THE DIGITAL DOPPELGÄNGERS OF NIKOLA TESLA AND BRANISLAV NUŠIĆ: A NEW APPROACH TO INTERACTIVE LEARNING AND CULTURAL HERITAGE

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Abstract:

With the advancement of AI and digital doppelgängers, the creation of virtual replicas of historical figures is becoming increasingly significant in the fields of culture, education, and scientific research. This paper analyzes theoretical aspects of developing digital doppelgängers and introduces a new subcategory—cultural-educational chatbots—through the examples of pioneering Serbian chatbot projects modeled after Nikola Tesla and Branislav Nušić. These pilot chatbots, currently undergoing testing in Serbian schools and museums, represent the first cultural-educational chatbots of their kind in Serbia. The study examines the technical, linguistic, and ethical challenges associated with replicating historical figures, exploring critical issues such as authenticity, cultural context, and the limits of digital immortality. Through the ongoing pilot testing, this paper highlights both the innovative potential and the practical considerations for the broader adoption of such chatbots in Serbian educational and cultural sectors.

Keywords:

AI, Digital Doppelgängers, Tesla Chatbot, Nušić Chatbot, Educational and Cultural Sector.

INTRODUCTION

In the age of advanced AI and digital doppelgängers, the attempt to "bring historical figures back to life" through chatbots is becoming an increasingly intriguing challenge. But how feasible is it, really, to replicate the mind and spirit of an individual—especially when it comes to greats like Nikola Tesla and Branislav Nušić? This raises an essential question: can we ever create an authentic replica of someone who lived more than a century ago? The paradigm of digital doppelgängers is closely tied to conversational AI. Today, different types of digital doppelgängers exist—from so-called "griefbots," which simulate communication with deceased loved ones, to projects like DigiDan, a chatbot modeled after the philosophical style of Daniel Dennett. The development of these technologies opens new possibilities, particularly in education, but also raises significant ethical concerns.

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This paper explores the challenges of creating digital doppelgängers of historical figures through the examples of the Nikola Tesla and Branislav Nušić chatbots—the first pilot cultural-educational chatbots in Serbia. In primary and secondary education, these chatbots can enhance the learning process and make teacher-student interactions more dynamic and immersive. By "reviving" the author or the scientist and speaking in their name, they can make learning more accessible and enjoyable while inspiring more engaging and motivating teaching experiences. In cultural institutions such as national museums, galleries, and endowments, these tools can promote cultural heritage in innovative and modern ways, fostering a stronger bond between visitors through interactive chatbot experiences. However, their potential development and usage brings up critical questions, including the selection of historically reliable sources, linguistic and cultural barriers, and the limits of authenticity in digital replication—at a time when artificial intelligence carries both great promise and deep ambiguity.

2. CHATBOTS IN EDUCATIONAL AND CULTURAL SECTOR

The term 'chatterbot' was coined by Michael L. Mauldin in 1994 [1], though chatbot development began earlier. These computer programs are designed to simulate human-like conversations and respond intelligently based on predefined data structures [2]. Historically, early chatbot models such as ELIZA and ALICE demonstrated fundamental natural language processing capabilities, using pattern matching and rule-based responses. Contemporary AI-driven chatbots, including OpenAI's ChatGPT and Google's Bard/Gemini, leverage vast datasets and advanced machine learning techniques to generate contextually relevant responses [3]. A key distinction between the two is their training data—Bard/Gemini is trained on real-time internet-based text, providing more up-to-date information, whereas ChatGPT relies on curated dataset of books and articles, often leading to greater accuracy in factual responses [4].

In educational contexts, chatbots have been integrated into various learning environments, assisting students with homework, providing personalized learning experiences, and delivering immediate feedback [5] [3]. Additional advantages of AI chatbots for students include flexible personalized learning and skill development [3].

However, researchers caution that excessive over-reliance on AI-generated information may undermine students' critical thinking and problem-solving abilities [5]. From an educator's perspective, AI chatbots offer time-saving assistance and enhanced pedagogy, but human expertise remains essential for making informed pedagogical decisions. Teachers' primary concerns include reliability, accuracy, fair assessment—particularly in written assignments—and ethical considerations [3]. To ensure the safe and constructive use of AI chatbots, institutions must adapt their policies and practices accordingly [6].

The integration of chatbot-powered educational tools in museums and cultural heritage institutions, though not yet widely adopted, is gaining momentum, particularly as a means of digital innovation, enhancing audience engagement, and improving museum management. These AI tools create a welcoming environment where visitors feel comfortable asking questions, making museum visits more engaging. They help build trust and encourage interaction, especially among young visitors and families.

Chatbots make museum visits more engaging by sparking curiosity and inviting visitors—especially those who are not experts—to explore exhibits more deeply. Through personalized and interactive conversations, they create a more immersive experience while also helping museums learn what truly interests their audience. Museums primarily use AI to reinterpret collections, encourage participatory storytelling, and support digital learning [7]. A key example is the European H2020 ReInHerit project, which developed an AI-based multimedia chatbot to improve visitor interaction and answer visitor questions about artwork content and context.[1]

A group of authors introduced a context-aware chatbot system to overcome limitations in existing AI models, particularly their inability to provide accurate historical and cultural insights [8]. The authors developed the CHVQA (Cultural Heritage Visual Question Answering) dataset, which contains 2,890 cultural asset images and 55,000 question-answer pairs sourced from verified historical content. The open-source chatbot system offers museums a scientifically accurate tool to enrich visitor experiences. The authors also emphasize the need for clear regulatory compliance to ensure ethical AI usage in cultural heritage. Chatbots should rely on curated knowledge from museum experts rather than solely on AI-generated responses in order to minimize the risk of misinformation. Additionally, obtaining user consent before data collection and ensuring secure data storage are crucial for maintaining visitor trust.

1 https://reinherit-hub.eu/tools/apps/

In Serbia, the first and only chatbot currently in use exclusively in the higher education sector is ADA, developed by the Belgrade Business and Arts Academy of Applied Studies [9]. Initially designed to assist with communication and e-learning administration during the COVID-19 pandemic, ADA'S but purpose was subsequently broadened to include facilitating exam registrations and providing instant academic support through integration with Viber and Facebook Messenger. To date, no chatbots have been implemented in the educational or cultural heritage sectors in primary and secondary schools, museums, galleries, or endowments across Serbia. The goal of this project was to develop chatbots with practical applications within these institutions. In classrooms, the use of the chatbot goes beyond administrative tasks, as it can actively assist both students and teachers in learning and teaching processes, making teacher-student interaction more engaging. Within cultural institutions, the chatbot can serve as virtual guides, providing historical context, answering questions, and personalizing the visitor experience. It can also offer information in multiple languages, making cultural heritage more accessible to international visitors. Another potential application is its integration into special programs, where it can be used in interactive storytelling or simulations of historical events.

2.1. DIGITAL DOPPELGÄNGERS

Digital doppelgängers of individuals can be categorized into three types [10]: (1) historical digital doppelgängers – chatbots that enable communication with significant figures from the past (e.g., DigiDan), (2) griefbots – chatbots designed to simulate deceased individuals for the purpose of remembrance and emotional support (e.g., HereAfter AI), and (3) special-purpose digital doppelgängers–chatbots that play a crucial role in cultural memory, such as preserving the voices of Holocaust survivors, ensuring their testimonies remain accessible even after they are gone. Since DigiDan is the closest existing chatbot to the ones we propose, this paper will not focus on the second and third category of digital doppelgängers but will instead draw a parallel with it.

In 2023, DigiDan, a chatbot trained on the works of philosopher Daniel Dennett with his approval, was created. Using a fine-tuned GPT-3 model, DigiDan replicated Dennett's writing style, reasoning, and humor. A study with over 400 participants found that even professional philosophers struggled to distinguish the chatbot's responses from Dennett's actual words [11]. Notably, Dennett was still alive when the chatbot was developed but passed away shortly after its release, raising important questions about digital immortality and the role of AI in preserving intellectual legacies.

Within the first category of doppelgängers, which includes DigiDan, we propose a subgroup of cultural-educational digital doppelgängers—chatbots designed for educational purposes and the promotion of cultural heritage within cultural institutions. Our pilot projects involve the Nikola Tesla and Branislav Nusic chatbots—virtual representations of Serbia's distinguished historical figures: Tesla as a renowned scientist, engineer, futurist, and inventor, and Nušić as a prominent playwright, satirist, essayist, novelist, and founder of modern rhetoric in Serbia. Developed for long-term integration into both the educational system and cultural sector, these chatbots aim to make historical personalities more accessible and engaging by authentically articulating their ideas, lives, and creative contributions. Additionally, the chatbots have been developed for inclusion in a broader platform, envisioned as a central digital space where various Serbian historical figures will be interactively available, facilitating enriched learning experiences and cultural exploration.

Two research studies are currently being conducted to assess the effectiveness and application of both Tesla and Nušić chatbots. In classrooms, these chatbots aim to help students learn about history, literature, and science in an engaging, interactive way. The Branislav Nušić chatbot can primarily enhance Serbian language and literature classes by offering analyses and explanations that deepen understanding of his literary works, especially his comedies and satires. Meanwhile, the Nikola Tesla chatbot provides detailed information about his inventions, patents, and scientific contributions, making it suitable for integration into subjects such as Physics, History, Serbian language and Literature, and English language. Currently available in both Serbian and English, the Tesla chatbot is also valuable in bilingual educational settings.

In cultural institutions, interactive chatbot communication enriches visitor experiences. The Nikola Tesla chatbot is primarily intended for the Nikola Tesla Museum in Belgrade but can also be used in other institutions such as the Museum of Science and Technology or various Tesla endowments nationwide. Similarly, The Branislav Nušić chatbot would serve institutions like the Branislav Nušić Endowment, the Branislav Nušić National Library, or the Branislav Nušić Theatre.

Importantly, their use is not limited to institutions explicitly bearing their names; the chatbots could effectively enhance other cultural and educational spaces aligned with their respective themes. This approach would promote Serbian cultural heritage and scientific achievements globally, by presenting them in an engaging and modern format. Through interactions with local and international visitors, these chatbots can significantly enhance the museum experience and foster deeper appreciation for Serbia's national heritage.

3. CREATING NIKOLA TESLA AND BRANISLAV NUŠIĆ CHATBOTS

3.1. TESLA'S CHATBOT: CHALLENGES IN REPLICATING A SCIENTIFIC GENIUS

Developing a chatbot to represent Nikola Tesla proved significantly easier compared to Branislav Nušić, primarily due to the abundance of information available about Tesla's life, work, and inventions. Biographies, scientific articles, patents, and letters related to Tesla are available in multiple languages and from diverse sources, providing a richer corpus for training the chatbot. However, an extensive dataset does not necessarily guarantee authenticity. Numerous myths and legends surrounding Tesla prompt critical questions: Which sources are reliable? How can genuine information be differentiated from sensationalist stories? These issues necessitate meticulous selection and validation of data.

Another significant challenge is the language or dialect Tesla used. Tesla spoke in the Ijekavian variant of the Serbian language, requiring special linguistic adaptations within the chatbot. This poses particular difficulties when adapting content accurately from the perspective of speakers predominantly familiar with the Ekavian variant. Furthermore, Tesla employed terminology typical of his era, which required additional effort to adapt accurately. Linguistic assistance and meaningful comprehension of historical context are essential for creating an authentic digital representation of Tesla.

A more complex issue is Tesla's multilingual abilities. Historical accounts indicate he spoke nine languages, yet details on his proficiency in each are limited. If the chatbot were ever to converse or write in multiple languages, it would be necessary to determine whether Tesla was truly fluent or only superficially familiar with each language. Ironically, AI naturally improves with training, meaning the chatbot might eventually surpass Tesla's own command of languages, such as German. This scenario raises fundamental questions: Would the chatbot remain authentic representation if it surpasses Tesla's linguistic capabilities? Furthermore, if the chatbot is to communicate realistically, more details on Tesla's speech patterns and possible accents when speaking foreign languages would be essential.

Another challenge is the historical authenticity of Tesla's language and terminology. Replicating Tesla's voice requires the use of the historically accurate linguistic expressions and stylistic nuances of his time. Since historical records do not provide exhaustive insight into Tesla's proficiency in each of the nine languages he spoke, careful consideration is needed when determining the chatbot's linguistic capabilities.

The irony deepens: due to machine learning, the chatbot could eventually surpass Tesla's original linguistic skills. Would such a chatbot remain truly authentic? Is a digital doppelgänger a faithful representation if it acquires knowledge the original person never possessed? These questions raise profound philosophical and ethical dilemmas about authenticity and identity in the digital age. If an AI-driven chatbot develops skills and knowledge beyond what the historical figure originally had, can it still be considered a faithful replica—or is it instead an evolved version of the original personality? Does authenticity require adherence strictly to historical fact, or can it be grounded in an idealized potential of the reconstructed individual?

The problem becomes even more complex when considering subjective interpretations: if Tesla himself were alive today, would he recognize this chatbot as his digital heir, or see it as an interpretation shaped by modern technology and others' expectations? Ultimately, the critical question remains whether a digital doppelgänger should remain a static reconstruction of a particular historical era, or evolve into something the original figure could never have become—but which, under different circumstances, might align with their vision and potential.

3.2. NUŠIĆ'S CHATBOT: CHALLENGES IN DIGITIZATION AND CONVEYING HUMOR

Creating a chatbot inspired by Branislav Nušić presents a unique set of challenges. Although Nušić's literary works left an enduring mark on Serbian culture, they are neither widely digitized nor extensively translated. This gap poses a significant obstacle in building a comprehensive dataset needed for chatbot training.

To overcome this challenge, efforts have begun to digitize Nušić's writings, including analyses and critiques by other authors. While essential for the chatbot's authenticity, this effort also highlights a broader societal issue: the inadequate digitization of cultural heritage. Ideally, national libraries and cultural institutions should undertake this task, yet the responsibility has largely fallen to individuals attempting to revive cultural heritage through modern technology.

In contrast to the extensive data available for Tesla, the case of Nušić is starkly different. Many of his works are not yet digitally available, limiting material crucial for chatbot training. Nušić's unique style and humor are intimately tied to a specific historical period. If the chatbot utilizes contemporary language, can it still be considered faithful to the original? The lack of digital resources points to the broader issue of cultural heritage digitization.

Another critical challenge is accurately conveying Nušić's humor. Humor is strongly influenced by cultural and historical context. If the chatbot employs contemporary language, it risks straying from authentic stylistic expression. Language is not merely a communication tool; it reflects the spirit of the era—sentence rhythms, vocabulary choices, and subtle meanings that shape humor. Nušić's style was rich in archaic expressions, bureaucratic language satire, and specific social contexts that informed his comedy. If the chatbot instead uses modern expressions, it risks sounding like a 21st-century author imitating Nušić rather than genuinely replicating him.

Conveying context ia another issue. Nušić's humor was not simply wordplay but a sharp critique of society, satirizing particular political and social conditions—bureaucracy, provincial mentality, societal hypocrisy. While a chatbot could recognize patterns in Nušić's writing, it would struggle to fully comprehend the deeper motivations behind his jokes and their historical relevance. Replacing these satirical moments with generalized humor would dilute their essence and strip them of nuance.

Nevertheless, could such a chatbot still be useful? If seen as a tool to adapt Nušić's humor for contemporary audiences, it could generate a new interpretation of his style, adjusted to modern realities. Rather than literal reconstruction, the chatbot could employ Nušić's method of identifying and satirizing modern-day absurdities, thus preserving the spirit of his satire. The question remains: Would this chatbot be a true digital representation of Nušić, or rather something entirely new, inspired by his legacy yet inevitably different—a digital doppelgänger with a life and purpose of its own?

4. ETHICAL DILEMMAS

Throughout the development and testing of our pilot projects, several ethical dilemmas have surfaced, particularly concerning authenticity, knowledge boundaries, and ethical use of AI. Creating digital replicas such as those modeled after Nikola Tesla nad Branislav Nušić raised important questions about uniqueness of human experience. If historical figures can be digitally reconstructed, does it diminish their authentic human essence [12]? While our chatbots are constantly trained to mimic linguistic styles and speech patterns as much as possible, they inherently lack consciousness, genuine emotional responses, and authentic thought processes. For instance, can a chatbot truly replicate Nušić's humor, or is it limited to recombining exhisting comedic content? Moreover, despite carefully replicating speech, our chatbots are fundamentally unable to authentically engage with personal or emotionally compelx questions.

Another issue arising from our projects concerns the authenticity of historical representation when contemporary data is incorporated. Are our digital replicas historically accurate, or do they represent modernized versions? Ethical challenges become particularly evident when programming the chatbots to simulate emotions. For instance, is it ethical for the Tesla or Nušić chatbot to mimic expressions of sadness or joy without genuine emotional experiences? Furthermore, we confronted the sensitive dilemma of how chatbots should interact with descendants of these historical figures versus general visitors or admirers.

Authenticity of knowledge presented another significant challenge. Historical figures like Tesla or Nušić had clear knowledge limitations. For example, questions arose during testing such as whether Tesla knew who the king of Norway was in 1940—a fact easily retrieved today, but perhaps never known by Tesla himself. Providing answers beyond the figure's historical knowledge base compromises authenticity and credibility. Moreover, how should chatbots handle historical uncertainties or unknowns? Unlike humans, who naturally forget or selectively recall information, AI has a comprehensive, unfiltered access to data, complicating the distinction between confirmed historical knowledge and speculative information.

AI's unpredictable behavior has been another ethical concern in out pilot tests. Often described as a "black box" phenomenon, AI's decision-making processes can be opaque, making it challenging to understand why a chatbot generated a particular response. Although this

sometimes leads to novel insights, it equally introduces potential errors, biases, and incorrect information, particularly problematic in educational contexts [13]. AI inference relies on statistical probabilities rather that genuine understanding, fundamentally differentiating chatbot reasoning from human cognition.

Bias also posed a practical ethical dilemma in our projects. Despite careful consideration, creators and trainers inevitably influence chatbot responses, potentially embedding their own biases into digital replicas of historical figures. Additionally, privacy emerged as a key issue. During testing, we noted users' uncertainty regarding how their interactions with chatbots might be recorded, stored, or accessed by third parties. These concerns were compounded by the lack of comprehensive data regulation and risks associated with the misuse of sensitive information [14] [15].

Reliability posed further challenges. The historical sources—letters, memoirs, newspapers, and literary works—are inherently subjective and limited, complicating efforts to ensure historical accuracy in our chatbots. For the Tesla and Nušić chatbots, publicly available materials were supplemented by consultations with Tesla's biographer, Milovan Matić, and historian Lieutenant Uroš Jovanović, who provided valuable assistance regarding the history of the Serbian Military Frontier (Srpska vojna Krajina).

Legally, our use od public-domain materials, such as the works of Branislav Nušić, is permissible, but significant ethical concerns still remain. For instance, we need to thoughtfully consider how the descendants of Tesla and Nušić might perceive the creation of digital replicas of their ancestors being created. It is essential to recognize and respect their perspectives, especially concerning consent, privacy, preservation of family legacy, and our ethical responsibility toward these families. Thus, even when the use of creative or historical content is legally acceptable, it can still raise serious ethical questions if explicit consent is not obtained. This legal and ethical grey area clearly requires further discussion and calls for establishing clear regulatory guidelines.

5. CONCLUSION

A critical limitation identified in our pilot projects is the inability of educational chatbots to fully replicate the emotional support and mentorship provided by human educators [3]. To maximize AI's educational potential while mitigating its shortcomings, we recommend that institutions adopt preventive measures informed by our experience—raising student awareness about digital inequality, AI reliability, and ethical implications, alongside offering professional development opportunities for educators. Training should focus on integrating AI as a complementary tool rather than a replacement for human instruction, thereby nurturing students' critical thinking and problem-solving skills.

Our pilot experiences also demonstrated the importance of ongoing chatbot refinement in cultural context. Incorporating visitor feedback significantly improves chatbot accuracy, engagement, and inclusivity. Additionally, ethical challenges, such as transparency, data privacy, and misinformation [8], must be proactively managed. Our projects have stressed the need for balancing technological innovation with cultural authenticity, ensuring chatbots enrich rather than distort historical narratives.

Creating digital doppelgängers like the Nikola Tesla and Branislav Nušić chatbots extends beyond technical innovation; it pushes us to reconsider our understanding of historical authenticity, cultural interpretation, ethical responsibility, and identity. As virtual replicas become more sophisticated, it remains crucial, as our pilot projects illustrate, to view these technologies as tools for enhancing educational and cultural experiences—not as substitutes for genuine human legacies. Rather than striving for perfect replicas, our aim should be developing innovative tools that help us better appreciate and understand ideas and contributions of the great minds.

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