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# Concept of the Intelligent Guide with AR Support

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**ABSTRACT** In order to save time and money for tourists, as well as taking into account their limited mobility in the conditions of Covid, the concept of an intelligent guide based on augmented reality (AR) is proposed. A UML method diagram and algorithm for communication of the system with the user with AR and voice control support have been developed, as well as an application that allows tourists to immerse themselves in the historical retrospective of recreational places. On the example of the central part (downtown) of Ternopil, Ukraine, AR locations are offered, which gives an opportunity to get acquainted in more detail with the information about the tourist object. At the same time, the shortest tourist route is illuminated of historical monuments.

**KEYWORDS** Augmented reality; intelligent guide; tourism.

## I. INTRODUCTION

TOURISTS around the world are interested in the advanced information systems that can save their time and money, as well as provide additional contextual information and access to attractive historical and cultural values. At the same time, digital innovations and high technologies are the engines of development and demonstrate their influence everywhere, including in the field of tourism services. In particular, the impact of digitalization on tourism should be considered at several levels: mega-, macro-, meso- and micro-levels. The mega-level corresponds to the level of international tourism, which is most affected by new digital technologies. Today, every tourist has a smartphone that can receive information from various sensors and provide a user-friendly interface to such information systems.

However, the real situation with Covid imposes significant restrictions on the mobility of tourists and in accordance with the range of travel services.

Therefore, developing the concept of an intelligent guide with the support of AR, is one of hot topics of tourism business. This article is devoted to this topic, the rest of which is distributed as follows: Section 2 discusses the analysis of related work; section 3 presents the method of building an intelligent guide with AR support; section 4 the implementation of one of the modules of the method. Section 5 presents the conclusions of the study.

## II. RELATED WORK

The paper [3] presents an overview and analysis of IT solutions based on the implementation of augmented reality in industrial applications. In [1] several strategies for forecasting the information needs of the user in the house with Augmented Reality and Virtual Reality (VR) support are investigated. In [2] the results of AR implementation as a part of the interactive user manual are presented. An original approach to the introduction of automated augmented reality systems for industrial production and entrepreneurship is presented [4, 19].

In [18] the authors analyzed the elements that affect the tourism experience in the context of cultural tourism from a theoretical point of view, discussing the impact of VR and AR technologies on the learning experience of visitors. Study [15] outlines tourism requirements for mobile applications for tourism in AR, contrasting them with themes in mobile computing identified in previous studies to confirm previously defined requirements and explore new elements and perceptions of tourists in line with modern technology. The study [16] integrated the Technology Acceptance Model (TAM), stimulus-response structure (SOR) and flow theory to study the impact of mobile AR applications on the behavior of buyers of tourist impulses. The study [17] proposes a new model for the adoption of augmented reality technology, based on the adaptation of the technology implementation model, as well as through the use of tourist surveys and structured interviews for public and private agents working in the tourist context of the city.

The work [21] is aimed at researching, identifying and discussing the benefits and general role of big data and artificial intelligence in the tourism sector. The paper [11] compares the characteristics of both traditional tourist information services and those included in smart tourism. In [20] the information technologies for modeling of tourist demand taking into account the characteristics of the most important factors are presented. The paper [14] highlights the support of decision-making on the tourist route based on the model of buffer analysis of neural networks. [13] proposes a conceptual model that aims to improve GRS for tourism using game techniques, smart agents modeled on the context and profile of tourists, such as psychological and socio-cultural aspects, and dialogue games between agents for the post-recommendation process. A conceptual model of an intelligent information system for smart tourist destinations based on the most modern technologies used in tourist directions is proposed [10]. The article [5] developed an intelligent tourist information system that uses virtual reality technology. The study [6] developed an interactive application that can visually display information and tourist objects in the form of 360° images to make it easier for users to view tourist attractions. In article [7] the intelligent tourist platform for the mobile terminal is developed. The paper [8] presents a web platform for mobile platforms based on deep neural networks for autonomous identification of historical monuments. A study [9] developed a smart map to identify tourist attractions based on tourist desires.

The paper [12] presents a simple method of developing a conversational agent with the most modern tools by mapping the types and properties associated with tourism to conversational elements in a direct and general form. The study [22] explored the useful features of a virtual hands-free guide, without eyes, which can answer questions using the interface for conversational dialogue and inform the user about interesting features while driving, the tourist in different directions. The work [23] is aimed at developing approaches that combine different elements of sound reproduction, geolocation and other sensory capabilities of smartphones, which allows to create exciting geolocation stories in a mobile application.

The above-mentioned works describe the introduction of tourism activities with the help of information technology and with the support of AR, there are also intelligent systems for tourism. It is important to combine AR with intelligent systems for sightseeing. In this regard, the purpose of this article is to develop a method of developing an intelligent guide with the support of AR, which will develop a full-fledged application that will allow tourists to immerse themselves in the historical retrospective of recreational places.

Unlike analogues [12, 22, 23], the proposed concept of the intelligent guide is based on a combination of the following technologies: identification, AR, GMS, IoT, sound effects support and intelligent voice chatbot.

## III. MATERIALS AND METHODS

The impact of digitalization on tourism should be considered at several levels: mega-, macro-, meso- and micro-levels. The mega-level corresponds to the level of international tourism, which is most affected by new digital technologies. And it is for international tourists that it is important to have the opportunity for more convenient sightseeing.

To this end, the concept of an intelligent guide with AR support has been proposed, which, based on the appropriate software environment, will help the tourist to better perceive the tour.

Therefore, the method of developing an intelligent guide with AR support is represented by the following steps and UML diagram (Fig. 1):

Step 1. The tourist submits a request to log in and passes the identification and transfers personal data to the system.

Step 2. In this step, the tourist, the system provides the opportunity to use the Smart tourist infrastructure of the city. These include:

- Personal control - providing a higher degree of personalization in hotels and on flights, because it provides the ability to control more devices or services through a centralized device, tablet PC or user's own phone.
- Seamless journey. Sensors can be used to alert restaurant staff when a guest arrives and automatically send them the desired table number.
- Location information. Travel companies can use this technology to send customers location information and collect valuable data, send notifications about local attractions and times when they are least busy, or point to public transportation nearby. IoT technology can be used to collect accurate data on the number of people who use specific hotel services at different times to optimize staffing levels.
- Maintenance and repair. Warning about failure of tourist locations.

Step 3. The basis for communication between the system and the user is an intelligent chatbot with voice control. The algorithm is described below (Fig. 2). Voice control works by combining artificial intelligence, connecting to the Internet and, in some cases, the Internet of Things (IoT). A customer can get travel information by asking correspondent questions.

Step 4. Next, the tourist has the opportunity to choose a tourist route with AR support. The sound effects and voice accompaniment of the tour are connected accordingly.

The method presented above allows tourists to immerse themselves in the historical retrospective of recreational places with the support of AR.

Within the framework of the concept, an algorithm for communication between the system and the user has been developed, which is an intelligent guide with AR support and voice control and the ability to select a route, and which is represented by the following steps (Fig. 2):

Step 1. The tourist (block 1) submits a voice request for route selection (block 2).

Step 2. Converts human speech to AR-enabled text (block 3), after which the NLP algorithm (block 4) structures and labels it relative to the conversation script knowledge base (block 5). Automatic Speech Recognition (block 3) - reads the user's oral language and converts it into text format for further processing. It is important to remember that the system needs to extract as many features as possible from the received text, especially for the correct operation of the next module. Natural Language Understanding (block 4) - trains the obtained models and on this basis creates an additional layer of logic, which controls the work of the entire architecture and becomes the foundation of the module of the intelligent guide with AR support.

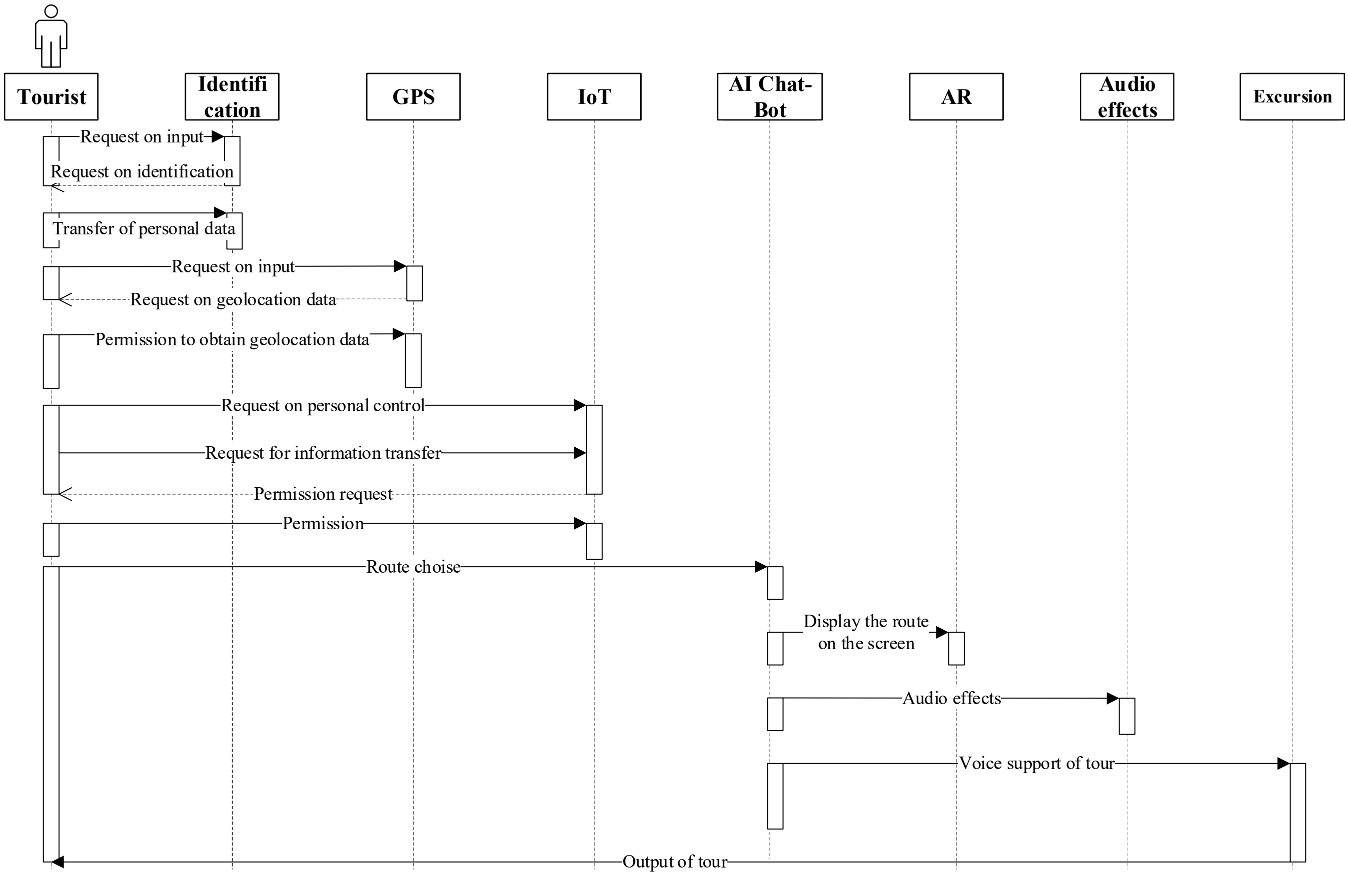


Figure 1. UML diagram of smart guide with AR support

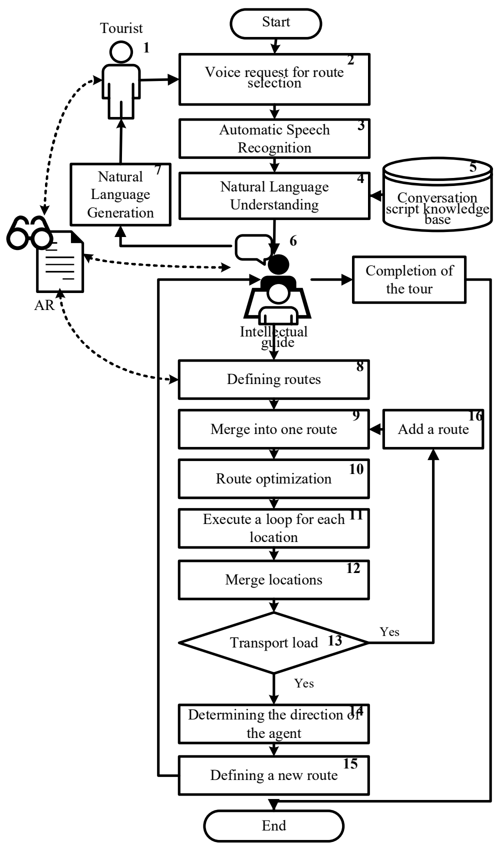


Figure 2. Algorithm for intelligent guide with voice control and the ability to choose a route with AR support

Step 3. Next, an intelligent guide with AR support interprets it into teams and conducts the entire system (block 6). Intelligent guide (block 6) - the locomotive of the dialog system, which decides to execute or ignore the user's request. It is closely related to backend processes that can access third-party services or databases. Also, one of our next developments will be the introduction of the opportunity to buy a ticket during the tour and watch (listen) to a virtual concert at the opera house, which is generally very important during the restrictions associated with the pandemic.

Step 4. At the output (block 7) the user receives the expected result, accompanied by the generated text, audio message, link or image. Natural Language Generation (block 7) is the last bastion in the machine's attempt to understand human intention and produce the final result. Having collected the necessary information from all previous modules, it generates a response relevant to the query in human language.

Step 5. Next, the input parameters of the local route points, which include the route area (block 8).

Step 6. Merging routes (block 9), as a result, a map of routes is created, in which points (cities) were visited n number of times (block 10).

Step 7. The cycle runs as long as there is at least one route in the combined route (block 11-14). If the need can be met, the parameters are placed in a new route (block 15), and if not met, the cycle is repeated until a new route is created. If the conditions of the total needs of the client group are met, the cycle ends and the tourist route is displayed through an intelligent guide with AR support. If not, the cycle repeats again.

## IV. EXPERIMENTAL RESULTS AND DISCUSSION

Based on the algorithm of an intelligent guide with voice control and the ability to choose a route with AR support, developed an application for a tour of the central part of Ternopil, Ukraine (Fig. 3).

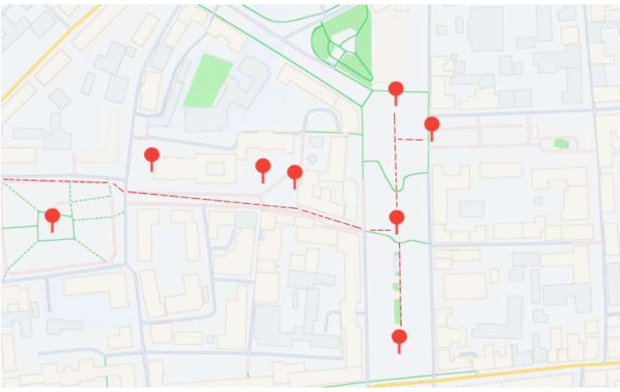

Figure 3. Route with AR locations in Ternopil

In the application (Fig. 4) there is a possibility of voice control and output of the entered text on the screen. AR locations also have information directories, which is represented by an additional designation above the corresponding object. When the customer clicks on the marker, a pop-up window will appear with information about the monument and its historical photos. If the user wants to get acquainted with the information in more detail, he can go to the window with complete information.

Figure 4. Guide interface with AR support

The next important aspect of the application is the presentation of the guide in the form of a historical figure, namely Jan Tarnowski. Jan Amor Tarnowski - statesman, politician, military figure of the Kingdom of Poland, founder of the city of Ternopil. It appears when the user clicks on the button as a voice icon. He is waiting for a user question. Then he talks about the sights. Voice control is developed on the basis of the algorithm developed above (see Fig. 2) intelligent guide with voice control and the ability to choose a route with AR support from 1 to 4 steps.

Another feature is AR navigation. In this application, the function is displayed by highlighting the route to historical monuments. What is developed on the basis of the algorithm developed above (Fig. 2) intelligent guide with voice control and the ability to choose a route with AR support from 5 to 7 steps.

The authors conducted a research test of the developed application among students in Computer Science at West Ukrainian National University. 132 students from the 1st to the 4th year of the bachelor's degree and the 1st year of the master's degree took a part in the testing. The testing was conducted on personal smartphones with Android OS. Students went on a tour as testers (Table 1) according to a different scenario (randomly) (Fig. 5), in particular:

- Tour Guide – Testing the main default tour.
- Study of city history - Check of the program function regarding history.
- Touristic tour - Selecting the desired geolocation of tourist site and the opportunity to track it.
- Back-alley tour - Check of the least used program features.
- Boring tour – Spending the time minimum per each program screen, filling the minimum of fields and selection of the shortest route.

**Table 1. Structure of questions during the developed application testing**

| № | Question | Variants of answers |
|---|---|---|
| 1 | Year of study | 1-5 |
| 2 | Type of testing | Tour guide; Study of the history of the city; Tourist tour; Tour on the back alley; Boring tour. |
| 3 | The operating system version of your smartphone | OC Android 4.4; OC Android 5.0-5.1; OC Android 6.0; OC Android 7.0-7.1; OC Android 8.0-8.1; OC Android 9.0; OC Android 10.0; OC Android 11.0; OC Android 12.0. |
| 4 | Was there a problem with installing the application? | 0 – no, 1 - yes |
| 5 | How long has the application been starting? | Number of seconds |
| 6 | How do you like the idea of the application? | 0 - like; 1 – don't like |
| 7 | Convenience of the placed buttons | 0 - convenient, 1 – not convenient |
| 8 | Convenience of the size of buttons | 0 - convenient, 1 – not convenient |
| 9 | Were there any problems with connecting the camera to the app? | 0 – no, 1 - yes |
| 10 | How many errors did you make while passing your type of test? | Number of errors |
| 11 | Were there any problems with geolocation determining? | 0 – no, 1 - yes |
| 12 | Were there any problems with your mobile internet connection? | 0 – no, 1 - yes |
| 13 | Were there any problems with voice control? | 0 – no, 1 - yes |
| 14 | Were there any problems with determining the shortest path? | 0 – no, 1 - yes |
| 15 | Is the text size convenient? | 0 - convenient, 1 – not convenient |
| 16 | Evaluate the usability of your type of testing | 0-10 |
| 17 | Overall usability rating | 0-10 |
| 18 | Will you use this application in the future? | 0 - yes, 1 - no |

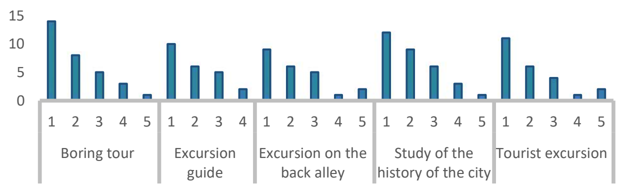


Figure 5. Distribution of testing scenarios between students by year of study

Fig. 6 shows that the students who took the most part in testing of the developed application were students of 3 and 2 years of study, respectively 30% and 29%.

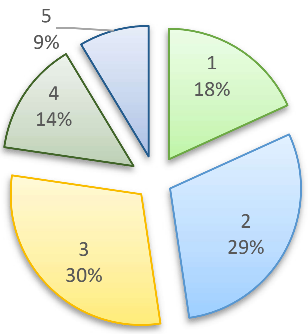


Figure 6. Distribution of testing scenarios between students by year of study

To analyze received results of testing above let's consider the average download time of the application (Fig. 7). As it can be seen from the respondents, the higher the version of the Android OS, the shorter the download time of the application. This is understandable, because smartphones with a higher version of Android have better technical characteristics, respectively, and AR processing is running faster.

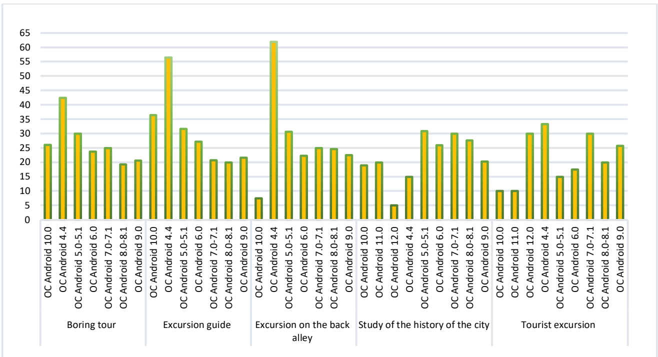


Figure 7. Distribution of test scenarios relative to software download time

Note, the only 2% run for more than 40 seconds. Most applications downloaded fairly quickly.

Most of testers (Fig. 8) had 5 errors in passing different scenarios, which is 15% of all. The 25% of testers got one error and the 24% had no errors.

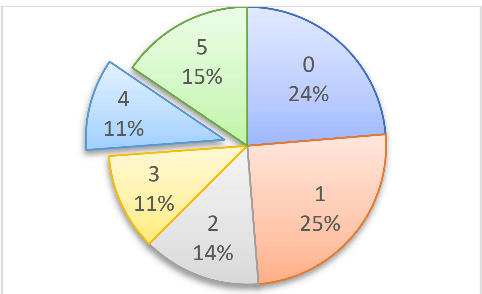


Figure 8. Percentage of the average number for detected errors

Fig. 9 shows that the average number of errors which were detected in the test scenarios is the largest in the "Study of city history." The fewest errors were found in the "Boring Tour" scenario.

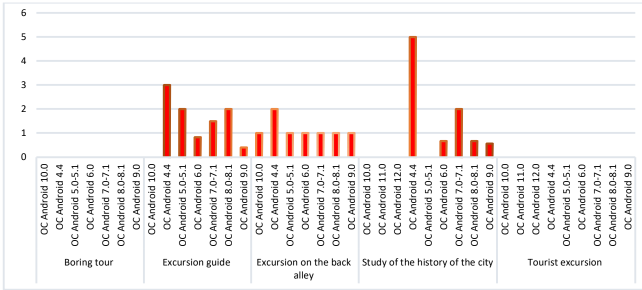


Figure 9. Distribution of test scenarios relative to the average number of detected errors

Let's consider the distribution of test scenarios for detected errors in more detail. As it can be seen from Fig. 10 most bugs appeared in older versions of Android OS. In particular, in Android 4.4, the only problem was installing the application, but this OS no longer has a proper support from the developers, so fixing these errors is not relevant.

Testers analyzed the placement of buttons, taking into account their size and text size. At the same time, testers who had screens with lower resolution in older smartphones had incorrectly displayed button sizes on the screen.

Nobody had any problems connecting the camera. There were no significant problems with voice control, only 6% had errors.

Users with older versions of Android had the most problems with geolocation and Internet connection, which is 35% and 34%, respectively, for all users. Also, in the scenario "Tour guide", several errors were found with the installation of geolocation (for users with older versions of Android).

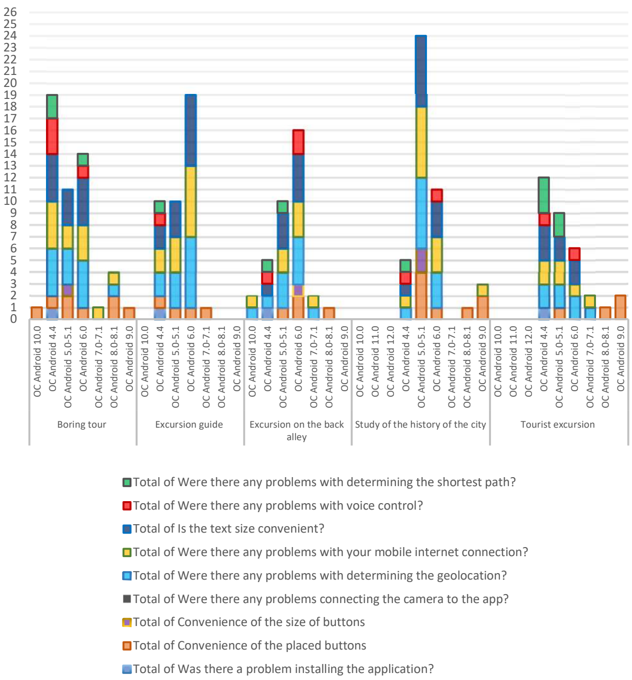


Figure 10. Distribution of test scenarios for detected errors

When evaluating the usability of the application (Fig. 11), users with older versions of the Android OS had the lowest average rating. The authors believe that this is because the application on their smartphones worked less stably and there were many errors. This statement is confirmed by the fact that users with newer versions of Android have better impressions and, accordingly, the higher evaluation of application usability. In particular, the 23% and 25% of testers scored 9 and 8 points respectively on application usability.

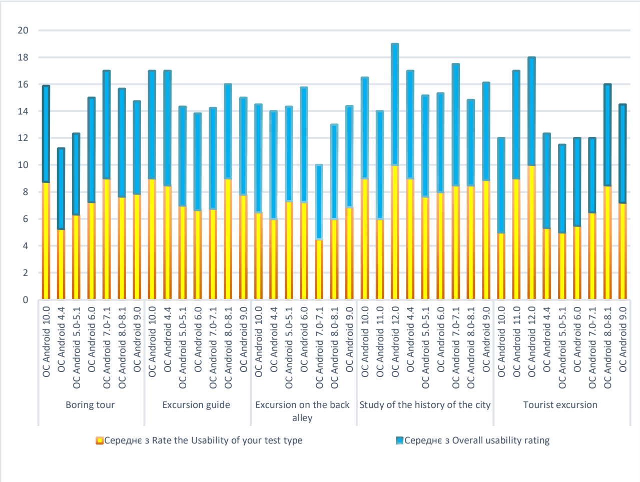


Figure 11. Distribution of testing scenarios for usability evaluation

The case study confirmed that 95% of people plan to continue using this application after modifications.

The developed application gives everyone the opportunity to get an unforgettable experience, thanks to augmented reality technology. Tourists can use GPS and a compass to get detailed location information as well as information about the surrounding area on the screen of their mobile devices. In augmented reality, there is a great opportunity to demonstrate large objects in the city space, such as buildings, structures, premises, etc.

It is expected, the modified version of Intelligent Guide will be integrated with the AURA project MagneticOne [23]. AURA will be a WEB platform that allows to buy tickets for VR viewing performances for opera houses, which are currently represented by 3D model for theaters in Florence, Berlin and Lviv. At the same time, it will be possible to buy a ticket during the tour and watch (listen to) a virtual concert in the opera house, which is generally very important during the restrictions associated with the pandemic.

## V. CONCLUSIONS

The concept of an intelligent guide with AR support has been developed, represented by a combination of method, UML diagram and algorithm, which allows tourists to immerse themselves in the historical retrospective of recreational places. The algorithm demonstrates the communication of the system with the user-intelligent guide with AR support and voice control, as well as the ability to choose a tourist route.

The algorithm is implemented in the form of an application using AR location for the central part of Ternopil, Ukraine, which enabling to learn more about the information of the tourist object. At the same time, the shortest tourist route is illuminated by historical monuments.

To assess the capabilities of the application, its testing was conducted, in which 132 students in Computer Science at West Ukrainian National University took part. Testing was conducted according to the scenarios: "Tour guide", "Study of city history", "Touristic tour", "Back alley tour" and "Boring tour".

The developed application interested students and accordingly 95% of them are going to continue using this application after revisions. Most errors are observed in the scenario "Study of city history".

In future the authors are going to develop the identification module, smart tourism infrastructure module and new AR locations, in particular some API routines and protocols to provide listening to virtual concerts based on auralisation project.

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## References

[1] S. Zehtabian, S. Khodadadeh, L. Bölöni, D. Turgut, "Modeling an intelligent controller for predictive caching in AR/VR-enabled home scenarios," *Pervasive and Mobile Computing*, vol. 71, 101334, 2021. https://doi.org/10.1016/j.pmcj.2021.101334.

[2] A. Ivaschenko, P. Sitnikov, M. Milutkin, D. Khasanov, A. Krivosheev, "AR optimization for interactive user guides," In K. Arai, S. Kapoor, R. Bhatia (eds) *Intelligent Systems and Applications IntelliSys 2018, Advances in Intelligent Systems and Computing*, vol. 869, Springer, Cham, 2019, pp 948-956. https://doi.org/10.1007/978-3-030-01057-7_70.

[3] A. Ivaschenko, M. Milutkin and P. Sitnikov, "Industrial application of accented visualization based on augmented reality," *Proceedings of the 2019 24th Conference of Open Innovations Association (FRUCT)*, 2019, pp. 123-129, https://doi.org/10.23919/FRUCT.2019.8711981.

[4] A. Ivaschenko, V. Avsievich, P. Sitnikov, "AR guides implementation for industrial production and manufacturing," In: Radionov A., Karandaev A. (eds) *Advances in Automation. RusAutoCon 2019. Lecture Notes in Electrical Engineering*, vol. 641, Springer, Cham, 2020, pp. 715-723, https://doi.org/10.1007/978-3-030-39225-3_78.

[5] J. Tseng, Y. Jiang, S. Peng and H. Wei, "Development of intelligent tourism information system based on virtual reality," *Proceedings of the 2018 IEEE International Conference on Advanced Manufacturing (ICAM)*, 2018, pp. 202-205, https://doi.org/10.1109/AMCON.2018.8615073.

[6] A. Bastian, T. F. Prasetyo and N. J. D. Atmaja, "An application of virtual reality with android device for tourism assistant," *Proceedings of the 2019 2nd International Conference of Computer and Informatics Engineering (IC2IE)*, 2019, pp. 1-5, https://doi.org/10.1109/IC2IE47452.2019.8940861.

[7] Z. Wanchun, "Design and implementation of intelligent tourism platform for mobile terminal," *Proceedings of the 2017 International Conference on Smart Grid and Electrical Automation (ICSGEA)*, 2017, pp. 705-708, https://doi.org/10.1109/ICSGEA.2017.172.

[8] M. Etaati, B. Majidi and M. T. Manzuri, "Cross platform web-based smart tourism using deep monument mining," *Proceedings of the 2019 4th International Conference on Pattern Recognition and Image Analysis (IPRIA)*, 2019, pp. 190-194, https://doi.org/10.1109/PRIA.2019.8785975.

[9] I. D. Wahyono, K. Asfani, M. M. Mohamad, A. Aripriharta, A. P. Wibawa and W. Wibisono, "New smart map for tourism using artificial intelligence," *Proceedings of the 2020 10th Electrical Power, Electronics, Communications, Controls and Informatics Seminar (EECCIS)*, 2020, pp. 213-216, https://doi.org/10.1109/EECCIS49483.2020.9263435.

[10] T. Gajdošík, "Towards a conceptual model of intelligent information system for smart tourism destinations," In: Silhavy R. (eds) *Software Engineering and Algorithms in Intelligent Systems. CSOC2018 2018. Advances in Intelligent Systems and Computing*, vol 763, Springer, Cham, 2019, pp. 66-74, https://doi.org/10.1007/978-3-319-91186-1_8.

[11] Y. Li, C. Hu, C. Huang, L. Duan, "The concept of smart tourism in the context of tourism information services," *Tourism Management*, vol. 58, pp. 293-300, 2017. https://doi.org/10.1016/j.tourman.2016.03.014.

[12] O. Panasiuk, Z. Akbar, U. Şimşek, D. Fensel, "Enabling conversational tourism assistants through schema.org mapping," In: Gangemi A. et al. (eds) *The Semantic Web: ESWC 2018 Satellite Events. ESWC 2018.*

*Lecture Notes in Computer Science*, vol. 11155, Springer, Cham, 2018, pp. 137-141. https://doi.org/10.1007/978-3-319-98192-5_26.

[13] P. Alves, J. Carneiro, G. Marreiros, P. Novais, "Modeling a mobile group recommender system for tourism with intelligent agents and gamification," In: Pérez García H., Sánchez González L., Castejón Limas M., Quintián Pardo H., Corchado Rodríguez E. (eds) *Hybrid Artificial Intelligent Systems HAIS 2019, Lecture Notes in Computer Science*, vol. 11734, Springer, Cham, 2019, pp. 577-588. https://doi.org/10.1007/978-3-030-29859-3_49.

[14] Z. Xiao, L. Sen, F. Yunfei, L. Bin, Z. Boyuan, & L. Bang, "Tourism route decision support based on neural net buffer analysis," *Procedia Computer Science*, vol. 107, pp. 243-247, 2017. https://doi.org/10.1016/j.procs.2017.03.086.

[15] D.-I. Han, T. Jung, "Identifying tourist requirements for mobile AR tourism applications in urban heritage tourism," In: Jung T., tom Dieck M. (eds) *Augmented Reality and Virtual Reality. Progress in IS*, Springer, Cham, 2018, pp. 3-20, https://doi.org/10.1007/978-3-319-64027-3_1.

[16] H.-N. Do, W. Shih, & Q.-A. Ha, "Effects of mobile augmented reality apps on impulse buying behavior: An investigation in the tourism field," *Heliyon*, vol. 6, issue 8, e04667, 2020. https://doi.org/10.1016/j.heliyon.2020.e04667.

[17] J. N. Azevedo and B. Alturas, "The augmented reality in Lisbon tourism," *Proceedings of the 2019 14th Iberian Conference on Information Systems and Technologies (CISTI)*, 2019, pp. 1-4, https://doi.org/10.23919/CISTI.2019.8760706.

[18] D.-I. Han, J. Weber, M. Bastiaansen, O. Mitas, X. Lub, "Virtual and augmented reality technologies to enhance the visitor experience in cultural tourism," In: tom Dieck M., Jung T. (eds) *Augmented Reality and Virtual Reality. Progress in IS*, Springer, Cham, 2019, pp. 113-128. https://doi.org/10.1007/978-3-030-06246-0_9.

[19] O. Dulishkovych, H. Lipyanina, O. Sachenko, T. Lendyuk, O. Osolinskiy, & I. Kit, "Business process management of virtual enterprise based on augmented reality," *Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021)*, 2021, pp. 422-431. http://ceur-ws.org/Vol-2851/paper39.pdf.

[20] V. Krylov, A. Sachenko, P. Strubytskyi, D. Lendiuk, H. Lipyanina, D. Zahorodnia, V. Dorosh, T. Lendyuk, "Multiple regression method for analyzing the tourist demand considering the influence factors," *Proceedings of the 2019 10th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*, 2019, pp. 974-979, https://doi.org/10.1109/IDAACS.2019.8924461.

[21] D. Samara, I. Magnisalis, and V. Peristeras, "Artificial intelligence and big data in tourism: a systematic literature review," *Journal of Hospitality and Tourism Technology*, vol. 11, issue 2, pp. 343-367, 2020. https://doi.org/10.1108/JHTT-12-2018-0118.

[22] P. Bartie, W. Mackaness, O. Lemon, T. Dalmas, S. Janarthanam, et al., "A dialogue based mobile virtual assistant for tourists: The SpaceBook Project," *Computers, Environment and Urban Systems*, vol. 67, pp. 110-123, 2018. https://doi.org/10.1016/j.compenvurbsys.2017.09.010.

[23] R. Indans, E. Hauthal, & D. Burghardt, "Towards an audio-locative mobile application for immersive storytelling," *KN – Journal of Cartography and Geographic Information*, vol. 69, pp. 41–50, 2019. https://doi.org/10.1007/s42489-019-00007-1.

[24] MagneticOne became the technical partner of AURA project. [Online]. Available at: https://www.magneticone.com/aura-project/

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