehension and incidental vocabulary learning, he could not come to conclusive results what particular types of glosses were more efficient [13].

In general, the effectiveness of glosses results from several factors. Firstly, in comparison to dictionaries they are more accessible and more accurate because the learner does not need to choose the appropriate meaning for the given context. Secondly, glosses can enhance learners' conscious learning process due to the fact that they draw learners' attention to specific words, and thus 'support the notion of "consciousness-raising" and "input-enhancement" [6]. Another advantage of using glosses is that they can encourage learners to read and reread the text from different directions, and thus support word processing with the possible result of better retention.

6. FROM THEORY TO PRACTICE

Taking into consideration the theoretical framework proposed earlier in the work, the author of this paper analysed reading comprehension output of 60 pre-intermediate and intermediate secondary school students. The main aim of this analysis was to find the correlation between vocabulary knowledge and the overall understanding of the texts, as well as to explain whether, and to what extent, the glosses provided in the text influenced students' overall comprehension output.

First, the students were given the task to translate a set of 10 words from English into Serbian. These words belong to a highly specialised medical register. The students had never studied these words in the formal language environment before, and the author opted for this set of words because she assumed that they were unfamiliar to students because they have a very restricted use and belong to a highly professional medical register. The results proved this assumption to be justifiable because only 5 out of 60 students knew the exact translation of a set of 3-5 words, and 11 students could provide the correct translation of one or two words. The majority of students either made wrong guesses in their translation answers or left the answer sheet empty.

Another task involved reading comprehension of a text with these words included. Due to the fact that students had had the opportunity to deal with a similar content in their mother tongue in different medical subjects, the topic was very familiar to them, and it explained the structure of the heart. All 60 students had to provide translations of these words now when they had read the text, and the results were far better than in the first task. 13 students understood the meaning of more than 6 words, and only 22 students did not understand any of these words, or they understood less than three words, and there were 25 students whose score was average – they could understand three to five of the emphasised words.

In the last task students were divided into two groups. Both groups had the same text to analyse – this time the topic was completely knew for them, they had never dealt with the topic in any other subjects before, and it referred to a description of a chronic bone disorder called Paget disease. Students were given six comprehension questions which heavily relied on understanding certain words which the author had assumed students did not know the meaning of. One group read the text with glosses which provided translation in Serbian for these words, and the other group read the text

without any explanation. The results were rather different. The group which had the glosses outperformed the other group in this comprehension task – 12 students could understand four or more questions, and 7 of them did not understand any of these questions or they understood only one or two questions, and11 students had the average score of three correct answers.

The group which did not have any help did far worse in this task – only 4 students could understand four or more questions, and 19 of them did not understand any of these questions or they could understand only one or two of the questions, and 7 students had the average score of three correct answers.

Furthermore, those students who had the text with glosses did the vocabulary test next class – they were given the same text without glosses, and the aimed words were underlined. Their task was to provide translation for these words. The results were quite satisfactory - 6 students could remember the meaning of four or more words, and 15 of them did not understand any of these words or they could understand one or two words, and 9 students had the average score of three correct answers.

The results of the performed tasks support the view that reading comprehension largely depends on vocabulary knowledge. They also emphasise the importance of comprehensible input and background knowledge of the reading content. Students could understand the meaning of words completely new for them in English because they had solid knowledge in the specified topic, and they used the strategy of inference in order to understand the meaning of the text. On the other hand, the same group of students could not comprehend the meaning of the analysed text which contained content unfamiliar to them. It means they did not have much to rely on in deducing the meaning of the words themselves, nor could they comprehend the meaning of those parts of the text which contained these key words. The results also point out to the importance of organising instructed lessons, with a meaningful comprehensible input which will facilitate students' reading comprehension. Those students who had help in the form of glosses could much more successfully perform the given task.

7. PEDAGOGICAL IMPLICATIONS

The studies reviewed in this paper and the results of various investigations and research presented in the previous chapters imply that it is very important to understand the principles of second language vocabulary acquisition and how it can be enhanced by technology. When planning to introduce technological tools or applications, every language instructor needs to be aware of the pedagogical implications.

In the first place, the language instructor should be well aware of students' needs, interests, age and the level of their language proficiency. This knowledge can greatly help teachers select the type of texts that best suit their learners. There are several criteria for the selection. First of all, the text should be meaningful for students, and include the content which is relevant for their needs and interests. In order to enhance their reading comprehension skills and allow subconscious vocabulary acquisition, the language instructor needs to select those texts which contain a meaningful comprehensible input, with sufficient amount of contextual hints and clues which will facilitate the process of learning.

The accompanying tasks should be devised in such a way that learners focus attention not only to the overall reading comprehension but also to the lexical level, and, thus, consciously, through the use of the aimed words subconsciously acquire these words [10]. These tasks should also contain the target vocabulary which is frequently used in different contexts and environments so that the criterion of exposure is satisfied.

If the text does not contain context which is sufficient for the proper understanding of the target vocabulary, material developers and language instructors have at their disposal various technological tools and applications which can aid students' language learning process. Among these different kinds glosses have proved to be very helpful and purposeful in developing reading strategies and second language vocabulary acquisition. Language learners, not only at advanced but also at lower levels of proficiency, can benefit from reading authentic texts if these are supported by meaningful explanations which do not distract the natural speed of reading.

8. CONCLUSION

Approaches to foreign language teaching, their underlying principles and pedagogical implications stemming from them have been modified in recent decades due to the advancement of computer technology and development of various tools and applications. The new trends in ELT show that computer-assisted language learning is gaining in popularity, and numerous studies have proved that the use of technology, if properly applied, can be rather beneficial for language learners.

In this work we have examined the effects technology-mediated instructions can have on reading comprehension and second language vocabulary acquisition. The results of various studies reviewed in this paper, as well as the results of the analysis of student's reading comprehension related to medical texts show that technology can greatly help learners understand reading demands. We have also examined the correlation between second language acquisition and reading comprehension. In order to enhance learners' vocabulary both intentional and incidental learning are valuable methods, and various computer-assisted techniques can contribute to a more effective learning process. Different types of glosses which accompany reading texts have been proved to be rather useful, especially in cases when the context does not provide a meaningful input for the interference of the meaning. With the use of glosses, especially of the multimodal type, learners can be encouraged to learn with more confidence within their zone of proximal development.

Although it has been proved that technology-mediated foreign language learning improves reading comprehension skills and contributes to the expansion of vocabulary, applied linguistics is facing the challenge of providing more studies and research related to vocabulary retention and production.

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TRADITIONAL LANGUAGE TEACHING VERSUS ICT- ORIENTED CLASSROOM

Maja Veljković Michos*,
Katarina Nasradin,
Valentina Bošković Marković

Singidunum University,
Belgrade, Serbia

Abstract:
The 21st century classroom is, with the necessary infrastructure, an environment much more developed than the traditional classroom. Since the purpose of a language is communication between people, both written and oral, the Internet has become an extraordinary resource for teaching and learning a foreign language. The Information and Communication Technologies (ICT) make it possible to accelerate the teaching and learning process, as they help students learn from a distance. In other words, they are an effective, fast and cheap way to acquire a new language, which is why it is gaining more or more attention. Nevertheless, traditional classroom still exists and functions with very effective results. The research conducted for the purpose of this paper shows how students perceive and evaluate both traditional and ICT supported learning of a foreign language in higher education environment, with the aim of discovering which of the two approaches students find more suitable for learning a foreign language.

Keywords:
Foreign language learning, traditional classroom, Internet, ICT.

1. INTRODUCTION

Education has experienced significant changes in recent years due to technological advancements. Language teaching, as a specific branch of education, has experienced these changes as well. Foreign language teachers tend to use the latest methodological trends, and they do their best to be well-informed regarding everything that educational technology can provide in their field.

At the same time, our students, as digital natives, live in fast and changing environment, with many possibilities and answers accessible by using the Internet and new technologies.

The role of teachers and students has experienced important changes during the digital age. In comparison with the traditional classroom where the teacher was a central figure, as someone who is both a leader and the main source of knowledge and information, whereas students were mostly receivers of the educational contents provided by teachers and textbooks, nowadays, students play the main role in the teaching and learning process. The teacher´s role has transformed from traditional

Correspondence:
Maja Veljković Michos

e-mail:
mveljkovic@singidunum.ac.rs

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figure of teacher-educator to the new role of moderator, facilitator, and instructor. The learners have become the very active participants and responsible protagonists in the teaching-learning process. Moreover, the learning environment has also changed. The students of today can choose not only how to learn, access and share information, but where and when to learn. The learning experience has been changed with the use of ICT, breaking the barriers of time and space (e-learning).

Therefore, new generations of teachers should be skilled to select, update and use knowledge in a specific context, and to be able to adapt their knowledge to new, changeable situations [1].

However, the question is if the ICT are always effective for language teaching and learning. Another relevant question is whether we use these new resources properly, as well as whether we as teachers really have all the necessary tools to achieve effective learning at our disposal. Furthermore, do our students always expect their teachers to use ICT tools in the classroom? What is the opinion of our students regarding the way they learn a foreign language and the resources that are used in their language classrooms? That is why we have decided to understand how our students perceive and evaluate both traditional and ICT supported learning of a foreign language.

2. ICT IN THE CLASSROOM

The presence of ICT (information and communications technology) or LTK (language tool kit) in foreign language teaching has become essential in order to satisfy the demands of modern education contexts of Information and Knowledge society [2]. The new digital skills of teachers of a foreign language are required and indispensable, mainly those related to the creation and adaptation of digital materials, communication activities in digital media, as well as the implementation of digital strategies for learning a foreign language, such as autonomy or evaluation. We agree with Zabalza [3] regarding necessary skills and professional teacher´s competences, in order to achieve effective teaching:

1. Planning the teaching-learning process,
2. Selecting and preparing the course contents,
3. Offering understandable and well-organized information and explanations (communicative competence),
4. Using new technologies,
5. Designing the methodology and organizing class activities (Organization of space; Methods selection; Selection and creation of activities),
6. Communication with students,
7. Mentoring,
8. Evaluating,
9. Educational research,
10. Identifying with the institution and team- work skills.

As stated above, the fourth skill refers explicitly to new technologies, and nine other teachers´ competences are applicable to 'pre-digital' era as well. As professionals of the digital society, language teachers definitely need to know how to search, select and distinguish relevant information as fresh, updated teaching material and how to use and apply the three essential elements of new technologies (ICT) in their classroom: 1. Devices (smartphones, tablets, etc.); 2. Applications (Google Play Store, appStore, Office, multimedia, and many others), and 3. Web.

We relate those ICT elements with concepts of motivation and familiarity of their users – students, who also have expectations about their way of learning.

For that reason, and despite benefits of the Internet and adaptation to the new digitalized context, it is also important to mention that ICT have drawbacks:

- Loss of time: teachers and students need time to find proper and updated information within amounts of unreliable information;
- The Internet is a privilege for the user but it also implies a responsibility, and digital courtesy or *netiquette* [1];
- The interest of students can be distracted to other contents than those planned by the teacher;
- Students´ motivation can be lost if they spend much time searching, reading and interpreting different contents, assigned by teacher, which can cause disorientation and cognitive overload;
- Regarding language skills, the gap between oral and written skills can cause negative feedback.

3. TRADITIONAL CLASSROOM

The sheer term "traditional classroom" gives away the idea of it being very different than modern, well-equipped

1 Rules of behavior, good manners or moral practice and norms in digital environment and virtual interactions, Rinaldi (1997) [4].

clasroom of contemporary society. If we compare the classroom of the past and a contemporary classroom, we might conclude that the main components are tables, board, and a marker/ chalk, along with the teacher and his/her desk. The modern classroom has sounding system, a computer, projector and very often an interactive whiteboard. A classroom has students and a teacher, as that is its main purpose from its creation. If we analyze the teaching methods regarding foreign languages, grammar- translation method was most often used in the past. It later transformed into communicative method, and today we call it task-based language learning. Is it really easier to learn a language in a modern classroom? There are numerous factors which can affect the language learning process and we will name a few: general motivation of students, the way a language is taught- individually or in a group with a teacher and additional resources, the characteristics of the teacher, textbook and materials which are used, the time spent on studying, age of students, previous experience in language learning, talent, etc. Despite the fact that a language can be learned completely free of charge online, students still claim that the role of teacher is important and that their success depends a lot on the teacher's skills. Both traditional and modern teachers have the role of not only someone who transfers knowledge, but someone who also evaluates their work, leads them, educates them and motivates them. The teacher should be motivated, enthusiastic, tolerant, compassionate, fun, creative, always ready to gain new skills. Also, what affects the learning process is the attitude of students toward the language, the teacher, the culture and the course.

The teacher's knowlegde of course content, as well as the teaching method, contribute a lot to students' achievements [5]. It is also stated that the teacher's flexibility and creativity play an important role in this process. In other words, that means the teacher can easily adapt to their students and their needs, and to make the class more interesting and innovative. Students are mostly motivated by the teacher who is also higly motivated and energetic. The teacher with great rethorics, body language and good interaction with students is certainly more successful than the one without these traits. The atmosphere of the group is also essential when learning a foreign language. The atmosphere should be friendly and relaxed, aimed at success, and not at mistakes. Real studying starts once students remove their anxieties. The teacher with authoritative attitude in teaching cannot achieve successful results, at least when it comes to foreign language teaching. Speaking and writing skills are reproductive skills which can only be acquired by active speaking or writing, which is why it is necessary for students to be active participants all the time, in order to memorize new words or practice new grammar units. Anxiety usually comes as the result of fear of failure. This mostly happens when the interaction with the teacher is inappropriate, i.e. when there is no mutual trust [6].

The main role of the teacher is to prepare students for permanent self-education [7]. No matter how long a foreign language is being studied, it can always be improved. Any language (mother tongue or a foreign language) is a life-long learning process with vocabulary that is constantly being expanded [8]. Furthermore, every student has their own memorizing techniques (repeating outloud), visualization (imagining situations), kinaesthetic (acting and movements), rewriting words, reading texts, watching movies etc.

4. RESEARCH METHODOLOGY AND RESULTS

As teachers, we all try to find the best way for our students to acquire a foreign language in every class and to respond to the needs of every type of student. However, for gaining meaningful results not only for this paper, but for our future classes as well, we have also decided to conduct a very brief empirical research with our students. Based on their answers, we will conclude if and how much modern classroom can accelerate and ease foreign language learning, as well as whether students find that there is a difference between ICT and traditional classroom and what that difference would be in their personal opinion. In this way, we will have an insight into students' motivation, ambitions and studying goals.

The research, conducted for the purpose of this paper, implies a quantitative analysis among 119 male and female students who study at Singidunum University in Belgrade, Serbia. More precisely, 53.8% of the interviewees study at Faculty of Business, whereas 45.5% of them study at Faculty of Tourism and Hospitality Management, and 0.8% of the examinees are students of Faculty of Technical Sciences. When it comes to the year of their studies, the highest percentage (46.9%) are the second year, 32.8% of them are in their first year of studies, 11% of them are third year students, and 5.9% are at their final year of studying. All students who participated in the research study the English language (119), and they can choose the German language (34) and the Spanish language (22) as their second foreign language. There

are also other elective language courses at Singidunum University, but we have chosen German and Spanish as they cover the highest number of students.

Table 1.

Number of students	Foreign Language		
	English	*German*	*Spanish*
	119	34	22

The instrument used for this study was an online, anonymous questionnaire which students were asked to fill in during their foreign language (English, German, and Spanish) classes. The form of questionnaire was Google online questionnaire form. Prior to being given the questionnaire, students were asked in an informal discussion whether they are familiar with the concept of ICT and we can conclude that they are not at all acquainted with this official term, though they are quite aware of the concept of the usage of online tools in the classroom. The questions given to students were multiple-choice questions and they could choose only one answer per question. In other words, questions were closed-ended. Only the questions about which language the interviewees study had more than one answer, as all students at Singidunum University can study at least two foreign languages. For most questions that were statements about ICT or traditional classrooms, students had the following answers to choose: strongly agree, agree, disagree, and strongly disagree.

The overall results of the questionnaire show that students, 80.3% of them, are certain that ICT should be used in the classroom, although a small percentage, 19.7% of them think it is a waste of time. On the other hand, 91.6% of the interviewees find the Internet to be an essential tool for learning any language and they claim they use it for the same purpose on a daily basis. Almost the same percentage of the interviewed students answered positively to the question if they use the Internet to consult language topics. From 119 responses, 92.4% of them use the Internet in order to question language topics, while only 7.6% do not consult the Internet when they need an answer to a language topic. The next question that was significant was about how often they used their smartphones, tablets or laptops in language classes. Only 8.4% of students answered that they always use their mobile devices in language classes, and only 3.3% responded that they never use them. The most of them, 46.7% and 41.8% replied that they rarely or often use them in the language classroom, respectively.

What might be a surprise is their answer to the question 'Do you prefer to practice foreign language with a textbook and workbook or with your computer and Internet?' as almost 50% of them said they preferred a textbook and workbook, which is a form of a traditional teaching method. Furthermore, the same percentage may be applied when answering the question: 'Can you imagine your language class without the use of ICT?', where 51.6% of students answered "yes", which leads us to the conclusion that, although they think ICT should be used in the classroom, they still prefer the traditional, or "old- fashioned" way of teaching and studying, highly valuing the teacher´s lectures and explanations in classroom. We must add that we have received the same comment from our students verbally, while we were discussing these issues during our regular classes. They do not expect their language teacher to use ICT tools during each class if there is not a clear, teaching and learning purpose behind their use. Consequently, for question 'Are a teacher's lectures, presentations and explanations more effective than the use of ICT tools for language learning?' 64.7% of the students answered that they agree, and 27% strongly agree, while only 6.6% students disagree and 1.6% strongly disagree.

Table 2.

Answers	Are a teacher's lectures and explanations more effective than the use of ICT tools for language learning?	
	Strongly agree	*Agree*
	33	79

One of the question in the questionnaire was whether students learn more effectively in traditional or contemporary classroom, where 64% of students chose ICT classroom. Furthermore, we have also asked our students whether how much modern and well-equipped classroom can motivate students to learn a foreign language. Around 60% of students claim that this would be a great motivation source for them.

Table 3.

Answers	Do you find it easier to learn language with ICT tools?	
	Yes	*No*
	112	10

We have to agree that modern generations enjoy using the Internet, smart phones, tablets and other modern means not only in their free time and not only for pleasure, but for studying as well. Students from older generations could not possibly imagine online learning or using some Internet resources for studying as it would damage their sight, unable highlighting the main and most important points, and it would not include the mere sound of turning the pages or carrying their precious books with them. The newer generations are accustomed to this type of studying. For them, traditional learning, which is not followed by some videos, visual illustrations or similar applications, can sometimes be very boring and demanding. Therefore, we should ask ourselves whether there is a chance for old, traditional classroom to become obsolete in modern world, due to the constant usage of ICT? At this point, these two learning types are intertwined and the best solution would be to use them both, which is also the main argument of our students and interviewees. To be more precise, 77% of students claim that the usage of ICT in the classroom has a very positive effect on their attendance. We should be aware of the fact that, due to the online era in which we can do anything we want via the Internet, students' attendance is constantly decreasing. Nowadays, even when it comes to learning, there is a special distance-learning program for students and online materials and various resources. However, the statement that ICT contributes to students' attendance at such point is most certainly a positive one.

Table 4.

Answers	Is it necessary to use ICT tools in the language classroom?	
	Yes	*No*
	98	24

When it comes to various online resources used in modern classroom, the interviewees state that they prefer watching videos (46%), using their smart phones (23%) - for an online language game, spell check, vocabulary check etc; using online dictionaries (17%) and using their laptops (13%).

Therefore, as we have previously supposed, what our student actually need and what actually is the best option for learning a foreign language is a combination of both traditional and ICT approach, as all students would benefit from what they find to be more appropriate for their language acquisition.

Table 5.

Answers	Can you imagine your language class without the use of ICT?	
	Yes	*No*
	60	59

5. CONCLUSION

If we analyze the difference between ICT and traditional classroom in theory and in practice, we will most certainly find numerous differences. Moreover, if we ask students and teachers about their opinion regarding these issues, we will get diverse answers as well. To be more precise, in theory, it has been believed by teachers that ICT is a more desirable approach for students in modern language classroom, even though teachers themselves are more likely to prefer traditional teaching methods. In practice, students find ICT not to be an essential, but just an additional and optional part of language learning process, whereas traditional materials such as textbooks and workbooks are still a very useful tool that helps them acquire a foreign language, regardless of which language that is. In other words, what we as teachers think students might want and need from our lectures in the classroom is not just the usage of ICT and definitely not the usage of ICT in every class, but a mixture of both ICT and traditional learning/ teaching methods. Furthermore, when it comes to certain language aspects, students actually prefer the old, traditional tools such as textbooks and workbooks.

In contemporary education and, more specifically, in the foreign language classroom, it is essential to stimulate developing of speaking skills and communication skills. The integration of students´ speaking, listening, reading and writing skills in each class, supported with ICT, are highly valued by new pedagogies. This combination can stimulate students' motivation for both language learning and improvement of their language skills. If there is no appropriate pedagogy of the language teacher behind the use of ICT in classroom, language teaching and learning process is not possible to be functional and effective. On the other hand, the mere usage of traditional methods in the form of simple usage of textbooks and workbooks cannot be successful any more. Therefore, in order to be effective foreign language teachers, we, as teachers, must comply with both modern tendencies and students' demands, even when these two are completely juxtaposed, especially if this affects their motivation and class attendance, let alone

their results in language learning and their acquisition of language skills. In other words, we should combine the advantages and benefits of both traditional and ICT approach in our classrooms, while maintaining the role of educators, mediators and at the same time recognizing the needs of our students which, as we have seen in this research, do not necessarily have to comply with modern tendencies in education. When asked whether we would rather use traditional classroom or ICT classroom, our answer should depend firstly on our students' skills, needs and motivation. Only then will we be able to achieve our goals as successful foreign language teachers.

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THE USE OF INTERNET TO INCREASE STUDENT MOTIVATION IN THE FOREIGN LANGUAGE LEARNING PROCESS

Aleksandra Gagić*,
Milica Zelić,
Milica Čolović

Singidunum University,
Belgrade, Serbia

Abstract:
It is very difficult to keep your students motivated all the time. Nowadays, it may become even more challenging to do that. The millennial generation spends many hours on the computer, often the Internet.How to motivate your students to value class activities, and without external pressure, to carry them out on their own?.In this paper we agree that teachers should use digital tools in the teaching process and to combine them with well known methods and approaches. Teachers today tend to classify students as not being able to concentrate. We should help our students in this situation using innovative digital aids; they are using them a lot on a daily basis, so, in this way, we can get closer to them. Using something similar in our classroom may make lessons more appealing to them, and it can surely motivate them to learn. We should be aware of the fact that nowadays students prefer looking at a screen than books, so we should use new resources.

Keywords:
motivation, learning, internet, millenials, methods.

1. INTRODUCTION

There are various definitions of motivation.It is defined as a psychological process that affects the initiation, direction, intensity, and duration of certain behavior [1]. To be motivated means to be moved to do something. The one who feels no inspiration to act is characterized as unmotivated, whereas someone who is energized or activated towards an end is considered motivated [2]. According to another author motivating is when the desire to learn something is stimulated [3]. There are two major types of motivation:

- Intrinsic motivation - doing of an activity for its inherent satisfaction rather than for some separable consequence.It exists within individuals. It is also noticed that with each advancing year age in schools, intrinsic motivation becomes weaker.
- Extrinsic motivation -is a construct that pertains whenever an activity is done in order to attain some separable outcome. This typr contrasts with intrinsic motivation, which refers to doing an activity simply for the enjoyment of the activity itself, rather than its instrumental value. Given that many of the educational activities

Correspondence:
Aleksandra Gagić

e-mail:
agagic@singidunum.ac.rs

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prescribed in schools are not designed to be intrinsically interesting, a central question is how to motivate students to value and self-regulate such activities, and without external pressure, to carry them out on their own [2].

Since the motivation has an impact on learning styles, there are:

- Deep learners –intrinsically motivated students who like difficult and complex subjects.
- Strategic learners are the students motivated primarily by the rewards. They like competing with others, have good grades, but will not make an effort unless are rewarded.
- Surface learners - their motivation is avoiding the failure. Teachers should help them gain confidence in their abilities [4].

Middleton, Littlefield and Lehrer have suggested the model of intrinsic motivation. They said that in the first stage, students are judging whether the activity is interesting or not. If it is not, then they think about two factors: stimulation and personal control. If the activity possesses these two factors, then it becomes interesting for them. But, if over time, the activity provides little stimulation or control, students remove it from their mental list of interesting activities [5].

These authors were focused on the ways in which teachers attempted build student motivation into their lessons, and the belief systems of teachers as compared to those of their students. The results showed that when teachers can predict their students' beliefs, they are more successful in motivating them for learning.

2. MILLENIALS

The millennial generation is also called generation Y, the Net generation,and also the NeXt generation.The generation which spends many hours on the computer, often the Internet, interacting with peers, doing schoolwork, playing games, shopping, and otherwise entertaining themselves.

They are self-confident, extremely social, goal-oriented, but, on the other hand, impatient, materialistic, and self-centered. These people can be challenging to deal with. Our lessons are not inspiring enough for them and that is why they are not motivated and do not respect them, but, we can reach them if we adjust our classes to their interests [3].

Although this is generally true, our opinion is that they do not have such a good interaction with peers, they are not extremely social, but we would definitely agree that they are self-centered.

It is very difficult to keep your students motivated all the time. Nowadays, it may become even more challenging to do that. Teachers rely on outdated approaches and methods, use old books, and, generally, are not willing to change much in their classes, especially those working in schools which do not have any modern equipment. On the other hand, students belonging to millennial generation, accustomed to all sorts of digital devices, find it very easily to lose any motivation in such circumstances. In order to gain students' attention, teachers need to make some changes when it comes to their lessons. How to keep your students motivated? There are various strategies we could use .

3. STRATEGIES FOR MOTIVATING STUDENTS

The students more motivated want to learn more, so they achieve more.

- Use different materials

Bringing technology into our lessons is a great way to motivate students.

Modern time and modern education require modern and innovative materials:

- Use of interactive boards and tablets
- The possibility of learning through the Internet; various platforms for learning and certain android applications
- Contemporary audio-visual and multimedia teaching aids

In this way students are developing critical thinking and research abilities, and are motivated to research and find information on their own.

Computer is a powerful device, and, if it is equipped with software and the Internet it can replace various teaching aids.

Interactive whiteboard is widely used in the world. They make classes much more interesting, improve the quality of teaching, and make students participate actively. Some of its main characteristics are displaying of the videos, showing pictures with great resolution, the usage of educational software.

Tablets are becoming the main teaching aids in modern classrooms. In other words, tablets are computers

but with touch screens. The advantages they give in the classroom are various since a lot of useful applications can be installed.

Multimedia classrooms are equipped with the various modern teaching aids, like computers, projectors, slide projectors with DVDs, video screens, smart boards, so that new information technology can be used. Multimedia should provide multitasking (the ability to do more processes at the same time) and interaction.

Amazon echo is one of the most modern teaching aids. Its main characteristic is sensitivity to voice. That means that students can give it voice commands, ask questions and get answers, for example, about historical events, book content, but also get current information from the real world.

Samsung gear VR looks like glasses which enable the experience of virtual reality; so that students via this device can get better impression about the things they learn in the class.[6]

Our students use a lot of digital devices in their free time. As a consequence, they find the lectures boring. Teachers today tend to classify students as not being able to concentrate, unmotivated and very often it is talked about ADHD. What they can do to help students in this situation is for sure the usage of innovative digital aids; they are using them a lot on a daily basis, so, in this way, we can get closer to them. Using something similar in our classroom may make lessons more appealing to them, and it can surely motivate them to learn.

We should be aware of the fact that nowadays students prefer looking at a screen than books, so we should use new resources.

Of course, this is only one of the ways to keep our students motivated, not the only and possibly not the best way. Every teacher should search for the things that are the best for their classroom.

4. METHODS AND APPROACHES

According to Grammar-translation method,the goal is to learn foreign language in order to read its literature. The major focus is on reading and writing. Vocabulary is based on the reading texts. When it comes to accuracy, it is emphasized, and the grammar is taught deductively. The medium of instruction is the student's native language [7].

In the Direct Method, the classroom instruction was conducted only in the target language, and everyday vocabulary and sentences were taught, as well as speech and listening comprehension. The emphasis was on correct pronunciation and grammar, which was taught inductively.

In The Oral Approach and Situational Language Teaching the main point is that the language teaching begins with the spoken language. Material is thought orally before being presented in the written form. The language that is used in the classroom is the target language. New language points are introduced and practiced situationally.

According toAudio lingual method the language skills are learned more effectively if the items are represented in spoken form before presenting them in written form. Teaching a language in the first place means teaching the cultural system of the people speaking the target language.

In Communicative language teaching, the primary language function is interaction and communication, and primarily units of language are not its grammatical and structural features, but categories of functional and communicative meaning.

Total Physical Response is built around the coordination of speech and action; it is teaching language through physical activity.

Those who propose The silent way method claim that learning is easier if students discover or create than if they remember or repeat. (Richards & Rodgers, 1986, p.99)

In the classrooms where Community Language Learning method is used, there is a lot of foreign language conversation. What is more important, students participate actively, they are encouraged to ask questions.

The goals of a Natural Approach class are based on the assessment of student needs. The course is planned around situations in which students will use the target language; teachers do not organize lessons around a grammatical syllabus.

Suggestopedia is a method developed by Bulgarian psychiatrist-educator Lozanov. He describes Suggestology, the science from which suggestopedia is derived, as being concerned with the systematic study to which humans are responding. The main focus is on decoration, furniture, arrangement of the classroom, usage of music, and the authoritative behaviour of the teacher [7].

Based on all these methods and approaches, teachers can create an ideal mixture for their classroom.

5. DEFINE THE OBJECTIVES

On the level of the subject, this means that teacher should define the objectives at the beginning of the year. When you explain to your students the rules, and your expectations of them, you avoid any confusing situations and your students stay motivated for work [8].

It is of high importance to start every lesson with a good plan, and clear, reachable goals. If you want your students to be motivated and to participate all the time, you should involve them in every part of your lesson. Writing down a plan of your lesson on the board gives your students the chance to see where are you "taking" them (when it comes to teaching). In that way, they are highly motivated to let you be their leader, and they will surely leave the classroom satisfied.

The success of every task lies in giving clear instructions. A good teacher should be clear when setting a task, but it is also very important to give your students time to prepare and to ask some additional questions if they still do not understand. In that way teacher gets a classroom full of motivated students, who will, if not give the right answers to the task, at least try to solve it. Students find it very important to have a clear idea of what they are supposed to do, and otherwise, they would feel highly frustrated if they do not succeed because they had not understood the task in the first place [9].

6. CREATE A THREAT-FREE ENVIRONMENT

The key words for this section are positive reinforcement. Teachers should set boundaries and explain their students that they are responsible for their actions, but, teachers should not build the relationship with students based on the things they are not allowed to do. Learning in the threat-free environment is much more motivating for students. Creating a safe environment and showing your students that you believe in them will create the atmosphere full of joy and motivation. In this way students are willing to fulfill teacher's expectations [8].

If we remember the affective-filter hypothesis, it will also confirm us that the students learn when relaxed.

Positive reinforcement is adding a pleasant stimulus to intensify certain behavior.

Negative reinforcement is removing an aversive stimulus to enhance a behavior.

The goal of punishment is to make an undesired behavior less likely to happen, continue, or strengthen in the future. The difference is that reinforcement aims to increase a behavior, while punishment wants to decrease a behavior. Since punishment is proven to be actually harmful to brains, it is better to use reinforcement, even the negative [10].

7. CHANGE YOUR SCENERY

Can you remember early school days and the feeling of pure excitement when teacher took you outside and gave her lecture in the park or the museum and various other places?

Of course that the classroom is the most appropriate place for learning, but spending every day in the same place can make students feel a bit bored. To keep your students motivated to learn, you should always bring something new to your classes. Students could be taken out on some kind of an educational trip, to the library, or simply to the park. A good idea is also to bring in some speakers, as guests to your class [8].

Our brains like experiencing new and different things!

8. OFFER VARIED EXPERIENCES

In order to help students to stay engaged and pay attention to lessons, teachers should offer a variety of experiences during the class. In this way, even if they did not get the chance to know all of their students well, they will for sure focus them on the things they like best. Successful lesson is a perfect mix-up of different tasks for students with different preferences.

This is the way to maintain order in the classroom [10].

An essential thing is to teach students critical thinking and to make improvements while thinking. Teacher can create this environment with lectures, discussions, case studies, role playing, field work, and many other techniques. Many teachers never give their students opportunity to ask questions, they are simply giving the answers. If we want to create natural critical learning environment, we should encourage our students to compare, apply, evaluate, analyze, but never to simply listen and memorize [11].

One additional piece of advice for the teachers is always to have a plan B! If, for instance, teachers notice that the students are not listening, that they are bored, they should stop giving a lecture. It is better to ask students

what they would like to listen or talk about; and then, by talking about the topic of students' choice, teachers should still try to talk about the things related to the lesson.

9. INVOLVE YOUR STUDENTS

Teaching 'ex-cathedra' is outdated. It does not motivate students because they do not want to be passive all the time. If we really want to keep students motivated, we should involve them and let them be active.

Students are the center of the class and the teacher is only a guide. Letting them choose the activity, or, for example, a topic for discussion in the classroom will give them the sense of control and equality to the teacher [9]. Even the naughtiest students calm down when we let them be in charge.

Carol Ames wrote an article about how classroom environments influence students' views about the nature and purposes of learning. She said that of crucial importance is creating a connection between environment, goals and student motivation. In one part she also suggested that teachers should involve students in the lessons and decision making, and that is essential for creating 'positive motivation patterns' in children [12].

Giving students responsibility makes them motivated to meet the expectations. If they are aware of the fact that they are responsible for a certain classroom activity it gives them the sense of motivation [8].

10. VARY THE SOCIAL DYNAMICS

The social interaction can get students excited about things in the classroom and students might motivate one another to reach goal.Working in pairs or groups can be fun and motivating for students to try to find solutions to the problems, work on projects, do experiments, or simply exchange the ideas or opinions. To keep students' attention a teacher can set a variety of engaging activities thus creating a friendly atmosphere in which they can talk and move freely [9].

However, teachers should be careful not to force students, who like individual work the best, to join the group work.

11. GET TO KNOW YOUR STUDENTS

Getting to know your students is a lot more than just memorizing their names. Showing your students that you respect them as individuals and that you appreciate their work motivates them to work harder [8].

If you succeed in getting to know your students, you will also have the opportunity to relate the lesson material to the things they find interesting. In that way, motivation on the side of the students is inevitable.If you want them to be truly loyal to you, you should show that you care about them and their success. Before judging your students, try to understand what kind of person is each of them, introvert or extrovert, but also show interest for their lives outside the classroom, find out if they are dealing with any problems or having hard times, which may cause them having difficulties in studying, concentrating on lectures, etc. Also, if a student begins displaying a sudden change in behaviour, that should be a sign for the teacher to try and find out what problems he or she is having at the moment. If you decide to talk to a student about possible problems, it is very important not to do that in front of the whole class. Teachers should be careful with students, because it is really important to them how others see them.

According to Joshua Eyler, teaching is a challenging profession, but on the other hand, we can make it easier by finding out more about the ways our students learn. We can do the research in lot of fields, like developmental psychology, cognitive neuroscience, and anthropology.

12. MAKE LEARNING FUN

The most memorable classes are those in which teacher succeeded in combining learning and entertainment. Students of any age like fun and playing games. Positive competition in some cases can motivate students to try harder. It gives them the opportunity to interact with each other, show off their knowledge, but also to have fun.

13. PRAISE

One way to motivate your students is to get them take a hard look at themselves and determine their own strengths and weaknesses [8]. Everyone wants to succeed, and no one likes being criticized by the teacher. So, if you encourage self-reflection in students, they will be responsible for their success, and will be given a chance to shine. There is no better form of motivation than encouragement. Giving praise for a well-done job will be motivational for the whole class, the only thing a teacher

should pay attention to is not to degrade others by praising one student. It is much better to observe a class as a team and encourage them all to achieve even better results. Simple words like 'well done' or 'thank you' build students'self-cofidence. If we apply this to a task-level, that means that teacher should give a task where the students can see the results of their effort.

That feeling of 'Yeah, I did it!', that 'a-ha' moment students get when they have done a difficult exercise, boosts their motivation [9].

14. DON'T OVER CORRECT

Over-correcting should be avoided, especially in speaking exercises. No one likes being interrupted and not listened to. That also has a bad impact on motivation. Over-correcting may cause that students become insecure and not believe in their own abilities. Good teachers rather explain that making mistakes is a natural part of learning. It is better to show our students that we are good listeners.

15. BE A ROLE MODEL

The best way to keep your students motivated is to share your enthusiasm. A teacher who is a role model to the students is the one that is excited about teaching, the one that loves the job, and loves students. This is the way of transferring motivation to students. The passion of the teacher motivates students [14]. According to Cavanagh teachers who really want to get students' attention, need to include emotions in their teaching style. In that way, students' persistence can be prolonged, they will make an effort, and stay focused and motivated for learning [15].

What is even more important is to explain your students that making mistakes is part of a learning process. Nothing is irreparable. It is perfectly normal to have ups and downs in learning,as well as in everyday life.

16. CONCLUSION

In this paper we all agree that supportive classroom environments, practical activities with a lot of carefully chosen digital tools combined with various methods and approaches, teachers' personal and professional qualities, interaction and encouragement are very helpful for the language learning process in the classroom.

In our opinion, what keeps students motivated is a motivated teacher. We should put a lot of energy and time; we should make an effort in order to create interesting lessons. It is important to offer the right amount of the challenge so that students feel motivated to learn and they do not get bored or discouraged.

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MOBILNA APLIKACIJA HELLO TALK – NEDOVOLJNO ISKORIŠĆENA MOGUĆNOST U UČENJU I USAVRŠAVANJU STRANIH JEZIKA

Neda Maenza*,
Tijana Gajić

Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Savremene tehnologije, nova generacija pametnih telefona, kao i mnoštvo mobilnih aplikacija umnogome su obogatili načine učenja i usavršavanja stranih jezika. Pristup internetu uvek i na svakom mestu otvorio je neograničeno korišćenje edukativnih materijala, koji na sasvim nov i kreativan način podstiču korisnike većoj zainteresovanosti za usavršavanje znanja stranih jezika, sistematski doprinoseći razvijanju svih jezičkih veština. U radu se postavlja pitanje u kojoj meri i koliko dugo se koristi mobilna aplikacija Hello Talk - aplikacija zasnovana na tandemskom učenju dva interaktivna lica koja su voljna da jedno drugo nauče svoj maternji jezik, s akcentom na konverzaciji, koja osim što omogućava učenje jezika, uvodi i u kulturološke spoznaje datog naroda. Istraživanje je sprovedeno s ciljem ispitivanja stavova studenata šta je od presudnog značaja da ovu, s njihove strane potvrđeno, odličnu aplikaciju, nakon nekog vremena, prestanu da koriste ili je koriste u mnogo manjoj meri. Rad takođe nudi i opis metodologije istraživanja, način obrade podataka i interpretacije dobijenih rezultata. Na kraju, nakon sumiranja rezultata, date su preporuke kako za moguće dalje istraživanje tako i za uspešnije i produktivnije korišćenje ove aplikacije, kao alata za usavršavanje stranih jezika, na nematernjem jeziku u sasvim drugačijem socio-kulturnom miljeu.

Ključne reči:
mobilne aplikacije, učenje stranih jezika, tandemsko učenje.

1. UVOD

Moderne tehnologije su sastavni deo našeg svakodnevnog života u svim domenima, pa i pri učenju stranih jezika. Neophodno je obratiti pažnju na koncept mobilnog, odnosno, m-učenja, koje u prvi plan ističe dostupnost korisnih obrazovnih materijala na svakom mestu i u svakom trenutku. Bonk ističe da uz pomoć mobilnih uređaja, obrazovni događaj ili aktivnost prati učenika, umesto da učenik mora da dođe na određeno mesto da bi to postigao [1]. Čaka smatra da MALL (Mobile Assisted Language Learning) predstavlja budućnost učenja jezika, jer ovakvo učenje odlikuju: mobilnost, sveprisutnost i povezivost; prenosivost i laka nosivost; spojivost, multifunkcionalnost, mogućnost korišćenja različitih uređaja u iste svrhe, mogućnost izbora i prikladnost; pristup, pristupačnost, dostupnost i priuštivost; svest o kontekstu, personalizacija i fleksibilnost [2]. Isto tako, pojedine mobilne aplikacije uključuju elemente

Odgovorno lice:
Neda Maenza

e-pošta:
nmaenza@singidunum.ac.rs

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gemifikacije koji dodatno podstiču i inspirišu korisnike. Ovi elementi čine aplikaciju zanimljivijom i kod korisnika pobuđuju takmičarski duh, a prikaz osvojenih poena može biti odmah vidljiv [3]. Određene mobilne aplikacije za učenje stranih jezika svojim adaptivnim testom jezičkih veština omogućavaju i pomažu korisnicima u pripremi za polaganje standardizovanih ispita (TOEFL, IELTS), posebno za veštinu pisanja i govorenja, za one čiji maternji jezik nije engleski. Istraživanje je pokazalo da je uspeh korisnika mobilne aplikacije u znatnoj korelaciji sa ukupnim rezultatima postignutim na polaganju navedenih ispita [4]. Konstantne inovacije u vaspitno-obrazovnom procesu od neprocenjivog su značaja za učenje i usavršavanje stranih jezika na zanimljiv i utilitaran način.

Bez obzira na ogromnu popularnost koju m-learning uživa kod mlađe populacije, nema mnogo radova koji se bave ovom temom kada je u pitanju nastava stranih jezika na tercijarnom nivou. Od autora sa ovih prostora, treba pomenuti Žanu Knežević koja, u svojoj doktorskoj disertaciji, analizira savremene trendove u nastavi i učenju engleskog jezika kao jezika struke, i kao jedan od vodećih trendova navodi upravo e-learning, odnosno, m-learning [1].

Katarina Krželj i Nataša Hartweger u radu Implementacija mobilnog učenja u nastavi stranih jezika na primeru nemačkog uspešno kritički sagledavaju potencijal mobilnog učenja i njegov doprinos podizanju kvaliteta znanja nemačkog jezika [5]. Janjić, Librenjak i Kocijan sa Filozofskog fakulteta Sveučilišta u Zagrebu u svojim radovima predstavljaju rezultate radionica za nastavnike stranih jezika kako bi se na najbolji mogući način iskoristile sve prednosti koje savremena tehnologija može da ponudi, uopšteno u nastavi, a sa posebnim osvrtom na učenje stranih jezika [6].

Iz svega navedenog, može se zaključiti da postoji potreba za istraživanjem koje se bavi primenom mobilnih aplikacija u ovladavanju stranim jezicima.

Model tandem učenja se značajno širi [7; 8; 9]. Ovaj način učenja obuhvata dva interaktivna lica koja se trude da jedno drugo nauče svoj maternji jezik na neformalan i nimalo naporan način. Pozitivne strane ovog tipa inovativnog učenja i ovladavanja stranim jezicima su trenutne povratne informacije i korekcije. Učenje u paru (tandemu) spada u inovativne oblike učenja i savladavanja stranog jezika i može se posmatrati sa psihološkog, didaktičkog i socijalnog stanovišta [10].

Hello Talk je mobilna aplikacija, za iOS i Android uređaje, zasnovana na konverzaciji, koja omogućava učenje jezika na praktičan, jednostavan, zanimljiv i intuitivan način, jer korisnicima omogućava da se sinhrono povezuju i razgovaraju sa izvornim govornicima iz čitavog sveta [11]. Ova aplikacija omogućava korisnicima da se usavršavaju i postižu napredak brzinom i dinamikom koja njima odgovara. Akcenat je na tandemskom učenju i uzajamnom rešavanju jezičkih nedoumica koje se bazira na opuštenom razgovoru i ćaskanju sa izvornim govornicima [10].

Na prvi pogled ova aplikacija može izgledati kao bilo koja aplikacija za dopisivanje, ali je ona znatno bolja jer ima sledeće opcije: za slanje audio poruka (korisne pri vežbanju izgovora ili slušanja), za obavljanje poziva, za slanje slika, za pravljenje crteža. Dodatne prednosti korišćenja ove aplikacije su: direktno prevođenje poslate ili dobijene poruke, prebacivanje audio poruke u tekstualnu i obrnuto, ispravljanje grešaka direktno u tekstu poruke bez potrebe da je sami prepisujete i ispavljate, deljenje momenta, gde korisnici postavljaju slike svog grada, države, putovanja i sl. i mogućnost komentarisanja istih. Učenje stranog jezika putem ove aplikacije temelji se na komunikaciji a ne na nastavnom planu i programu, bez domaćeg zadatka, već samo putem ćaskanja i zabave [12].

Mana ove aplikacije može biti da učesnik ostane bez odgovora svog sagovornika. Zato je preporučljivo lepo urediti svoj Hello Talk profil, odvojiti vreme i pažljivo razmisliti o temama i odgovorima koje se mogu ponuditi sagovorniku [10].

U ovom radu je predstavljeno kvalitativno istraživanje manjeg obima u formi fokus grupe kako bi se došlo do zaključka koji su glavni razlozi koji doprinose smanjenju interesovanja studenata za korišnjenje aplikacije Hello Talk ili za potpuni prestanak korišćenja.

Ovladavanje i poboljšanje svih jezičkih veština putem ove aplikacije bazirano je na komunikaciji tokom opuštenog razgovora, bez utvrđenog plana i programa, rutiniranih gramatičkih partija i tipiziranih domaćih zadataka. Ova aplikacija se koristi pre svega u svrhu učenja stranog jezika, ali treba imati u vidu da među sagovornicima postoje kulturološke, sociološke, antropološke, civilizacijske i geopolitičke raznolikosti sa kojima se možemo susresti, s obzirom na veliku raspostranjenost korisnika ove aplikacije, što i predstavlja jednu od njenih specifičnosti i autentičnosti - mogućnost sticanja iskustva pri učenju stranog jezika na originalan način.

2. CILJ ISTRAŽIVANJA I HIPOTEZE

Kao što je i navedeno u uvodnom delu, ovo istraživanje je imalo za cilj ispitivanje mišljenja studenata

nematičnih fakulteta o razlozima prestanka korišćenja ovog alata za usavršavanje stranih jezika. U tu svrhu, pre izvođenja samog istraživanja, postavljene su sledeće hipoteze:

- Pretpostavlja se da studenti ovu aplikaciju koriste za usavršavanje, pre svega, veštine govorenja.
- Pretpostavlja se da studenti doživljavaju zasićenje korišćenjem ovakvog vida usvajanja jezika zbog nemogućnosti lakog nalaženja adekvatnog sagovornika.
- Pretpostavlja se da studenti zbog obaveza koje imaju na fakultetu nemaju vremena da se više, marljivije i doslednije posvete korišćenju ove aplikacije.

3. ISPITANICI

Ispitanici su studenti Univerziteta Singidunum koji su dobrovoljno pristali da učestvuju u istraživanju. Važno je napomenuti da uzorak čine studenti iz svih gradova u Srbiji, a ne samo iz Beograda, koji studiraju na Univerzitetu Singidunum, a delom i bivši studenti sa državnih univerziteta, što znači da uzorak čini, uopšteno, studentska populacija u Srbiji, pa se on, kao takav, može smatrati relevantnim. Sprovedeno je kvalitativno istraživanje, u formi fokus grupe, kako bi se dobila što jasnija slika najvažnijih razloga za prestanak korišćenja mobilne aplikacije Hello Talk za učenje stranih jezika. U fokus grupi je učestvovalo 7 studenata Univerziteta Singidunum, koji su koristili ili sada u manjoj meri koriste ovu mobilnu aplikaciju, te se njihovo mišljenje može smatrati signifikantnim.

Studenti, učesnici fokus grupe, su prethodno popunili onlajn anketu i time učestvovali u kvantitativnom delu istraživanja na temu glavnih prednosti i mana korišćenja mobilnih aplikacija u nastavi stranih jezika i prilikom učenja jezika generalno, a koji je bio deo ranijih istraživanja autorki ovog rada [13]. Pomenuto kvantitativno istraživanje je nedvosmisleno potvrdilo da su studenti veoma otvoreni za nove načine usvajanja jezika, ali i da su nedovoljno upoznati sa svim mogućnostima koje im se pružaju uprkos vremenu koje provode koristeći savremenu tehnologiju.

U okviru fokus grupe, njihov zadatak je bio da detaljno analiziraju sve pojmove iz kvantitativnog dela koji tamo nisu mogli biti pojašnjeni na adekvatan način, kao i iznošenje mišljenja i utisaka nakon par meseci korišćenja ove aplikacije. Autorke su se opredelile za kvalitativno istraživanje smatrajući ovakav vid istraživanja pogodnijim za iskazivanje individualnih iskustava, mišljenja i stavova kada je predmet ovog rada u pitanju.

4. REZULTATI ISTRAŽIVANJA

Na pitanje zašto su prestali da koriste mobilnu aplikaciju Hello Talk, studenti, učesnici fokus grupe, su rekli da se dešavalo da im danima niko od potencijalnih sagovornika nije odgovarao što je dovelo do ređeg korišćenja, a nakog izvesnog vremena i prestanka svakodnevnog, ali ne i potpunog korišćenja ove aplikacije, što potvrđuje drugu hipotezu autorki ovog rada. Jedna ispitanica navodi da joj je dopisivanje postalo monotono i tipizirano, jer nije uspevala ni sa kim da produbi komunikaciju, odnosno, razgovaralo se uvek na iste teme. Ispitanici navode da bi bilo korisno da postoje teme koje aplikacija predlaže i da bi se tako preko zajedničkih interesovanja lakše došlo do povezivanja i održavanja kontakata među sagovornicima. Na pitanje „Šta su glavni uzroci nezadovoljstva pri korišćenju ove aplikacije“, većina ispitanika kao glavni razlog navodi relativno mali broj potencijalnih sagovornika koji žele konstantno da učestvuju u prepisci i da održavaju redovan kontakt. Jedan ispitanik navodi da su dostupni sagovornici uglavnom stariji ljudi. Takođe, jedna ispitanica navodi da joj je neprijatno da komunicira sa nepoznatim ljudima. Po mišljenju ispitanika ono što ovu aplikaciju izdvaja od ostalih je to što je razumljiva i laka za korišćenje, što postoji više nivoa znanja i što se putem ove aplikacija može usavršavati više jezika. Ispitanici vide mnoge pozitivne strane ove mobilne aplikacije, a ono čime su posebno zadovoljni je to što se odmah, na licu mesta, može ispraviti uočena greška, što je mogućnost koju druge aplikacije ne nude. Pozitivna strana je i brzina povratne informacije, sagovornik odmah ukaže na grešku koja je napravljena i ponudi adekvatno rešenje. Na pitanje koje jezičke veštine se najviše mogu unaprediti korišćenjem ove aplikacije, ispitanici jednoglasno tvrde da je to veština pisanja u čemu im je Hello Talk posebno pomogao. Takođe, korišćenjem audio zapisa doprinosi se napretku veštine slušanja i razumevanja, dok veština govorenja nije toliko zastupljena, te se ovim putem najslabije razvija i na njoj se ne potencira, što opovrgava prvu hipotezu autorki rada.

Ispitanici tvrde da je ova aplikacija podesna za osobe koje već poseduju određeni nivo znanja datog jezika, a ne propučuje se apsolutnim početnicima. Neophodno je bar minimalno poznavanje jezika koji se želi izučavati i usavršavati. Studenti smatraju da putem ove aplikacije ne bi mogli da nauče neki jezik sa kojim se nisu do sada

susretali. Studentima se dopala mogućnost da pomažu strancima pri učenju njihovog maternjeg jezika, jer se na taj način osećaju korisno i žele da pruže pomoć i znanje svojim sagovornicima prilikom učenja, u ovom slučaju, srpskog jezika. Kao jednu od najvažnijih stvari u kojima im je ova aplikacija pomogla, studenti ističu nestanak ili smanjenje treme i jezičke barijere kao i evidentan pomak po pitanju poboljšanja komunikativnih sposobnosti i prevazilaženja jezičkih blokada. Naglašava se važnost komunikacije sa realnim „živim" ljudima, gde vas vaši sagovornici dobronamerno ispravljaju i srčano bodre i podržavaju. Posebno se navodi deo Moments, vrsta zajedničkog četa koji podseća na društvene mreže, gde postoji više sagovornika koji vam odmah ukazuju na eventualnu grešku, ali vas u isto vreme srčano hvale i podržavaju, što ispitanici vide kao veoma pozitivno i zbog čega vole da koriste ovu aplikaciju.

Ispitanici su napravili paralelu između aplikacije Hello Talk i Duolingo, koja se pokazala kao najčešće korišćena jezička mobilna aplikacija. Došlo se do zaključka da bi spoj ove dve aplikacije bio savršen, jer Duolingo omogućava bogaćenje vokabulara i vežbanje određenih gramatičkih partija, ali vremenom postaje dosadna i predvidiva, jer se svodi na puko „kliktanje"; s druge strane, aplikacija Hello Talk dozvoljava realnu, stvarnu komunikaciju sa „živim" ljudima, uvek na nov, drugačiji način.

Većina ispitanika je potvrdila da im je korišćenje Hello Talk aplikacije donelo nova internacionalna poznanstva, što se većini dopada. Na pitanje „Da li biste preporučili ovu aplikaciju za usavršavanje znanja stranih jezika i zašto?", svi ispitanici su potvrdno odgovorili, smatrajući da je to odličan način da se bude u svakodnevnom kontaktu sa stranim jezikom, a posebno ističu slobodu komunikacije, u smislu da korisnik sam bira šta želi da uči, o čemu želi da priča, kojoj oblasti želi da se posveti, ništa nije nametnuto i obavezujuće, zadovoljni što postoji prava, autentična konverzacija, što sve zajedno oslobađa od mnogih stega i čini učenje stranih jezika zanimljivim i drugačijim. Nažalost, zbog nedostatka slobodnog vremena i svakodnevnih obaveza na fakultetu, studenti nisu u prilici da redovno koriste ovu aplikaciju, da joj se dublje i marljivije posvete, te ovo potvrđuje treću hipotezu autorki rada.

5. ZAKLJUČAK

Neophodno je naglasiti da je istraživanje predstavljeno u ovom radu manjeg obima, odnosno, broj ispitanika je relativno mali kako bi se mogli izvesti sveobuhvatni zaključci o mišljenju studenata nematičnih fakulteta o Hello Talk aplikaciji za učenje stranih jezika. Uzorak u pogledu obrazovnih profila – Informacione tehnologije, Turizam i hotelijerstvo, Finansije i bankarstvo, Računovodstvo i revizija i Marketing je zadovoljavajući kako bi se pribavio makar delimičan uvid u ovu kompleksnu temu i može predstavljati polaznu tačku za obimnija istraživanja u budućnosti. Studija je nedvosmisleno potvrdila da su studenti veoma otvoreni za nove načine usvajanja jezika, ali i da ova aplikacija nije u potpunosti zaživela među studentskom populacijom u Srbiji. S druge strane, studenti smatraju da su manjak slobodnog vremena, ali i nedovoljna zainteresovanost glavni razlozi za neredovnu upotrebu aplikacije. Može se izvesti zaključak da je ovo odličan alat za otklanjanje straha, treme i jezičke blokade pri korišćenju stranog jezika, da je poželjno koristiti je makar s vremena na vreme, na obostranu korist sagovornika i da ovakav način usavršavanja stranog jezika donosi uvek nešto novo, kreativno, a neobavezujuće. Upotrebljavajući strani jezik kontinuirano u razgovoru sa realnim, stvarnim ljudima, korisnici imaju mogućnost da nauče više od samog jezika; oni se upoznaju sa različitim kulturama, tradicijama i običajima, što sve doprinosi širenju vidika, prevazilaženju jezičkih barijera i drugačijem doživljaju kulturoloških različitosti.

PRILOG: FOKUS GRUPA – PITANJA

1. Zašto ste prestali da koristite aplikaciju HelloTalk?
2. Šta su glavni uzroci nezadovoljstva prilikom korišćenja ove aplikacije?
3. Šta je to što izdvaja ovu aplikaciju od ostalih aplikacija?
4. Da li je moguće, koliko i na koji način unaprediti jezičke veštine slušanja, čitanja, pisanja i govorenja?
5. Da li smatrate da ste korišćenjem ove aplikacije unapredili znanje jezika? Na kom nivou?
6. Da li ste koristeći ovu aplikaciju uspeli da saznate nešto više o zemlji, tradiciji i običajima naroda čiji ste jezik izučavali?
7. Da li ste stekli nova prijateljstva?
8. Da li biste preporučili ovu aplikaciju drugima? Zašto?

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INFORMATION TECHNOLOGY IN SPORT AND RECREATION

MOGUĆNOSTI PRIMENE INFORMACIONIH TEHNOLOGIJA U FIZIČKOM VASPITANJU

Aleksandar Gadžić*,
Aleksandar Živković,
Tamara Ratković,
Radovan Ilić

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Koncept nastave fizičkog vaspitanja u našoj zemlji već dugo vremena se zasniva na unapređenju fizičkih sposobnosti, motoričkih veština i znanja iz oblasti fizičke i zdravstvene kulture učenika. Ipak učenici nisu zadovoljni nastavom fizičkog vaspitanja kakva im se nudi školskim planovima i programima. „Milenijalci" su u ogromnom broju aktivni na nekoj od društvenih mreža gde mogu da se upoznaju i sa raznim vrstama vežbanja i fitnes aplikacija. U praksi fizičkog vaspitanja najčešće su bile primenjivane tehnologije u vidu monitora srčane frekvencije i pedometara, što za „milenijalce" predstavlja zastarelu tehnologiju. U savremenoj nastavi fizičkog vaspitanja se najčešće primenjuju aplikacije na iPad-u i mobilnim telefonima kao i aktivne video igre (AVI). Više savremenih autora se slaže da će *wearables* ili mobilni softveri imati sve veću primenu u praksi fizičkog vaspitanja kao i neke društvene mreže kao što je *Edmodo*. Moderne tehnologije nikada ne mogu da budu zamena za klasičnu fizičku aktivnost i da „tehnologija sagori" kalorije umesto učenika, ali da može biti dodatno sredstvo ili podsticaj učenicima da egzaktnije prate svoj napredak i da razviju veću posvećenost vežbanju koja bi trebala da postane njihovo celoživotno opredeljenje.

Ključne reči:
informacione tehnologije, fizičko vaspitanje, mobilne aplikacije.

1. UVOD

Koncept nastave fizičkog vaspitanja u našoj zemlji već dugo vremena se zasniva na unapređenju fizičkih sposobnosti, motoričkih veština i znanja iz oblasti fizičke i zdravstvene kulture učenika. Ostvarenje tako koncipiranog cilja nastave fizičkog vaspitanja treba da se ostvari putem raznovrsnih i sistematskih motoričkih aktivnosti, a čime bi se doprinelo integralnom razvoju ličnosti učenika. I pored toga što je tim konceptom na prvom mestu navedeno unapređenje motoričkih spsobnosti učenika, u više istraživanja je utvrđeno opadanje nivoa tih sposobnosti u našoj školskoj populaciji [1, 2, 3]. Opadanje nivoa motoričkih sposobnosti dece i omladine nije svojstveno samo našoj populaciji i s obzirom na rezultate inostranih istraživanja sada se slobodno može govoriti o tome kao široko rasprostranjenom problemu [4].

Odgovorno lice:
Aleksandar Gadžić

e-pošta:
agadzic@singidunum.ac.rs

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Ipak, mora se priznati da pomenuto opadanje nivoa motoričkih sposobnosti je utvrđeno na osnovu rezultata pojedinačnih istraživanja i da trenutno ne postoje pouzdani podaci na reprezentativnom uzorku na nacionalnom nivou. Upravo nedostatak reprezentativnih podataka o stanju motoričkog statusa učenika današnjice podstakao je grupu domaćih autora koji su, u saradnji sa Zavodom za vrednovanje kvaliteta obrazovanja i vaspitanja, kreirali *Priručnik za praćenje fizičkog razvoja i razvoja motoričkih sposobnosti učenika u nastavi fizičkog vaspitanja* [5]. Naime, autori su na osnovu pregleda brojnih sistema i modela praćenja motoričkih sposobnosti u različitim zemljama, kao i na osnovu rezultata istraživanja na reprezentativnom uzorku učenika osnovnoškolskog uzrasta u našoj zemlji, ustanovili bateriju testova za praćenje fizičkog razvoja i razvoja motoričkih sposobnosti učenika osnovnih škola u Srbiji. Rezultati primene utvrđenog modela tek treba da budu predstavljeni s obzirom da se isti primenjuje od školske 2017/18. godine kao obavezan. Zanimljivo je da su autori, na osnovu rezultata pomenutog istraživanja na reprezentativnom uzorku učenika osnovnoškolskog uzrasta u našoj zemlji, definisali i standarde za oblast *Razvoj motoričkih sposobnosti*.

Sa druge strane, postoje relevantna istraživanja u našoj zemlji koja su pokazala da učenici, a naročito učenice adolescentnog uzrasta, nisu zadovoljni nastavom fizičkog vaspitanja kakva im se nudi školskim planovima i programima. U isto vreme učenici su iskazali interesovanje za nekim novim nastavnim sadržajima [6,7]. Navedene činjenice ukazuju na potrebu kreativnijeg pristupa nastavi fizičkog vaspitanja, što može da se odnosi i na primenu savremenih informacionih tehnologija.

Poznato je da je ljudsko ponašanje pod velikim uticajem socijalnog konteksta, a generacije rođene posle 2000. godine („milenijalci“) su u ogromnom broju aktivni na nekoj od društvenih, odnosno socijalnih mreža (Instagram, Facebook, Twitter itd.) gde mogu da se upoznaju i sa raznim vrstama vežbanja i fitnes aplikacija. Prema slobodnim procenama danas je u opticaju oko 8,000 fitnes aplikacija koje su dostupne za preuzimanje [8]. Ovakva situacija predstavlja mogućnost i izazov za stručnjake iz oblasti fizičke kulture da promovišu vežbanje i zdrave životne stilove.

2. METODOLOGIJA

U radu je primenjena bibliografska metoda uz pretraživanje dostupne literature o istraživanjima vezanim za primenu informacionih tehnologija u kontekstu fizičkog vaspitanja. Literatura je prikupljena sa relevantnih bibliografskih baza podataka Google Scholar, Kobson i Research Gate.

3. RANIJA PRIMENA INFORMACIONIH TEHNOLOGIJA U KONTEKSTU FIZIČKOG VASPITANJA

S obzirom na frekvenciju primene u praksi fizičkog vaspitanja najčešće su bile primenjivane tehnologije u vidu monitora srčane frekvencije i pedometara.

Monitori srčane frekvencije (Heart Rate Monitors)

Monitori srčane frekvencije se koriste u populaciji odraslih vežbača već duži niz godina u cilju egzaktnog praćenja rada srca ali i procene intenziteta vežbanja. U poslednjih petnaest godina nastava fizičkog vaspitanja u zemljama Zapada je sve više fokusirana na zdravstveno usmeren fitnes učenika, a najpouzdaniji način određivanja zona vežbanja jeste upravo srčana frekvencija. Osnovna namena monitora srčane frekvencije je da pokažu preciznu vrednost pulsa vežbača (učenika) za vreme fizičke aktivnosti. Primena ovih uređaja u nastavi fizičkog vaspitanja omogućava nastavnicima i učenicima da jasno odrede „ciljanu“ zonu srčane frekvencije koja je individualna za svakog učenika. Pojedinačno određivanje ciljane srčane frekvencije kod učenika stvara osećaj veće uključenosti u proces vežbanja ali i odgovornosti za sopstveni nivo fitnesa. Naravno, prilikom određivanja ciljanih zona opterećenja, nastavnik uzima u obzir uzrast učenika, pol, nivo sposobnosti i ostale bitne pokazatelje.

Prema nekim stranim autorima [9], monitori srčane frekvencije se sve više koriste i u praksi fizičkog vaspitanja u cilju:

1. Dodatka nastavnom programu fizičkog vaspitanja, oblast fitnesa
2. Motivisanja učenika da postignu veći intenzitet vežbanja
3. Procenjivanja napretka učenika u ostvarivanju većih intenziteta vežbanja.

Posebno mesto u pogledu izvrsne prakse i potvrde opravdanosti primene modernih tehnologija u nastavi fizičkog vaspitanja predstavlja primer dugogodišnjeg programa srednje škole u Nejpervilu (Naperville Central High School, Illinois, USA). U tom malom mestu od 1992. godine, učenici na časovima fizičkog vaspitanja nose monitore srčane frekvencije kako bi svaki učenik vežbao u svojoj, od nastavnika fizičkog vaspitanja,

zadatoj zoni rada. Od tog vremena, škola i distrikt Nejpervil napravili su velike korake ka najvažnijem cilju nastave fizičkog vaspitanja, a to je dobro sveukupno zdravstveno stanje učenika, njihov fitnes i spremnost za učenje. Naime, u tom periodu, u školi je primećeno da neki učenici nemaju zadovoljavajući školski uspeh zbog lošijeg čitanja i znanja iz matematike. U školi je ubrzo pokrenuta dodatna nastava za takve učenike, uz dodatak jednog časa fizičkog vaspitanja pre časova čitanja i matematike. Časovi fizičkog vaspitanja su nazvani „Fizičko vaspitanje kao priprema za učenje“ (LRPE). Časovi fizičkog su namerno planirani pre časova čitanja i matematike jer su kreatori programa (profesori fizičkog vaspitanja Paul Zientarski i Phil Lawler) želeli da provere efekte tako koncipiranih časova na pomenutu problematiku učenika. Veoma brzo postalo je jasno da su učenici rapidno napredovali kako u čitanju tako i u matematici.

Na poznatom međunarodnom testiranju znanja učenika iz velikog broja zemalja iz čitavog sveta u oblasti nauke i matematike (TIMSS – Trends in International Mathematics/Science), učenici osmog razreda škole Nejpervil Central su 1999. godine nastupili kao posebna grupa i zauzeli su prvo mesto u znanju iz nauke i šesto mesto u matematici. Od tog vremena do danas, program je konstantno obogaćivan sadržajima na časovima fizičkog vaspitanja, tako da danas učenici ove škole imaju savremenu teretanu, veštačku stenu za penjanje, zatvoren bazen, salu za ples itd. Takođe, u proceni fitnesa učenika, u toj školi se danas koriste najsavremeniji softveri kao što su TriFIT Software i FITNESSGRAM [10].

Na kraju potrebno je istaći da primena monitora srčane frekvencije ipak ima svoja ograničenja u kontekstu fizičkog vaspitanja koja se ogledaju u tome da novije generacije imaju više interesovanja za novije tehnologije, ali i koštanje takvih sistema.

Pedometri

Drugi primer ranije primene informacionih tehnologija u kontekstu fizičkog vaspitanja odnosi se na primenu pedometara kao sredstva za merenje nivoa fizičke aktivnosti učenika. Japanci su napravili prvi elektronski pedometar koji su nazvali “manpo-kei” što je značilo merač 10.000 koraka [11]. U tom periodu (pre 30-ak godina) u japanskim medijima bio je popularan i veoma promovisan vežbački cilj od 10.000 koraka dnevno. Kasnija istraživanja pokazala su da je taj nivo aktivnosti dosta realističan kada se govori o benefitima za zdravlje odraslih osoba [12, 13].

Brojanje koraka se čini kao jedan od najlakših načina da se kvanitifikuje nivo fizičke aktivnosti, a pedometre mogu da koriste osobe svih uzrasta. Još jedna pogodnost pedometara ogleda se u tome što oni mogu da se koriste u različitim aktivnostima i zadacima, od brzog hodanja do obavljanja svakodnevnih poslova.

Ovakve pogodnosti pedometara vrlo brzo su prepoznate i kao sredstvo procene nivoa fizičke aktivnosti školske populacije. Grupa autora je pre 15 godina izvršila evaluaciju pouzdanosti rezultata dobijenih na osnovu pedometara, ali i validaciju tih rezultata u odnosu na neke standardizovane upitnike o načinu provođenja slobodnog vremena koji se baziraju na samoproceni (Leisure Time Exercise Questionnaire - LTEQ). Rezultati istraživanja su pokazali visoku pouzdanost podataka ($R = .79$) dobijenih iz pedometara o nivou fizičke aktivnosti učenika srednjeg školskog uzrasta (299 učenika uzrasta od 10 do 14 godina). Zanimljivo je da su autori došli do saznanja da su korelacije između dva načina merenja nivoa fizičke aktivnosti učenika dosta niske ($r = .05$, $p \geq .05$), odnosno da upitnik ne može da pruži informacije o nivou fizičke aktivnosti učenika kao podaci dobijeni iz pedometara, te da rezultate dobijene upitnikom treba uzimati sa rezervom [14].

Tokom vremena pedometri su ušli u širu primenu kada je u pitanju merenje nivoa fizičke aktivnosti dece i omladine. Novija istraživanja u vidu meta analiza pokazala su da primena pedometara kod dece starije od pet godina predstavlja validan, pouzdan i objektivan način merenja nivoa fizičke aktivnosti [15].

Pored evidentne koristi od primene pedometara u naučnim istraživanjima vezanim za nivo fizičke aktivnosti učenika, slično kao i kod monitora srčane frekvencije, pedometri za „milenijalce“ predstavljaju zastarelu tehnologiju, pa se njihova primena u realnim školskim uslovima uglavnom svodi upravo na istraživački kontekst.

4. AKTUELNA PRIMENA INFORMACIONIH TEHNOLOGIJA U KONTEKSTU FIZIČKOG VASPITANJA

Nastavnici današnjih generacija učenika osnovne škole suočavaju se sa specifičnim izazovom, a to je rad sa učenicima koji bukvalno ne poznaju život bez kompjutera, mobilnog telefona i/ili tableta. Takve promene dramatično menjaju i celokupno obrazovanje današnje omladine. Ubrzan razvoj tehnologije u poslednjih 20 godina omogućio je brojne nove i kreativne načine na koji prosvetni radnici mogu da prezentuju nastavne sadržaje.

Sve donedavno, to se odnosilo na tzv. desktop tehnologiju, što je u velikoj meri ograničavalo njenu primenu u kontekstu fizičkog vaspitanja.

U razvijenim zemljama današnjice, tehnologije kao što su razni projektori, pametne table i uređaji povezani sa bežičnim prenosom podataka (WiFi i Bluetooth) omogućavaju prezentovanje i prenos informacija na mnogo atraktivniji i efikasniji način nego što su to tradicionalne metode putem table i krede. Nastavnici fizičkog vaspitanja, takođe, mogu da poboljšaju nastavu fizičkog vaspitanja putem ovih tehnologija, ako ih pametno i adekvatno primenjuju.

iPad i mobilni telefoni u nastavi fizičkog vaspitanja

Ranije je pomenuta primena monitora srčane frekvencije i pedometara koja je i dalje više nego aktuelna u mnogim školama širom sveta, tako da današnje, naprednije verzije monitora srčane frekvencije imaju mogućnost povezivanja u jedinstven sistem praćenja srčane frekvencije za celi razred putem iPad-a (Slika 1.).



Slika 1. Prikaz srčane frekvencije svih učenika u razredu na iPad-u

Primena iPad-a, kao još jednog modernog tehnološkog sredstva koje je našlo širu primenu u kontekstu fizičkog vaspitanja, može da bude i u vidu snimanja izvođenja nekih motoričkih zadataka koje potom nastavnik zajedno sa učenicima pregleda i ukazuje na detalje koje treba korigovati.

Drugi, za učenike još zanimljiviji, način primene iPad-a na časovima fizičkog vaspitanja je kada učenici rade u parovima i snimaju izvođenje određenih motoričkih zadataka svojih partnera (slika 2.). Nakon završetka rada, snimci se prebacuju na Google Drive u sportski portfolio (*Sportfolio*) koji je prethodno kreiran za svakog učenika. Na taj način učenici postaju aktivniji subjekti nastave, vrše samoprocenu svojih motoričkih znanja i umenja, i što je najvažnije postaju više zainteresovani za sam predmet.



Slika 2. Primena iPad-a u fizičkom vaspitanju

Primena mobilnih telefona u nastavi fizičkog vaspitanja može da zvuči kao loša šala, ali činjenice su da moderni, „pametni“ telefoni imaju mogućnost instaliranja brojnih vežbačkih aplikacija. Jedna od zanimljivijih aplikacija je svakako čitač QR kodova koji može da se instalira na iPad-u ili mobilnom telefonu, a da se iskoristi na veliki broj načina u fizičkom vaspitanju. Na primer, kada se izvode aktivnosti u prirodi (izleti, logorovanja i sl.), vrlo efektno može da se izvede igra *Potraga za blagom* (Treasure Hunt), gde učenici dobijaju „nagoveštaje“ u vidu QR kodova na tačno određenim mestima kako bi na kraju otkrili blago, odnosno prvi završili potragu. Takvi sadržaji u sebi nose mnogo uzbuđenja i podstiču učenike u sva tri razvojna domena (kognitivni, fizički, afektivni).

Druga, veoma interesantna, mogućnost primene aplikacije QR čitača kodova je kod kružnog načina vežbanja. Naime, nastavnik postavlja na stanicama za vežbanje QR kodove sa zadatim vežbama. U svakoj grupi nastavnik određuje kapitena koji telefonom očitava QR kod i prikazuje vežbu na mobilnom telefonu (jedan telefon po grupi učenika). Zatim učenici izvode vežbu u skladu sa zadatim brojem ponavljanja ili vremenom predviđenim za izvođenje vežbe.



Slika 3. Učenici skeniraju QR kod na radnoj stanici u kružnom vežbanju na času fizičkog vaspitanja

Sledeći način primene čitača QR kodova su takozvane *Digitalne kartice sa zadacima* (Digital Task Cards), gde se učenicima prikazuju određeni sportsko-tehnički elementi koje treba da usvoje/savladaju. Snimljeni materijal treba da bude visokog kvaliteta u smislu motoričkog izvođenja – demonstracije, kako bi učenici „imitirali" dobar model izvođenja.

Aplikacija čitanja QR kodova putem iPad-a ili mobilnih telefona može da ima veoma raznovrsnu primenu u praksi fizičkog vaspitanja i detaljniji uvid u iste prevazilazi okvire ovog rada.

Primena video igara u nastavi fizičkog vaspitanja

Primena video igara u kontekstu nastave fizičkog vaspitanja takođe može da odigra ulogu podizanja interesovanja učenika za vežbanje i, na određen način, da ih uputi u kreiranje programa vežbanja. Istraživanjima je potvrđeno da aktivne video igre (AVI) ili „exergames" postaju sve popularnije kod dece i adolescenata [16].

Jedan od uspešnijih načina primene AVI u fizičkom vaspitanju je putem Nintendo Wii konzole i igre Wii Fit. Wii Fit je predstavljen javnosti 2007. godine u Japanu i od tog vremena je postigao veliku popularnost širom sveta. U suštini, Wii Fit predstavlja video igru sa elementima fizičkog vežbanja na ploči za balansiranje. Ova ploča omogućava „interpretaciju" pokreta celog tela igrača koji se koriste kao osnova za kontrolu pokreta u okviru igre. To znači da igrači fizički pokreću celo telo u cilju kontrolisanja likova na ekranu u različitim aktivnostima kao što su joga, skijanje, trčanje ili vežbe za jačanje mišića.



Slika 4. Primena Nintendo Wii Fit konzole u fizičkom vaspitanju

Primena Wii Fit AVI u kontekstu nastave fizičkog vaspitanja u zadnjih deset godina stekla je svoje pristalice, ali i oponente. Naime, prema istraživanju grupe autora primena Wii Fit „programa" vežbanja na razvoj ravnoteže kao motoričke sposobnosti se pokazala jednako uspešnom kao neke tradicionalne metode za razvoj ove važne motoričke sposobnosti na uzorku studenata fakulteta za fizičku kulturu [17].

Sa druge strane, istraživanje na uzorku dece uzrasta 10-12 godina nije potvrdilo povećanje nivoa fizičke aktivnosti kod ispitanika koji su koristili AVI (Wii Fit) u odnosu na decu koja su jednostavno igrala obične (neaktivne) video igrice [18]. Treba napomenuti da su autori istakli određena ograničenja istraživanja u vidu činjenica da autori nisu davali sugestije/instrukcije da deca budu aktivna, uzorak je bio manji (n=78) i da se rezultati odnose samo na uzrast 10 do 12 godina.

Pored Nintendo Wii Fit igre, treba napomenuti da su u praksi fizičkog vaspitanja često korišćene i AVI na konzolama Play Station, X-box, kao što su Dance Dance Revolution, Kinect Sports, Fortnite i druge.

Sistematsko pregledno istraživanje skorijeg datuma o efikasnosti primene AVI u kontekstu škole, odnosno fizičkog vaspitanja, ukazalo je na neka zanimljiva saznanja [19]. Naime, istraživanjem su obuhvaćene samo eksperimentalne studije bazirane na primeni AVI u školama. Relevantnost istraživanja obezbeđena je pretraživanjem radova iz baza podataka kao što su ERIC, PsycINFO, PubMed, SPORTDiscus i Web of Science.

Nakon primenjenih procedura eliminacije neadekvatnih istraživanja, analizirana su 22 istraživanja. Autori su rezultate analize podelili u zavisnosti od cilja

sprovedenih i analiziranih istraživanja na istraživanja gde je utvrđivan efekat AVI na:

1. nivo fizičke aktivnosti i fitnesa
2. indeks telesne mase i telesne kompozicije
3. motoričke veštine

Kada su u pitanju efekti primene AVI na nivo fizičke aktivnosti i fitnesa ispitanika, kojima se bavilo 9 od 14 istraživanja iz analize, utvrđeno je da AVI utiče na smanjenje ukupnog sedentarnog vremena ispitanika i da povećava laganu i umerenu fizičku aktivnost.

U šest istraživanja iz analize procenjivan je i uticaj AVI na indeks telesne mase i telesnu kompoziciju. Rezultati iz tri istraživanja su pokazali da AVI utiče na smanjenje indeksa telesne mase, dok u preostala tri istraživanja nisu zabeležene značajne razlike.

Uticaj AVI na motoričke veštine ispitanika je ispitivan u pet istraživanja obuhvaćenih analizom, a rezultati tih istraživanja su pokazali da su učenici iz AVI bili uspešniji u usvajanju motoričkih veština od učenika iz kontrolnih grupa.

5. BUDUĆNOST INFORMACIONIH TEHNOLOGIJA U KONTEKSTU FIZIČKOG VASPITANJA

Digitalna tehnologija je zauzela istaknuto mesto u školskim programima i obrazovnoj politici u većini razvijenih zemalja. U praksi fizičkog vaspitanja, za razliku od drugih područja sveukupnog obrazovanja učenika, često je dolazilo do „oklevanja“ ili bolje rečeno neprihvatanja primene digitalne tehnologije. Međutim, ubrzan tehnološki razvoj, posebno kada su u pitanju mobilne tehnologije (tableti, pametni telefoni, *wearables* ili mobilni softveri) znače da su danas dostupne softverske aplikacije koje mogu da se lakše primene u praksi.

Važnost praćenja savremenih trendova u obrazovanju i vaspitanju ogleda se i u primeni moderne tehnologije. U tom smislu, već od 2020. godine kao deo standarda u oblasti fizičkog vaspitanja u Americi očekuje se da će nastavnici morati da zadovoljavaju odgovarajuće kriterijume u primeni savremenih tehnologija [20].

Više savremenih autora se slaže da će *wearables* ili mobilni softveri imati sve veću primenu u praksi fizičkog vaspitanja. Novi merači nivoa fitnesa i pametni satovi (fitness trackers and smartwatches) se plasiraju na tržište svake godine. Ovi uređaji su opremljeni različitim vrstama senzora, algoritama i mobilnih aplikacija. Prema novijem istraživanju na tržištu postoji 423 jedinstvena uređaja koji predstavljaju 132 različita brenda [21].

Evidentno, pojavljivanje sve većeg broja mobilnih aplikacija, koje se lako preuzimaju i instaliraju na pametne telefone, govori u prilog prognozama velikog rasta primene novih tehnologija. Prema slobodnim procenama danas postoji oko 40,000 health & fitness mobilnih aplikacija na internetu.

Savremene mobilne fitnes aplikacije korisniku omogućavaju lako praćenje parametara vežbanja, a u zavisnosti od brojnih i raznovrsnih opcija nude baze vežbi, posebno dizajniranih treninga za razvoj određenih sposobnosti (obično brzine, snage i izdržljivosti) ili jednostavno poboljšanje opšteg nivoa fitnesa. Postoji veći broj obrazovnih aplikacija koje mogu da se integrišu u nastavni program iz fizičkog vaspitanja. Najprimenljivije su aplikacije koje podrazumevaju slike i video analizu kretanja. Jedna od takvih aplikacija je i Coach's Eye (trenerovo oko) koja omogućava detaljan uvid u motoričku kretnju putem usporenog video snimka.

Činjenica da većina učenika srednje ali i osnovne škole poseduje i konstantno nosi pametni telefon ukazuje na bitnu karakteristiku savremenog društva, a to je povezanost. Pametni telefoni neće nestati tek tako iz svakodnevne upotrebe i tu, opštepoznatu, činjenicu treba znati iskoristiti, kao i sve veće prisutnost povezivanja mladih putem društvenih mreža. Predviđa se da će se i u fizičkom vaspitanju više koristiti neke društvene mreže kao što je *Edmodo*. Ova društvena mreža predstavlja edukativni ekvivalent Fejsbuku (Facebook) i omogućava nastavnicima instantno kreiranje personalizovanih društvenih mreža sa učenicima. Po registraciji, učenici unose jedinstven pristupni kod koji daje nastavnik i dobijaju pristup i mogućnost međusobnog deljenja sadržaja koji su relevantni za predmet. Edmodo omogućava rad sa različitim medijima od slika, dokumenata, video zapisa do internet stranica i predstavlja odlično mesto za razvijanje širokog spektra diskusija o zdravlju i vežbanju.

Primena savremene digitalne tehnologije u fizičkom vaspitanju postala je toliko aktuelna da je jedan nastavnik fizičkog vaspitanja iz Australije pokrenuo internet stranicu „The PE Geek“ (štreber fizičkog vaspitanja) na kojoj uspešno i detaljno promoviše upotrebu raznih digitalnih uređaja, aplikacija i internet platformi u kontekstu fizičkog vaspitanja (https://thepegeek.com/).

6. ZAKLJUČAK

Fizičko vaspitanje predstavlja veoma dinamičan školski predmet i upravo ta karakteristika se može pripisati i nastavnicima koji usmeravaju učenike ka zdravim

životnim stilovima. Ponekad su nastavnici fizičkog vaspitanja skloni tradicionalnom pristupu nastavi u smislu što više znoja i napora na časovima fizičkog vaspitanja, to bolje. Međutim, vreme, ali i relevatna istraživanja [7], pokazali su da to nije uvek najefikasniji izbor. Savremeni pristup nastavi fizičkog vaspitanja predviđa bolje razumevanje kako učenika kao aktivnih subjekata nastave, tako i samog procesa aktivnijeg kognitivnog i afektivnog angažovanja učenika.

Moderne tehnologije su svuda oko nas i one neće nestati već samo mogu postati još prisutnije. Nastavnici fizičkog vaspitanja treba racionalno da pristupe mogućnostima primene novih tehnologija u nastavi fizičkog vaspitanja. To se pre svega odnosi na proverene i uspešno potvrđene primene tehnologije kao što su monitori srčane frekvencije i pedometri. Takođe, pozitivne reakcije i aktivacija učenika se može očekivati i kod primene nekih mobilnih aplikacija koje su navedene u tekstu (QR čitač kodova, određene AVI i Coach's Eye).

Na kraju je potrebno istaći i ograničenja primene modrenih tehnologija, a koja se prvenstveno odnose na koštanje tih sistema, što ih direktno čini manje dostupnim za veći broj učenika. Takođe, jasno je da primena moderne tehnologije nikada ne mogu da budu zamena za klasičnu fizičku aktivnost i da „tehnologija sagori" kalorije umesto učenika, ali da može biti dodatno sredstvo ili podsticaj učenicima da egzaktnije prate svoj napredak i da razviju veću posvećenost vežbanju koja bi trebala da postane njihovo celoživotno opredeljenje.

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STRUKTURALNA, BIOMEHANIČKA I FUNKCIONALNA ANALIZA SMEČA U ODBOJCI

Predrag Nemec*,
Vesna Nemec,
Radovan Ilić,
Miloš Milošević

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

U radu je primenom Selspot 3D sistem za praćenje i merenje kretanja i tenziometrijske platforme urađena strukturalna, biomehanička i funkcionalna analizu smeča u odbojci. Strukturalna analiza ukazuje da se smeč može uslovno podeliti u 4 faze: faza zaleta, faza odskoka, faza leta - smeča i faza doskoka. Biomehanička analiza daje sve aspekte operacionalizacije efikasnog smeča. U tom smislu daje u svakoj fazi smeča njegove kinematičke i dinamičke parametre. Funkcionalna analiza ukazuje na to da reverzibilna kontrakcija predstavlja integralni deo svih opisanih pokreta u odbojci, da je jako složena i uslov za šampionska postignuća, da se ona mora posebno učiti i trenirati uz različitu upotrebu uma, trenažnih metoda i sredstava.

Ključne reči:

informacione tehnologije, Selspot 3D sistem za praćenje i merenje kretanja, faze smeča, reverzibilna kontrakcija.

1. UVOD

Danas je gotovo nemoguće bilo koji sportski sistem [1] i njegovo uspešno funkcionisanje, zamisliti bez primene informacione tehnologija. Posebno je nemoguće zamisliti pripremu vrhunskih sportista, posmatrajući je prvenstveno sa aspekta visoke trenažne tehnologije i nastupa sportista na važnim takmičenjima [2, 3, 4]. Isto važi i za savremenu odbojku [5, 6],

U odbojci, za potrebe strukturalne, biomehaničke i funkcionalne analize, kao i za potrebe upravljanja trenažnim procesom, potrebno je upotrebljavati savremene informacione tehologije. U ovom radu prikazaćemo njenu primenu u strukturalnoj, biomehaničkoj i funkcionalnoj analizi smeča u odbojci [1, 2, 4, 5].

2. METODOLOGIJA

Na rezultatima jednog vrhunskog odbojkaša urađema je strukturalna, biomehanička i funkcionalna analiza smeča u odbojci [1, 2, 3, 5]. U tu svrhu korišćen je Selspot 3D sistem za praćenje i merenje kretanja i tenziometrijska platforma. Selspot sistem pruža precizne podatke o merenju

Odgovorno lice:
Predrag Nemec

e-pošta:
pnemec@singidunum.ac.rs

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mnogih vrsta kretanja pa tako i odbojku i kombinovan sa primenom MultiLab softerskog paketa koriščen je za komletnu analizu podataka smeća. Kamere umerežene u Selspot sistem registruju X i Y kordinate signala, beleže digitalni signal, a zatim šalju podatke u računar radi analize i pisanja izveštaja. 3D analiza je moguća već sa dve kamere dok sistem podržava umrežavanje čak 16 kamera i 120 LED dioda [7]. Osnovna brzina uzorkovanja je 10 kHz, sa dve kamere i 5 LED dioda brzina uzorkovanja je 1000Hzs, rezolucija je 0.025% od mernog opsega a nelinearnost detektora je manja od 0.1% opsega [7]. Sistem omogućava i unos 48 analognih kanala koji podržavaju analogne senzore, kao što su senzori sile, EMG elektrode, i slično. Na ovom mestu treba naglasiti da informacione tehnologije nisu nužno digitalne već mogu biti i analogne, dok se izbor jednog ili drugog načina beleženja signala u istraživanjima zasniva na njihovoj ontološkoj razlici [8].

Podaci prikupljeni kamerama i drugim senzorim dalje su sinhronizovani od strane sistema. MultiLab je programski paket visokog nivoa koji izvodi sve proračune za uglove, brzine, ubrzanja, trenutke i slično i pruža prilagođene izveštaje koji sadrže sve informacije potrebne za sofisticirnu analizu kretanja [7]. Uz pomoć tenziometrijske platforme merila se produkcija mišićne sile u smeću [1, 5]. Piezoelektrični senzori ugrađeni u platformu velikom brzinom (1000 Hz) registruju kompresione sile tokom izvođenja odskoka i omogućavaju detaljnu dinamičku analizu svih faza skoka i visoku validnost svakog izvedenog pokreta. Osim standardnih parametara, tenziometrijska platforma omogućava praćenje dinamike i tranzitivnosti razvoja sile, brzinu izvođenja skoka, stepen dubine odskoka (doskoka), efekte istezanja, sposobnosti brzog smenjivanja ekscentrične i koncentrične kontrakcije kao i transfer elastične energije.

3. STRUKTURALNA ANALIZA SMEČA

Jedan od najvažnijih tehničko-taktičkih elemenata u odbojci predstavlja smeč [5, 6]. Njegova uloga u nadigravanju može da se višestruko ispoljava. Pozicija gde se smeč izvodi u početku nadigravanja je svakako servis. Kako se igra odvija tako je važnost smeča sve više dolazila do izražaja. Osim smečiranja iz zone napada u poslednje vreme sve češće se viđa da u odlučujućim akcijama smeč izvodi korektor iz zone odbrane. Iako je tačno da postizanje poena u igri implicira po pravilu više ili manje složenu motoričku aktivnost nekoliko igrača, što može slikovito da se predstavi kao lanac čija snaga zavisi o snazi najslabije karike, ipak poslednja karika tog lanca najčešće predstavlja smeč kojim se pokušava postići poentiranje. Sam smeč može bitno smanjiti verovatnoću postizanja poena, iako su sve prethodne radnje izvedene besprekorno, kao što može i da nadoknadi propuste koji su mu prethodili.

Smeču na mreži prethodi više radnji, a najvažnija je zamah ruku i postavljanje šake pre udarca po lopti. Sve ostalo ima za cilj da obezbedi najbolje uslove za uspešno izvođenje. Osim toga, ova analiza će prikazati smeč - servis sa daleko visokim skokom i pravolinijski smeč prema mreži u pravcu kretanja koji se najčešće sreće u igri.

Smeč se odvija kroz četiri faze [5, 6]. Međutim u kinematičkoj analizi (Slika 1) se detaljnije opaža svako kretanje koje se dešava u pojedinoj fazi.

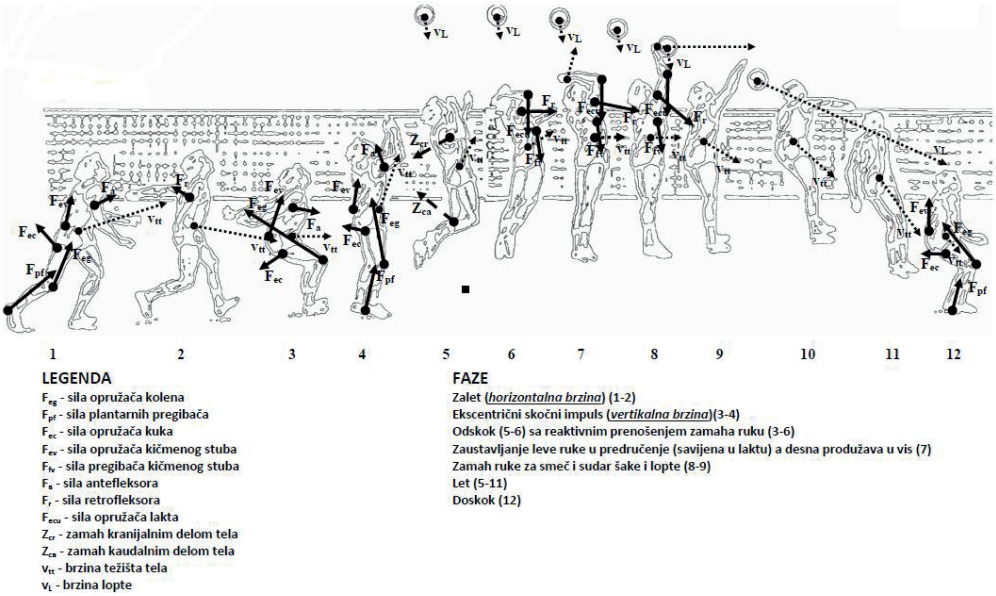
Prva faza - Zalet

Prva faza predstavlja uvodni deo udarca koji se vrši pri napadu [5, 6]. Zalet je dužine od 3 do 5m koja se prelazi sa dva ili tri koraka. On se tretira kao horizontalna brzina. Ponekad se ova daljina može preći i sa manje koraka. Kretanje koje igrač koristi može biti pod uglom, pravolinijsko ili korigovano, u zavisnosti od putanje lopte. Kod desnorukog igrača, ukoliko se govori o kretanju koje sadrži četiri koraka, prvi korak čini desna noga. Ovaj korak je mali i vrši se pre nego što igrač sazna putanju lopte. U ovom slučaju se obično prilikom gaženja ne oslanja na petu. Drugi, levi korak je veći i on je najvažniji jer njime igrač određuje ritam svog kretanja. Gazi se sa pete na prste i u trenutku vršenja ovog pokreta igrač uočava putanju leta lopte. Treći, odnosno desni, korak je posle malog naskoka koji sledi nakon drugog koraka. Ovaj korak se vrši skoro istovremeno sa četvrtim (levim) korakom i on priprema odskok. Poslednji korak prekida pravolinijsko kretanje, stopalo je okrenuto blago ka unutra i ono daje impuls pri odskoku.

Aktivna je muskulatura koja pripada kinetičkom lancu ekstenzora na telu sportiste, a posebno mišići plantarni fleksori u gornjem skočnom zglobu, zatim mišićna grupa ekstenzora u zglobu kolena i ekstenzori u zglobu kuka. Ove mišićne grupe se kod zaleta u fazi zadnjeg odskoka angažuju u koncentričnom režimu naprezanja. Mišićne grupe koje pripadaju ekstenzorima kičmenog stuba se u ovoj fazi naprežu u izometrijskom režimu. Ove motoričke aktivnosti prati i odgovarajući rad gornjih ekstremiteta koji u većoj meri igra stabilizujuću, odnosno kompenzatornu ulogu, pa se neće posebno analizirati.

Druga faza - odskok

Druga faza - noga koja gazi poslednja u zaletu stvara ekscentrični skočni impuls i određuje visinu skoka [5, 6]. Ruke se nalaze iza tela i vrše reaktivno prenošenje zamaha a telo je nagnuto unapred. Ugao između nadkolenice i podkolenice je optimalan. Od tog trenutka počinje skok. Noge se iz polučučnja ispružaju, ruke prolaze pored tela i podižu se prema gore velikom brzinom i težište tela se podiže. Vreme između pliometrije i miometrije mora biti svedeno na minimum.U tom trenutku ugao u kom se koleno nalazi je između 110 i 120 stepeni i razlikuje se od igrača do igrača u zavisnosti od anatomske razvijenosti tela. Ruke se kreću od zaručenja ka predručenju, i na kraju gore stižu do nivoa glave, gde, kod desnorukih, desna ruka ide u vis a leva ruka se u predručenju savija u laktu, pete se prve spuštaju na tlo, a posle njih prsti. Ispravnost skoka zavisi od položaja težišta tela unazad pre skoka. To se obično reguliše visinom i daljinom skoka prethodne faze i gaženjem na pete.



Slika 1.

Biomehanički posmatrano [1, 2, 4] u ovoj se fazi vrši transformacija kinetičke energije zaleta koja pretežno ovisi o brzini kretanja igrača, preusmeravanjem vektora brzine kretanja težišta tela, u potencijalnu energiju koja je određena visinom na koju će se u bespotpornoj fazi (fazi leta) podići vertikalno težište tela. Ovo preusmeravanje predstavlja u fizičkom pogledu promenu orijentacije i intenziteta vektora količine kretanja, što je ekvivalentno zbirnom impulsu sila koje su u fazi odskoka delovale na težište, odnosno odskočnom impulsu. Zahtev za preusmeravanje vektora količine kretanja težišta tela je uslovljen i zahtevom da se u fazi leta ne dodirne mreža, što za posledicu ima i specifično postavljanje stopala u odnosu na smer kretanja težišta tela i ekscentrično delovanje lanca ekstenzora donjih ekstremiteta. Delovanje aktivne muskulature može da se posmatra u fazi amortizacije i fazi odskoka. U prvoj - amortizacionoj fazi, preovlađuje angažman mišićnih grupa ekstenzora u zglobovima kolena i kuka u ekscentričnom režimu naprezanja. U ovoj fazi se mišići ekstenzori kičmenog stuba naprežu u izometrijskom režimu, što prati angažman mišića antefleksora koji započinju energičan zamah gornjim ekstremitetima.

U fazi odskoka se ekstenzorima u zglobu kolena i kuka pridružuju i plantarni fleksori u gornjem skočnom zglobu. Ovaj kinetički lanac ekstenzora se u ovoj fazi napreže u koncentričnom režimu, dok mišići opružači kičmenog stuba izometrijskom kontrakcijom održavaju stabilnost trupa.

Treća faza - faza leta

Treća faza - posle odvajanja nogu od tla počinje faza leta [5, 6]. U ovoj fazi dolazi do reaktivnog prenošenja zamaha gornjim ekstremitetima koji je izvršen za vreme

faze odskoka (Pozicija 5.). Ovo se manifestuje dovođenjem tela u položaj hiperekstenzije u kičmenom stubu i zglobu kuka čime se stvaraju preduslovi za efikasan smeč. Naime, iz ovakvog početnog položaja je moguće na dužem putu delovati silama koje treba da ubrzaju ruku kojom se smečira, čime se povećava udarni impuls i samim tim početna brzina lopte nakon smeča. Ova faza je povezana sa uspešnim računanjem leta lopte za vreme zaleta. Ruke nastavljaju kretanje do visine glave dok se leva ruka zaustavljala ispred tela a desna nastavlja kretanje iza glave, prolazi pored glave. S tim počinje faza napada. Snaga mišića ramenog pojasa je ona koja odlučuje koju tehniku koristimo. Pominjemo tri vrste tehnike:

- kad lakat prethodi u kretanju u nazad i prolazi pored ramena ili iznad njega
- ruka se zaustavlja kad lakat prolazi ispod ramena i kretanje je skoro kružno
- ruka se podiže pravo gore pa se onda savija u laktu i šaka se pokreće unazad.

U fazi leta telo sportiste predstavlja konzervativan sistem koji nema mogućnost da sile koje se generišu kompenzuje silama reakcije podloge, odnosno drugog čvrstog oslonca. Iz tog razloga se virtuelni oslonac za potrebno biomehaničko delovanje dobija reaktivnim prenošenjem količine kretanja, odnosno zamaha pojedinih segmenata tela. Tako se ključni pokret retrofleksije kojeg prati opružanje u zglobu lakta i pregibanje u zglobu šake, kompenzuje pokretom fleksije kičmenog stuba. Sve mišićne grupe uključene u sinhrono izvođenje ovog pokreta se naprežu u koncentričnom režimu rada. Neophodno je konstatovati da brzina izvođenja smečiranja isključivo zavisi od periferne brzine šake.

Četvrta faza - doskok

Četvrta faza - doskok igrača se dešava na prste obe noge istovremeno, kolena su savijena, daljina skoka zavisi od brzine tela za vreme odskoka [5, 6]. Lopte koje su blizu mreže ne dozvoljavaju slobodno kretanje tela i praćenje ruke posle udarca lopte. Najbolja tehnika se vrši prilikom smečiranja lopti koje su udaljene od mreže.

Kod doskoka se pretežno angažuju mišići plantarni fleksori u gornjem skočnom zglobu, ekstenzori u zglobovima kolena i kuka u ekscentričnom režimu naprezanja, dok se opružači kičmenog stuba izometrijskim naprezanjem angažuju na održavanju stabilnosti trupa.

4. BIOMEHANIČKA ANALIZA SMEČA

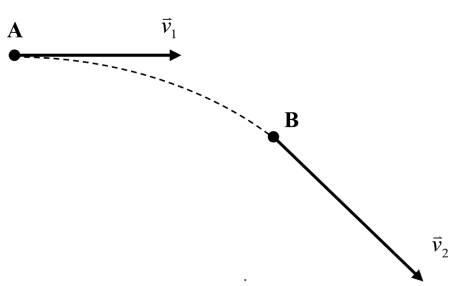
Cilj efikasnog smečiranja predstavlja izvođenje ovog tehničko-taktičkog elementa odbojkaške igre na način kojim se protivnikove šanse blokiranja, odnosno odbrane, minimiziraju. Ako se posmatra izolovano motorička aktivnost igrača koji smečira (Slika 1), postizanje navedenog cilja se operacionalizuje na sledeći način:

- udarac po lopti izvršiti u optimalnoj tački trajektorije kojom se lopta kreće,
- udarac po lopti izvesti najvećom mogućom brzinom (snagom),
- uputiti loptu u željenom smeru.

Biomehanički aspekti operacionalizacije efikasnog smeča su mnogobrojni [1, 2, 4]. U prvom redu je potrebno izvršiti pravilnu procenu prostorno vremenskih parametara koji su relevantni za realizaciju smeča. To podrazumeva izvršiti procenu kretanja lopte i rezultate procene dovesti u vezu sa procenom kretanja sopstvenog tela sa ciljem koordinisanog delovanja sa postizanjem maksimalnih efekata. Pored toga sopstvene motoričke radnje treba da budu izvršene na najbrži i naefikasniji način, kako bi se predupredilo efikasno blokiranje napada od strane protivnika. Iz tog razloga je poterbno da se smanji u maksimalnoj mogućoj meri zalet neophodan za postizanje visokog odskoka neophodnog za kvalitetno smečiranje.

Odskok koji prethodi smečiranju svojom visinom u značajnoj meri utiče na efikasnost smečiranja. Odskok se izvodi sunožnim odrazom koji prati kratak i efikasan zalet. Zalet je potreban da bi se za vreme faze odskoka izmenio vektor količine kretanja težišta tela pod uticajem odraznog impulsa.

Drugi Njutnov zakon definiše da je promena količine kretanja tela u jedinici vremena proporcionalna sili koja je delovala na telo (Slika 2.).



Slika 2.

Ako je količina kretanja (K):

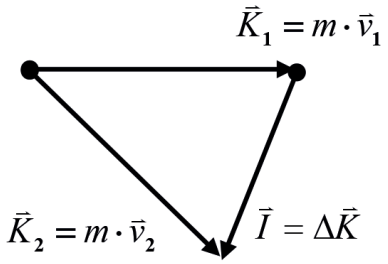
$$\vec{K} = m \cdot \vec{v} \tag{1}$$

gde je K - količina kretanja, m - masa tela i v - brzina kretanja tela, onda se drugi Njutnov zakon može prikazati kao:

$$\vec{F} = \frac{m \cdot \vec{v}_2 - m \cdot \vec{v}_1}{t_2 - t_1} = \frac{\Delta \vec{K}}{\Delta t} \tag{2}$$

gde je F - sila.

Ova relacija grafički može da se prikaže na sledeći način:



Slika 3

iz čega sledi:

$$\vec{F} \cdot \Delta t = \Delta \vec{K} \tag{3}$$

Veličina sa leve strane znaka jednakosti predstavlja impuls sile. Ova relacija se zbog naknadne analize dinamike odskoka može prikazati i na sledeći način:

$$\vec{I} = \int_{t_i}^{t_f} \vec{F}(t) \cdot dt \tag{4}$$

gde je I - impuls sile koji manifestuje sila $F(t)$ u vremenskom intervalu $\Delta t = t_f - t_i$.

Ove relacije se mogu prikazati i na sledeći način:

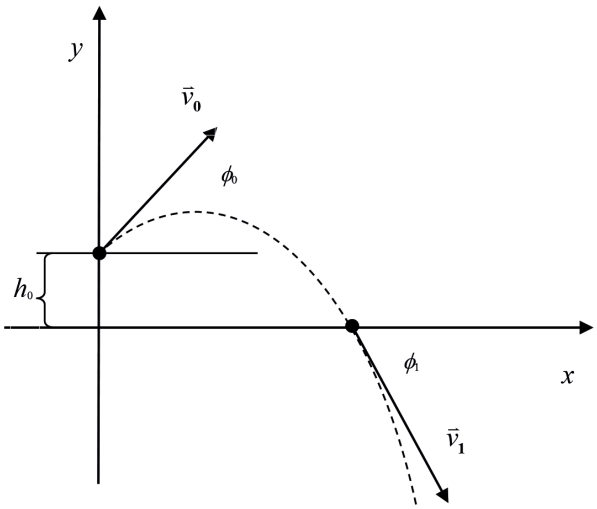
$$\vec{F} = \frac{m \cdot \vec{v}_2 - m \cdot \vec{v}_1}{t_2 - t_1} = m \frac{\Delta \vec{v}}{\Delta t} \tag{5}$$

odnosno:

$$\vec{F} = m \cdot \vec{a} \tag{6}$$

Dakle, ukoliko se tokom odskoka realizuje odrazni impuls odgovarajućeg intenziteta, onda se može očekivati daleko viši odskok ukoliko se težište tela igrača prethodno kretalo određenom brzinom, nego ukoliko se odskok vrši iz mesta. Naime, delovanjem odraznog impulsa je moguće da se promeni smer vektora količine kretanja i na taj način doprinese većoj početnoj brzini koju će težište tela imati u trenutku kada igrač napušta podlogu. Veća početna brzina će imati za rezultat i veću vertikalnu komponentu koja direktno uslovljava visinu odskoka.

Ovo proizlazi iz opštih jednačina koje definišu kinematiku materijalne tačke (težišta tela) kod kosog hica u opštem slučaju (Slika 4.):



Slika 4.

h_0 - početna visina (razlika nivoa) kod kosog hica sa razlikom nivoa

ϕ_0 - elevacioni ugao

ϕ_1 - finalni ugao

v_0 - početna brzina težišta igrača

v_1 - finalna brzina težišta igrača

Ubrzanje praćene tačke (težišta tela) kod kosog hica sa razlikom nivoa po vertikali je rezultat delovanja sile zemljine teže i odgovara ubrzanju sile zemljine teže:

$$\ddot{y} = -g \tag{7}$$

gde je $\ddot{y}$ - vertikalna komponenta ubrzanja; g - ubrzanje sile zemljine teže (9.80665 m • s $^{-1}$).

Ubrzanje praćene tačke (težišta tela) po horizontali je jednako nuli pošto za vrijeme faze leta na telo ne deluju sile u horizontalnom smeru (podrazumeva se zanemarivanje delovanja sile otpora vazduha):

$$\ddot{x} = 0 \tag{8}$$

gde je $\ddot{x}$ - vertikalna komponenta ubrzanja.

Iz relacije 7. sledi da je vertikalna komponenta brzine kretanja određena izrazom:

$$\dot{y} = v_{0y} - g \cdot \Delta t \tag{9}$$

gde je $\dot{y}$ - vertikalna komponenta brzine; Δt - vremenski interval protekao od početka kretanja; v_{0y} - vertikalna komponenta početne brzine kod kosog hica određena izrazom:

$$v_{0y} = v_0 \cdot \sin\phi_0 \tag{10}$$

gde je ϕ_o - elevacioni ugao kod kosog hica.

Iz relacije 8. sledi da je horizontalna komponenta brzine kretanja određena izrazom:

$$\dot{x} = v_{0x} = v_0 \cdot \cos\phi_0 \tag{11}$$

gde je v_{0x} - horizontalna komponenta početne brzine kod kosog hica.

Na osnovu relacije 9. položaj tačke čije se kretanje posmatra po vertikali je određen izrazom:

$$y = h_0 + v_0 \cdot \sin\phi_0 \cdot \Delta t - \frac{g \cdot \Delta t^2}{2} \tag{12}$$

gde je h_0 - razlika nivoa kod kosog hica.

Na osnovu relacije 11. položaj tačke čije se kretanje posmatra po horizontali je određen izrazom:

$$x = v_0 \cdot \cos\phi_0 \cdot \Delta t \tag{13}$$

Trajanje kosog hica sa razlikom nivoa je određeno relacijom:

$$\Delta t = \frac{v_0 \cdot \sin\phi_0 + \sqrt{2 \cdot g \cdot h_0 + v_0^2 \cdot \sin^2\phi_0}}{g} \tag{14}$$

Iz navedenih relacija se dobija izraz za izračunavanje dometa kosog hica:

$$x = v_0 \cdot \cos\phi_0 \cdot \left(\frac{v_0 \cdot \sin\phi_0 + \sqrt{2 \cdot g \cdot h_0 + v_0^2 \cdot \sin^2\phi_0}}{g} \right) \tag{15}$$

iz kojeg se vidi da domet kod kosog hica sa razlikom nivoa ovisi o veličini razlike nivoa, elevacionom uglu i veličini početne brzine.

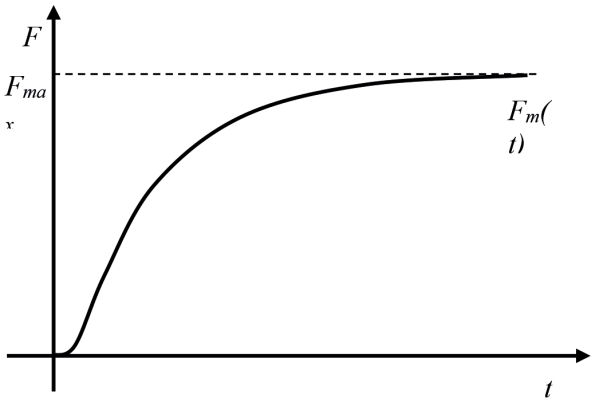
Ugao pod kojim se kreće težište tela u trenutku završetka kosog hica određen je sljedećom relacijom:

$$\phi_1 = arctg\left(\frac{v_{0y} - g \cdot \Delta t}{v_{0x}} \right) \tag{16}$$

Inspekcijom gore prikazanih matematičkih relacije koje određuju ponašanje materijalne tačke (težišta tela) kod kosog hica u opštem slučaju, ukazuju na ključni značaj vertikalne komponente početne brzine u trenutku napuštanja podloge (jednačina 12.), jer je visina na koju će težište tela igrača da se popne u bezpotpornoj fazi leta, direktno proporcionalna produktu početne brzine i sinusu ugla pod kojim se težište tela kreće u trenutku napuštanja podloge.

Drugi aspekt koji je od posebnog značaja kada se analizira značaj i doprinos zaleta na visinu odskoka koju igrač izvodi je vezan za biomehaniku mišićne kontrakcije. Naime, mehaničko ponašanje aktivnog mišića, ili mišićne grupe, karakteriše i fenomen vremenske zavisnosti nivoa ispoljenih sila. Naime, intezitet sile kojom mišić deluje na svojim pripojima nije konstantan od trenutka uključenja mišića do trenutka u kojem zbog iscrpljenja energetskih rezervi dolazi do pada nivoa sile zbog pojave zamora.

Mišićna se sila postepeno razvija u vremenu od trenutka početka kontrakcije do trenutka u kojem se manifestuje maksimalna mišićna sila (Slika 5.).

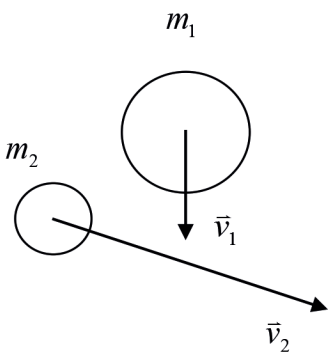


Slika 5.

$$F_m(t) = F_{\max} \cdot \left(1 - e^{-k \cdot \Delta t}\right) \tag{17}$$

Ovu osobinu mišćne kontrakcije kod naprezanja mišića u izometrijskim uslovima opisuje eksponencijalna kriva čiji parametar *k* tzv. gradijent sile, opisuje svojstvo koje se naziva eksplozivnošću i predstavlja jednu od komponenti balističkog mišićnog potencijala.

Ukoliko se sunožni odskok vrši iz mesta onda se mišić uključuje u vremenskom trenutku koji odgovara trenutku u kojem sam pokret odskoka započinje. Ukoliko početku odskoka prethodi amortizaciona faza u kojoj mišići prvo treba da svojim impulsom anuliraju količinu kretanja nastalom kao posledicom zaleta, onda se u početnom položaju za odskok aktuelni mišići nalaze već u značajno aktiviranom stanju. Iz tog razloga će isti mišići u odskoku kojem prethodi zalet imati daleko veće impulse sila koje će da manifestuju, od impulsa sila koje bi mogli da relaizuju odskokom iz mesta.



Slika 6.

Sam odskok se vrši sinhronim delovanjem više različitih mišićnih grupa. Njihov je cilj maksimalno moguće podizanje težišta tela u fazi odskoka za što kraći vrmenski period. U tome učestvuju pored plantarnih flreksora u gornjem skočnom zglobu, ekstenzora u zglobu kolena i ekstenzora u zglobu kuka i mišići antefleksori u zglobu ramena, jer zamahom ruku i podizanjem težišta gornjih ekstremiteta dolazi i do ukupnog podizanja težišta tela igrača. Kao stabilizatori tokom trajanja odskoka deluju mišići opružači kičmenog stuba, čime se efekat zamaha ruku prenosi na kaudalne regije tela.

U fazi leta je potrebno da se igrač pripremi za snažan udarac po odbojkaškoj lopti. Shematski ovo može da se posmatra kao sudar dva elastična tela koje predstavlja šaka igrača i lopta (Slika 6.). Rezultujuća kinetička energija lopte nakon sudara šake sa loptom će biti jednaka zbiru kinetičkih energija šake i lopte pre sudara.

Kinetička energija šake je propocionalna masi i kvadratu brzine kojom se težište šake kreće (jednačina 18.).

$$E_k = \frac{m \times v^2}{2} \tag{18}$$

iz čega sledi da je potrebno tehnikom udarca povećati masu koja učestvuje u sudaru, kao i njenu brzinu.

Ovo se dobija sinhronim delovanjem mišića pregibača u zglobu kuka koji trup igrača iz položa kojeg u fazi leta karakteriše hiperekstenzija kičmenog stuba, dovodi u položaj fleksije u zglobu kuka i simultane fleksije kičmenog stuba pod dejstvom pregibača kičmenog stuba. Na taj način se referentni koordinatni sistem vezan za centar zgloba ramena ruke koja udara po lopti, ubrzava i u trenutku sudara šake sa loptom rezultujuća brzina predstavlja zbir brzina koje su proizvedene delovanjem pregibača u globu kuka i pregibača kičmenog stuba s jedne strane i delovanjem retrofleksora u zglobu ramena aktivne ruke.

Sam pokret ruke koja udara po lopti predstavlja u suštini rotaciono kretanje sistema nadlaktica - podlaktica sa centrom rotacije u zglobu ramena u kojem mišićna grupa retrofleksora predstavlja osnovni aktuator pokreta. Brzina šake se određuje u skladu sa sledećim izrazom:

$$\vec{v} = \vec{\omega} \times \vec{r} \tag{19}$$

gde je v - brzina kretanja šake, ω- ugaona brzina kretanja sistema nadlaktica - podlaktica i r - udaljenost šake od centra rotacije.

Učestvujuća masa u sudaru šake sa loptom se povećava izometrijskom kontrakcijom mišića pregibača šake, opružača u zglobu lakta i retrofleksora u zglobu ramena, čime se masa celog tela unosi u udarac koje se izvodi.

5. FUNKCIONALNA ANALIZA SMEČA

Svi pokreti u smeču sastoje od ekscentričnih i koncentričnih faza u kojima skraćenju mišića predhodi, posebno kod vrhunskih odbojkaša, njegovo naglo izduženje (Slika 1). Kombinacija ekscentrično koncentrične kontrakcije (ciklus) u opisanim pokretima naziva se reverzibilna kontrakcija [4, 5] U ekscentrično koncentričnom ciklusu u fazi skraćivanja (koncentrična kontrakcija) ostvaruje se veća sila nego pojedinačno u ekscentričnoj ili koncentričnoj kontrakciji mišića iz nekoliko razloga. Prvo, u najvišoj tački ciklusa, u trenutku kada prestaje izduživanje a počinje skraćivanje mišića, sila se razvija u izometrijskim uslovima. Drugo, obzirom da sila počinje da raste u ekscentričnoj fazi, vreme u kome je moguće generisati silu u reverzibilnoj kontrakciji se produžuje. Treće, na nivo sile utiče mišićno tetivna elastičnost (akumulacija elastične energije u fazi izduživanja mišića i tetiva) i četvrto refleksna kontrakcija mišića. Već je rečeno da se dužina svih mišića koji učestvuju u smeču menja ali se naglo menja i njihov nivo sile. To je posebno izraženo kod opružača nogu nakon kontakta sa tlom u doskocima ili doskok odskocima. Dakle, mišići se forsirano izdužuju a u isto vreme se jako povećava njihova napetost. Te promene u isto vreme kontroliše i delimično održava u ravnoteži zajedničko dejstvo dva motorička refleksa: refleks na istezanje, održavajući optimalnu dužinu mišića i refleks Goldžijevog tetivnog organa, sprečavajući izuzetno veliko i štetno mišićno naprezanje. Ekscentrično pražnjenje ka mišiću u fazi izduživanja modifikuje se zajedničkim delovanjem dva refleksa, refleksa na istezanje i tetivnog Goldžijevog refleksa. Refleks na istezanje ima pozitivno dejstvo (povećanjem pražnjenja) a Goldžijev refleks negativno (inhibitorno) eferentno dejstvo i njihovo dejstvo je mera ispoljene sile. Ono što je važno za učenje reverzibilne kontrakcije pri velikim mišićnim naprezanjima u odbojci je da aktiviranje Goldžijevog tetivnog organa sprečava dalju aktivnost mišića odnosno koncentričnu kontrakciju jer sprečava eferentni priliv u mišić. Međutim, u doskocima sa amortizacijom ili blokadom, doskok odskocima, naglom izduženju mišića pri servisu, usled mogućnosti narušavanja integriteta organizma um reaguje amplifikatorskim i dezinhibicionim dejstvima na različitim nivoima. U tom slučaju retikularni sistem počinje da deluje amplifikatorski povećavajući eferentni priliv. Zatim se centralno inhibiraju Renshaw-ovi inhibitorni interneuroni što rezultira slobodnim prolazom povećanog eferentnog konsekutivnog priliva inpulsa. I periferno se inhibira Goldžijev tetivni organ čime se skida poslednja smetnja povećanom prilivu eferentnih impulsa u mišić. Neuralna dezinhibicija, iz rečenog uslova, utiče na porast refleksa na istezanje (skraćuje se vreme latencije refleka a povećava se brzina i nivo generisane sile u refleksu). Dalje, neuralna dezinhibicija uslovljava povećanja brzine uključenja i nivoa sinhronizacije rada motornih jedinica mišića, promenu obrazca uključenja motornih jedinica pri čemu se prve uključuju motorne jedinice najvećeg praga paljenja i sile (unutarmišićna koordinacija) i reprogramiranje (povećanjem) granice sile svih motornih jedinica iznad maksimuma izmerenog na standardnim testiranjima. Dakle, najveći uticaj enormnom povećanju sile uz skraćenje vremena njenog generisanja u reverzibilnoj kontrakciji u svim fazama smeča ima neuralna komponenta mišićne kontrakcije, u prvom redu dezinhibicioni proces na svim nivoima Najveći izazov šampionskom umu u učenju i vladanju reverzibilnom kontrakcijom je učenje i vladanje dezinhibicijom. Oni odbojkaši koji slabo vladaju dezinhibicionim procesom u reverzibilnoj kontrakciji i ako na testiranjima imaju mnogo veće nivoe maksimalne sile od onih koji dobro vladaju reverzibilnom kontrakcijom, po pravilu od njih imaju slabiji servis, smeč, skokove i slabije doskok odskoke zbog neobučenosti, pored ostalog i u savladavanju efekata Goldžijevog tetivnog refleksa u fazi koncentrične kontrakcije. S obzirom na to da reverzibilna kontrakcija predstavlja integralni deo svih opisanih pokreta, da je jako složena i uslov za šampionska postignuća, ona se mora posebno učiti i trenirati uz različitu upotrebu uma, trenažnih metoda i sredstava. Naravno, neki od opisanih pokreta mogu se realizovati samo uz pomoć koncentrične kontrakcije ali će onda svi efekti biti dosta slabiji.

6. ZAKLJUČAK

Na osnovu urađenih analiza smeča u odbojci (strukturalna, biomehanička i funkcionalna) primenom kamere visoke rezolucije i tenziometrijske platforme može se konstatovati sledeće. Rezultati strukturalne analize ukazuju da se smeč može uslovno podeliti u 4 faze: faza zaleta, faza odskoka, faza leta i faza doskoka. Rezultati biomehaničke analize daju sve aspekte operacionalizacije efikasnog smeča u odbojci. U tom smislu, prikazani su u svakoj fazi smeča njegovi kinematički i dinamički

parametri. Rezultati funkcionalne analize ukazuje na to da reverzibilna kontrakcija predstavlja integralni deo svih opisanih pokreta u odbojci. Da bi rečena kretanja odbojkaša imala šampionske odlike u njihovoj totalnoj, vrhunskoj samoaktuelizaciji na takmičenjima, reverzibilna kontrakcija treba da što kraće traje uz velike količine generisane sile. Uvećanje sile i skraćenja vremena reverzibilne kontrakcije svih mišića protagonista servisa i smeča predstavlja rezultat inhibicije Renshaw – ovih interneurona, inhibicije refleksa Goldžijevih organa, porasta refleksa na istezanje, skraćenja vremena smenjivosti ekscentrične i koncetrične kontrakcije, povećanja brzine i sinhronizacije uključivanja motornih jedinica, poboljšanja unutar i međumišićne koordinacije, odnosno reprogramiranja granica sile motornih jedinica, što pretpostavlja povećan i sinhron priliv inpulsa i promenu obrasca regrutovanja motornih jedinica. S obzirom na to da reverzibilna kontrakcija predstavlja integralni deo svih opisanih pokreta, da je jako složena i uslov za šampionska postignuća, ona se mora posebno učiti i trenirati uz različitu upotrebu uma, trenažnih metoda i sredstava.

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UNAPREĐENJE EUROFIT BATERIJE MOTORIČKIH TESTOVA UPOTREBOM INFORMACIONE TEHNOLOGIJE

Vladan Marković*,
Aleksandar Živković,
Tamara Ratković,
Miloš Milošević

Univerzitet Singidunum,
Beograd, Srbija

Rezime:

Cilj ovog rada je bila analiza mogućnosti unapređenja Eurofit baterije motoričkih testova upotrebom informacione tehnologije radi postizanja bržeg, efikasnijeg i preciznijeg prikupljanja upotrebljivih podataka o motoričkom i funkcionalnom statusu dece predškolskog i školskog uzrasta. Predložena je upotreba revidirane baterije motoričkih testova i analizirana je mogućnost upotrebe softverskih i hardverskih (tehnološki unapređenih) rešenja u procesu merenja. Takođe je analiziran potencijal upotrebe revidirane baterije motoričkih testova u oblasti fizičkog vaspitanja i sporta. Na osnovu analiza zaključeno je da postoji potreba za konstrukcijom i validacijom predložene baterije testova što je preduslov njene široke praktične implementacije.

Ključne reči:

motoričke sposobnosti, merenje, digitalne tehnologije, fizičko vaspitanje.

1. UVOD

Razvoj digitalnih, pre svega informacionih i komunikacionih, tehnologija kao i prodor medija u privatni život ljudi, kroz njihovu povećanu prisutnost u svakodnevnom životu, ostavlja utisak neograničenog rasta njihovog uticaja u svim sferama ljudskog života i društva. Imajući u vidu povezanost između tela i njegovih pokreta i kognicije, koje je u skladu sa evolutivnim stanovištem koje kao nužan uslov za pojavu svesti vidi kretanje [1], i Pijažeovim (Jean Piaget) stanovištem da inteligencija nastaje i razvija se iz ograničenog broja senzo-motornih (akcionih) šema [2, 3], odnos količine kretanja i konzumacije novomedijskih sadržaja posebno je problematičan. Iz ovog razloga je njihova negativna povezanost [4, 5], osnova kritike formativnog uticaja razvoja digitalnih tehnologija na mlade generacije.

Gojaznost i nepravilan fizički razvoj, kao posledica smanjenog kretanja uzrokovanog pre svega povećanjem vremena provedenog u gledanju televizijskog programa i igranju kompjuterskih igara i smanjenjem vremena provedenog u slobodnoj igri i aktivnostima u prirodi uočeni su još krajem prošloga veka. Ubrzani razvoj tehnologije, njena povećana dostupnost i masovna upotreba u sve ranijem uzrastu ostavljaju teške posledice pre svega po kognitivni ali i ukupan razvoj ličnosti.

Odgovorno lice:
Vladan Marković

e-pošta:
vladanmarkovic@singidunum.ac.rs

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Broj dece kojima je dijagnostifikovan deficit pažnje i hiperaktivnost koji se manifestuju u formi ADHD (attention deficit hyperactivity disorder) sindroma ubrzano raste poslednjih godina i u Amerci obuhvata preko 11% predškolske i školske dece [6]. Broj dece sa sličnim simptomima koja nisu registrovana u zdravstvenom sistemu ili se u blažem obliku suočavaju sa ovim problemima značajno je veći. Iako je još uvek upitno šta je uzrok ovim promenama, on bi se mogao potražiti u trendu smanjenja fizičke aktivnosti i povećanja vremena koje deca provode ispred televizora, računara, mobilnog telefona i sličnih medijskih naprava [7]. Slično sugerišu i nalazi eksperimentalnih studija [8]. Mala je verovatnoća da će se uočeni trend povećanog prisustva medija u svakodnevnom životu promeniti, zbog čega se može očekivati nastavak rasta broja dece sa sličnim problemima u budućnosti.

Hiperaktivnost i nemogućnost usmeravanja pažnje imaju negativan uticaj na školsko učenje i postignuće [9], kao i funkcionisanje u socijalnim situacijama i povećanu agresivnost [10]. Bilo da se radi o dijagnostifikovanom sindromu ili blažem obliku poremećaja pažnje potreban je dodatni rad i stimulacija dece kako bi se izbegao loš razvojni uticaj. Iako studije pokazuju da fizička aktivnosti ima blagotvoran efekat kod dece sa ADHD sindromom [11, 12] i šire na razvoj pažnje i ostalih kognitivnih sposobnosti [13], detaljno ispitivanje povezanosti konkretnih kognitivnih i motoričkih sposobnosti tema je koja nije dovoljno dobro ispitana [14]. Zbog ovoga, iako se fizička aktivnost često od strane institucija, medija i prosvetnih radnika proklamuje kao efikasan način za menjanje negativnih bihejvioralnih manifestacija, pogotovo u školskom okruženju, lako se može uvideti nedostatak konkretizacije ovakvih preporuka, odnosno koji tip, vrsta, obim fizičke aktivnosti treba upražnjavati.

Jedan od razloga opisanih manjkavosti aktuelne istraživačke prakse treba tražiti u tradicionalnim metodama merenja motoričkih sposobnosti koje ne uspevaju da odgovore na potrebe radikalno promenjenog istraživačkog i društvenog konteksta. Eurofit baterija motoričkih testova jedan je od najilustrativnijih primera mernog instrumenta u širokoj primeni, kako u fizičkom vaspitanju tako i u sportu, čija su revizija i ponovna validacija neophodni kako bi se odgovorilo na opisane promene. U ovom smislu, nove tehnologije, zapravo treba da postanu saveznik u istraživanju i otklanjanju negativnih razvojnih posledica koje su paradoksalno njihovim razvojem i uzrokovane.

Cilj ovog rada je da analizira mogućnosti unapređenja Eurofit baterije motoričkih testova, upotrebom informacione tehnologije koja bi omogućila efikasnije, brže, obimnije i preciznije prikupljanje upotrebljivih podataka o motoričkom statusu pre svega dece predškolskog i školskog uzrasta što za krajnji cilj ima dolaženje do novih uvida i znanja u domenu fizičke kulture, sporta ali i kognitivnih nauka i psihologije što će pomoći kako istraživačima tako i praktičarima u preventivnom delovanju, stimulaciji pravilnog razvoja i otklanjanju negativnih razvojnih pojava.

2. EUROFIT BATERIJA

Testiranje motoričkih sposobnosti važan je element praćenja razvoja dece, bez obzira da li se bave sportom ili ne. Redovno testiranje dece omogućava praćenje razvoja onih sposobnosti koje su neophodne za pravilan razvoj, odnosno utvrđivanje da li i na koji način bavljenje sportom utiče na razvoj tih sposobnosti. Takođe, testiranje omogućava pravovremeno uočavanje eventualnih neuravnoteženosti u motoričkom razvoju, čime se olakšava rad na korekciji kao i kontinuirano praćenje dinamike napretka.

Savet Evrope je još 1963. godine kao jedan od svojih osnovnih ciljeva postavio omasovljenje upražnjavanja fizičke aktivnosti, kako u uzrastu predškolske i školske dece tako i u odraslom dobu, što je označeno kao „Filozofija: sport za sve“. Ovaj cilj proistekao je iz jasno uočene i opisane povezanosti fizičke aktivnosti i psiho-fizičkog razvoja i očuvanja zdravlja. U tu svrhu 1983. konstruisana je Eurofit baterija kardiorespiratornih i motoričkih testova koja je omogućila jeftino, lako i brzo prikupljanje podataka i praćenje fizičkog i zdravstvenog statusa predškolske i školske dece kao i razvojnih procesa.

U okvir Eurofit baterije ulaze sledeći testovi:

- Test ravnoteže – Flamingo Balance Test (FBL), ravnoteža,
- Taping rukom –Plate Tapping (PLT), frekvencija pokreta ruke,
- Duboki pretklon u sedu –Sit and Reach (SAR), gipkost,
- Skok u dalj iz mesta –Standing Borad Jump (SBJ), snaga mišića nogu,
- Dinamometrija šake – Hand Grip (HGR), jačina mišića šake,
- Ležanje-sed – Sit Ups (SUP), repetitivna snaga trupa,

- Izdržaj u zgibu – Bent Arm Hang (BAH), mišićna izdržljivost ruku i ramenog pojasa,
- Čunasto trčanje – Shuttle Run 10x5 (SHR), brzina i agilnost [15, 16, 17].

Eurofit baterija prošla je opsežne validacione studije [15] i zbog svojih karakteristika danas predstavlja zlatni standard u merenju i praćenju motoričkih sposobnosti dece predškolskog i školskog uzrasta, širom Evrope. Eurofit je i jedan od retkih instrumenata ove vrste koji je validiran i pogodan za primenu i kod dece sa posebnim potrebama ali i na starijim uzrastima [15, 17].

Sa druge strane, savremeno društvo i tehnološki napredak sporta prati i odgovarajuća moderna tehnologija testiranja. Sam podatak da je EUROFIT baterija testova dizajnirana pre punih 35 godina, govori da je ona u velikoj meri zastarela i prevaziđena, pre svega u izboru testova i opreme koja se koristi za sprovođenje istih.

Takođe, prediktivna moć rezultata dobijenih ovim testiranjem, pogotovo u cilju identifikacije talenata i selekcije vrhunskih sportista kreće se u opsegu od slabe do vrlo slabe u zavisnosti od konkretne sportske grane i sportske igre [17].

Osnovne metrijske karakteristike: valjanost, pouzdanost, osetljivost, i objektivnost standardizovanog procesa merenja Eurofit baterijom prilično su upitni za današnje standarde.

Čunasto trčanje 10x5m je test za procenu agilnosti, odnosno brzine promene pravca kretanja i kao takav, ne može se smatrati testom za procenu brzine. Ova konstatacija direktno utiče na valjanost primenjenog testa za procenu brzine, za koju je sprint na 20-30 m bio bolji izbor. Takođe, kod netrenirane populacije 10x5m je predugačak zadatak, odnosno završetak testa je pod uticajem mišićne izdržljivosti.

Dok valjanost direktno zavisi od izbora odgovarajućeg testa, preostale karakteristike su visoko zavisne od instrumenata koji se koriste za merenje. Na primer upotreba štoperice u merenju vremena u sprintu na nivou grupe daje slične rezultate kao i merenje foto-ćelijama, dok na bazi pojedinačnih rezultata ta greška značajno raste [18]. Sa druge strane, potencijalno još veće razlike se pojavljuju kada je objektivnost merenja u pitanju, pošto objektivnost direktno zavisi od merioca i njegovih sposobnosti (reakcija prilikom starta i prilikom prolaska kroz cilj). Na kraju korišćenje fotoćelija omogućava merenja sa prolaznim vremenima, dok bi štopericom bilo potrebno više merilaca (što dovodi do greške na svakom prolazu) ili posebna merenja za pojedine testove.

Sa druge strane, kod testa za procenu snage mišića nogu (skok u dalj iz mesta) problem je direktno u izboru testa, odnosno valjanosti testa skok u dalj iz mesta. Skok u dalj iz mesta zahteva viši nivo tehnike izvođenja u odnosu na vertikalni skok [19], pa samim tim vertikalni skok predstavlja logičan izbor, posebno kod populacije koja nije sportski usmerena. Takođe, postoji nekoliko metoda za procenu snage mišića nogu korišćenjem vertikalnih skokova od kojih se najčešće koristi metod merenja visine skoka na osnovu vertikalne razdaljine između inicijalne i finalne oznake nekog dela tela (prsti ruke, struk, glava, centar mase tela; Sardžentov skok, Abalakov skok) i metod merenja visine skoka na osnovu trajanja faze leta.

Po Sardžentovoj metodi ispitanik skače zamahujući rukama i pravi otisak kredom što je više moguće na zidu. Rezultat se izražava u maksimalnoj visini dohvata ili razdaljini između inicijalne i finalne oznake napravljene kredom – visini leta. Za ovaj protokol navodi se da predstavlja grubu procenu eksplozivne snage nogu [20]. S obzirom na to da se ovaj skok izvodi isključivo zamahom rukama, nalazi brojnih autora navode na zaključak da visina ovog skoka nije isključivo posledica snage ekstenzora nogu, što se mislilo da ovaj skok meri, već i koordinacije između zamaha ruku i ekstenzije u zglobovima nogu.

Abalakov (Вита́лий Миха́йлович Абала́ков) je prvi autor koji je razmatrao vertikalni pomeraj centra mase kao indikator postignute visine vertikalnog skoka. Po ovom metodu, ispitaniku se za specijalno dizajnirani pojas, smešten oko struka, zakači merna traka, koja je drugim krajem blago pričvršćena za kopču na podu, tako da se pri skoku može izvući. Visina skoka predstavlja razliku između mera koje pokazuje zategnuta traka pred skok i posle skoka. Na sličan način, pojedini autori merili su visinu skoka pomoću infracrvenih zraka emitovanih sa pojasa ispitanika na fotosenzitivne ćelije na zidu [21].

Prema ideji Abalakova da je indikator visine vertikalnog skoka vertikalno pomeranje centra mase tela, iskorišćen je napredak kompjuterske tehnologije da bi se procenjivala visina skokova na osnovu trajanja faze leta dobijene preko kontaktne podloge povezane sa modifikovanim tajmerom [22]. Metod merenja visine skoka na osnovu trajanja faze leta je moguć pomoću kontaktnih podloga (ili modifikacije kontaktnih podloga sa laserskim zracima) i platforme sile. Autori navode da visina skoka dobijena metodom merenja na osnovu trajanja faze leta nije u potpunosti precizna i da dobijene vrednosti prevazilaze stvarne vrednosti zato što je

visina centra mase pri doskoku niža od one pri odskoku [19, 23]. Do nepreciznosti merenja dolazi zbog različitih uglova u zglobovima kolena i skočnog zgloba pri odskoku i doskoku. Bez obzira na prethodne činjenice ova metoda je najjednostavnija i najprimenjivija u redovnim terenskim testiranjima sportista [19, 24].

Na kraju, problemi u pojedinim testovima ogledaju se pre svega u njihovoj osetljivosti, koja je takođe direktno povezana sa instrumentima koji se koriste. Tu se pre svega misli na test dinamometrije šake, koji se izvodi sa mehaničkim i elektronskim dinamometrima. Dok mehanički dinamometri daju samo rezultate produkovane sile na analognoj skali, elektronski pored produkovane sile mogu izmeriti i brzinu produkcije sile (rate of force development – RFD) [25, 26].

Pojedini važni indikatori motoričkog i funkcionalnog statusa kao što su brzina i agilnost ili mišićna izdržljivost nisu predmet direktnog i specifičnog merenja testova iz Eurofit baterije dok su u proces merenja takođe uključeni i ometajući faktori (interferišuće varijable). Tako je test izdržaj u zgibu pod velikim uticajem mase tela, pa se preporučuje upotreba testova pri kojima se dobija rezultat koji nije pod uticajem mase kao što su sklekovi, odnosno maksimalni broj sklekova koje pojedinac može da izvede.

Test ravnoteže, flamingo balans test, je test koji se izvodi na površini oslonca širine 3cm pri čemu se administracija vrši brojem pokušaja za 60 sek. Moderna tehnologija omogućava nam primenu ovog testa, kao i drugih testova za procenu ravnoteže (npr. Roda test), korišćenjem elektronskih stabilometara, koji pored osnovnog rezultata u testu, može dati i čitav niz drugih podataka koji mogu imati ulogu u procenu zdravstvenog statusa pojedinca [27].

Tradicionalni način merenja manjkav je i u pogledu količine i upotrebljivosti odnosno pogodnosti za dalju upotrebu podataka koji se njima pribavljaju.

Sve nabrojane manjkavosti Eurofit baterije su zapravo kompromis koji je u njenom konstruisanju napravljen kako bi se obezbedila ekonomičnost (finansijska pre svega) i masovna upotreba. U promenjenom društvenom i tehnološkom kontekstu, ni zahtev za ekonomičnošću više se ne može smatrati kao ispunjen jer testiranja traju predugo. Sa druge strane, proces digitalizacije i demokratizacije tehnologije [5, 28] omogućio je znatno ekonomičnije merenje (i u vremenskom i u ekonomskom smislu) koje bi imalo bolje metrijske karakteristike. Takođe, podaci pribavljeni na ovaj način omogućili bi veću upotrebljivost ali i prediktivnu snagu testiranja.

3. SOFTVERSKO REŠENJE

Iako na tržištu postoji veći broj softverskih rešenja koja bi se mogla upotrebiti u svrhu prikupljanja podataka i njihove obrade, svako od njih vezano je za jedan ili nekoliko srodnih hardverskih sistema što zahteva kombinovanje više softverskih rešenja u sprovođenju testiranja većom baterijom testova.

Ovo je jedan od razloga zbog koga je potrebna konstrukcija novog softverskog rešenja koje bi omogućilo vezu i preuzimanje podataka iz svih opisanih hardvera odnosno povezivanje spoljašnjih uređaja sa centralnim računarom i očitavanje i dekodiranje informacija koje ulazni uređaj prikuplja. Ovako prikupljene informacije u drugom koraku iz raznorodnih mernih sistema na kojima se hardverska rešenja baziraju treba da budu u drugom koraku transformisana u jedinice SI sistema. Ovako kodirani podaci ređali bi se u numeričke matrice u predeterminisanom rasporedu, što bi omogućilo njihovu obradu i intrepretaciju na individualnom i grupnom nivou kao i poređenje između pojedinaca i grupa. Numerička matrica podataka koju bi kreirao softver tokom merenja trebala bi da bude kompatibilna najčešće korišćenim softverima za analizu i obradu podataka kao što su Metleb (Matlab), SPSS, Majkrosoft Eksel (Microsoft Excel) i slično.

Standardizovano softversko rešenje omogućilo bi umrežavanje i formiranje baze podataka. Pored praćenja i korišćenja u zaključivanju velikih globalnih uzoraka ispitanika, baza podataka obezbedila bi mogućnost praćenja napredovanja pojedinca i grupa i opisivanje individualnih i grupnih razvojnih procesa. Kombinovanje metode ponovljenog merenja i primene nelinearnih regresionih modela omogućilo bi procenu kapaciteta motoričkih sposobnosti [29], što je jedan od ključnih prediktora sportske uspešnosti [30]. Prednost koju umrežena baza podataka pruža je testiranje i korigovanje nelinearnih modela u realnom vremenu sa svakim novim izmerenim ispitanikom u bazi.

Pored prikupljanja podataka u svrhu naučnih istraživanja i praćenja stanja i razvojnih procesa pojedinca i populacije, u softversko rešenje bi trebalo integrisati i korisničku aplikaciju koja bi na osnovu prikupljenih podataka i izborom određenih predeterminisanih željenih efekata omogućilo planiranje i programiranje treninga kako na individualnom tako i na grupnom nivou (odeljenje, tim i slično). Praćenje efekata treninga predstavljalo bi i povratnu informaciju za korisnike koji se bave organizacijom fizičke aktivnosti (trenere i nastavnike fizičkog vaspitanja) o kvalitetu sprovedenih aktivnosti.

4. MOGUĆNOSTI PRIMENE U FIZIČKOM VASPITANJU I SPORTU

Unapređena baterija motoričkih testova mogla bi se primenjivati u svim domenima u kojima se do sada primenjivao i Eurofit, s tom razlikom što bi omogućila validniji proces merenja i kvalitetniju upotrebu prikupljenih informacija.

Ovaj aspekt revidirane baterije motoričkih testova od posebne je važnosti za naučno-istraživački rad u oblasti nauka o fizičkom vaspitanju i sportu. Kvalitetnija istraživanja dalje će imati uticaj na podizanje kvaliteta pedagoške i sportske prakse.

Praćenje dinamike i kvaliteta psiho-fizičkog razvoja dece predškolskog i školskog uzrasta osnovni je cilj primene unapređene baterije testova u fizičkom vaspitanju. Iz žive interakcije prakse fizičkog vaspitanja i naučno-istraživačkog rada, koji ova baterija omogućava pre svega kroz upotrebu digitalnih informacionih i komunikacionih tehnologija, mogu se razviti kvalitetni programi za podsticanje psihofizičkog razvoja i prevenciju patoloških pojava. Pravovremena dijagnostika patoloških pojava omogućiće i pravovremeno reagovanje kroz kvalitetne interventne mere koje bi se takođe bile proizvod opisane interakcije teorije i prakse.

U domenu sporta, opisani proces merenja i praćenja razvojnih promena omogućio bi veću preciznost predikcije sportskih rezultata. Na ovoj mogućnosti zasniva se i potencijal upotrebe revidirane baterije u procesu identifikacije i selekcije talenata. Takođe, opisani proces prikupljanja i obrade podataka omogućio bi efikasnije planiranje, programiranje i praćenje efekata trenažnog procesa, kao preduslova za pravilan i efikasan razvoj talenata.

5. ZAKLJUČAK

Na osnovu sprovedenih analiza može se zaključiti da postoji potreba za unapređenjem (i revizijom) Eurofit baterije motoričkih testova. U ovom procesu postoji veliki prostor za upotrebu informacione tehnologije, koja bi donela unapređenje procesa merenja i povećala potencija upotrebe prikupljenih podataka.. Predložene inovacije i unapređenja Eurofit baterije imala bi svoju primenu u naučno-istraživačkom radu i praksi u fizičkom vaspitanju i sportu. Kao posebno važan aspekt njihove primene izdvaja se praćenje i podsticanje psihofizičkog razvoja dece predškolskog i školskog uzrasta, prevencija nepravilnog razvoja i intervencija kod pojave patoloških razvojnih procesa. U domenu sporta kao posebno važno mesto za primenu unapređene baterije motoričkih testova uočava se proces identifikacije talenata i selekcije, ali i sistematsko planiranje i programiranje trenažnog procesa i njegovih efekata.

Ograničenja šire primene informacionih tehnologija u modernizaciji Eurofit baterije u školskom kontekstu prevashodno se odnose na materijalna sredstva koja su potrebna pre svega za nabavku opreme i u manjoj meri za obuku kadra. Ipak, tend rapidnog opadanja cene i sa njim povezan proces demokratizacije tehnologije, kao i opisani benefiti njene primene u školskom kontekstu navode na zaključak da su dodatna materijalna ulaganja opravdana i isplativa.

Iz svega navedeno može se zaključiti da je opravdano krenuti u proces konstrukcije i validacije revidirane baterije motoričkih testova kao osnovni preduslov za njenu široku implementaciju.

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KOMPJUTERSKA ANALIZA POKRETA U STRELJAŠTVU

Goran Mikec,
Ivan Ćuk,
Srđan Marković*

Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Detektovanje i ispravljanje grešaka u stavu i tehnici u streljačkom sportu zahteva sofisticiranu i veoma osetljivu opremu i softver za analizu pokreta. S tim u vezi, glavni cilj ove studije predstavlja analizu SCATT sistema koji se koristi u treningu strelaca sa aspekta kretanja tela, tačnije oružja, u procesima nišanjenja i pucanja. Korišćenje SCATT sistema kod početnika ubrzava napredak zato što strelac ne uvežbava greške jer ih u startu prepoznaje i eliminiše iz procesa treninga. Kod vrhunskih strelaca, SCATT služi za detektovanje sitnih grešaka koje imaju uticaja na konačni rezultat, a koje bi sigurno prošle neopaženo bez primene ovog sredstva. Podaci dobijeni ovim sistemom su nedvosmisleni i daju apsolutno realan prikaz radnji koje izvodi strelac za vreme nišanjenja, pucanja i neposredno nakon pucanja. SCATT je u savremenom streljaštvu nezamenjivo i višestruko korisno sredstvo za trening koje ubrzava rezultatski napredak kod početnika, a formiranim strelcima pruža podatke koji su esencijalni za postizanje i održavanje vrhunskih rezultata.

Ključne reči:
trening, strelci, analiza pogodaka, preciznost, meta.

1. UVOD

Streljaštvo je sport koji zahteva visok nivo preciznosti i koncentracije. Reč je o „statičnom" sportu u kome su pokreti koji su važni za precizno i uspešno izvođenje, skoro nevidljivi za posmatrača i samim tim veoma nepogodni za analizu. Analiza se uglavnom svodi na subjektivan osećaj strelca i na eventualno ispravljanje grubih vidljivih grešaka u tehnici. Ovakvi izvori analize su često neprecizni i nepouzdani jer su pod subjektivnim utiscima sportiste. Ukoliko sportista ne zna ili ne može da detektuje i opiše greške koje se dešavaju za vreme treninga ili takmičenja onda trener može samo da nagađa gde je i u čemu je problem. Neiskusan trener može da donese pogrešne zaključke i da dovede do narušavanja ispravnih elemenata tehnike. Nekada je bolje da se loš trening samo „isprati", bez pomeranja elemenata i menjanja tehnike i da se sačeka sledeći trening za eventualnu intervenciju. Donošenje ishitrenih i pogrešnih zaključaka može dovesti do veoma velikih zastoja u rezultatskom napretku sportiste. Detektovanje i ispravljanje grešaka u stavu i tehnici u streljačkom sportu zahteva sofisticiranu i veoma osetljivu opremu i softver za analizu pokreta [1, 2].

Odgovorno lice:
Srđan Marković

e-pošta:
smarkovic@singidunum.ac.rs

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Glavni cilj ove studije jeste analiza SCATT (SCATT Electronics LLC) sistema koji se koristi u treningu strelaca sa aspekta kretanja tela, ta**čnije oružja**, u procesima nišanjenja i pucanja.

2. METODE

Za potrebe ove studije korišćen je bibliografsko-deskriptivni metod. Pretraga literature sprovedena uz pomoć sledećih servisa: *PubMed*, *Google*, *Google Schoolar* i Kobson. Ključne reči za traženje odgovarajuće literature bile su: *sport shooting, training, computer analysis, accuracy, target.*

3. REZULTATI I DISKUSIJA

Suočavajući se sa problemima neadekvatne analize u svakodnevnom treningu, krajem 80 tih godina prošlog veka, strelci iz tadašnjeg SSSR-a su uz pomoć svojih naučnika započeli razvoj trenažnog sredstva koji bi omogućio detaljnu i preciznu analizu pokreta oružja.

Prvi SCATT sistem (slika 1) se pojavio 1991. godine i predstavljao je revoluciju u treningu strelaca. Sastojao se od optičkog senzora, okvira i softvera.



Slika 1. Prvi model Scatt optoelektronskog trenažera

Prvi sistem imao je određene nedostatke, ali je, kao takav, predstavljao veliki korak unapred u analizi i unapređenju treninga u streljaštvu. Nedostaci su se manifestovali u tome što je SCATT sistem mogao da se koristi samo na vazdušnom oružju na 10 metara i nisu mogle da se ispaljuju dijabole za vreme korišćenja SCATT-a.

Za strelce pištoljem problem je predstavljala težina optičkog senzora i kabla kojim je senzor povezan sa kompjuterom. Dodatni problem je predstavljala i činjenica da pogodak na ekranu nije bio 100% verrno prikazan na ekranu jer nije uzeto u obzir pomeranje oružja tokom procesa okidanja. Princip funkcionisanja prvog SCATT-a je bio da se papirna meta stavi u okvir koji reflektuje infracrvene (IC) zrake. Optički senzor na oružju je registrovao IC zrake iz okvira i slao podatke u računar. Softver je analizirao podatke i grafički ih prikazivao kao kretanje po meti na ekranu i pokazivao mesto pogotka.

Tokom godina razvio se veliki broj SCATT sistema koji su našli različita mesta primene. U Tabeli 1. prikazane su karakteristike sistema koje se primenjuju u streljaštvu [3].

Tabela 1. Sistemi za analizu pokreta u streljaštvu

SCATT MODEL	USB	WS1	MX-02	MX-W2
Rastojanje do mete (m)	5-10	5-10	od 2	od 2
Simulirano rastojanje (m)	do 1000	do 1000	do 1000	do 1000
Tip optičkog senzora	USB	IC	USB	Wi-Fi
Mogućnost korišćenja uz upotrebu municije	Ne	Ne	Da	Da

SCATT USB

SCATT USB je elektronski sistem za trening sa žičanim optičkim senzorom, dizajniran za trening sa fiksiranom metom. Namenjen je upotrebi u zatvorenim prostorima sa elektronskom metom na realnim distancama od 5 do 10m, pri čemu se simulira pucanje na distancama i do 1000m. Sistem ima svetlosne signale (crvena i zelena svetla) na krajevima mete koji služe za vremenska pucanja.

SCATT WS1

SCATT WS1 sistem je napredni model u odnosu na model SCATT USB pre svega u pogledu povezivanja

optičkog senzora sa računarom. Za razliku od prethodnog modela povezivanje kod SCATT WS1 je bežično putem IC tehnologije.

SCATT MX-02

SCATT MX-02 model (slika 2) omogućava trening sa oružjem svih kalibara na većim daljinama, u otvorenim i zatvorenim streljanama. Prednost ovog modela je u tome što ne postoji okvir, jer je optički senzor koji je montiran na oružju ustvari kamera koja prepoznaje crni krug kao metu. Na osnovu sredine kruga, kamera prikazuje kretanje oružja u odnosu na metu.



Slika 2. Scatt MX–02 na vazdušnoj pušci

Nepostojanje okvira oko mete omogućava normalan trening, čak i sa municijom velikog kalibra, bez rizika od oštećenja skupe opreme. Na ovaj način, SCATT predstavlja trenažno sredstvo koje u realnom vremenu prikazuje potrebne parametre značajne za analizu. Montiranje kamere na cev oružja je veoma jednostavno i brzo jer je težina kamere samo 26 grama.

SCATT MX-W2

Prednost SCATT MX-W2 (slika 3) modela ogleda se u tome što je kamera (56 grama) na oružju bežičnim putem spojena sa kompjuterom. Veliku korist od ovog sistema imaju strelci pištoljem, kojima je senzor na prethodnim modelima bio pretežak i direktno uticao na balans oružja, a kabl kojim je bio povezan na sistem nepraktičan jer je morao da ide uz ruku kojom se drži pištolj i preko ramena do kompjutera [4]. Sa ovim modelom je moguće pucati čak i na papirne mete jer funkcioniše u potpunosti samostalno, bez okvira i dodatnih senzora. Autonomija baterije je 3 sata.



Slika 3. Scatt MX –W2 na vazdušnom pištolju

SCATT kao trenažno sredstvo

SCATT je danas nezaobilazno sredstvo u treningu sportskog streljaštva. Koristi se u svim stavovima i svim disciplinama. Najveća prednost ovog sredstva je ta što dozvoljava strelcu i/ili njegovom treneru da vide i bolje razumeju šta se dešava tokom celog procesa nišanjenja i okidanja. SCATT pokazuje gde je pogodak "završio", ali ono što je važnije je da on pokazuje i zašto je pogodak tamo gde jeste [3].

Analizom se dobijaju esencijalni podaci o:

- načinu (pravac i brzina) ulaska u metu,
- pravoj nišanskoj tački strelca,
- procesu okidanja,
- reakciji strelca na opaljenje,
- zadršci posle opaljenja,
- konstantnosti tehnike [5].

Korišćenje SCATT-a kod početnika ubrzava napredak zato što strelac ne uvežbava greške jer ih u startu prepoznaje i eliminiše iz procesa treninga. Veoma veliki problem je kada sportista grešku u tehnici utrenira do nivoa da ona postane automatizovana kretnja (motorna navika). Prepoznavanje i ispravljanje utrenirane greške zahteva izuzetno mnogo vremena i napora. Najbolje je da se treniranje pogrešne tehnike izbegne u startu i da se trenira samo pravilna tehnika izvođenja pokreta ili kretanja. Kod vrhunskih strelaca, SCATT služi za

detektovanje sitnih grešaka koje imaju uticaja na konačni rezultat, a koje bi sigurno prošle neopaženo bez ovog sredstva [6].

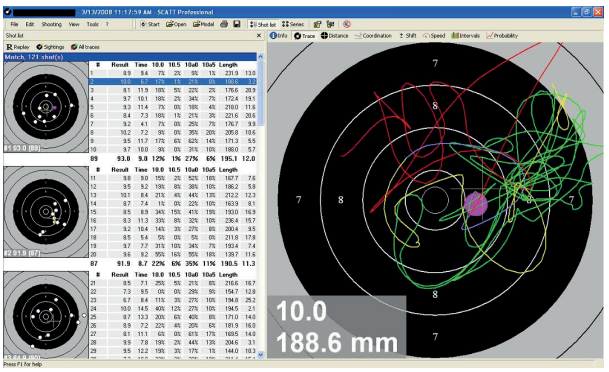


Slika 4. Prikaz idealno postavljenog nišana u odnosu na metu

Na slici 4, prikazan je idealno namešten nišan koji vidi strelac pištoljem. Treba imati na umu da je meta (crni krug je prečnika cca 6 cm) na daljini od 10 metara i apsolutno je sigurno, da čak ni vrhunski strelac ne može da u potpunosti isprati kretanje pištolja, stav, nišane, proces okidanja i zadršku posle opaljenja i da bude 100% siguran da je njegov pogodak završio u centru mete [7]. Kod strelaca koji se takmiče puškom, zbog specifičnosti streljačkog stava i opreme, kretanje oružja je minimalno tj. pomeranje nišana je gotovo neprimetno i strelci veoma lako mogu da steknu privid da je sve idealno [8].

Prikaz kretanja oružja na ekranu pomoću SCATT-a je realan i pruža mnogo važnih informacija za vreme nišanjenja. "Trag" kretanja je obeležen zelenom bojom, poslednje sekunde pre pucanja žutom, poslednje 0,2 sekunde plavom, a kretanje nakon pucanja crvenom bojom. Plava linija tj. vreme od 0,2 sekunde predstavlja sliku koju strelac vidi u trenutku kad odluči da završi okidanje i stvarno izvrši okidanje. Vreme od 0,2 – 0,3 sekunde odgovara i fiziološkom vremenu reakcije [7]. Na levoj strani ekrana (slika 5) se nalaze tabele sa osnovnim potrebnim podacima: rezultat, vreme opaljenja od ulaska nišana u metu, procenat žute linije (poslednja sekunda) u krugu desetke, procenat žute linije u krugu 10.5, dužina žute linije, brzina pri opaljenju [3].

Na slici 6, prikazana je analiza okidanja strelca puškom slobodnog izbora na 50 m koji ima odlično mirovanje, ali koji u trenutku opaljenja pravi grešku i brže povlači obarač i pravi pokret koji "izbacuje" pogodak iz kruga 10 u devetku. Tehnički je sve odlično izvedeno (stav, nišanjenje, izvlačenje obarača), do momenta okidanja. Greška u okidanju je spojena sa trenutkom opaljenja. U ovom slučaju strelac puca "na klik" i ne postoji odskok puške zbog ispaljenog metka pa je greška na SCATT-u očigledna. Bez SCATT-a i sa pucanjem sa metkom (zbog odskoka) vrlo je verovatno da bi greška prošla neopaženo od strane strelca. Tačnije, ishod greške (devetka u meti) bi bila vidljiva i očigledna, ali uzrok greške bi bio pod znakom pitanja (uticaj jačine i smera vetra, greška u nišanjenju, greška u stavu...) [8].

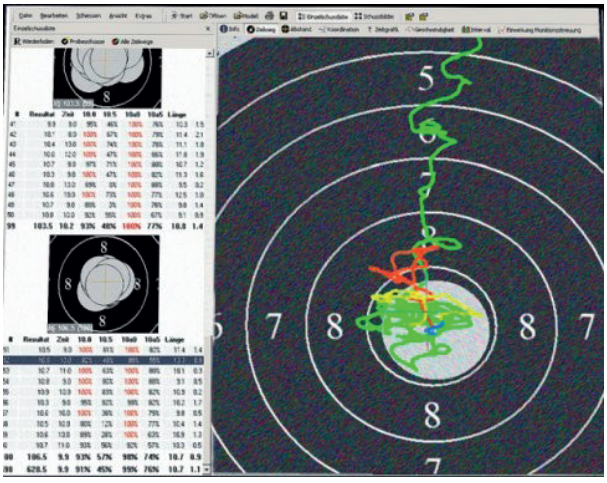


Slika 5. Hitac –vazdušni pištolj nišanska tačka je desno od centra, povećano kretanje pištolja



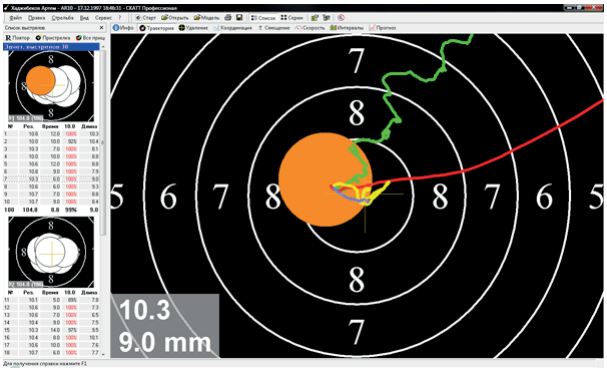
Slika 6. Hitac -MK puška greška u tehnici okidanja

Hitac skoro savršenog pogotka strelca iz vazdušne puške prikazan je na slici 7. Strelac u metu ulazi skoro idealno sa gornje strane, ima jako lepo mirovanje u strogom centru mete. Plava linija koja predstavlja poslednjih 0,2 sekunde se nalazi u sredini opaljenog metka što znači da je strelac u ovom slučaju izveo savršeno okidanje.



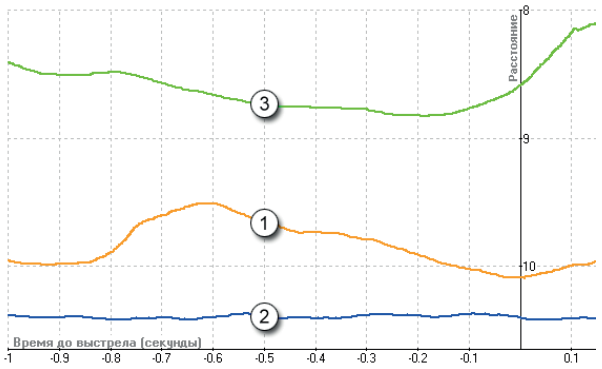
Slika 7. Hitac –vazdušna puška idealno mirovanje, pravovremeno okidanje i idealna zadrška posle opaljenja

Na slici 8, prikazano okidanje strelca vazdušnom puškom koji je "strelac prve slike" odnosno strelac nema duže zadržavanje u centru i postepeno izvlačenje obarača nego je njegovo okidanje brzo i odsečno čim nišani dođu u idealnu poziciju [9]. Ovaj stil pucanja daje strelcu određenu prednost jer mu ciklus jednog opaljenja traje jako kratko i samim tim može da pravi pauze u toku meča. Ovaj strelac mora da ima visok nivo kontrole stava, savršeno okidanje i razvijene specifične psihološke osobine [10, 11].



Slika 8. Hitac – vazdušna puška okidanje na "prvu sliku"

SCATT ima izuzetno mnogo dodatnih opcija u kojima može da se vide značajni parametri. Veoma bitan podatak je mogućnost da se vidi brzina pomeranja oružja u svakom trenutku nišanjenja, a od posebnog značaja je to, da li se brzina značajno ubrzava pre opaljenja (slika 9).



Slika 9. Grafički prikaz brzine pomeranja oružja i vremena pre opaljenja (1. Opadanje brzine neposredno pre opaljenja; 2. Ravnomerna brzina kretanja oružja; 3. Povećanje brzine kretanja oružja pre opaljenja)

Ništa manje bitan podatak je da SCATT može da računa teoretski ukupni rezultat, ukoliko je opaljenje sekundu ranije ili može da pokaže koliko ranije strelac treba da opali metak kako bi teorijski postigao najveći ukupni rezultat [3].

4. ZAKLJUČAK

U poslednjih 20 godina rezultati u streljaštvu su se značajno poboljšali. Jedan od razloga za navedeno poboljšanje leži u modernizaciji streljačke opreme i kvalitetnijeg testiranja municije. Mora se naglasiti da je i SCATT svojim kvalitetima pozitivno uticao na efikasnost streljačkog treninga, a samim tim i na poboljšanje rezultata.

Veoma važna uloga SCATT-a je i ta, što je iz analize izbacio subjektivnost strelca i pružio treneru mogućnost da "gleda kroz oči strelca". Podaci dobijeni ovim sistemom su nedvosmisleni i daju apsolutno realan prikaz onoga šta i na koji način strelac radi za vreme nišanjenja, opaljenja i neposredno nakon opaljenja.

Međutim, kod već formiranih strelaca pištoljem ne treba često koristiti trening sa SCATT sistemom. Čak i kad se koristi trebalo bi da se koristi kao pomoćni sistem, odnosno da se obavezno puca u normalnu metu, a da SCATT bude priključen kao kontrolno sredstvo koje trener koristi za analizu dok strelac trenira. Razlog za ovo je, pre svega, velika brzina kretanja pištolja. Formirani strelci imaju "fini" osećaj ("tajming") kada da opale metak da bi pogodili "centar" mete. Ukoliko vide na SCATT-u da je kretanje pištolja u stvarnosti mnogo veće nego što oni pretpostavljaju da jeste, može da dođe do

gubitka samopouzdanja i do neopravdanog straha koji će najverovatnije dovesti do pada rezultata.

SCATT je u savremenom streljaštvu nezamenjivo i višestruko korisno sredstvo za trening koje ubrzava rezultatski napredak kod početnika, a formiranim strelcima pruža podatke koji su esencijalni za postizanje i održavanje vrhunskih rezultata.

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PRIMENA INFORMACIONIH TEHNOLOGIJA U MODERNOM SPORTU

Aleksandar Živković*,
Tamara Ratković,
Srđan Marković

Univerzitet Singidunum,
Beograd, Srbija

Rezime:
Informacione tehnologije (IT) u sportu uključene su u sve segmente i to prvenstveno u rad sportista i trenera, a onda i zvaničnika i gledalaca. Sportisti i treneri IT koriste u treningu kao i na samom takmičenju. U treningu se koristi kroz kontrolu opterećenja, dijagnostiku i analizu, a na takmičenju kroz video tehnologiju, foto-finiš, Hawk-eye, gol-tehnologiju, miCoach Elite System. Tehnologija pomaže stručnjacima da podrže svoje komentare i analize za vreme i nakon igara, te da izvođači preispitaju svoju taktiku i svoje protivnike kako bi utvrdili što trebaju učiniti kako bi poboljšali i formulisali strategiju. Gledalac sportskog događaja nije više pasivan posmatrač kod kuće ili na stadionu. Tehnologija je omogućila gledaocima da imaju aktivniju ulogu u događajima. Pokrivenost događaja mikro-kamerama pruža više uglova gledanja, prate pojedinačne sportiste ili sve izvođače, statističke informacije o pojedincima, utakmici i prethodnim nastupima. Interaktivni softveri - aplikacije nude pristup robama, informacijama, takmičenjima, igrama i glasanju preko veza na ulaznicama i programima ili preko preuzimanja. Pomoću digitalnih medija može se pratiti širok spektar amaterskih i profesionalnih sportova na mnogo različitih načina, na telefonu, tabletu, laptopu, računaru, a društveni mediji dozvoljavaju fanovima da imaju ličnu vezu sa sportistima i klubovima.

Ključne reči:
informacioni sistem, analize, trening, takmičenje, uređaji.

1. UVOD

Još od drevne Grčke sport je opčinjavao ljude, a sportisti imali veliki uticaj i status u društvu. Međutim, nakon obnove Olimpijskih igara počela je ekspanzija sporta od amaterizma do profesionalizma, da bi u poslednje vreme prelazio sve granice pojmljive ljudskom umu, dodirujući granice naučne-fantastike. Tehnologija je promenila život uopšte, a tu promenu nisu izbegli ni sportisti. Na današnjem nivou razvoja teško je razdvojiti tehnološku inovaciju i sport, odnosno današnji sport nemoguće je zamisliti bez upliva tehnologije. VAR tehnologija, odela za plivanje od specijalnih materijala koji omogućavaju bolju „plovnost“ tela kroz vodu, čipovi u lopti i obući za analizu kretanja, sve su tehnološka rešenja koja su nezaobilazni elementi priče o sportu. Sveobuhvatno gledano, informacione tehnologije (IT) predstavljaju neophodne resurse za prikupljanje i obradu podataka u cilju realizacije ciljeva sportske organizacije.

Odgovorno lice:
Aleksandar Živković

e-pošta:
aleksandar.zivkovic@singidunum.ac.rs

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Razvoj novih informacionih sistema i njihov uticaj na sport predstavljaju ogroman potencijal svim učesnicima u sportu u rešavanju problema, nalaženju novih puteva razvoja, usavršavanju performansi, smanjenju grešaka, povećanju zabave.

Glavni cilj ove studije jeste analiza mogućnosti primene informacionih tehnologija u sportu sa stanovišta neposrednih učesnika – sportista i trenera, sa jedne strane, ali i organizacionih struktura i gledalaca sa druge strane.

2. METODE

Za potrebe ove studije korišćen je bibliografsko-deskriptivni metod. Pretraga literature sprovedena uz pomoć sledećih servisa: *PubMed*, *Google*, *Google Schoolar* i Kobson. Ključne reči za traženje odgovarajuće literature bile su: *sport, technology, IT, performance, training, competition, analysis.*

3. REZULTATI I DISKUSIJA

Tehnologija se koristi za poboljšanje nastupa sportista u svim fazama - pre, za vreme i nakon događaja. Tehnologija se koristi u oblastima fizičke pripreme, zdravlja, opreme, odeće, obuće, objekata i površina za igru. Nosivi uređaji prate kardiovaskularne parametre sportiste, hiperbarična terapija kiseonikom pomaže oporavku nakon povrede, manji turbo motori u sportskim automobilima su ekonomičniji, kacige za biciliste su lakše i bolje su ozračene, patike sa kramponima su lakše i bolje prijanjaju pri kretanju, četvrta generacija (4G) terena se može koristiti bez obzira na vreme, tokom cele godine, veštački sneg omogućava da se zimski sportovi održavaju bilo gde u svetu.

IT koriste timovi za podršku sportista, kao što su treneri, medicinski radnici, skauti, kao i sami sportisti. IT ima važnu ulogu u praćenju i analizi učinka sportista, identifikujući kvalitete kao i područja za poboljšanje. IT se koristi i za prikupljanje i analizu podataka, što može pomoći u poboljšanju kondicije, poboljšanju veština, prevenciji povreda te pomoći u dobijanju utakmica učenjem različitih taktičkih rešenja.

Kreiranje informacionih sistema u sportskim organizacijama, podrazumeva kvalitetno sređene informatičke aktivnosti, kao i raspolaganje informatičkom tehnologijom, adekvatnim programima i kvalifikovanim kadrovima. Ovo pretpostavlja kvalitetno selektovanje, obradu, predstavljanje i plasiranje podataka u cilju napretka sporta [1].

IT u sportu pokriva tri segmenta učesnika, a to su:

1. sportisti i treneri,
2. zvaničnici, sudije i menadžeri i
3. publika.

Možda najvažniji uticaj IT u sportu jeste uticaj koji IT ima na direktne učesnike u sportu, odnosno na same sportiste i ljude koji upravljaju njihovom pripremom, trenere. IT obezbeđuje različite tipove podrške kojom se utiče na povećanje sportskog postignuća. Iako je danas trening i takmičenje teško odvojiti, načelno uticaj IT na ovu grupaciju može se podeliti na uticaj na treningu i uticaj na takmičenju. Kada se priča o treningu IT je napravio proboj u planiranju, kontroli i analizi primenjenog opterećenja, dijagnostici i analizi trenažne aktivnosti, dok se na takmičenju ogleda u tehnologiji kojom se prati (video) i kontrolišu odluke na takmičenje (fotofiniš, Hawk-eye, VAR).

IT pomaže trenerima da podrže svoje zahteve igračima kroz analize za vreme i nakon igre, te da sportisti preispitaju svoju taktiku i svoje protivnike kako bi utvrdili šta trebaju učiniti kako bi poboljšali i formulisali strategiju ili taktiku. IT pomaže sportistima da obaraju rekorde u različitim sportskim disciplinama. Ovi rezultati su direktan produkt naprednih tehnologija. Tehnologija omogućava mnoge benefite koji utiču na poboljšanje performansi, a samim tim i sportski rezultat. Pozitivni efekti se obezbeđuju kroz optimizaciju treninga i maksimizaciju koristi od treninga [2].

Nosivi uređaji (Wearable computers) predstavljaju poseban napredak u prostoru kontrole koji omogućavaju praćenje karakteristika sportista (frekvencija srca, krvni pritisak, metabolizam) u realnom vremenu. Od njihovog stvaranja, slučajevi dehidracije, srčanog udara ili smrtnog ishoda, dramatično su se smanjili. Kada je Kori Stringer preminuo od toplotnog udara tokom trening kampa svog NFL tima 2001. godine, kompanije su počele da istražuju načine praćenja vitalnih funkcija u realnom vremenu i izbegavaju ovakve tragedije. Tehnika koja se može nositi napravila je razliku u životima mnogih sportista, nadgledanjem frekvencije srca, hidratacije i temperature kroz svoj bežični i mikroskopski sistem praćenja zdravlja.

U vrhunskom sportu, gde se dostižu granične mogućnosti ljudskog organizma, veoma je važno nadzirati unutrašnje organe, temperaturu, varijabilnost otkucaja srca. Međutim, često ne postoji mogućnost da se ovi parametri provere. U tu svrhu koriste se nesvarljive tablete, koje iz gastrointestinalnog trakta šalju vitalne informacije o telu. Dakle, ako postoji bilo kakav problem

u organizmu, može se rešiti pre bilo kakve nesreće. To će pomoći da se smanji broj smrtnih ishoda od iscrpljivanja, što je drugi najčešći razlog kod smrtnih slučajeva sportista.

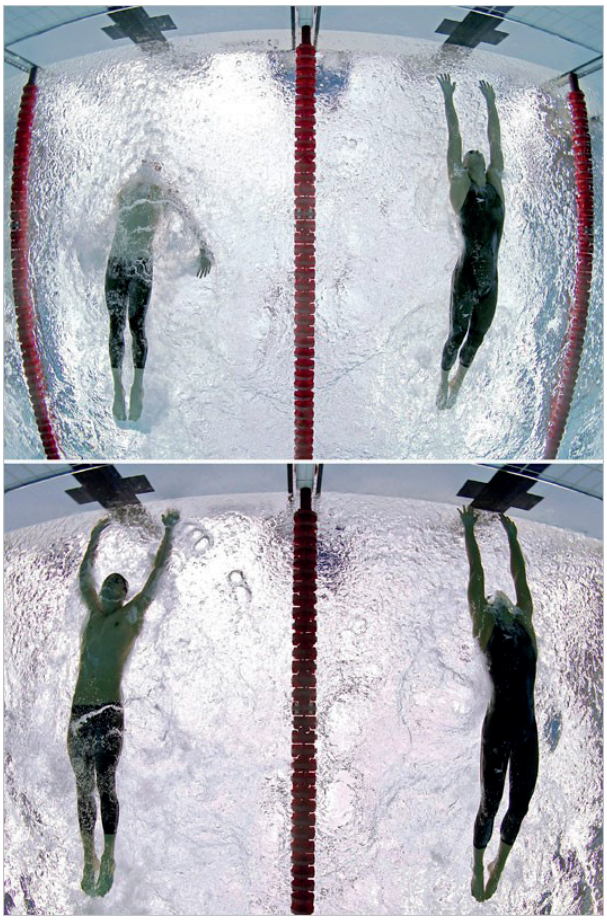
Mnogi računarski programi se više ne koriste samo za osnovne informacije o imenima igrača ili o kretanju rezultata. Sada sistemi kao što je „Moj trener" (miCoach Elite System) daju podatke trenerima o stanju sportiste u svim fazama igre. Bežičnom tehnologijom trener na računaru prati vitalne funkcije, fizički i psihički status, uz pomoć senzora koji se nalaze na sportistima. Samim tim trener ima jasnu sliku i može pravovremeno doneti adekvatne odluke u korist sportiste [3].



Slika 1. MiCoach elite system

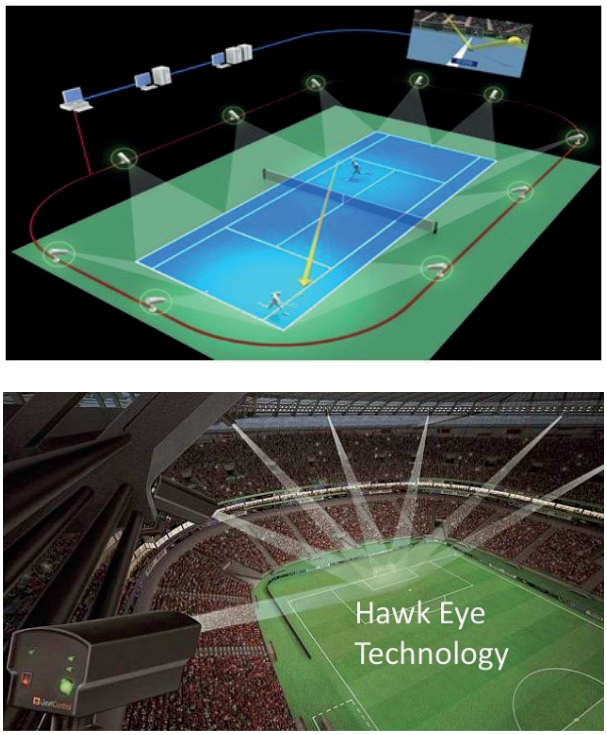
Protetski uređaji za sportiste sa invaliditetom, su ono što je nekada bilo potpuno imaginarno, a danas predstavlja novi početak. Ljudi sa invaliditetom nekada nisu imali priliku da se takmiče, ali sa napredovanjem protetske tehnologije sve više i više fizički hendikepirani se takmiče, kao i osobe bez invaliditeta. Dr. Rori A. Cooper je lider u razvoju vrhunske protetike. Kao direktor laboratorija za ljudske inženjerske resurse na Univerzitetu u Pitsburgu, Dr. Cooper oblači sportiste u odela sa ugrađenim senzorima pokreta. Sportisti zatim prolaze kroz niz vežbi baziranih na sportskim pokretima, a kamerama i nosivom tehnologijom dobijaju izveštaje o svojim kretanjima. Procesni dizajn počinje nakon ove dijagnostike kretanja, koji na kraju stvara prilagođeno protetsko pomagalo koje se kreće zajedno sa telom sportiste [4].

Na samom takmičenju osim direktne koristi koje ima sam sportista, IT pomaže i sudijama u donošenju odluka, a samim tim utiče na regularnost takmičenja. Problem nastaje još u 19. veku jer je postalo preteško odrediti pobednika na konjičkim trkama. Nastaje nova tehnologija *foto-finiš* (eng. photo-finish) koja je prvi put postavljena na Olimpijskim igrama u Stokholmu, 1912. godine. Automatski fotografski uređaj zajedno sa preciznim elektronskim časovnikom beleži sliku i vreme svakog od takmičara koji je prešao ciljnu ravninu. *Foto-finiš* funkcioniše tako što se kroz usku vertikalnu pukotinu pomoću kamere snima cilj pomerajući film u smeru kretanja takmičara. Na ovaj način dobija se precizna slika i vreme svakog takmičara i postiže se visok nivo regularnosti takmičenja.



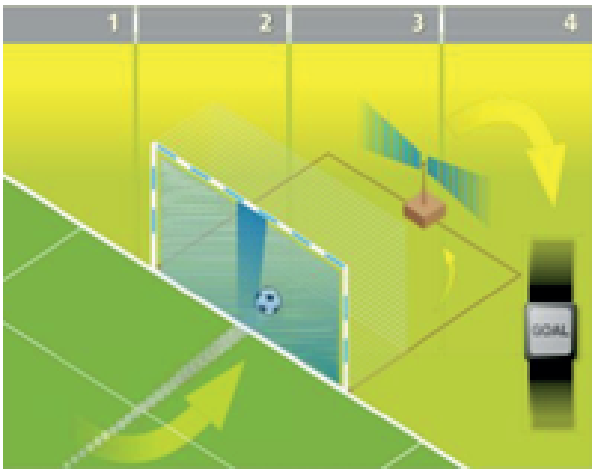
Slika 2. *Foto-finiš* analiza finala u disciplini 100m delfin stilom na OI u Pekingu 2008. godine

Hawk-eye („Oko sokolovo“) predstavlja jedan od najpoznatijih video sistema koji je razvijen krajem prošlog i početkom ovog milenijuma. Dr Pol Hokins je stručnjak koji je 2001. godine i zvanično završio i predstavio ovaj sistem. *Hawk-eye* uz pomoć super brzih kamera prati putanju lopte. Kamere su postavljene iznad terena i istovremenim snimanjem i proračunavanjem određuje najverovatniju putanju lopte. Nakon analize dobija se 3D slika kretanja lopte. Moguća greška je u proseku 3,6 mm. Ovom 3D slikom svi akteri meča, igrači, sudije i gledaoci mogu razjasniti dileme da li je lopta u terenu ili van njega, da li je lopta prešla gol liniju i sl. U tenisu sistem beleži i statistiku gde su padale loptice na terenu tokom različitih segmenata igre, tako da igrači i treneri mogu analizirati i svoju i igru protivnika te na osnovu toga graditi svoju taktiku. Na teniskim ili odbojkaškim mečevima, a u poslednje vreme i fudbalskim mečevima (VAR tehnologija) gde se ovaj sistem najviše koristi publika aktivno učestvuje. U analizi preko velikih ekrana i kroz neizvesnost iščekivanja uživaju u sportskoj predstavi. Sudije su na ovaj način pošteđene teških odluka i negodovanja igrača i publike. Sve ovo omogućava veću regularnost takmičenja [5].



Slika 3. Hawk-eye sistem u tenisu i fudbalu

Gol-line (gol tehnologija) omogućava precizan odgovor da li je lopta prešla gol liniju i da li je regularan gol. Potreba za ovom tehnologijom se javila zbog odlučujućih golova koji nisu priznati na fudbalskim utakmicama koje su se igrale na Svetskim prvenstvima, klupskim utakmicama visokog uloga, iako je lopta celim svojim obimom bila unutar gola. Ovo je dovelo do toga da se stvori ovakva tehnologija i prvi put isproba 2012. godine na svetskom klupskom prvenstvu u Japanu. Tehnologija se pokazala kao 100% precizna, što dovodi od strane FIFA do priznavanja ovog sistema i uvođenja na Svetskom prvenstvu u Brazilu, 2014. godine. Takođe, engleska fudbalska liga je prva liga koja je uvela da se na svim stadionima postavi ova tehnologija od sezone 2013-14. Korišćenjem brzih kamera ili niskofrekvetnog magnetnog polja oko gola i elektronskog polja u samoj lopti, dobija se brz odgovor da li je gol postignut i to se očitava na ručnom satu glavnog sudije. Gol-line tehnologija je omogućila da više neće biti dilema da li je gol postignut ili ne. Par godina kasnije tehnologija je unapređena u VAR tehnologiju kako bi se pokrilo više segmenata igre [6].

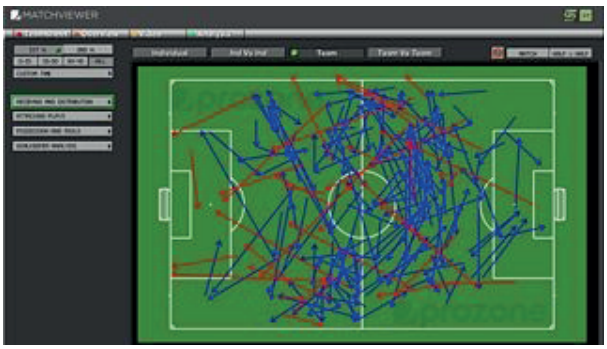


Slika 4. Gol tehnologija u fudbalu

Video tehnologija pre 1980. godine je najbolje opisati sa presedanom „Čudo na ledu“ koje nije emitovano uživo. Epska olimpijska hokejaška bitka između SAD-a i SSSR-a, koju su SAD osvojile, bila je na kašnjenju na kaseti, završivši se više od sat vremena pre početka TV-emitovanja. Danas je sve uživo, i to ne samo na kućnom televizoru, već na vašem pametnom telefonu, tabletu i računaru. U današnjem sportskom svetu nikada niste daleko od pristupa uživo te se iskustvo gledanja sporta dramatično promenilo na bolje. 3D tehnologija za prenos utakmica je tehnologija koja je stvorena za gledaoce koji iz svoje fotelje gledaju prenos utakmice i uz pomoć

3D naočara kao da su na samom terenu pored igrača. 26. Januara 2010. godine odigrana je prva utakmica koja je odigrana između Arsenala i Mančester Junajteda i prenošena u 3D tehnologiji. Ovaj sistem je televizija SKY razvijala dve godine [7].

Kako bi bolje razumeli sastavne delove koji promovišu sportski uspeh, video i statistička analiza preuzele su važno mesto u pripremi sportista za takmičenja. U sportskim igrama, uspešnost na takmičenju predstavlja interakciju različitih tehničkih, taktičkih, fizičkih i psiholoških faktora. Savremene analize, na osnovu video snimka utakmice, obezbeđuju tehničko-taktičke obrasce kretanja pojedinca i ekipe (precizna/neprecizna dodavanja, dobijeni/izgubljeni dueli, udarci glavom, pasovi na različitim distancama, ofanzivne/defanzivne obrasce kretanja, interakcije između igrača u pojedinim zonama...) i fizičke parametre pojedinca i grupe (pretrčana distanca, pretrčane distance u pojedinim zonama opterećenja, parametri u pojedinim delovima utakmice...) [8, 9].



Slika 5. Prikaz analize kretanja igrača tokom utakmice

Informaciona tehnologija igra ključnu ulogu u tome kako se sport igra i gleda. To znači da su zvaničnici, gledaoci i mediji povezani tokom nastupa [10].

Tehnologija oblikuje kako zvaničnici upravljaju kvalitetom prvenstveno kroz:

- komuniciranje pomoću slušalice i mikrofona sa kojim se konsultuju sa drugim zvaničnicima na i izvan terena
- Kod donošenje odluka, omogućena je reprodukcija snimaka za gledanje događaja iz različitih uglova kako bi se donela ispravna odluka.
- Praćenje lopte kako bi se obezbedila tačnost odluka u tenisu, fudbalu ili odbojci.
- Preciznije merenje dužine skokova i daljina izbačaja različitih rekvizita uz pomoć laserske tehnologije
- Praćenje vremena, merenjem vremena u napadu u košarci ubrzava se igra i održava se uzbuđenje
- Vođenje evidencije računarima za praćenje dobrih poteza i grešaka za više sportista odjednom.

Na kraju, gledaoci sportskog događaja nisu više pasivni posmatrači kod kuće ili na stadionu. Tehnologija je omogućila gledaocima da imaju aktivniju ulogu u događajima na različite načine:

- Kroz pokrivenost događaja fotoaparatima na daljinsko upravljanje i mikro-kamerama pružaju više uglova gledanja, prate pojedinačne sportiste ili sve izvođače.
- Kroz statističke informacije - o pojedincima, utakmici i prethodnim nastupima koje su dostupne na ekranu ili klikom na dugme tokom igre.
- Interaktivne aplikacije nude pristup robama, informacijama, takmičenjima, igrama i glasanju preko veza na ulaznicama i programima ili preko preuzimanja.
- Digitalni mediji omogućuju da ljubitelji sporta mogu pratiti širok spektar amaterskih i profesionalnih sportova na mnogo različitih načina, na telefonu, tabletu, laptopu, računaru.
- Društveni mediji dozvoljavaju fanovima da imaju ličnu vezu sa svojim sportskim herojima i klubovima.

4. ZAKLJUČAK

Informacione tehnologije igraju vitalnu ulogu u životu ljudi, posebno u polju sporta i igara. One pomažu da se izbegnu greške u organizaciji i administraciji u sportu na različitim nivoima, posebno na onom vrhunskom. Informacione tehnologije u sportu prerastaju u posebnu naučnu disciplinu. Istraživačke aktivnosti, unapređeno učenje i vođenje treninga, biomehaničke analize i terenska istraživanja i dalje evoluiraju. Unapređenje zdravlja, priprema treninga, video analize, procena fizičkih sposobnosti, čuvanje rezultata, analiza učinka tima u toku utakmice, predstavljaju samo neka od polja u kojima informacione tehnologije nalaze svoju primenu u modernom sportu. Kao takve mogu se iskoristiti za ostvarivanje zadatih ciljeva u svim oblastima koje pokrivaju sport.

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