OPINION

of a dissertation for awarding a scientific degree "Doctor "
Field of higher education: 5. Technical sciences
Research area: 5.3. Communication and computer systems and technologies
(Automated information processing and management systems)
Dissertation theme: "DEVELOPMENT AND RESEARCH OF A SERVICE FOR DELIVERING PERSONALIZED CONTENT TO VISITORS OF OPEN-AIR MUSEUMS"
Author of the dissertation: MSc. Eng. Victoria Tsvetanova Velkova
Scientific jury member: Prof. DSc. Ivaylo Ivanov Atanasov

1. Topic and relevance of the dissertation

The present dissertation addresses a current and significant scientific issue. It is related to personalized content for visitors to open air museums, which improves the visitor experience by customizing information to individual interests and knowledge levels, leading to more engaging and memorable visits. This approach is especially valuable in open air spaces, where diverse exhibits and a different demographic of visitors require flexible and adaptive content delivery. MSc. Eng. Victoria Velkova presents research focused on methods for outdoor localization, visitor profiling, content storage and presentation, as well as curator visualization tools, which are the main elements of such systems. The goal is clearly defined and it is oriented towards the development and research of a service that provides personalized content to visitors to open air museums and uses push notifications to deliver this content.

2. Research methodology

In the process of developing the dissertation, the doctoral student has conducted an in-depth study of the existing scientific literature in the field of technologies and technological solutions used in smart museums, personalized content delivery and its specificity in open-air museums. 158 sources were analyzed, all in English. Based on a comprehensive review of the existing digital technologies in the field, the goal and the resulting scientific tasks of the dissertation were formulated. A detailed analysis and classification of the publications are given in Appendix 1 to the dissertation. The developed models, algorithms and experiments conducted in the dissertation work testify to the in-depth knowledge of the state of the problem by MSc. Eng. Victoria Velkova, as well as her ability for analytical and critical interpretation of the existing advances in the research area. This contributed to the successful implementation of the set goal and the resulting tasks.

3. Contributions of dissertation

Based on a comparative analysis of centralized, decentralized and distributed service-oriented architectures to achieve the goal, the doctoral student focused on a microservices architecture. Technologies for implementing the service and the application were selected. The microservices used to develop the service for delivering personalized content were identified. A generalized algorithm for its functioning was developed and economic aspects of its

implementation were studied. By using segmentation methods, groups of visitors were identified according to demographic data, interests and behavior. A proposed user segmentation methodology aims to better personalize the content provided. Recommendations for museums for implementing segmentation in real conditions were developed. Analyzing the existing localization technologies, technologies were selected for positioning visitors in museums (Global Positioning System (GPS)), and for tracking them (Near Field Communications tags (NFC) and Bluetooth Low Energy (BLE) beacons). A technology was selected to develop a tangible user interface for the visitor with the information presented about the exhibits. A mobile application was developed that uses the created service for registering, profiling, segmenting and notifying users. An algorithm was developed to estimate the value of the attenuation exponent along the path for different locations in open-air museums in order to more accurately calculate the distance to the BLE beacons. To validate the developed service and application, a simulation environment, a collection of exhibits, a collection containing information about each organization using the service were developed. The following aspects were tested: accuracy of detecting the nearest beacon, filtering stability, switching hysteresis, the influence of the attenuation exponent and performance in a real environment. The user interface of the application was also tested. A geofence creation service was developed that allows users to create geofence zones of arbitrary shape using GPS maps. Geofencing technology was used to create a virtual geographic boundary, allowing the software to trigger a response when a mobile device enters or leaves certain area. Experiments were conducted to evaluate functional key performance indicators of the service within a region located in the Ethnographic Open-Air Museum "Etar". An application was developed that allows exporting geofencing information to a cloud-based MongoDB database. An environment was developed for testing the application.

The results of the conducted research are summarized as 3 scientific, 3 applied scientific and 4 applied contributions. They relate to the creation of new and improvement of existing models, methods and approaches in the scientific field under consideration, as well as the expansion of existing knowledge.

The formulated contributions are justified correctly and reflect the research work carried out by the doctoral student. They are relevant and applicable in the development of services and applications for personalized content provision for visitors to open-air museums.

4. Publications and citations of publications on the dissertation

The results of the dissertation have been presented in 8 publications, of which 7 at international conferences in Bulgaria and 1 at an international conference abroad, 5 of the publications are referenced in the SCOPUS database, and 4 – in the Web of Science. In 2 of the publications, the doctoral student is the sole author. At the time of preparing this opinion, 5 of the publications have been cited by foreign authors, with a total of 10 citations noted. All this testifies to the acceptance and popularization of a significant part of the topic developed in the dissertation.

5. Authorship of the obtained results

In two of the publications attached to the dissertation, Eng. Victoria Velkova is an independent author, and in the others, she is a co-author, in two of them she leading author.

At the time of writing the opinion, there are no claims whatsoever, i.e. oral or written, that concern in any degree the authorship of the obtained results. The above clearly proves that the obtained results, which are presented in the dissertation work, are undoubtedly the fruit of personal scientific and applied scientific activities.

6. Opinions, recommendations and remarks on the dissertation work

The dissertation is precisely formulated and it is structured clearly and logically. The presented research demonstrates the author's in-depth knowledge in the scientific field and has practical significance. I have no significant remarks on the content of the work.

I recommend that M.Eng. Victoria Velkova continue her research on the latency of services that have requirements for real-time or near-real-time execution, as far as it is an important current direction.

7. Conclusion

I believe that the presented dissertation meets the requirements of the Act on the Development of Academic Staff in the Republic of Bulgaria and the Regulations on the Conditions and Procedure for Acquiring Scientific Degrees at TU-Gabrovo. The achieved scientific, applied scientific and applied results, supported by a sufficient number of publications, constitute a serious basis for a positive assessment of the work. Based on the above, I 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 technology, doctoral program Automated systems for information processing and management.

31.07.2025 Member of the scientific jury:

Sofia /Prof. DSc. Ivaylo Atanasov/