Virtual Reconstruction of the Ancient Russian Fortress Koporye

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Abstract. One of the major strategic tasks in Russia's northwest of the past centuries was the defense of the country's territories from enemy incursions coming from the West. In order to solve this task, a robust shield in the form of a system of fortresses was created between the 13th and 15th centuries. The system included such fortresses as Koporye, Yam, Korela, Oreshek, and others. In our age, these monuments have become an essential part of Russia's historic and cultural heritage and an important element of the tourism cluster "The Silver Ring of Russia." The Centre of Design and Multimedia at St. Petersburg National Research University of Information Technologies, Mechanics and Optics, jointly with the Department of History and the Faculty of Arts at St. Petersburg State University, working under a three-year grant from the Russian Foundation for Humanities Research (#12-01-12041), is implementing a multimedia information system "Ancient Fortresses of Russia's Northwest". Historically accurate virtual reconstruction of several fortresses as they existed during certain historic periods, done in such a way as to allow the future creation of virtual tours of these sites, has become the focus of this project's research. In the present paper, we describe the main phases and results of virtual reconstruction of the best-preserved fortress, Koporye.

Keywords: Virtual Reconstruction, Russian Northwest, Multimedia Information System, Cultural and Historic Heritage, Information Technologies, Koporye, NRU ITMO, SPbGU

1   Introduction

The system of ancient fortresses in the Russian northwest, built between the 13th and 15th centuries, formed a robust defense shield. It protected Old Russia's borders from foreign invaders (belligerent Swedish feudal lords and knights of the Livonian Order), provided access to the Baltic Sea, and ensured Russian sovereignty over the country's remote Finnish-speaking parts [3].

The fortresses constituted the only serious obstacle on the path of an advancing invader. Their role was to compel the enemy to conquer them: otherwise, their garrisons were capable of mounting attacks from the rear and organizing raids deep into the adversary's territory [1].

New techniques in the military art of laying siege and the advent of firearms resulted in the originally wooden fortresses being rebuilt in stone. Since the invaders were increasingly moving from engaging in battles under the fortresses' walls to direct assaults on them, the walls had to be built higher and sturdier. To further complicate access to the walls, towers were constructed.

Throughout the centuries, periods of wars and hostilities alternated with those of peace and quiet, so the fortresses played roles other than that of military installations. Many were also administrative, commercial, and religious centers of the surrounding territories.

In the 19th century, the fortresses began to be viewed as unique artifacts of Russia's cultural and historic heritage. The need for state-financed conservation and restoration efforts was accepted. The fortresses became sites of local history museums and over time evolved into large historical and museum research institutions. The Korela Fortress Museum, launched under the auspices of the historico-military festival "Russian Fortress," which takes place at the fortress, is one example of this.

Recently, the fortress system in the Russian northwest has become part of the tourism cluster "The Silver Ring of Russia" which aims to familiarize visitors with the development of ancient Russian culture in the country's northwest.

The Centre of Design and Multimedia at St. Petersburg National Research University of Information Technologies, Mechanics and Optics, jointly with the Department of History and the Faculty of Arts at St. Petersburg State University, is implementing a multimedia information system "Ancient Fortresses of Russia's Northwest" (http://nwfortress.ifmo.ru/) [4]. This work, financed by a grant from the Russian Foundation for Humanities Research (#12-01-12041) began in 2012 and is scheduled for completion in 2014.

The multimedia information system is being developed as an Internet portal providing comprehensive information on Northwestern Russia's fortresses. The contents for each fortress are split into five topical categories:

1. About the fortress (general information).
2. History.
3. Architecture.
4. Archeology.
5. Interesting facts.

Besides textual material, the portal contains a breadth of multimedia content:

1. Video interviews with experts (historians, archeologists, architects, restorers, etc.) directly involved in historical research activities at the fortress.
2. Galleries of HDR photographs.
3. Virtual tours of the fortresses of the northwest (Fig. 1).

Fig. 1. Virtual tour of the Koporye fortress. The middle tower.

Historically accurate three-dimensional virtual reconstruction of the fortresses during certain historic periods has become one of the main elements of the present project's research. Selecting a specific target period is necessary, since the fortresses were rebuilt many times over their lifespans. The main criteria for making this selection are the completeness of the fortress as a fortified military installation during the period in question and the availability of project documentation and archive materials needed for reconstruction.

Once its three-dimensional reconstruction is complete, the virtual fortress, augmented with virtual museum elements, can be posted to the portal. This allows the user to "tour" it.

2   Virtual Reconstruction of the Fortress Koporye

Fortress Koporye is situated on the North-Western tip of Izhorskiy Plateau, near the Gulf of Finland. The fortress occupies a small area of rock promontory. The south and west sides of fortress are limited deep by deep ravine through which flows a river Koporka [5].

The fortress consists of a powerful fortress walls, complex of strengthening for gates, located on the eastern walls, of four towers, two of which (South and North towers) protect the entrance to the fortress, the other two towers (middle and corner) are located on the North (accessible) walls. South (inaccessible) walls have a semi-circular structure according to the form rock on which stands the fortress Koporye (Fig. 2).
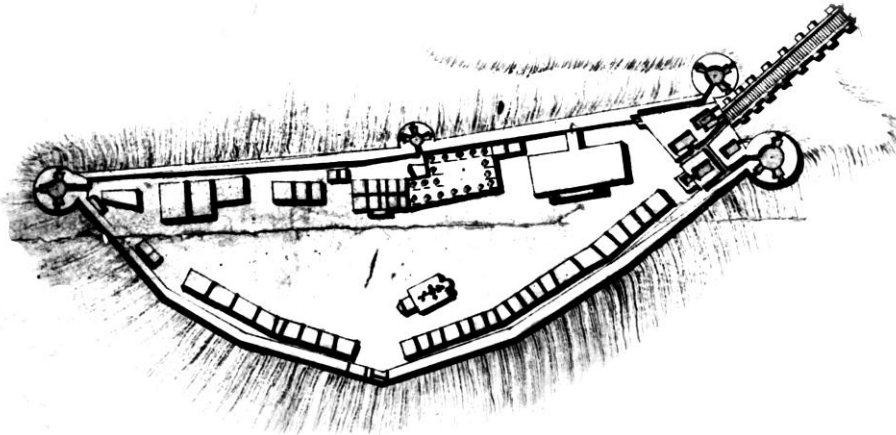
Fig. 2. A general view of the fortress Koporye.

In the central part of the fortress yard is the Preobrajensky Cathedral, built in the XVI century. In addition to the cathedral in the fortress housed such constructions as:

1. Commandant's office - a stone building, in which were all the threads of the military and civil administration. Koporskaya fortress and the county.
2. Fortress commandant's house - part of the yard of the complex with auxiliary buildings and a large garden.
3. Barracks - a long series of one-story wooden buildings, where lived in the fortress garrison soldiers.
4. "Magazeyny" - storage facilities for purveyance and military ammunition.
5. Stablings.

The fortress Koporye is the best preserved ancient fortification monument, which almost didn't touched by the hand of the restorer. One of the unique architectural features of the fortress is the gate system consisting of a branched defense system. Through the fortress bridge, protected by two towers, the enemy went to a system of large and small passages, closing by drawbridges. If you do not have time to raise the bridges, the entrance was barred by iron gratings ("Gersa"), after "Gersa" located a system of gates and doors [2]. Before we get into the tower, the enemy was forced moves on the fortress wall were placed an appropriate inputs in fights towers.

Virtual three-dimensional computer reconstruction of the fortress Koporskaya carried out in collaboration with architect restorer of the highest category Khaustova Iren Alexandrovna, who worked a long time on the territory of the fortress and has a unique documentary material on the history and architecture of the fortress was. Having examined the technical documentation and archival materials, it was decided to restore the virtual fortress during the beginning of the XVIII century. At this time Koporie became the administrative center of the Koporsky county.

During the preparatory work has been selected the following software is required to create the object "Koporskaya fortress":

1. Autodesk 3D Studio Max - main program to create a fortress.
2. Autodesk AutoCAD - drawing creation.
3. Adobe Photoshop - work with images and textures.
4. Unity - creating a scene "Koporskaya fortress" to be placed on the web portal of "Ancient Fortresses of Russia's Northwest".

In the initial phase of reconstruction was compiled simulation algorithm location of the "Koporskaya fortress", which includes:

1. The territory on which the fortress was situated.
2. The "body" of the fortress - the eastern, northern and southern walls (Fig. 3).
3. Four towers of the fortress.
4. The courtyard of the fortress - Preobrajensky Cathedral (during the XVI century) and other buildings which are located in its territory.
5. Various objects placed in the fortress (the cart, gun, etc.) - the basis for the creation of a virtual museum "Koporskaya fortress".
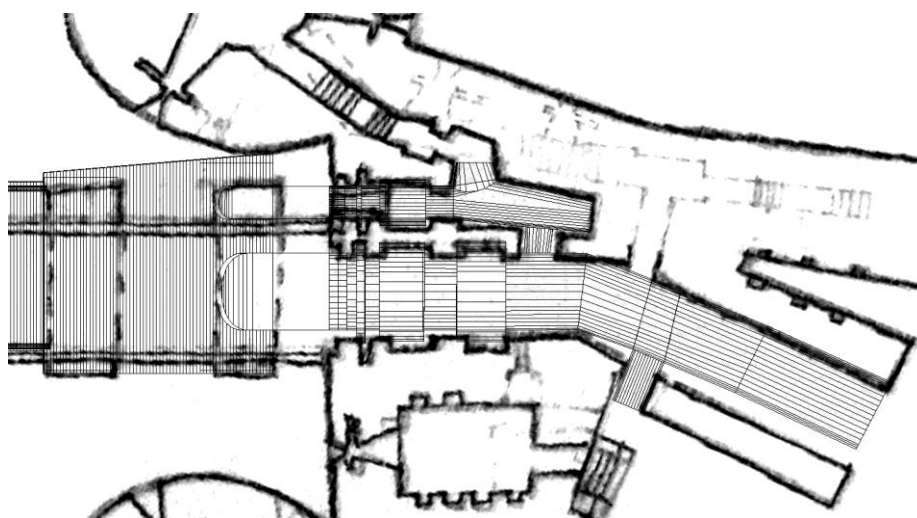

Fig. 3. "Entrance complex", the process of modeling.

The next step after creating three-dimensional computer model of the fortress and the facilities on its territory was the process of texturing. Apart from the use of seamless textures of wood, masonry, ground cover, etc. have been used images photographed directly in the fortress and converted to the texture.

On Fig. 4 shows the result of a three-dimensional virtual reconstruction Koporskaya fortress at the beginning of the XVIII century.
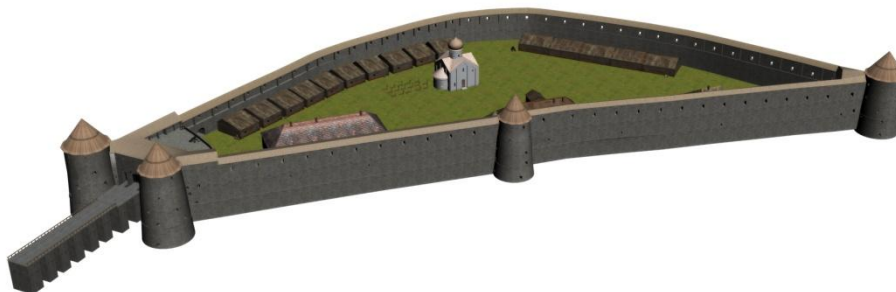
Fig. 4. Koporskaya fortress - a virtual three-dimensional reconstruction in the period of the beginning of the XVIII century.

Three-dimensional computer reconstruction of the fortress Koporskaya (like any authentic virtual three-dimensional reconstruction) may be useful in the restoration, scientific research, education, archival, entertainment and other activities, which proves the importance and relevance of the work for the conservation of cultural heritage in digital forms.

3 Conclusion

Create any web portal with the scientific content and the various multimedia applications can be considered as a resource of information, research and entertainment system. Web portal "Ancient Fortresses of Russia's Northwest" will be part of the information space, designed to promote among internet users of all ages qualities such as: interest in science, patriotism, desire to create their own multimedia resources, etc. Methods of creating a virtual three-dimensional reconstruction of the object Koporskaya fortress used in teaching the subject of "The technology of computer reconstructions".

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