The use of augmented reality technology in the reconstruction of a lost cultural heritage site

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Abstract. The paper is devoted to the study of the possibility of using augmented reality technology in the process of hypothetical (virtual) restoration of the authentic appearance of lost cultural heritage structures on the example of an object of regional significance - the cinema “Sever”. Based on the collected archival data and field studies, a historical and retrospective analysis of the cultural heritage object and its territory is presented, the construction history of the monument site is developed, dimensional drawings are restored and three-dimensional models of the object in various historical periods of the monument life are created. A detailed description of actions for creating an augmented reality object and exporting its animated model to an accessible digital platform (Instagram) was developed. The expediency of using the augmented reality approach in the reconstruction of lost cultural heritage objects is shown. This technology allows recreating the appearance of the lost monument in conjunction with the actual architectural component of the urban space. Successful implementation of this approach will allow for more detailed cultural, historical, archaeological, ethnographic, anthropological and other research.

1. Introduction
In the context of global digitalization, modern technologies, as a complex of information resources and equipment, are one of the main elements of any type of activity, including the preservation and promotion of cultural heritage objects [1].

Currently, a large number of unique historical buildings due to various reasons (anthropogenic impact, technological progress, imperfect legislation on the preservation of cultural heritage, etc.) are destroyed and irretrievably lost [2]. The issue of searching for modern, informative and at the same time cost-effective solutions to restore the appearance of lost monuments is becoming more and more urgent [3-6].

One of the possible methods of oriented work with historical and architectural heritage is the use of augmented reality technology (AR - augmented reality) - one of the fastest growing technologies of the XXI century.

Augmented reality is often confused with virtual reality (VR-virtual reality), but this technology is not formed only from digital objects located in 3D space. In augmented reality, objects are part of the existing environment, and the mobile device display shows the user the real physical world with added virtual objects.
In the context of the reconstruction of cultural heritage sites, the use of augmented reality technology is preferable, as it allows recreating the appearance of the lost monument in relation to the actual architectural component of the urban space [7, 8]. Successful implementation of this approach will allow conducting cultural, historical, archaeological, ethnographic, anthropological and other research in the future.

Thus, the aim of this work was to evaluate the possibility of using augmented reality technology to recreate the authentic appearance of lost cultural heritage structures on the example of an object of regional significance – the cinema “Sever”.

The implementation of this technology involves a number of research activities: archival and bibliographic research; field research; historical and retrospective analysis of the territory and the object; development of a 3D model of the object that illustrates the appearance of the object in its life periods; creation of augmented reality of the object and export of its animated model to an accessible digital platform (Instagram) for further use and popularization.

2. Materials and methods

2.1. Materials

The object of research was selected as the object of cultural heritage of regional significance “E.K. Plotnikova’s city estate in Arkhangelsk “Cinema” 1903-1915. The building of the cinema “Sever” is located on the line of Teatralky lane and is part of the complex of development of the city merchant’s estate, which is a monument of history and culture of the late XIX-early XX centuries [9].

As of June 2020, the facility is almost completely dismantled. In its place there is now a vacant lot enclosed by a metal fence. Work on the restoration of the monument is not underway (figure 1).

![Figure 1. View of the main facade of the cinema “Sever” (June 2020): a – photo-fixing point 1; b – photo-fixing point 2.](image)

Archival and field studies, as well as existing project documentation for the restoration of this object served as the basis for the development of three-dimensional models, followed by their animation and integration into augmented reality technology.

2.2. Methods

To create realistic three-dimensional models of the Sever cinema in various historical periods, the following licensed application software was selected [10]:

[10]
1. Autodesk AutoCAD (the program created drawings of the main structure of the cinema in *.dwg format, which were then imported into the corresponding package for three-dimensional modeling in the form of two-dimensional curves (spline));
2. Autodesk 3ds Max Design 2009 (realistic three-dimensional models of the cinema were created in the image editor);
3. Adobe Photoshop CS3 (required for creating realistic images (textures) that are then superimposed on the corresponding parts of the modeled object exterior);
4. The program Spark AR Studio was used to work with augmented reality.

3. Results
Based on the historical and archival research of the object, six main periods of its existence were identified:

_I period. 1895-1908. Market stalls._
When comparing the design drawings of stalls with subsequent drawings of reconstructions, it becomes obvious that only a small part of the masonry of the street facade along Teatralny lane survived fragmentally from the original building to the present day.

_II period. 1908-1915. Power station._
Nothing remains of the power station. All its walls and ceilings were dismantled or redone during repairs.

_III period. 1915-1929. Edison Electric Theatre._
The electric theatre, founded by E.K. Plotnikova stood for fourteen years. However, the private “Edison” was too small for a city movie theatre. After the expansion and reconstruction of the building, three facades were preserved in fragments: North, East and South.

_IV period. 1929-1950. Edison cinema._
The principle of the internal layout of the 1929 cinema, oriented to the East (on the screen), did not change significantly. Unfortunately, it is little known about the design of facades and interiors. During this period, the main entrance to the building was arranged from the side of Teatralny lane.

_V period. 1950-1991. Cinema “Sever”._
Reconstructions of this period were mainly concerned with the interior design of the cinema, giving the interiors more grandeur and convenience in the style of the 1950s.

_VI period. 1996 - to the present time. Cinema “Sever”._
In 1996, the building was transferred to the State Museum Association “Art culture of the Russian North”. During this period, restoration work begin at the monument to adapt to the modern use of the cinema building. Since its construction, the building has repeatedly changed not only its size and architectural appearance, but also its purpose – from “commercial” to cultural and entertainment.

By scaling archived plans, sections, and building facades, they can determine their true dimensions in different time periods. The study of project documentation for the restoration of the cinema, namely floor plans, facades and sections, as well as photos of the building and its individual parts, allowed developing three-dimensional models of the object in the main historical periods of its existence (figures 2-5).

**Figure 2.** Solid model of an extended extension to retail stores, 1903-1908. Facade of the yard.  
**Figure 3.** Solid model of power station, 1903-1909. Facade of the yard.
The next step after modeling an object is texturing and its rendering; and the final step is creating an augmented reality scene from the object and the planar tracker. Figures 6-13 show the results of this work sequentially.
**Figure 10.** Publish an Effect page in Spark AR Hub. Media and Visibility settings groups.

**Figure 11.** An Instagram page with accepted interactive work.

**Figure 12.** The backyard power plant, 1908-1913
Augmented reality on mobile devices.

**Figure 13.** Cinema “Sever”, 1951
Augmented reality on mobile devices.
4. Discussion
Thus, the obtained practical results indicate the feasibility of using the augmented reality approach to solve the following tasks:
1) virtual reconstruction of lost cultural monuments based on historical documents; 
2) virtual reconstruction of existing cultural monuments with the possibility of virtual visits to them.

5. Summary
The study was carried out as a practical recommendation for recreating cultural heritage objects by three-dimensional modeling and embedding in the existing architectural landscape using augmented reality technology. Using this approach allows conducting cultural, historical, archaeological, ethnographic, and anthropological research. In addition, it should be noted that the implementation of the proposed technology does not require special expensive technical support.

6. References
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