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INTRODUCTION OF AUGMENTED REALITY TECHNOLOGIES TO MUSEUM EXPOSITIONS

Mark A. Stepanov, Daniil V. Horshev, Sergey S. Elesin

National Research Tomsk State University, Tomsk, Russia
e-mail: stekramand@gmail.com

Abstract: *The article is dedicated to the integration of augmented reality technologies into museum practice. The authors believe that a careful introduction of such technologies helps to solve several problems at once: convenient receipt of reference information, detailed examination of exhibits with limited access, virtual reconstruction of completely or partially lost artworks, etc. It is assumed that the use of tools of that kind will help to organize spectator's interaction with museum expositions. In addition, the authors summarize the experience in development and application of augmented reality technologies to the historical exposition at Tomsk Regional Museum of Local History "The Siberians: Voluntary and Non-Voluntary".*

Keywords*: museum, exposition, technologies, augmented reality, 3D model, content, project.*

The development of information technology puts today's museums in competition with new media. When carrying out the task of preserving the cultural heritage, the museum ceases to be a platform for its popularization. According to the statistics provided by a research group from the Higher School of Economics, only 16% of Russians visit museums, 70% of Russians do not know about museums and are not interested in them, the remaining 14% know about museums, but do not visit them [1].

The most struggling are small regional museums, the well-being of which directly depends on the number of visitors, since other sources of funding only help to get by. Such museums, unlike bigger ones, do not have large resources at their disposal and accordingly are not able to attract a wide audience. To build up their potential, they need new ways of presenting the contents. It requires a superstructure, additional features, and presentation of exhibits in a new context that would meet the requirements of the younger generation focused on active interaction with information. In fact, the new interactive dialogue revalues the role of the museum as a cultural and educational space that can become one of the ways to organize leisure time smartly. Therefore, to attract new visitors, many museums have to study the audience, use various advertising strategies and introduce innovative technologies [2].

Today, the most relevant technologies introduced in museums are technologies of augmented and virtual reality. Despite the fact, that these technologies are not new, they have not acquired a mass character yet continuing to attract attention from various industries. Taking into account the growing interest of consumers to the augmented reality, its introduction into the museum environment can increase interest in museums and correspondingly improve their cultural and educational function [3]. According to some researchers, it is technologies of augmented reality that are a promising means for flexible adaptation of museums to modern realities [4].

Augmented reality is an effective tool to solve many problems of modern museums.

- Limited composition of the exposition. Fragility and dilapidation of some exhibits, special preservation and positioning conditions, impose restrictions on composition. Technologies of augmented reality allow to examine exhibits, access to which is limited, to gain experience of interaction with exhibits, which are not allowed to touch, to take them apart into pieces and to study their smallest details. The exhibit in the virtual space can be presented in any form, in which the visitor wants to see it.
- The size of the exhibition space of the exposition. Most of the exhibits are stored in museum archives and are not displayed for visitors, due to the lack of necessary exhibition space. The virtual space has no limitations, so you can place the entire collection in it.
- Inaccessibility of some information. Often some information about the exhibits is not available to visitors, especially when visiting the museum without a guide. In the virtual space, any useful information about it can be attached to the exhibit.

In addition, the technologies of augmented reality impel a person to action when working with information, introduce interactivity and expand the potential of working with museum expositions. Thus, the visitor becomes an active participant and a "co-author" of the represented historical and cultural events. All the mentioned above enhances the effect of exposure and improves the quality of information perception, which has a positive effect on improving the cultural and educational function of museums and attracting new visitors.

However, there are certain difficulties that accompany the process of integrating technologies of augmented reality into the museum practice:

- Distrust by the museum administration. Many museums are wary of the introduction of new technologies that have not yet been sufficiently tested. In addition, there are risks associated with the destruction of the traditional museum environment and the development of negative attitudes among visitors as a consequence.
- Insufficient motivation of museum staff. If there is a question about the introduction of new technologies in the museum walls, then there is a possibility of an

additional burden for the museum staff. At the same time, their salary rate remains the same.

- The presence of potential threats that may arise when introducing technologies of augmented reality into the museum environment. This includes the destruction of the traditional museum environment, a complete change in museum concept in terms of providing information, satiety of information, especially in 3D format.
- Certain damage to the exhibits. For example, when an exhibit is fading out due to the constant projector lighting, when the temperature rises in the exhibition room, etc.

Of course, these technologies can lead to negative consequences only if they are used unskillfully. Correct use of augmented reality and its introduction into the cultural and educational museum environment will allow visitors to learn and experience through complex aesthetic perception. Technology will foster the manifestation of independence, initiative and creativity [5]

Given the obvious breadth of opportunities offered by the technology of augmented and virtual reality, regional museums usually can not afford such innovations because of their high cost. A low budget imposes certain restrictions on the choice of equipment used. In consideration of that fact, the most available devices for displaying the content of virtual and augmented reality are smartphones or tablets.

Tomsk Regional Museum of Local History named after M.B. Shatilov with exposition "The Siberians: Voluntary and Non-Voluntary", which was proposed to implement new technologies, is not an exception. The project budget was limited to only 100,000 rubles. Given the budget considerations, top-performing but cost-effective solutions were needed. Work on the project was conducted by undergraduate students of the Laboratory of Humanities Informatics of the National Research Tomsk State University in close cooperation with the museum staff.

In the course of the project, the following stages can be identified.

1.The first stage: preparatory. This includes the collection of materials for the project, exposition objectives definition, specification of the range of application for augmented reality.

2.The second stage: the choice of means of implementation.

3.The third stage: implementation and approbation.

4.The fourth stage: analysis of preliminary implementation results.

At the first stage, all materials of the exhibition were examined: exhibits of the exhibition hall, unavailable exhibits, text materials and photographs related to the exposition, equipment involved and that which remained unused. The initial scope of technology application was defined, namely: a web site, an interactive screen, a projector, a monitor for simulating a moving train, and a sound track. For this reason, the introduction of technologies of augmented reality was a natural process, that was not in conflict with the very concept of the project "The Siberians: Voluntary and Non-Voluntary".

"The Siberians: Voluntary and Non-Voluntary" is a memorial, educational and research project, which has been realized by Tomsk Regional Museum of Local History since 2013. Its main goal is to show Russian history through the lens of private history by example of a typical Siberian family, the history of the place of settlement, and can be understood as an attempt to link private events, subjective memories and evaluations with the bigger context of public history [6].

The following tasks were defined:

- to attract new visitors;
- to expand the information scope of the exposition;
- to transform some exhibits within the virtual space.

Several factors influenced the adoption of ideas for implementation: the availability of necessary equipment, the possibility of careful introduction of technologies, and the implementation deadlines to be met. Therefore, it was planned to implement only two decisions and to test them for the "Night of Museums", which took place on May 19, 2017.

1.An application with augmented reality "Fitting clothes of immigrants". The idea was to use a monitor, looking at which the visitor could see himself dressed in the clothes of settlers. It was supposed to choose clothes from several available options.

2. An application with augmented reality for smartphones. To implement this decision, it was planned to transfer some of the exhibits into augmented reality. The content of the augmented reality is displayed inside the application after the mobile device camera has read special markers placed in the exhibition hall. This is a classic variant of using augmented reality in a museum space.

Within the second decision, it was decided to digitize the following exhibits: wheel plows and ordinary plows, horizontal and vertical spinning wheels, and a potato-maker. In addition to 3D models of these exhibits, it was decided to tie them in augmented reality in the form of photographs, videos and texts. Besides, a content to the history of settlers and the database of immigrants were added, in which the visitor can find potential relatives.

At the second stage the implementation means were chosen. The solutions were designed for various platforms. The first one for PC, the second – for smartphones and tablets. Taking into account the limited budget and due to certain advantages for the implementation of both solutions, the Unity 3D software was chosen with the use of the Vuforia package (for the second solution).

For the first solution, the following equipment was also required:

1. Device for playing a video stream on a large screen. For that purpose a monitor was used at the exhibition.

2. Depth-sensing camera. The Laboratory of Humanities Informatics provided an Intel RealSense F200 camera.

3. PC powerful enough for video processing. After the first test it was decided to use one of the developer’s a laptop.

However, the first solution was decided to be postponed in connection with the problems of equipment placement. For instance, all the necessary outputs of the monitor were isolated, and it was impossible to get close to any connectors. In addition, the range of the available camera's depth sensor was small, so that a correct recognition of the visitor's image would force her/him to go close to the monitor, which would be very inconvenient.

To implement the second solution, a mobile application was created and additional content for the selected exhibits was generated, after which the assembling of scenes of augmented reality for different exhibits began. Considering the complexities and nearing deadlines for the project implementation, a run-time version of the application was released, two 3D models were set ready: a horizontal and a vertical spinner. The remaining 3D models of selected exhibits will be available in subsequent versions of the application. Personal stories and settler's database will also be added later. As a temporary solution, the application has got a link to the web page of the project "The Siberians: Voluntary and Non-Voluntary" containing stories and the database of migrants to Siberia.

At the third stage, on May 19, 2017, the application "History beyond the Screen" was published on the Google Play Market. After the mobile application was ready, materials for the exhibition were created and printed:

- Instructions for installing the application from the Google Play Market;
- Image tags;
- Booklet with brief information about the project.

At the fourth stage, the preliminary implementation results were analyzed. Augmented reality solutions for the exhibition "The Siberians: Voluntary and Non-Voluntary" were conceived and implemented as addition to the exhibition, a small superstructure. They did not have to take visitors' attention from or change the "face" of the exhibition. The content in the augmented reality was closely related to the exhibits. After introduction to the exposition, tags and flyers designed in the style of the exhibition were placed. Thus, some conclusions about the quality of introduction could be made. Most people having tested the application were glad to get acquainted with the content of the augmented reality and gave a positive assessment to the project. However, some errors were identified during the exhibition, and the following considerations need to be taken into account when planning similar projects in the future:

- Only few visitors paid attention to the booklets with information how to install the application. In future, it's reasonable to distribute booklets and flyers more sensible in the exposition hall as well as find alternative ways to inform visitors about the application. For example, to use more actively the exhibition web site, to print information about the application directly on the museum tickets, or to hand out an additional booklet to the ticket.
- The tags for augmented reality did not have any context. Despite the fact, that the tags attracted the attention of visitors, their placement without any

context was a mistake. In this particular case, information about what one needs to do with these tags could appear as such a context.

- A poor account was taken of all the smartphone technical requirements: the lack of gyroscope and accelerometer required for correct viewing of additional content of the application, unlicensed firmware that made it difficult to download the application from the Google Play Market, unconventional operating systems not supporting the installation and operation of the application. In this case, several solutions to the problem are proposed. Firstly, there must be a sufficient number of devices with preinstalled software in the exhibition space, so that users have an opportunity to get acquainted with the product without extra efforts. Secondly, it is necessary to cover a wider range of smartphone types to make them run the application.
- It was suggested that visitors did not want to download the application because it was worth downloading only in the exhibition context. Thus, it is necessary to refine the function set for the application, so that visitors can use it repeatedly and for various purposes. For example, to put information that is excessive to share it within the excursion, so that visitors have the opportunity to look through at any convenient time.
- Some visitors faced difficulties when interacting with the content of augmented reality. Many people ignored the booklets with a visual guide to using the application. Typical user expects that the application will "prompt" him what to do, and expects to see the ordinary interaction interfaces. Therefore, you need to put an application usage guide into the application. For example, as a tooltip.

Summarizing all above mentioned, one shall anticipate all the potential difficulties that exhibition visitors may encounter in order to prevent or minimize possible organizational errors. The biggest challenge for integrating the technologies of augmented reality into museum practice is that developers do not have the opportunity to design it by a common pattern. Each museum is unique, and what is a good solution for one museum, may be useless for another. There are many examples of failed introduction when augmented reality contradicted the museum identity and served only the entertainment purpose. However, there are many good examples of how augmented reality technologies can smoothly fit into museum space. Moreover, with a competent approach, they are able to transform museums and breathe new life into them, as well as attract the attention of new visitors.

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