R E V I E W

of a dissertation

for obtaining the educational and scientific degree "Doctor" in

Field of Higher Education – 5. Technical Sciences
Professional Field – 5.3. Communication and Computer Engineering
Doctoral Program – "Automated Information Processing and Control Systems"

Author: MSc. Eng. Victoria Tsvetanova Velkova
Title: "Development and Research of a Service for Delivering Personalized Content to Visitors of Open-Air Museums"
Reviewer: Prof. DSc Stoyan Nedkov Kapralov

On the basis of Order No. Z-01-311 / 18.07.2025 of the Rector of the Technical University of Gabrovo, I was appointed as a member of the Scientific Jury in connection with the defense of the dissertation of MSc. Eng. Victoria Tsvetanova Velkova. According to the decision of the first meeting of the scientific jury, held on 22.07.2025, I was elected as a reviewer.

The present review has been prepared in accordance with the requirements of the Law for the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), its Implementing Regulations, and the Regulations for the Acquisition of Scientific Degrees and the Occupation of Academic Positions at the Technical University of Gabrovo.

I have received in electronic form, according to Art. 12 of the Regulations of TU–Gabrovo, the necessary materials for the preparation of the review: dissertation, abstract, and copies of all publications.

1. **Brief biographical data of the doctoral candidate**

Viktoria Velkova obtained a Bachelor's degree at the Technical University of Gabrovo in the specialty "Automation, Information and Control Systems" in 2017 and a Master's degree in the same specialty in 2018. In 2022 she was elected as an assistant at the Department of Computer Systems and Technologies. As an assistant, she conducts

seminars and laboratory exercises in the disciplines "Computer Programming and Use", "Programming in Internet Environment", "Programming for Mobile Devices", "Computer Graphics", and "Object-Oriented Programming" for students majoring in "Computer Systems and Technologies" and "Software and Computer Engineering".

2. Relevance of the topic

Technological innovations are increasingly entering cultural institutions such as museums, providing new opportunities for interaction with visitors. Personalization of content is an important part of this transformation. Modern visitors expect individualized experiences tailored to their interests and preferences.

The dissertation examines the use of modern technologies such as artificial intelligence, mobile applications, and IoT to create personalized experiences, thus addressing contemporary challenges in the cultural sector and contributing to the modernization of museum practice.

The proposed solutions include innovative approaches such as microservices, mobile applications, and audience segmentation, and have the potential for implementation in various museum institutions.

The research fills existing gaps in scientific and practical knowledge on the topic, offering innovative approaches to critical challenges in delivering personalized content to visitors of open-air museums.

3. Overview of the cited literature

The bibliography in the dissertation includes 158 sources, 4 of which are in Bulgarian and the rest in English.

Of particular interest is the methodology by which the literary sources were selected. Three main databases were used: IEEE, ACM, and PubMed. These databases were searched with primary keywords such as "museum", "personalization", "individualized content", "visitor experience" and "open-air museum", with search queries designed to

cover as fully and accurately as possible the scientific publications in the field of digital museum technologies.

4. General characteristics of the dissertation

The dissertation consists of 240 pages and is structured into four chapters, conclusion, bibliography, and 4 appendices.

Chapter 1 justifies the relevance of the problem, formulates the aim and tasks of the research. The main objective of the research is to design, develop, and experiment with a system for delivering personalized content to visitors in open-air museums using modern positioning and identification technologies. Nine tasks are formulated to achieve this objective.

Chapter 2 substantiates the choice of a microservice-based architecture and provides a detailed description of the proposed architecture and the microservices used. A generalized algorithm for the functioning of the service is also presented. Chapter 3 is devoted to the segmentation of museum visitors. A methodology for segmenting users is proposed, aiming at better personalization of the provided content. Chapter 4 discusses various technologies for visitor tracking with the purpose of content delivery. A comparative analysis of different technologies in the context of open-air museums is provided.

The conclusion of the dissertation summarizes the main contributions and suggests directions for future research.

5. Contributions of the dissertation

The contributions of the dissertation are presented in its conclusion and are structured into scientific, scientific-applied, and applied. The scientific and scientific-applied contributions are summarized into three main points each, with references to the corresponding sections of the dissertation where these contributions are substantiated.

I fully accept the presented contributions, which are the result of solving the main tasks

set in Chapter 1. These contributions are also presented on pp. 42–43 of the abstract and fully and correctly reflect the results achieved by the doctoral candidate.

The main scientific contributions are:

- An innovative microservice-based architecture is proposed.
- An original algorithm for personalized museum content delivery is developed. The algorithm ensures dynamic generation of personalized content through integration of generative artificial intelligence.

- An innovative methodology for visitor segmentation is developed.
The main scientific-applied contributions are:

- A methodology for experimental determination of the signal attenuation exponent when using BLE beacons is developed.

- An iterative algorithm with adaptive weighted averaging is created, which dynamically determines the attenuation exponent for different zones in a museum environment for the purpose of visitor localization in the absence of GPS.

- An algorithm is developed and tested, allowing real-time selection of beacons associated with the chosen organization that are in close proximity to a specific visitor.

As a rule, the ZRAS emphasizes only the scientific and scientific-applied contributions, but it is natural and obligatory in a Technical University for the dissertation work to also have engineering practical results.

The main applied results are as follows:

- A database has been created for the objects of the Ethnographic Open-Air Museum "Etar".
- Specialized mobile applications with innovative functionalities have been developed.
- A minimum viable product of the business logic of the service has been developed.
- A comprehensive system validation methodology has been developed, including functional, performance, and reliability tests.

6. Publications and citations

A total of 8 publications are presented on the dissertation. The list of publications is on p. 193 of the dissertation. The data for the publications in the list are incomplete, because, with the exception of the last two, the place and dates of the respective conferences are missing.

MSc. Eng. Velkova herself has made a detailed analysis of the publications, which deserves to be included in the review (p. 194).

Publication	Year	Authors	Intern. Conference	Scopus	WoS	Points
[V1] Delivering Personalized Content to Open-air Museum Visitors Using Geofencing	2022	2	Yes	Yes	Yes	20
[V2] Microservice for creating geofences	2022	2	Yes	-	-	-
[V3] Tangible and Personalized Smart Museum Application	2023	2	Yes	Yes	Yes	20
[V4] Mobile Application for Creating and Exporting Geofences	2023	2	Yes	Yes	Yes	20
[V5] Microservice-Based Interface to ChatGPT	2024	2	Abroad	Yes	-	20
[V6] Enhancing Museum Experiences: A Multi-Institution Mobile Multimedia Delivery System Using BLE Beacons	2024	2	Yes	Yes	Yes	20
[V7] User Segmentation Using Social Media Profiles	2024	1	Yes	-	-	0
[V8] Mobile App for Content Delivery for Museum Exhibits Using NFC Technology	2024	1	Yes	-	-	0

From the table, several conclusions can be drawn.

All publications are at international conferences (seven in Bulgaria and one abroad). One of the publications is at an IEEE conference abroad: IEEE International Conference on Automation, Quality and Testing, Robotics, AQTR 2024.

Three of the publications are at the authoritative international conference Digital Presentation and Preservation of Cultural and Scientific Heritage, in 2022, 2023, and 2024, respectively.

Six of the publications are co-authored with the scientific supervisor – Assoc. Prof. Dr. Rosen Ivanov, and the other two are single-authored.

Six of the publications are in English, and two are in Bulgarian.

All publications are from the period 2022–2024.

It is particularly impressive that 10 citations of five of the publications have already been cited, including of the 2024 IEEE conference paper. All citations are from foreign authors.

It is also impressive that five of the publications are indexed in Scopus, and four of them also in Web of Science. Accordingly, the doctoral candidate has achieved a total of 100 points from the publications, more than three times the mandatory minimum of 30 points.

In conclusion, in terms of both volume and quality, the publications significantly exceed the minimum requirements for obtaining the educational and scientific degree "Doctor".

7. Authorship of the results obtained

I believe that everyone who attended the meeting of the extended department council for the preliminary defense of MSc. Eng. Victoria Tsvetanova Velkova's dissertation is fully convinced that the results included in the dissertation are the work of the doctoral candidate.

8. Abstract

The abstract is prepared according to the requirements and correctly reflects the content of the dissertation.

9. Opinions, recommendations, and remarks on the dissertation

The arrangement of the literary sources in the Bibliography is not alphabetical, but in the order of occurrence. I consider this acceptable for articles with up to 15–20 titles, but not for a dissertation with almost 200 titles.

Instead of the word "polygon", the word "multigon" (e.g. on p. 146) could be used. The only recommendation: the dissertation would benefit from indicating the connection between individual chapters and publications, for example, at the end of each chapter to state in which of the publications the obtained results were presented.

10. Conclusion

I consider that the presented dissertation meets the requirements of the Law for the Development of the Academic Staff in the Republic of Bulgaria. The achieved results give me reason to confidently propose that the educational and scientific degree "Doctor" be awarded

to MSc. Eng. Victoria Tsvetanova Velkova

in the Field of Higher Education – 5. Technical Sciences,

Professional Field – 5.3. Communication and Computer Engineering, Doctoral Program – "Automated Information Processing and Control Systems"

31.08.2025

Signature:

/Prof. DSc Stoyan Kapralov/