

A Mobile Museum Guide Application

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Abstract. The paper describes the development and implementation of software, namely a guide for museums, which can replace or supplement traditional tours. An overview of existing solutions in this area is presented - from global multifunctional platforms to local applications for specific museums. A museum application has been designed and developed for a small historical and local museum considering the specifics of the presented exhibits and allows to convey to visitors all the information about the available museum objects ware, namely a guide for museums, which can replace or supplement traditional. All stages of the development life cycle of this application are described in detail including its approbation in the museum.

Keywords: museum software, mobile guide application, audio guide, IT in museums, presentation of electronic collections.

1 Introduction

The digital transformation in recent years has affected all spheres of public life, including museums, which in the development of the information society are forced to introduce innovative forms of work with visitors, change the ways of providing access to their collections and their distribution. The modern software market offers some solutions for large and small museums, which can be divided by functional orientation into the following groups:

- applications for registration, storage and management of collections;
- applications for better presentation of collections, increasing the visitors' interest and expanding their number.

The last ones include virtual and augmented reality systems [1], 3-D tours and virtual tours, audio guides and mobile guides. Such developments are global open platforms aimed at the widest possible coverage of historical and cultural monuments, local entertainment and game applications for excursions as quests in specific institutions, individually developed specialized applications for the needs of a

particular museum. Choosing a specific solution, each museum is guided by its needs, capabilities and objectives.

1.1 Purpose, Objectives and Prospects of the Study

The development of a mobile guide application for a small historical and local museum called the Zboriv Battle is the main matter. Firstly, a study of existing solutions in the domestic and global markets of museum software was conducted. Paying attention to the specifics of the historical event and the presented exhibits in the museum [2], it was decided to develop its own application that would meet the specific needs, i.e. provide a possibility of extensive audio for each exhibit, as the value of many of them is not in the museum objects, their form, preservation or other characteristics, it is in the related history, which requires detailed interpretation, sometimes with video and illustrative inclusions in augmented reality.

The choice in favor of a mobile rather than a desktop application is also obvious. Nowadays, almost everyone has a mobile phone or a smartphone, which has been transformed from a means only for communication to a means with multimedia and advanced functionality [3].

Using a mobile guide application that contains textual and audio information about the museum's exposition and exhibits is a way to provide information about the museum's exhibits and exposition. The use of the latest approaches and modern information technologies with the involvement of mobile phones will attract more tourists to the museum, improve the quality of received information and as a result it will be a better impression of visiting the museum. Moreover, museums have many exhibits that cannot be placed in exhibition halls at the same time, however, they can be presented virtually using a mobile guide application.

2 Problem Statement

It is analyzed the possibilities of some successful world and domestic projects that exist in the market of the museum software.

Guides4Art [4] is an application authored by Polish programmers, which is a kind of interactive manual and guide to culture and art. It allows you to plan the route of visiting museums in the area closest to a user with an Internet and GPS connection. Each institution in the collection of applications has brief information, travel advice in the form of address, opening hours or presentation of the collections. Individual object holders can add audio guides and manage the list of objects and their descriptions. Thanks to the application, it is possible to visit museums, add places to your favorites, browse the nearest institutions. The Guides4Art application is already available in 1,124 museums in Poland and is confidently conquering museums in three other countries, including Ukraine. There are the Zoological Museum of Lviv National University, the Lontsky Prison Museum, the National Museum named after Andrei Sheptytsky, Museum-Arsenal, museum-pharmacy Under the Black Eagle, Museum of Brewing, Lychakiv Cemetery Museum, Shevchenko Hai Ethno Park among Lviv attractions presented in the application.

Google Arts & Culture [5] is an online platform that allows users to access high-definition image artwork stored in the initiative's partner museums. The platform gives an opportunity for users to make virtual tours of museum galleries, get acquainted with physical and contextual information about works of art and create their own virtual collections. Each partner museum chooses one work of art for an ultra-high-resolution photo about 1,000 times larger than a conventional digital camera, for example the Van Gogh Museum in Amsterdam has chosen the painting called *Bedroom in Arles* as such work. The Google Arts & Culture mobile app allows users to admire the artwork of 1,200 museums, galleries, and organizations in 70 countries, regardless of their location. The developers have created a convenient and multifunctional viewing system. Any exhibit can be maximally detailed and viewed, as well as you can walk around the museum, using panoramic tours with a latitude of 360 degrees, as in panoramic Google Maps. An add from Google also provides thematic viewing of works. This means that a user could sort paintings or sculptures by specific color, era, year, artist etc. The advantages of this platform also have the following features such as the use of virtual reality mode using Google Cardboard glasses; recognition of exhibits (available in some museums); translation of information into the user's native language.

The absolute world leader among open platforms providing online guide services is the ambitious project of the Dutch developers **izi.TRAVEL** [6] launched in 2011. **Izi.TRAVEL** is both a content management system for museums, galleries and other tourist locations, and a mobile application that contains more than 10,000 free audio guides and allows users from around the world to travel to a variety of interesting places both online and offline (in terms of pre-downloading the tour). The idea of the service is that any user could use it to create their own audio tour dedicated to various interesting places to share their knowledge with other people. The advantages of Izi.TRAVEL include an accessibility on all platforms (IOS, Android, Windows Phone, Google Glass), multilingual support, intuitive procedure for downloading and editing multimedia content, automatic generation of QR-codes, detailed usage statistics, detailed help and video tutorials, unlimited space for high quality guides. The application acts as a single entry point to all museums and city tours, and is very easy to use from the point of view of the end user, easily customized to their needs and provides all the necessary tourist tools for quality educational travel.

Despite the opportunities provided by the described platforms to individual institutions to create their own tours and audio guides, a lot of museums that want to emphasize the originality of their collections and present them vividly, choose the path of developing their own applications.

Among the local applications developed for a specific institution for its needs, it is noted the mobile application **Second Canvas Museo del Prado**, developed for the Prado Museum [7]. The application is dedicated to 14 main masterpieces from the museum's collection, which are presented in ultra-high quality that allows you to enjoy the smallest details. The program also provides X-ray and infrared images of paintings. The app contains 60 paintings, thematically and historically related to the presented masterpieces. It helps to learn the history of painting and get acquainted with the technique of execution. There is also an audio guide in English and Spanish,

as well as an explanatory text for each of the pictures and an ability to connect to a TV for viewing in large format. In addition, the application has direct access to social networks, where the user can share their thoughts and impressions, and each of the pictures is automatically connected to the corresponding hashtag.

There are several successful domestic developments for local museums and tourist places such as the augmented reality application Tustan AR, which recreates the three-dimensional view of the ancient fortress city during its heyday; Poltava Open project, which allows you to virtually travel through the streets of Poltava, Dykanka, Myrhorod, Reshetylivka and see Poltava region from a bird's eye view; DMH LvivAR mobile application, developed for virtual tours of the Mykhailo Hrushevsky Memorial Museum in Lviv and many other applications.

3 Development of a Mobile Audio Guide Application for a Local Museum

3.1 Task Statement

In the process of developing a mobile guide application, it is necessary to solve the following tasks:

- to develop the system structure, which will be based on the modular principle that allows to improve quickly the developed software product at the stage of its life cycle;
- to develop software that should have the quality of cross-platform;
- to create a database that will allow you to store the necessary data about the exhibits, system settings, users, etc.

During the design of the mobile guide, the analysis of the existing approaches for the design of these systems was analyzed and the existing analogues were considered.

Based on the analysis, the following list of functions to be performed by the mobile system is identified, namely:

- Presence of a short user guide that demonstrates and describes the main functions of the system.
- Home screen with a description of general information about the museum. On this screen you need to specify the address, opening hours, ticket prices and contact information.
- List of exhibitions and expositions, where information about the existing expositions and the time of their work should be indicated.
- Information about the specific exposition involving a list of exhibits and general information about the exposition.
- Information about the exhibit containing the main description of the exhibit, the code of the exhibit, a photo, and the possibility of starting the audio track.
- Audio player with different modes of operation, which is responsible for controlling the playback of the audio file, navigation between audio files.
- Search for an exhibit by code, which is a QR / Barcode scanner.

- Search for an exhibit by number, where you can manually enter the code of the exhibit.
- Search for expositions and exhibits by keywords.
- System settings, where you can select the language, theme, and configure other parameters of the system.

3.2 Development of the Interface Design of a Mobile Guide Application

One of the important stages of building a system is the development of a mobile application design. The design of the application was developed on the free platform Figma [8]. This platform specializes in the development of vector design for mobile applications and websites. In addition, Figma includes an intuitive interface, which makes it easy to master and design mobile applications.

The design was framed in 2 stages. At the first stage, a schematic design of the application screens (Wireframe) was created, which presents the main elements and their location. The next step was the implementation of color, detailed screens and several iterations of specification and editing.

After that, the existing design was modified according to the style of the themes and the OS. There are four versions of the design such as light theme for Android application, dark theme for Android application, light theme for iOS application, and dark theme for iOS application (Fig. 1).

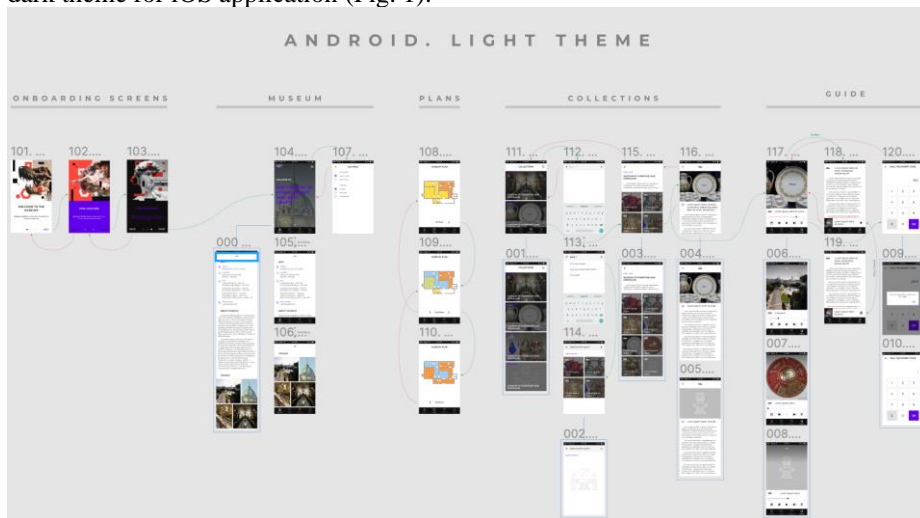


Fig. 1. Light theme design for Android application

3.3 Designing the Structure of a Mobile Guide Application

Based on the formed list of functions and the developed design, the general designing of system took place. The system was divided into the following modules (Fig. 2):

- Data download and deployment module about the museum. The module is responsible for the initial download and deployment of the SQLite database. This module is required so that the application can be used without an Internet connection.
- Database module, which is responsible for providing access to data on exhibits, expositions and audio files. This module encapsulates data from business logic and allows you to easily change the data configuration without changing the internal logic of the system.
- Module for working with user interface elements, which includes screens with which the user can interact, namely:
 - a short user guide;
 - main menu with information about the museum;
 - list of expositions;
 - information about the exposition;
 - information about the exhibit;
 - audio guide.
- Business logic module, which describes the basic logic of the system. The module is responsible for processing commands from the user, changing the state of user interfaces, transitions between screens and working with data. The main functions of the module include:
 - processing commands from the user;
 - work with data on exhibits and exposition;
 - navigation between screens;
 - filtering and searching of exhibits and expositions;
 - organization of audio guide work;
 - work with system settings.
- An audio service module that is responsible for organizing a separate service that may exist in the background even when the application is minimized or the phone is locked.
- Exhibit code scanning module, which is responsible for scanning QR / Barcodes and manually entering the exhibit code.

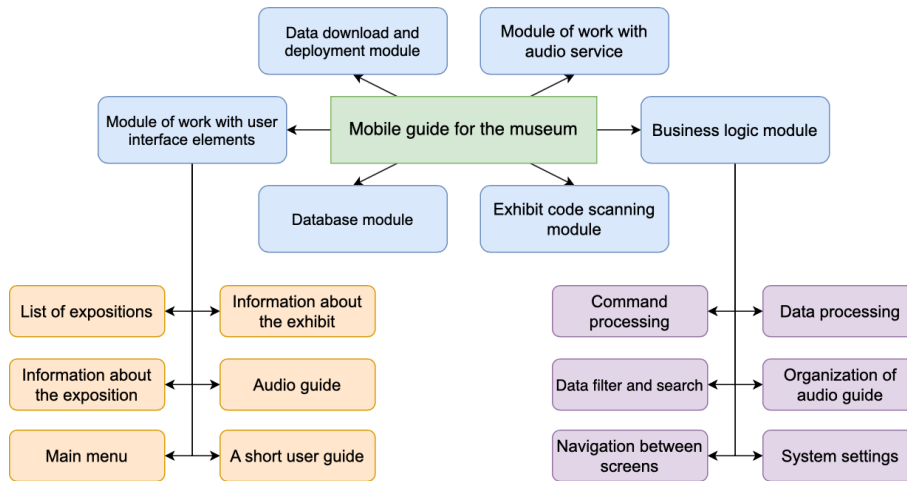


Fig. 2. The structure of a mobile guide system for the museum

Thus, the developed structure is based on the modular principle.

3.4 Software Implementation of a Mobile Guide Application

At the initial stage of implementation, it was decided to implement the system for Android, because according to data for April 2020, Android is used on more than 82% of mobile devices [9]. Accordingly, in order to cover the maximum number, Android is preferred over iOS.

The system is implemented for the Android mobile OS using the Android Studio development environment. The Kotlin programming language was used to develop an application. Google, which owns Android, recommends using Kotlin to develop Android applications. Kotlin is a static programming language that can run on JVM compatible devices. Accordingly, Kotlin is a cross-platform programming language, it is compatible with Java and its areas of use include the development of web-based apps, mobile applications, PC applications, etc.

The Android Studio development platform is the recommended environment for developing Android applications. The program runs on various operating systems and is free to use. The platform is based on the IntelliJ Idea Community Edition, developed by JetBrains.

During the system implementation, the MVP (Model-View-Presenter) architecture was used, which has a clear division at the level of working with user interfaces, business logic and working with data. The system also implements additional modules that are responsible for interaction with third-party services (Fig. 3-5).

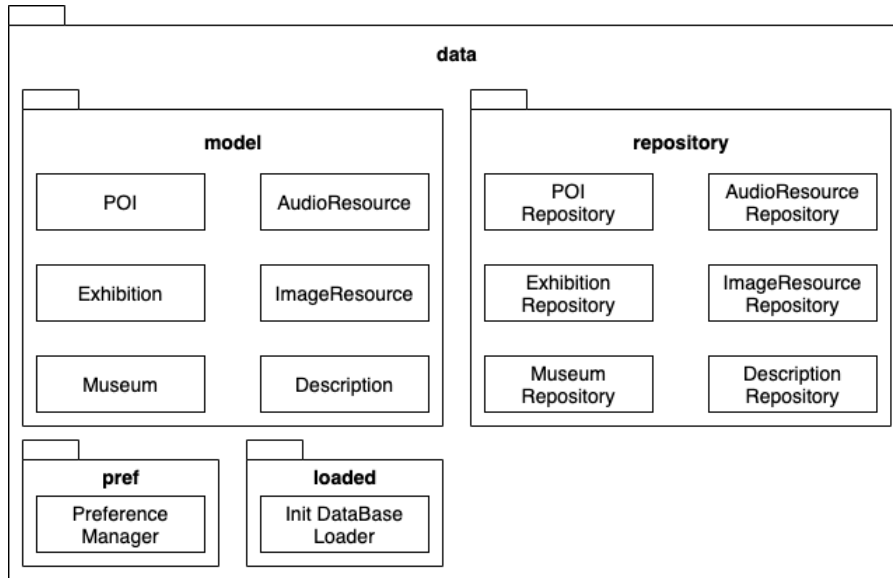


Fig. 3. Diagram of the data package, which contains the main classes for working with data

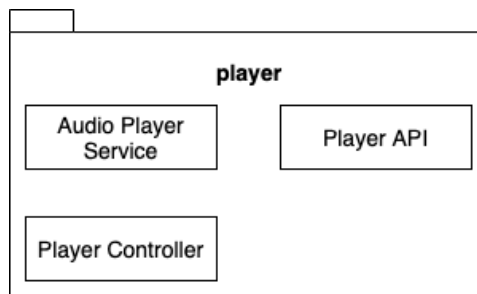


Fig. 4. Diagram of the player package, which contains the main classes for working with the audio service

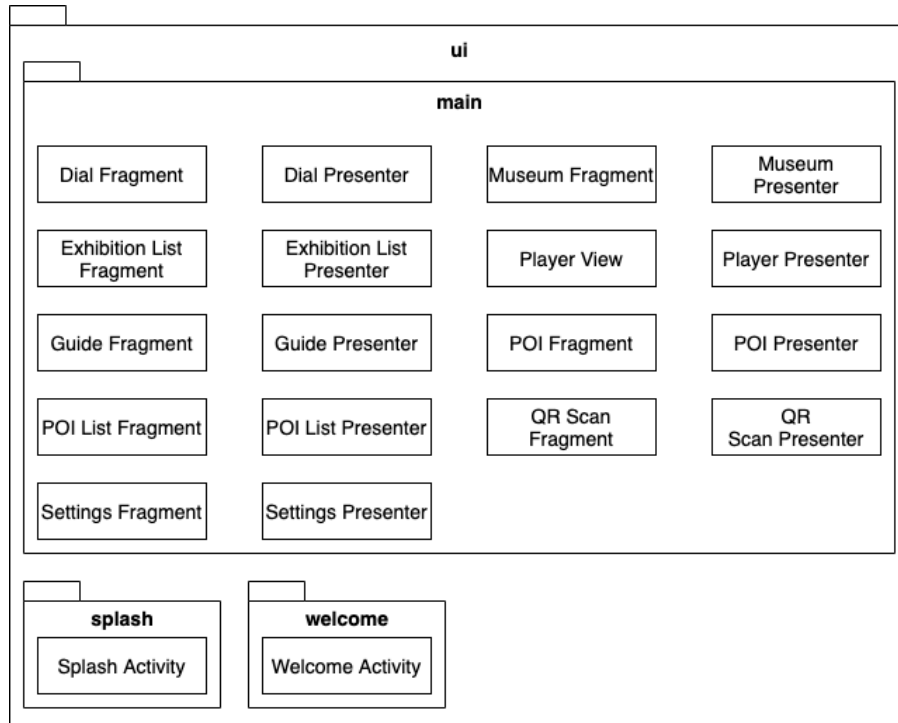


Fig. 5. Package diagram ui, which contains the main classes for displaying screens and implementing business logic

A software system model based on the use of the object-oriented programming language Kotlin has been developed.

3.5 Information Support of a Mobile Guide Application

To ensure efficient work with museum data, SQLite database was used. This is a free database that is built into the Android OS and can be used freely. The database contains information about the museum, exhibitions, and exhibits. The database consists of the following tables (Fig. 6):

- POI corresponds to an exhibit in the museum. Each element of this type contains unique identifiers for searching audio tracks and photo exhibits. Each of the exhibits is attached to the exposition.
- Exhibition corresponds to the exposition in the museum. Each of the exposition contains information about the time of creation, name, and description.
- Museum contains general information about the museum, such as name, description, address, etc.
- AudioResource contains information about the media resource. Each of the audio resources corresponds to a specific language.

- ImageResource contains information about the internal or external image for downloading.
- Description is a text description of an object that corresponds to a language. It is used with all the basic elements to support different languages.

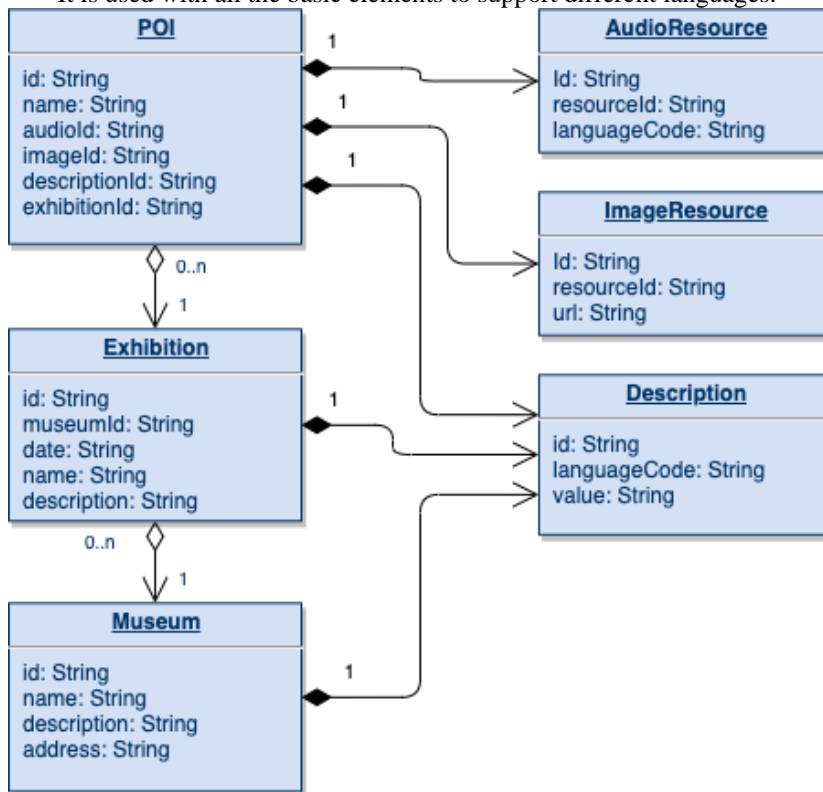


Fig. 6. Database structure for storing data about the museum

The information support of the mobile guide application for museums is based on the use of freely used SQLite database.

4 Approbation of a Mobile Application

Testing of the mobile application was carried out on the three most interesting exhibits from the point of view of the directorate. The exhibits were allocated to a separate exhibition within the application (Fig. 7). The exhibition includes a diorama canvas "Battle of Zboriv in 1649" by local artist S. Nechay, a copy of the mace of Hetman Bohdan Khmelnytsky and a valuable author's publication "Ukraine - the Cossack state" by V. Nedyak (Fig. 8).



Fig. 7. List of active exhibitions



Fig. 8. Exposition information

Each of the exhibits contains a separate screen where you can view detailed information. For example, Fig. 9 presents the image of the canvas, provides technical textual information (author, size, technique, etc.) and it is possible to go to the audio guide, which describes the details of the battle reproduced on the canvas. Information about other exhibits is similarly presented. In particular, the image of a copy of the hetman's mace is presented, which is supplemented by an audio story – the story of the disappearance of the original and the ways of its reproduction (Fig. 10).

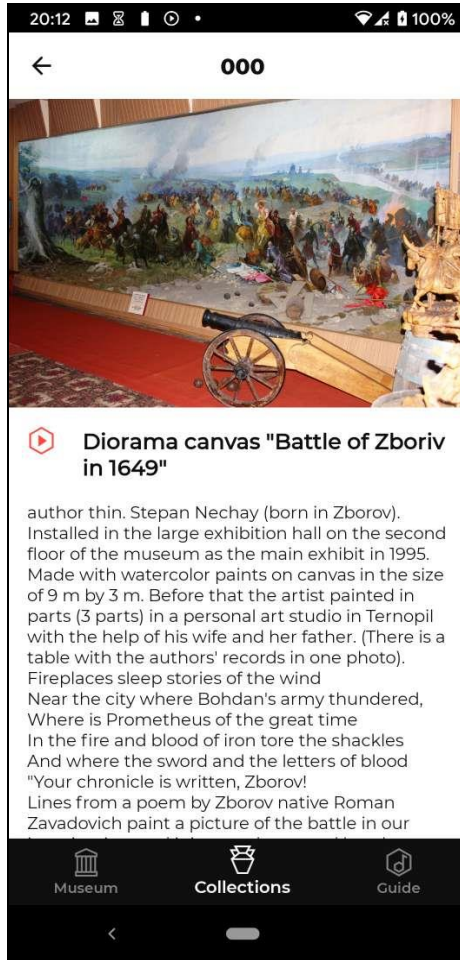


Fig. 9. Information about the exhibit

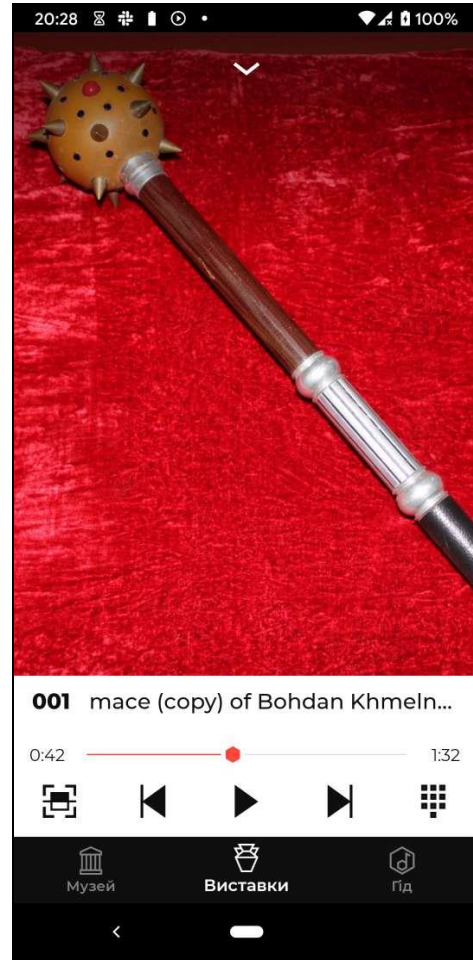


Fig. 10. Audio story about the exhibit

5 Conclusion

The structure of a mobile guide application for museums, which is based on the use of a modular principle providing rapid modernization of the built software product, has been developed.

The developed mobile guide application software uses the object-oriented programming language Kotlin and a software model based on this programming language, which allows cross-platform mobile application, the ability to operate under different mobile operating systems and is a distinctive feature of the developed mobile application.

The information support for a mobile guide application for museums is developed and implemented, which is based on the use of freely used SQLite database that will

significantly reduce the cost of the software product and store the necessary data about exhibits, system settings, users, etc. The advantage of the developed application is taking into account the features of the exhibits of a particular local museum, which will improve the quality of their presentation, attract new visitors and thus contribute to the preservation of the historical heritage in the region.

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