APPLIED INFORMATION TECHNOLOGY SESSION

WEB APPLICATION FOR DISPLAYING RESULTS OF AIR QUALITY MEASUREMENT USING VIEW PLUS RADON DETECTOR

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Abstract:

View Plus Radon Detector made by Airthings is a device that allows measuring a number of parameters related to indoor air quality. The device has the ability to connect wirelessly to the Internet, where it is possible to monitor the measurement results later on a purpose-built online platform - Airthings Dashboard. The Airthings Consumer API enables downloading of measured values outside the Airthings Platform as well. This paper presents a web application that allows downloading data from the Airthings Consumer API and displaying them in a graphical environment. This web application was created using React.js, JavaScript, CSS and HTML.

The solution presented in this paper is comparable to other studies results that offer similar functionalities. Similar solutions offer the possibility to monitor air quality parameters as well as our solution, taking into account the fact that hardware and software technologies are versatile and we have not found an identical combination of our hardware and software in other solutions. The display of results on the web offered by our solution is an approach that also exists in some other solutions. Mitigation and prediction are components that exist in some of the other solutions, and our goal is to enable our solutions with a support for these components.

Keywords:

Web Application, React.js, JavaScript, CSS, HTML.

INTRODUCTION

This report presents a web application created using React.js, which is a JavaScript framework and an open source library. The styling and display are done using HTML and CSS, while some functions are made using pure JavaScript. Downloading the data that the detector measures is done using the features offered by the Airthings Consumer API. An illustration of the operation of this web application is also shown. The report also describes some of the previous researches in this area, as well as the values (air quality parameters) that are measured using a detector and displayed in our web application. The chapter on detectors describes the possibilities offered by the View Plus Radon Detector, which measurement results are used by the web application. The API is the next chapter, which briefly describes the possibilities that the API offers for our web application. The web application chapter provides a description and presentation of the operation of our web application.

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2. PREVIOUS RESEARCH

There are studies in the area of measuring radon levels and implementing some methods of radon elimination in case of increased concentrations using the Internet of Things (IoT). Some of them are presented below.

One extensive dissertation [1] presents a system based on the potential of IoT that allows the radon level to be reduced on average by 93% compared to the initial level. "The main objective of this thesis was to develop a solution with IoT technologies, to detect, mitigate and predict radon gas in a home." [1]. Components of this system are a sensor, arduino boards and web services, and a fan was used to reduce the radon level. The data is recorded in the database data, and these data can be viewed in the web application in the form of graphs.

The popularity of low-cost IoT solutions can be seen in [2]. "This work presents a fully automated, low-cost indoor air quality control system that can monitor temperature, pressure, humidity, total volatile organic compounds (TVOC), and radon concentration. Using the radon concentration as an air quality measurement, we created a prediction algorithm. The system uses those predictions to control the ventilation system automatically." [2]. Web the frontend enables the visualization of the condition of the system . The prediction algorithm has the ability to send commands to the control devices that affect the ventilation system. The system is implemented with low-cost and well-known hardware components.

The researches mentioned above are not the only ones from this field. In paper [3], monitoring of radon levels in public buildings is enabled and population notification as well, but mitigation and prediction options are not supported. Greater possibilities are offered by [4] , where option mitigate is also supported, but the focus is only on public buildings and option predict is not supported. The work described in [5] is much more suitable for commercial use because it is robust and scalable, but similar to the previous solution, predict option is not supported.

The approach we propose should fulfill the objectives in accordance with the objectives of the above mentioned papers. Developing our own system that we propose is a long-term process, but it allows full control of each of the suggested goals.

3. AIR QUALITY PARAMETERS

View Plus Radon Detector offers the possibility to measure seven parameters of air quality (concentration radon, PM1, PM2.5, VOC, temperature, humidity and pressure). By looking at the values of these parameters, we can get to know of the quality of the air we breathe in a closed space and, if necessary, we can take actions to improve the air quality using different methods and devices.

Radon is a noble, invisible, odorless and tasteless gas that enters the air we breathe in. It is formed by the decay of uranium, and then it can reach the atmosphere from the earth. It has a disastrous effect on human health. Radon particles can cause damage to lung cells to such an extent that lung cancer can occur. Radon concentrations are relatively low outdoors. In a closed space (radon can escape from the ground into the air from building material, water and natural gas) the accumulation of higher concentrations of radon can occur. That is why it is desirable to monitor the level of radon in closed spaces, in order to implement elimination measures in case of concentrations that are higher than allowed ones.

Fine particles of air pollution (mixture of solid particles and liquid droplets) are marked with PM (particulate matter). It is a mixture of smoke, dust, dirt and liquid. The healthier the air is, there are less of these often invisible polluting particles. PM_1 are very small particles with a diameter of 1 micron or less (for example bacteria or corona virus), while $PM_{2.5}$ is made of fine particles with a diameter of 2.5 microns or smaller (e.g. finer dust particles). $PM_{2.5}$ particles which reduce visibility are the greatest danger to human health and can negatively affect the lungs and heart. In Serbia, due to combustion, industry, power plants and automobile exhaust gases, the level of these particles is quite high outdoors in winter when there is no wind and air movement.

Volatile Organic Compounds (VOCs) can cause short-term irritation of the nose, eyes or throat, headaches, but it has also more serious consequences on the liver or kidneys if there is a long-term exposure to higher concentrations to it. This combination of various odors and gases emitted by toxins and chemicals can be found in various items we use in everyday life and it gets into the air we breathe in a closed space. VOCs typically come from paints and varnishes, new furniture, mattresses, carpets, toys, plastics or from cleaning products, cosmetics, and even from cooking and the air we exhale or the smoke of candles and fire. It is often the case that these gases accumulate in higher concentrations indoors and pollute the fresh air.

If the detected pollution level is higher than the permitted level, the source of it must be detected in order to remove it.

Carbon Dioxide (CO_2) is a gas known as the cause of the greenhouse effect. Indoors, it comes predominantly from the air which we exhale and from the external CO_2. If the ventilation is not adequate in a closed space, there is an increase in concentration of this gas, which can become harmful (for example, it can cause reduced concentration and drowsiness, headache, sweating, increased blood pressure).

4. DETECTORS

The detector used for the analysis in this report is the View Plus Radon Detector [6] by Airthings. It is displayed on Figure 1. It is an active type of radon detector based on alpha spectrometry. It also has sensors that measure other air quality parameters. It has the ability to connect wirelessly to the Internet, which allows the results of the measurements to be stored in the Cloud. Those results are later available for viewing or downloading via Airithings online platform (Dashboard) [7]. There is also the possibility to access data through mobile applications created for these purposes. There is another important possibility to use the Airthings Consumer API. The API allows the developer to download the measured data in his own application and still freely work with it according to his needs outside the Airthings Platform.

One example of this use can be seen in the presented report. The detector used in this report was received as a donation, and measurements have already been made with it in the frame of the "Radon level measurements" project realized at the Technical College of Applied Studies in Zrenjanin (TCAS) during 2022. The project is financed by the Provincial Secretariat for Higher Education and Scientific Research, and the results of these radon measurements are presented in works [8], [9], [10], [11].

5. API

One of the significant features of using the View Plus Radon Detector is that the measured data can be downloaded and then used further in different applications. This possibility is achieved by using Application Program Interfaces, which abbreviation is API. "An API is a standardized way of interacting with a software application. APIs allow different software applications to interact with each other without having to understand the inner workings of the underlying functions." [12]. Since the user of the API is not familiar with the inner operation of the underlying functions, the API is provided with appropriate documentation. As our subscription level is Consumer, the API documentation we used was Getting Started with the Airthings Consumer API [7]. Consumer customers have limited access version of the API intended for a personal use.

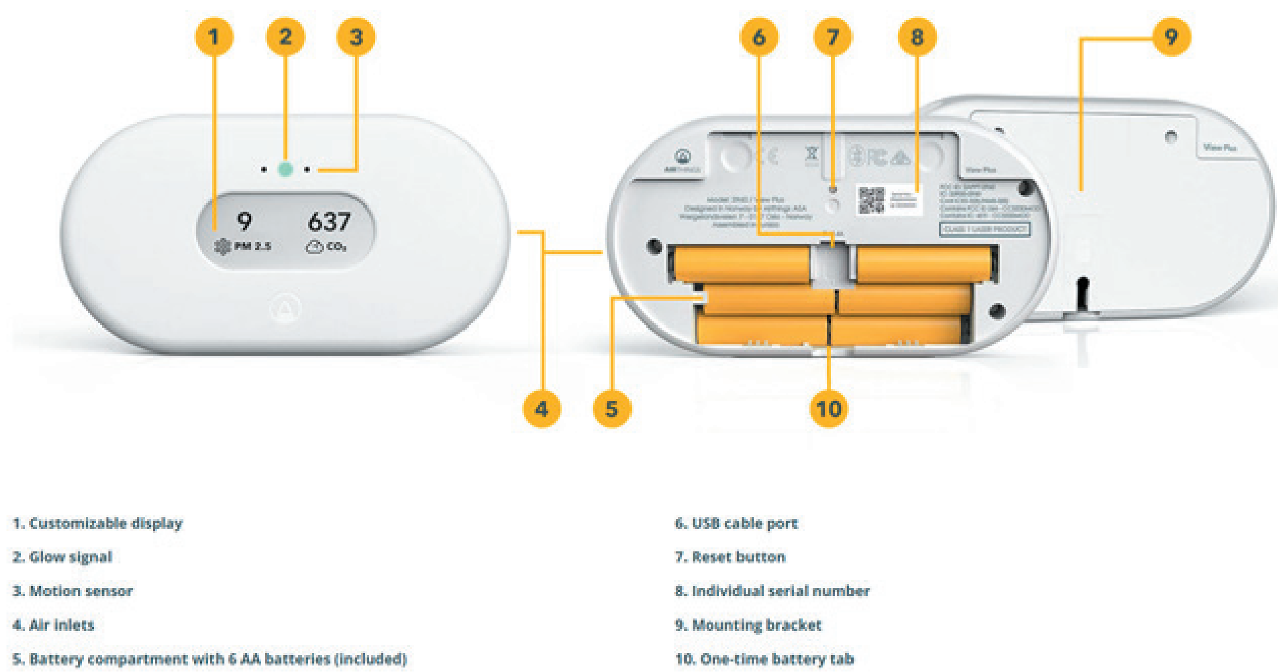

Figure 1 - View Plus Radon Detector [6].

At the "Rate Limits on the Airthings Consumer API" page the limits that exist in our version are given: "A consumer can create 1 Airthings API-client, with Client Credentials Grant authorization. The client can use it to obtain air quality data uploaded by the customer's own device. The API is limited to 120 requests per hour." [7]. The use of the mentioned API requires Authorizing use of the Airthings Consumer API, which is described on the page "Authorizing use of the Airthings Consumer API" of documentation website [7]. The required data are client id and client secret and they are obtained from Dashboard, and based on them, you can request a token from the accounts-api. A token is received as a response. On the page "Authorizing use of the Airthings Consumer API" the next is stated: "The token from the response can be used to access the endpoints in the API until it expires" [7]. For generating tokens in our project we used API platform for building and using APIs named Postman.

6. WEB APPLICATION

The development of the web application was carried out in accordance with the instructions on web page "Node.js Setup Guide" [7] and was adapted to our needs. The basis of the program code is the example recommended in the documentation [13], while free ones were used for the purposes of the GUI icons with [14].

Given the limitations set by our Consumer subscription level, we decided to show the last measured values for the following parameters:

1. Date and time of measurement;
2. Radon concentration (Bq/m^3);
3. PM_1 (μg/m^2) - Particulate matter, fine particles with a diameter of less than 1 microns;
4. $PM_{2.5}$ (μg/m^2) - Particulate matter, fine particles with a diameter of less than 2.5 microns;
5. VOCs (ppb) - Volatile Organic Compounds;
6. CO_2 (ppm) - Carbon Dioxide;
7. Humidity (%);
8. Pressure (hPa) ;
9. Relay Device Type – the type of device that performs the measurement; and
10. Battery (%) – battery charge level.

The web application is publicly available at https://node-monitoring-air-quality.onrender.com/.

When the user comes to this location, he needs to enter a PIN code. The correct code for the PIN is 0023, and after entering it, the Login button appears. Then you need to click on the Login button. After a successful login, only two buttons appear on the screen: sync (which allows sending requests for getting data) and a button to log out and return to the previous screen.

Figure 2 - Web application after synchronization.

After clicking on sync, you get a screen after synchronization with data. An illustration of the displayed data after pressing the sync button is given in Figure 2.

Time and date of the measurement is shown in the picture. The values of the measured parameters can also be read. Each of parameters has a corresponding icon, name and text value with a unit of measure. The design of the displayed data is adapted primarily to the screen width of smartphones, since these devices represent the most numerous type of device for loading this data today. At the same time, the current display is also kept on classic monitors, so that the design is adapted to all the most commonly used display devices today.

Text related to the parameter can be displayed in three different colors with the following meaning, in accordance with the recommended thresholds on page "View: understanding the sensor threshold" [7]:

- Green – good levels;
- Orange – average levels; and
- Red - poor levels.

The source code of the web application is available at [15].

7. CONCLUSION

This report presents a web application that is used to display the results of air quality measurements based on the data it receives from the View plus radon detector. The values that are measured are briefly described, an overview of the detector is given, the API is described that enables downloading the values measured by the detector, and the characteristics and the operation of the web application. The typically appearing screens during the operation of the web application were also shown. Some other previous researches done in this area were also presented. Taking into account that monitoring both the radon level and the level of other air quality parameters has become an objective, this work represents the first step in that direction.

The approach we propose should fit in with the goals of similar works in this field. Developing our own system using our own strengths is a long-term process, however it allows full control of every step. We believe that such an investment is justified because we already have or can provide all the hardware, software and human resources we need to develop such a system.

Furthermore, it is planned to implement a system for alerting about high levels of radon concentration and other air quality parameters, as well as creating a system that would carry out activities to reduce the increased concentration level of radon, VOC and CO_2 with ventilation, as well as optional activation of an air purifier in case of elevated values of other air quality parameters, and all that using IoT potentials. The challenge that follows is the development of a prediction algorithm.

8. REFERENCES

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