Implementing Mobile Applications for Virtual Exhibitions using Augmented Reality

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Abstract: The purpose of this article is to present the possibility of implementing a mobile application for virtual exhibitions. Nowadays, the history and art consumers have available web expositions, but compared to personal computers, the mobile smart devices provide a huge portability and very fast internet access. Sending the history/culture/art in this way is a step forward and could mean a scope extension. Also implementing such mobile applications in the field of history/culture/art could mean a helpful tool in education. The paper describes the mobile augmented reality systems and two different existing applications used in museums, in order to reveal the advantages of implementing mobile applications in the cultural field.

Key-Words: Mobile Application, Virtual Exhibition, Augmented Reality, Android.

1. Introduction

According to www.businessinsider.com, at the end of 2013, one of five people had a smartphone device (22% of the world population). At the end of 2012 the number of smartphones exceeded the number of personal computers. The publication says also the tablet market is a growing one and in the end of 2013 6% of the world population had a tablet. [1] According to www.digitalbuzzblog.com the average age of the first phone for a kid is 13 years old [2]. For the young people category, which represents a big part of smartphone users, using a smartphone is natural and mainstream. Considering all these premises, one of the most important purposes of the mobile application for virtual exhibitions is accomplished – promoting culture among the young people and not only.

As presented in [3], the evolution of new information technology solutions creates new opportunities to promote and valorize the cultural heritage. The potential offered by mobile technologies, the huge increase of mobile devices that can process multimedia content, both offline and online, facilitates the feasibility of virtual exhibitions. In the near future, mobile devices will become the best interface for accessing cultural heritage, although studies on the type of audience that access cultural content through mobile devices are still lacking.

Figure 1 below summarizes the important role of mobile devices and technologies in promoting the cultural heritage and creating virtual exhibitions that can be accessed anytime and anywhere.

The evolution of mobile devices and applications has made possible the cooperation between computer science and geography fields, when dealing especially with mobile applications containing maps and GPS localization.

Now, it is the time to combine computer science and history fields, by creating mobile applications dealing with virtual exhibitions and cultural heritage elements.

An important example of mobile application creating a virtual exhibition is represented by the project http://statuidedaci.ro, which shows significant statues of Dacians and different places around the world where they are present. The mobile application was implemented also for Android and iOS platforms and can be free downloaded from Google and Apple stores.

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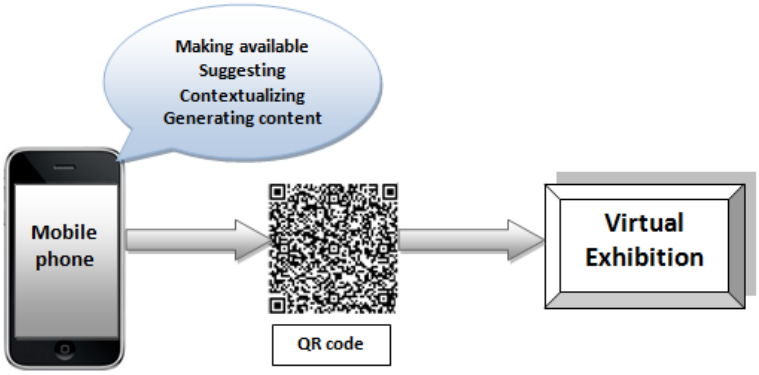

Figure 1. Diagram of mobile application for virtual exhibitions [4]

Nowadays, when almost all the people have a smartphone or a tablet, it is very important to valorize the documents and artefacts that are stored in museums and libraries, because people has no time to visit these institutions and prefer to access their elements online (virtual museums, virtual libraries, e-books, etc.).
At this time, in Google Play are available some interesting mobile applications, such as Caravaggio Virtual Museum or China Museum Alliance, which contains beautiful art galleries that visitors can see on their Android devices.
Virtual exhibitions have now an audience that is large and more heterogeneous than ever before and which is difficult to frame in traditional profiles. Also, virtual exhibitions are an opportunity for disadvantaged or aged people, with physical problems, giving them the possibility to surpass mobility barriers or time restrictions to visit real exhibitions [3].
Educational aspects are important criteria to define the content of virtual exhibitions, because through these presentations, the cultural content may be disseminated to ensure different degrees of learning, from the simplest to the highly complex [3].

2. Related Work and Motivation

When speaking about virtual exhibitions we think about the possibility of combining history and entertainment, in order to break the boundaries of physical space and to create a 3D universe where users can interact while learning more about a science that lately has become a major interest for software developers - history. The increasing number of edutainment applications can be explained by the flexibility they offer. A few years ago an application that could merge entertainment and cultural history was seen as a futuristic concept, but the growth of mobile usage and the evolution of technology managed to attract the attention of cultural institution.
The permanent access to resources was one of the most important factors not only in creating a virtual reality, but in revolutionizing the access to information also.
According to the definition of Azuma (1997) and Azuma and colleagues (2001) [5] an AR system can combine real information with the ones generated by the computer, in order to align virtual objects with physical ones, in real time. This being said, it is easy to accept why developers are more and more interested in developing mobile AR applications for virtual exhibitions. First of all, "smart devices become a mainstream technology, especially among young people" [6], so it is understandably why more than 35% of museums have started using forms of 3D presentation of their artifacts. Secondly, mobile AR applications can be used as a new form of education as well as a way of preserving the artifacts. The process of learning is easier and more exciting, especially because one does not necessarily have to walk throw large rooms, reading the legends of the artifacts, when a virtual character could narrate the story. Everything is now dynamic and entertaining, aiming to attract visitor. Even the European Union showed interest in many research projects related to cultural heritage and

archeology, supporting projects like SHAPE, 3DMURALE, ENAME 974 [7].
The mobile application for virtual exposition must extend the museums and expositions, encouraging involvement of every user, not to replace them. This function will be implemented using extra information about the exhibits, user interaction, questions and answers. One of the most advanced features of the application can be the virtual 3D reconstruction of the exhibits. Using all these features, users can watch closely the exhibits in a fast and accessible way, without affecting the exhibits. The ease of access and the ease of navigation represent considerable advantages over the web virtual expositions. Because of the portability, the mobile application for virtual exhibitions could be an efficient guide for visiting the real exposition.
Because of the latest mobile operating systems like iOS, Android and Windows Phone, the mobile application for virtual exhibitions can implement impressing technologies such as Augmented Reality and 3D object reconstruction, for creating an interactive learning system and for space orientation. Using these elements the Human-Computer interaction purpose can be reached: "to improve the interactions between users and computers by making computers more usable and receptive to users' needs" [8].
British Museum and Samsung achieved a project called "A gift for Athena". The project consists in a mobile application, which help the kids to understand better the exhibits and make them more involved about the museum. Some of the application features are: Augmented Reality trigged by the scanning QR codes, puzzle games and an interactive map of the museum [9].

3. Mobile AR Systems

According to Tobias H. Höllerer and Steven K. Feiner [5], when speaking about a mobile AR system (MARS) we should consider mentioning the most important components that MARS needs. To begin with, we need to have a computational platform in order to create the virtual material based on the physical environment, to enable an authentic AR experience and to control the AR displays.
Displays are another important component that has the capability of reflecting projected images. Head-worn displays, mobile hand-held displays and displays integrated in the physical world are such kind of devices capable of merging real world view with computer-generated images (CGI), using a methods like Optical See-Through or Video See-Through [10].
The alignment of virtual objects with physical ones is known as registration. The alignment can be done by tracking the position of the user's head in order to make the computer "see" the environment using the camera.
In order to perform actions like answer a question, make a selection or even collaborate with other MARS users, a person has to interact with the augmented world. This communication is enabled through wearable input and interaction technologies.
The communication with other people or computers needs a wireless network, but environmental monitoring using wireless sensor network could be a problem when thinking about data storage, another component of MARS. The problem appears when trying to provide information about the position of an individual after roaming. This problem was highly examined by researchers trying to find a way to provide the necessary information with the least effort.

4. The ARMuseum Application

An example of mobile application using AR technology is ARMuseum, a mobile game that takes place inside the Museum of Industrial Olive Oil Production in Lesvos. It was designed for children between ten and twelve years to help them learn more about history. The purpose of the application is to complete some tasks related to olive oil production process, in a specific order, with the help of a virtual character. The user has to locate some machinery exhibited in the museum, prompted by the virtual character, in order to complete a task. The 3D model

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was constructed using the floor plan of the main oil-mill building, but there are also additional markers located next to the exhibits, that need to be scanned in order to complete a task. When a level is completed, the virtual character provides some new information related to the marker that needs to be found next, like the history of the oil-mill. The user has to interact with the camera in order to discover the machineries, but also with some virtual button that appears on top of the 3D model of the oil-mill. After completing all levels, all the machineries discovered while playing are shown in a 3D reconstruction of the building. To remember the experience, the user can take a picture accompanying the virtual character from the game, which will be uploaded on the museum web server.

5. The AR Application for Terracotta Warriors Exhibit

China's Terracotta Warriors or the Terracotta Army is a collection of sculptures and over one hundred other rare objects found nearby Qin Shi Huang's tomb, depicting the armies of the first emperor of China [11]. Using the latest technology, the exhibits are brought to life using 3D objects. After observing the people visiting the exhibition, the Asian Art Museum concluded that most of them spend a lot of time sending texts or taking pictures, so they decided to implement a mobile application using AR technology in order to provide information about the exhibition in an entertainment manner. In the museum rooms visitors can identify some markers. When one of them is scanned with a camera, an exhibit appears. Users can take photographs with the soldiers, can share the photos with friends, but also can learn about the Chinese history.

The Asian Civilization Museum in Singapore invested resources in developing a similar AR application. Being concerned about the entertaining part as well as the educational one, they have created a series of mini-games to help visitors interact with the Chinese culture. After scanning a marker with a camera, users have to write some Chinese text or to fight a war with the help of the Emperor, who is the narrator of the story. While playing, people have the chance to discover the history of the exhibits and to use the obtained information in order to complete as many levels as possible.

The warriors were brought to live with a technology known as String AR. In order to display this life-sized 3D sculptures, sometimes surrounded by fire, this technology had to provide high frame rates. To create the 3D environment and animations it was used Unity 3D. The complexity of the application was a challenge for programmers, not only because they had to integrate interactive narrative, augmented reality and mini-games, but also because of the technical constrains. Figure 2 shows a simplified model of this application.

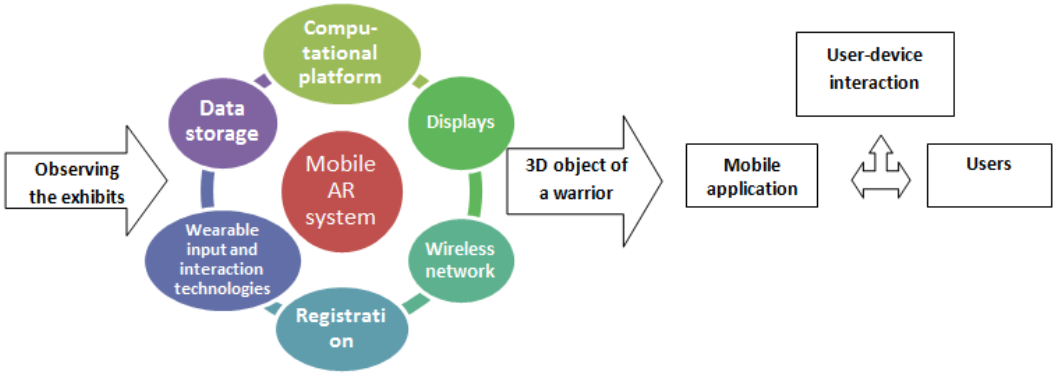

Figure 2. The model of AR mobile application

The use of new technology was a step forward in reaching the younger generation. Until now, going to a museum was perceived by some people as a monotonous activity, but, in the pursuit of finding new ways to stimulate the visitors,

museum have discovered that technology could attract more and more curious people, willing to engage in such experiences.
The development of a mobile augmented reality application could be considered very difficult and challenging when thinking about all the constraints that programmers should analyze, and more than that, the maintenance of devices using AR technology should be taken into consideration as arising additional problems. In spite of all, in a world where smart devices market is growing rapidly, the interaction between human and computer seems to be a necessity, especially when trying to promote art.

6. Conclusions

We must underline the high collaboration potential between culture and IT&C sector, and this collaboration must be enforced given the impact that the technology will have in the next years, especially in the virtual exhibitions area [3].
This kind of mobile applications having the objective to present virtual exhibitions on different cultural areas will have a significant growth in the next years, taking into consideration their impact in educational and cultural fields.

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