Development of an information model of a virtual space of a historically significant territory

IOP Conf. Series: Journal of Physics: Conf. Series **1278** (2019) 012007 doi:10.1088/1742-6596/1278/1/012007

Development of an information model of a virtual space of a historically significant territory

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Abstract. The article examines the questions of creating a virtual space of a historically significant territory as a means of communication and effective civil and patriotic education of young people. The proposed formal description of the model of the virtual space includes the sum of knowledge about a historically significant area (a historical site) presented in the form of a graph structure of frames. The creation of a virtual space in the form of a virtual museum is carried out using an open source software platform OpenSimulator 0.9.0, which is a server platform for 3D virtual worlds. Visualization of the museum is available to all Internet users. Thus, a thematic information environment has been created to provide access to relevant information and contributes to the growth of youth interest in the problems of national culture, history, and civil culture. In addition, an important role is played by the social aspect, as within the virtual world users can interact with others, observe their movements and actions, and communicate with them in real time.

1. Introduction

Currently, information technologies are increasingly being used in research works aimed at improvement of civic and patriotic education of young people. One of the data sources is knowledge about the objects of cultural and historical heritage. The study of these objects can be done with the methods of natural sciences that are well established and widely used in engineering. Civil and patriotic education of the digital generation requires an active use of information technologies, primarily network information resources that implement immersion in a fully three-dimensional web environment of virtual reality.

Virtual reality (VR) has raised great expectations for solving this problem: the possibility of reconstructing environments, buildings, objects, etc. It can be used for conservation, study and replication [1]. In addition, objects, sites and monuments can be accessible to a wider audience employing networks and computer technology. In the last decade, 3D digital models of virtual access to the cultural heritage have been widely used due to increasing interest in their application.

The use of modern information technologies for preserving historical and cultural heritage objects has been extensively discussed in the literature.

The general purpose of the work [2] is to provide an idea of making museums available for those who cannot visit them physically, whereas the main purpose is to protect the original cultural heritage by reproducing the same artifacts with respect to the original size as well as various dimensions. Digitization can be accomplished through many ways such as photography, panoramic display or by saving 3D coordinates of the art object.

The research by Shaw and Krug [3] was conducted as a part of the project designed to offer guidance on development of a youth oriented online space for a popular Canadian museum of heritage and immigration. This space would allow young people to learn about heritage, ethnicity, and cultural identity, and, ideally, aid in development of a positive ethnic identity.

As demonstrated in several case studies, 3D digital acquisition techniques may greatly help in documenting an archeological site and related findings. An accurate reality-based representation may also be used as a starting point for creating a scientifically sound virtual reconstruction of a site, embedding historical information of different provenances. The paper by Guidi et al [4] describes this whole process step by step, focusing on the iterative feedback that can allow to reach the best virtual reconstruction solutions, helping the archeologists to better focus their reasoning through a detailed visual representation, and technological experts to avoid misleading details in the final virtual reconstruction. The methodology has been applied to a group of Cham temples located at MySon, a UNESCO archeological area in central Vietnam

Sequeira and Morgado [5] present an overview of four different approaches to virtual archaeology projects that are presented in Second Life®, and its open source counterpart, OpenSimulator and that have been publicly discussed and analyzed; in particular, the last type shows a novel approach to virtual archaeology which is not found in other platforms, and explains how researchers have managed to extend the concept to new areas and develop methodologies to incorporate validation of historical accuracy to encompass these areas.

In this regard, the purpose of this work is to create an information resource for effective civil and patriotic education of youth through the study of value orientations and the level of civil and patriotic qualities of previous generations of people associated with historically significant and memorable places of municipalities [6].

2. Virtual space of a historically significant territory at different stages of its development

Creation of a model of a single information space using virtual modeling technologies for historical processes in a particular Russian region is only possible on the basis of a large number of archival materials, publications in the media, memories left by the witnesses of these processes, and mandatory geographic information supplement. The study of such information sources will reveal the dominant direction in the economic, social and administrative development of a particular region. Such studies should be carried out for certain historical periods for the selected region. The boundaries of the period under consideration may be some historical events of national or world importance, which left their mark and led to a change in the development of a particular region.

The results of such studies can be presented in a visual form. The ability to analyze changes in urban development of historically significant areas, closely related to historical events that affected them, allows us to determine the significance of these events and the magnitude of their impact on the course of further development of the region under study. Means of modern information technologies, in terms of their application to imaging, significantly activate a cognitive research direction in scientific work of this nature [2].

The approach proposed by the authors to the study of historical processes in the regions of the Russian Federation with the use of computer specific images, which are based on changes in urban planning, has not yet been widely used. The solution to this scientific problem will allow to manage regional socio-economic processes more effectively, as well as to influence the young audience in

evolving their patriotic feelings in the shortest possible time with minimal financial and labor costs on the basis of the acquired knowledge.

The authors propose a formalized description of a virtual space model, including a set of knowledge about a historically significant territory (a separate historical object), presented in the form of a graph frame structure.

$$V_{space} = \{St_o, S_o, Sp_o, M_o, M_o^g\}, \quad (1)$$

where St_o – frame describing the structural composition of a territory; S_o – frame describing the characteristics of the territory; Sp_o – ways to set the characteristics of the territory; M_o – models to determine the values of the territory's characteristics; M_o^g – models of graphic images of characteristics for which they are relevant.

It should be noted that:

$$s_{oi} = \{s_{oi}^{'}, z_{oit}^{'}, g_{oit}^{'}\}, i = \overline{1,N};\ t \in [0,T];$$

where $s_{oi}^{'}$, $z_{oit}^{'}$, $g_{oit}^{'}$ – accordingly, name of the characteristic's slot s_{oi}, its meaning and graphic image, N – number of properties; T – period of time of the territory's development.

The elements of the set Sp_o are terms:

Sp_o = {"set by the decision - maker" , "chosen by the decision - maker from the list",
"calculated by the model", "described by the linguisitc model",
"depicted by the georgraphic model"}.

It should be noted that the methods of setting characteristics may vary over time. Elements of the set M_o there are models for determining the values of the corresponding characteristics:

$$M_o = \{M_{o10}, ..., M_{oit}, ..., M_{oNT}\},$$

where M_{oit} – a model for determining the value of the *i*-th characteristic of an object at the *t*-th time.

Due to the fact that a single characteristic can have a numeric or a string value, either a mathematical model that determines the value of the characteristic by a number, or a linguistic model, such as a model of conceptual dependence that determines the value of the characteristic by a string of characters, can be used to determine it.

Elements of the set M_o^g are models of graphic images of the corresponding characteristics:

$$M_o^g = \{M_{o10}^g, ..., M_{oit}^g, ..., M_{oNT}^g\},$$

where M_{oit}^g – model of graphic image of the *i*-th characteristic at the *t*-th moment of time.

In turn, each *k*-th object of the virtual space V_{space} can be describe in the same (1) way:

$$V_{space,k} = \{St_k, S_k, Sp_k, M_k, M_k^g\}, k = \overline{1,K};$$

where St_k – a frame describing the structural composition of the *k*-th object or its element of the study area model; S_k – a frame describing properties specific to the *k*-th object; Sp_k – ways to define the characteristics of the *k*-th object; M_k – set of models to determine the characteristics' values of the *k*-th object; M_k^g – models of graphical images of the *k*-th object characteristics for which they are relevant.

$$s_{ki} = \{s_{ki}^{'}, z_{kit}^{'}, g_{kit}^{'}\}, i = \overline{1,N_k};\ t \in [0,T];$$

where $s_{ki}^{'}$, $z_{kit}^{'}$, $g_{kit}^{'}$ – accordingly, name of the characteristic's slot s_{ki} of the *k*-th element of the object, its value and graphic image, N_k – number of characteristics of the *k*-th element of the object; T – life cycle of the object.

Elements of the set Sp_k are the same terms as for Sp_o.

For the l-th characteristic of the *k*-th element of the object, the value of which is set by an analytical or an information-logical model, we propose the model M_{klt}:

$$M_k = \{M_{k10}, ..., M_{klt}, ..., M_{kN_kT}\}.$$

For the l - th characteristic of the k - th element of the object, which has a graphical image, we propose the model M^g_{klt}, implemented on time interval $[0,T]$:

$$M^g_k = \{M^g_{k10},\ ...,\ M^g_{klt}, ..., M^g_{kN_kT}\}\ .$$

It should be noted that the virtual model of the territory of V_{space} and the set $V_{space,k}\left|k=\overline{1,K}\right.$ (objects' models) have a similar structure.

Creation of a virtual space that implements the V_{space} information model in the form of a virtual museum is carried out using an open source software platform OpenSimulator 0.9.0, which is a server platform for 3D virtual worlds. Visualization of the Museum is available to all Internet users. Thus, a thematic information environment has been created that can provide access to relevant information, and contributes to the growth of youth interest in the problems of national culture, history, and social culture.

The use of a three-dimensional environment for the implementation of the virtual museum is attractive to users of the system due to the fact that their own personality is represented as an avatar that can move freely within the virtual world and study it from any point. In addition, an important role is played by the social aspect, as within the virtual world, one can meet other users, observe their movements and actions, communicate with them in real time. The presence of the game component is undoubtedly attractive to the young audience.

3. Practical implementation of the virtual space of the historically significant territory of the Central part of the city of Tambov

Let us consider individual components of the V_{space} for the historically significant territory of the Central part of the city of Tambov, in particular the model of graphic images of the main objects of the study area. Tambov was founded in 1636 at the confluence of the rivers Students and Tsna as a military fortress on the southern borders of the Moscow state.

As an example, virtual models of the following objects are included in the structure of the virtual space of the historically significant territory:

- XVII-XVIII century: fortress towers, bronze cannons, a wooden church, church utensils and decoration, a wooden house, household utensils;
- XIX century: Noble Assembly, Utkinskaya Church, Kazan monastery bell tower;
- XX-XXI century: Mikhailov's hotel, Drama theatre, Library named after A.S. Pushkin, Church college dormitory, music school.

Practical implementation of the virtual space on the example of the Central part of the city of Tambov was performed using an open source software platform OpenSimulator 0.9.0, which is a server platform for 3D virtual worlds. Figures 1-5 show visualization of the fragments of the virtual space referred to various chronological stages: the middle of the XVII century, the middle of the XVIII century; the end of the XIX century; the middle of the XX century; the modern period.

4. Results and discussion

In this paper, the authors have proposes a formalized description of a virtual space model, including a set of knowledge about a historically significant territory (a historical object) presented in the form of a graph frame structure. Creation of the virtual space that implements the V_{space} information model in the form of the virtual museum was carried out using an open source software platform OpenSimulator 0.9.0, which is a server platform for 3D virtual worlds. Visualization of the Museum is available to all Internet users. Thus, a thematic information environment has been created that can provide access to relevant information, and contributes to the growth of youth interest in the problems of national culture, history, and social culture. In addition, an important role is played by the social aspect, as within the virtual world, one can meet other users, observe their movements and actions, communicate with them in real time.

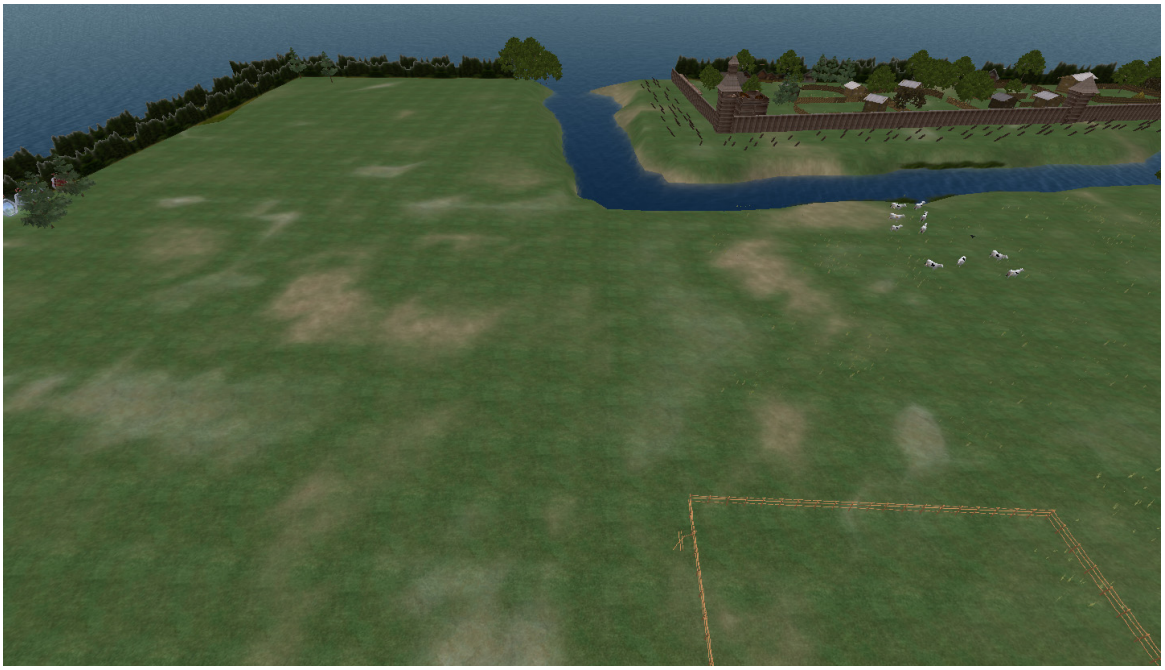

Figure 1. Virtual reconstruction of the Central part of Tambov in the XVII century.

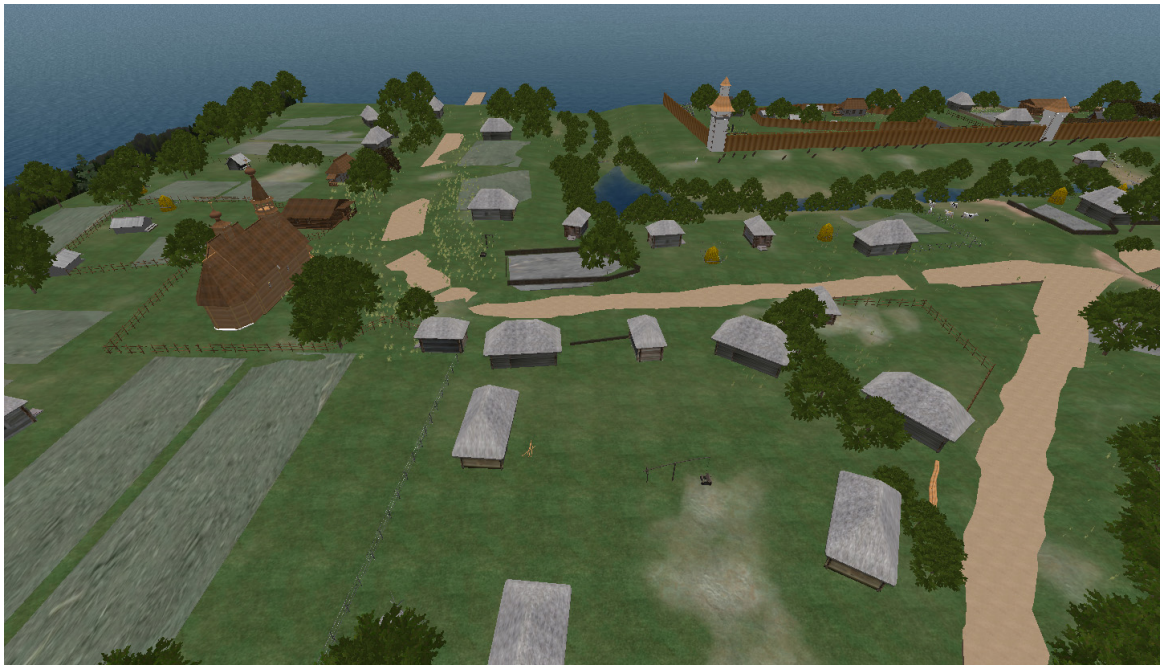

Figure 2. Virtual reconstruction of the Central part of Tambov in the XVIII century.

Figure 3. Virtual reconstruction of the Central part of Tambov in the XIX century.

Figure 4. Virtual reconstruction of the Central part of Tambov in the XX century.

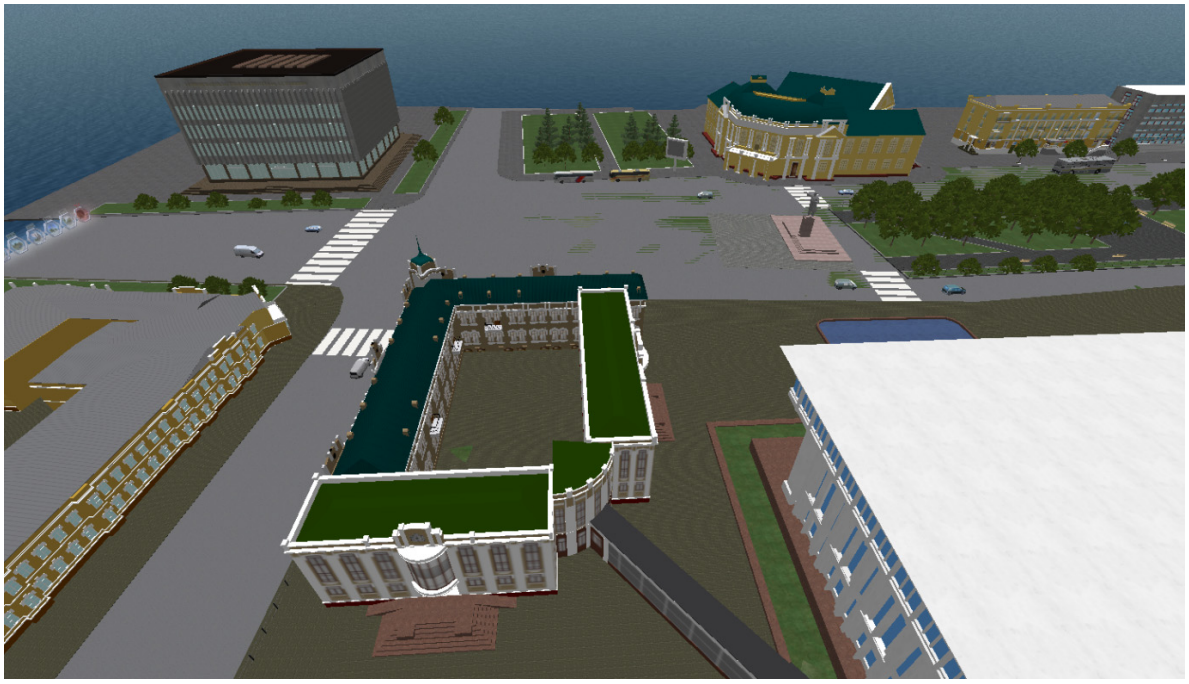

Figure 5. Virtual reconstruction of the Central part of Tambov in the XXI century.

5. Conclusion

A distinctive feature of this work is a versatile and multifunctional volume of information material related to development of particularly important areas of municipalities. Preference is given to visual images obtained by the means of GIS technologies for historically significant areas in the form of spatial and temporal models of objects, including: three-dimensional photorealistic images with its geographical references and various attribute information associated with both historical processes and urban planning related to the territory under consideration. Implementation of all stages of work for creation of a virtual space of a historically significant territory allowed us to present a complete picture of its development.

Analysis of the results will help to answer to the questions about the priorities in each of the considered historical periods in the study area starting from the foundation of objects in this area and their development up to the present time.

Knowledge gained by young people about urban development history of significant territories with the use of new information technologies will contribute to the growth of patriotism, a sense of pride for the ancestors and homeland.

Acknowledgements

This work is supported by the Russian Science Foundation under the grant No. 19-18-00044 “Analysis of historical processes in memorial places of the Tambov region, associated with well-known personalities from Russia using the technology of virtual modeling”.

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