Application of Geolocation Module in the Electronic Multimedia Guide

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Abstract. The paper presents the work in progress towards the enhancement of features and increasing the comfort of usability of the multimedia guide for the War Museum of Niš under the Open Sky. Previously, this electronic guide was realized as a mobile application that informs visitors about the persons and events to which monuments in the city of Niš are dedicated. Visitors could access information about the monuments through a list of monuments or by using an interactive map with the location of the monuments marked. Presently, we are introducing a new module that will improve user experience through the usage of location-based services. The visitor's location is used by the Geolocation module to show the information about the nearby monument. The monument has to be inside of a predefined radius (e.g. 2 *m* or more) in order to activate the projection of the information about the monument.

Keywords: Mobile Application, History, Monuments, Geolocation.

1 Introduction

Niš has been inhabited continuously since the Neolithic period until today. As it is located at the crossroads between the west and east, north and south of Europe and further towards Asia, it is inevitable that it has not only a long, but also a glorious history, and in certain periods tragic for its inhabitants. Many significant events from this rich history, as well as notable personalities, are marked with monuments throughout the city. In the centre of the city, next to the town hall and on the University square, there are over 20 monuments. In the area between the Niš fortress and the river on one side and the city square and the pedestrian zone on the other, the Heroes' Park is located, where there are monuments dedicated to national heroes and events from the Second World War.

This central location of the city is attractive for the presentation of the story about the monuments for the visitors that come to the city, but also for citizens of Niš especially the younger population who are passing through the monuments every day and who are not sufficiently familiar with the events of this period. Therefore, in our previous work (Tatić, 2022), we explained different methods used to inform visitors about the historical content of the monuments.

One of the solutions is that the monuments are marked with QR codes which provide the user with information about the historical event or the person to whom the monument is dedicated (Tatić, Gajić, & Stanković, 2015). In such a realization, it is necessary for the user to activate and use the QR code reader several times while walking around the park.

In addition to the QR codes, the ARhiMedia Group created a mobile application that serves as an electronic, multimedia, and multilingual digital guide presenting historical information about past events and important persons (Tatić D. , Stanković, Stojanović, & Jovanović, 2019). In this way, visitors have to search the content of the application and look if the related information is available. Searching the application is usually done by scrolling through an ordered list of the monuments or looking at the map for the exact location of the monument. Also, augmented reality technology is used to recognize elements of the real world to inform visitors about the monuments (Banterle, et al., 2015). A visitor has to point the camera to the monuments and recognize the monument of interest.

Some research papers explore the usage of geolocation technology with mobile devices to provide necessary information about cultural and historical heritage. For example, in (Alexandridis, Chrysanthi, Tsekouras, & Caridakis, 2019), geolocation technology is used for the creation of a recommendation system for the routes at archaeological sites. The development of location-based mobile games focused on cultural and historic locations is another application of geolocation technology. The players are directed to follow the route of the city through storytelling and visit historic locations (Luiro, et al., 2019). In this way, they achieve the goals for further progress in the game but also have the possibility to get more information about the historical background of the historical places. Gamified effects of 3D historical reconstructions of objects that no longer exist can be achieved by combining mobile augmented reality with location-based services, which can be appealing to visitors (Panou, Ragia, Dimelli, & Mania, 2018). Similarly, mobile applications based on geolocation augmented reality technology has been used to create a social platform for cultural heritage awareness where visitors can create social networks and exchange cultural heritage information in various multimedia formats based on historical location (Lim, Frangakis, Tanco, & Picinali, 2017).

In previous solutions that we provided (Tatić D. , Stanković, Stojanović, & Jovanović, 2022) visitors need to have more engagement in self-search by using a mobile device. We considered it more convenient to project the information through location-based services. This makes it possible for the user, when he activates the application, to walk freely and at the same time get information about the monuments he

passes. This paper presents the application, explains its improvement by adding a module for working with geographical coordinates, provides some technical details, and describes the practical realization of the added module.

2 Principles of Geolocation on Mobile Devices

For the completeness of the presentation, in this section, we briefly summarise the basic geolocation principles for mobile devices (Djuknic & Richton, 2001), (Vaughan-Nichols, 2009). The main idea is to relate the coordinates of the current position of a user with the coordinates of an object of his possible interest depending on the subject to which the electronic guide is devoted.

Most mobile devices are equipped with satellite navigation receivers that are capable to receive signals from satellite navigation systems orbiting on Earth in order to calculate precise geographical locations. There are several satellite navigation systems which are all under the global navigation satellite system (GNSS). GNSS systems usually supported by mobile devices are Global Positioning System (GPS), GLONASS, BeiDou Navigation Satellite System (BDS), and Quasi-Zenith Satellite System (QZSS).

The navigation receiver of a mobile device waits for signals from the satellites in GNSS to determine its precise geographical location. Satellites from GNSS emit a signal that contains information about the time when a signal was sent and the positions of the satellite. By receiving the signal, the distance between the satellite and the mobile device can be calculated. Distance is calculated by using the time of the travelled signal multiplied by the constant speed of the travelled single which is the speed of light. Further, the mobile device navigation unit calculates the position of the mobile device using the distance and position of the satellite. This process of calculation is called trilateration. At least four satellites have to respond in order to calculate precise location. When only four satellites respond, this is the lowest signal level, and when more satellites respond, the geographical location of devices can be determined more precisely.

Sometimes mobile device navigation receiver has problems receiving signals from GNSS due to weather conditions, indoor usage or big barriers such as tall buildings. According to that, Assisted GNSS (A-GNSS) can help or improve the mobile device to find precise geographical location. A-GNNS uses different ground network base stations to receive data for the determination of the geographical position of the mobile device. A-GNSS receives a radio signal which carries the time and satellite position of base stations in mobile device surrounding. These radio signals may be received from ground stations such as mobile networks like GSM or other for instance Wi-Fi systems. Accordingly, this communication via radio signal is faster than receiving information from the satellite. Therefore, A-GNSS can help in faster discovering geographical location upon phone or application startup and uses less battery capacity.

3 Implementation

Electronic tourist multimedia guide is a mobile software solution created by the ARhiMedia group for an easy adaptation of different content types in order to inform visitors in a contemporary way about cultural and historical heritage. This guide is created as a cross-platform solution realized in Unity with the purpose to publish the application for different mobile platforms such as Android or iOS. The main idea was to create an enhanced audio guide with other various multimedia modules applied. By using these modules, various applications could be created for different cultural heritage sites, touristic places, or archaeological sites. Using this electronic multimedia guide we created an application War Museum of Niš under the Open Sky. This application concerns the monuments in the Park of Heroes and other war monuments in the city of Nis and implements various types of information but we also included a purposely designed Geolocation information module.

3.1 Application Modules

As this electronic guide is realized in Unity, the applied modules are realized in the form of Unity scenes. All modules are dynamically defined by using an XML structure with multimedia material. Based on the type of material provided, two groups of modules are defined and divided into their subgroups.

- Informational modules – provide basic informational textual content that further links to the multimedia material and is divided into subgroups.
  - Main menu
  - List
  - Info
- Presentational modules – provide the multimedia information
  - Audio
  - Gallery
  - Video
  - 3D
  - Map
  - AR

Application modules are used to dynamically integrate the material in various multimedia formats. For example, the main menu presents the first navigation screen of the application with the title and buttons that link to other modules with the content. Also, the list module has a navigational role as it is embedded as a scroll list of subtitles linked to other modules and their content.

The info module is an informational module that has basically textual information. Also, it has links to the next modules like audio, video, or 3D. Link with the gallery module is achieved through the thumbnail gallery that is embedded in this module. This gallery module provides pictures to be visible on a full screen while the zoom option is enabled.

Audio and video modules are used to reproduce recorded material while the 3D module serves as a showcase of reconstructed historical material or scanned museum artifacts.

Map module is realized to present historical objects on a geographical map. This map is realized by using Google service to show the objects as interactive markers on the map. When pressed, each marker provides more information about a cultural or historical monument or a place. Also, this module enables visitors to see the route from the current location of the user to the marker on the map.

Augmented reality module is realized to recognize images, artifacts, or parts of the monuments at tourist locations in order to provide a new way of interaction and information at the exact place.

3.2 Geolocation Module

The Geolocation module is designed to provide information about the monument at the nearby location. This helps a visitor to retrieve information while walking near the monument. The advantage of using this module is the visitor opportunity to acquire information instantly without searching the content of the application. During the walking tour, the visitor gets a notification about the monument in the application when the nearest monument is in his radius (usually set to be about 2 meters). More information about the monument is displayed on a mobile device when visitors click on the notification.

Usage of the Module. On the main screen of the application, there is a button for the usage of the Geolocation module. The visitor has the possibility to enable the Geolocation module to get notifications while walking near monuments. When the module is enabled, user location-based service usage on the mobile phone is activated. In this way, the application receives the current precise geographical location of the visitor by accepting the latitude and longitude coordinates provided with location-based service on a mobile device. Based on this information, a comparison between the current location of the visitor and the monument's coordinates is made with the intention to find the nearest monument. When the nearest monument is selected, a further calculation is done to check if that monument is in the given radius of the visitor (by default 2 meters is set). If this monument is inside the circle of the given radius, the notification about this monument is displayed on the screen. As the visitor moves, this module performs calculation to check whether there is a new monument in the visitors' surroundings. This calculation is scheduled to be executed every few seconds. The notification of a nearby monument is realized as a button positioned at the bottom part of the mobile device screen. This button combines the thumbnail and title of the monument. Moreover, interaction is included and when the button is pressed, it usually links to other modules for more information.

3.3 Use Case

An example of the usage of the Geolocation module presented in this section is realized as the Multimedia electronic guide dedicated to the War Museum under the open sky. The War Museum under the open sky is a mobile application created to inform visitors about the monuments of past wars in the city center of Niš.

When this application starts, the Main menu is open on the screen are three options in the form of buttons. Each of these buttons presents one module that refers to the way the visitor wants to examine monuments information:

- List of the monuments
- Map with monuments
- Show the nearest monument

List of the monuments, the first button on the screen relates to the List module where all monuments are shown as ordered list items with titles and images (Fig. 1). By interacting with a specific item, more information about the monument is provided to the visitor.

Fig. 1. Opening of the List of the monuments in the mobile application

The second button opens the map module where all monuments are shown on the Google map (Fig. 2). These monuments are labeled as interactive pins where the interaction provides for the visitor a short description of the monument. This description is realized as a button where interaction links to detailed information. Also, the visitor has the option to find the route to the specific monument on the map based on his current position.

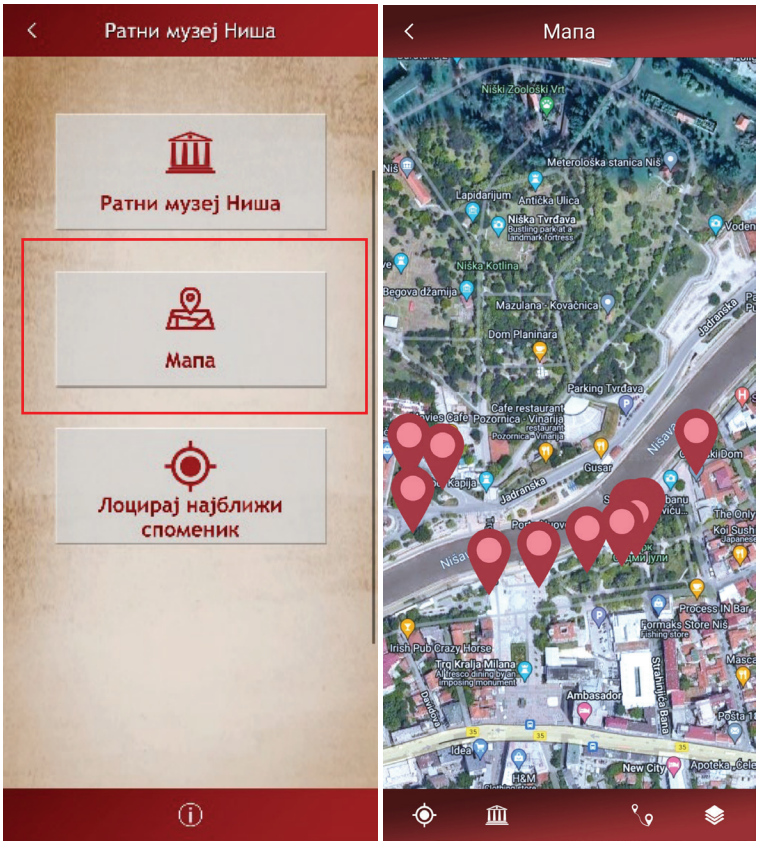

Fig. 2. Opening of the Map with monuments in the mobile application.

The third button is for the activation of the Geolocation module. When the button is pressed, the visitor can enable or disable the Geolocation module (Fig. 3). When this module is enabled, the visitor location service is activated on the mobile device. By activating this option, the visitor can freely walk across the park and receive information about the nearby monuments.

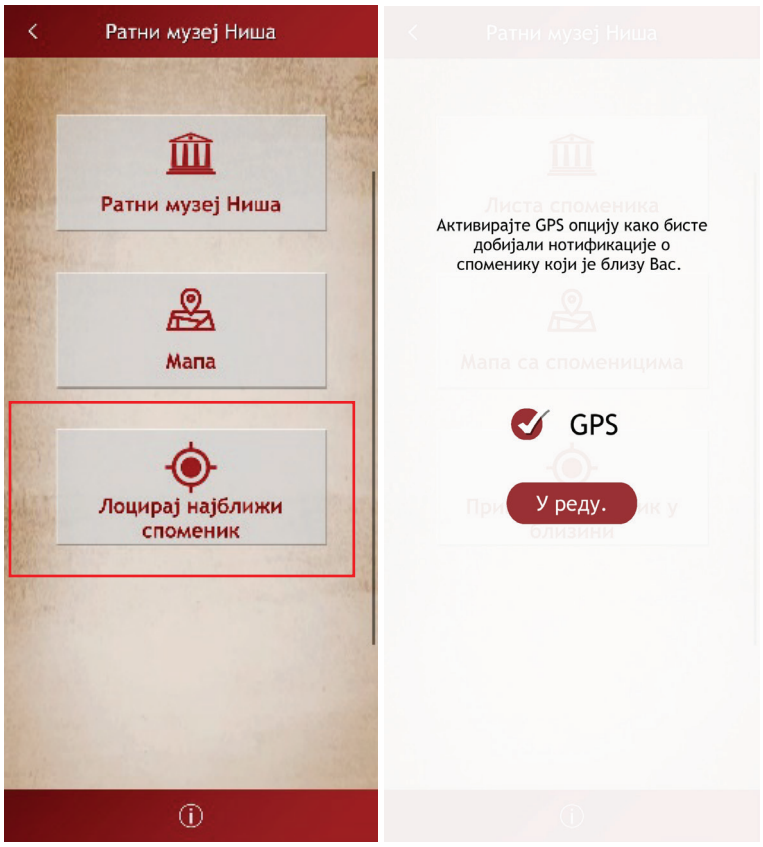

Fig. 3. Activation of the Geolocation module.

When a visitor is close to the monument within a radius of two meters, the basic information about the monument is displayed in the window at the bottom of the screen (Fig. 4.). This info window is interactive, and visitors can find more detailed information about the monument through interaction. When the button is clicked, the Info module is opened where more information is provided in the form of multimedia elements such as text, images, sound, and others.

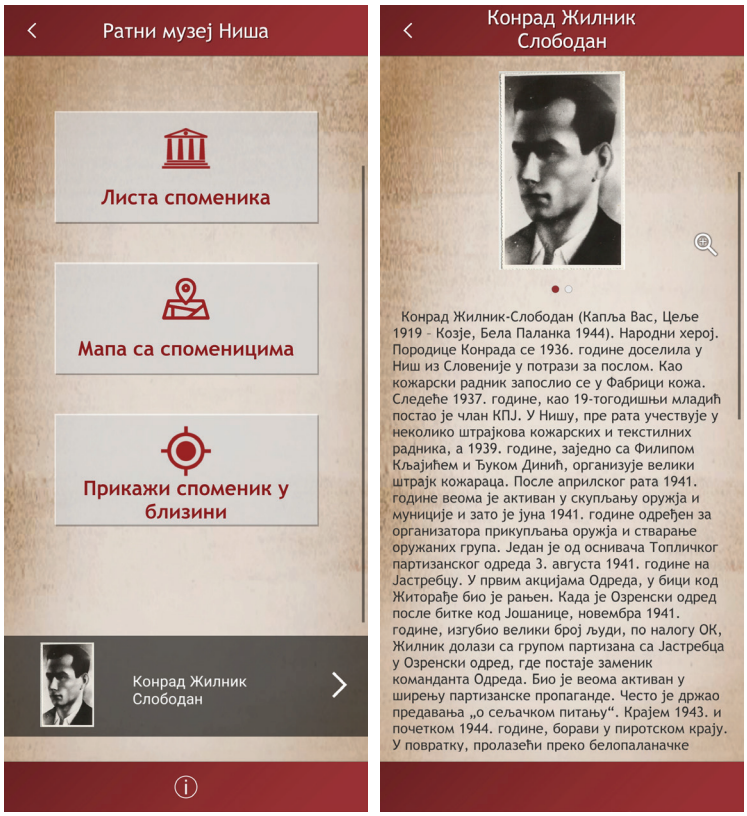

Fig. 4. Showing the monument information when a visitor is close to the monument.

4 Conclusions

This paper presents an improvement of previous works on Multimedia mobile guides. Previously many informational and presentational modules are added to this guide. Information presented to the user was in the form of an ordered list where visitors have to scroll the list with the monuments or by the map where visitors have to explore the monument location. Both modules involve the searching effort of the visitor with the intention to see information about a specific monument.

This paper presents a module for the Geolocation of monuments. In comparison, to previously designed modules, this module excludes the searching effort of the visitors. The advantage of this module is that visitors get information about nearby monuments while walking around nearby monuments. Based on the location-based service on a mobile device, the information is provided when the monument is in a radius of 2 m of the visitor's geolocation position. The use case is presented on the example of the application the War Museum of Niš Under the Open Sky.

More recently, the same module is applied to the application for the sculptures exhibited in the Park of Bukovička near Aнđelovac.

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