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DEVELOPMENT OF A VIRTUAL LIBRARY OF CULTURAL HERITAGE OBJECTS FOR TAMBOV REGION'S MEMORABLE PLACES

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ABSTRACT

… work, we have developed a database that is a combination of three-dimensional … of typical objects of cultural and historical heritage and their elements for the … sites of the Tambov region, associated with the famous personalities of … These objects include buildings and structures, household buildings, household … and interiors, household utensils, plants of the central part of Russia, animals, etc. … should be noted, that some real objects have now undergone significant changes up to … destruction. This database can be used by students, post-graduate students and … instructors. The library of three-dimensional models was used by the authors … multi-user three-dimensional virtual reconstructions of historically significant … at different time periods of their development in such software systems as … Simulator, Second Life, and others.

Keywords: information system, database, 3D-models, virtual museum, objects of cultural and historic heritage.

INTRODUCTION

Museums are important sources for presenting information about the past. However, … museums have some limitations like time, space, and modes of interaction. However, most museums do not have space and resources to exhibit all of their collections and also some objects are so fragile that museum curators hesitate to make them available to public. Due to an increasing use of computers and advanced technologies, virtual reality museums or digital museums are becoming a good alternative to traditional museums. Users can interact with 3D models of objects in different ways [1].

The digital age has drastically changed the traditional definition of a museum. In the past, the entire experience from visiting a museum included touring an exhibition and getting educated about artefacts on display, whereas museums are now becoming more important as comprehensive social learning spaces. Such a change in the museum's role has led to a variety of discussions about the museum space [2].

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As an important part of public service and educational infrastructure for national culture and heritage, a virtual museum gives user an experience of a real museum with virtual guides, and tourists interacting within a prepared digital cultural content by using a mouse, a touch panel, and augmented reality devices. The goal of a virtual museum is to help students and visitors to move around a virtual museum space freely and get experience and satisfaction from observing cultural heritage objects anytime, anywhere and from any device [3].

The work by Fabola et al [4] discusses the methodology of design, development and deployment of a virtual 19th-century Fish Curing Yard as an immersive museum installation. The museum building now occupies the same space where the curing yard was located for over 100 years ago; hence, deployment of a virtual reconstruction of the curing yard in a game engine enables the museum visitors to explore the virtual world from equivalent vantage points in the real world. The project methodology achieves the goal of maximizing user's experience for visitors while minimizing the cost for the museum, and focus group evaluations of the system revealed success of the interaction-free design with snackable content. A major implication of the findings is that museums can provide compelling and informative experiences that enable visitors to travel back in time with minimal interaction and relatively low cost systems.

A novel system for automatically generated immersive and interactive virtual reality (VR) environments using the real world as a template is presented in the paper by Sra et al. [5]. The system captures indoor scenes in 3D, detects obstacles like furniture and walls, and maps walkable areas to enable real-walking in the generated virtual environment. Depth data is additionally used for recognizing and tracking of objects during VR experience. Detected objects are paired with virtual counterparts to leverage physicality of the real world for a tactile experience. Presented approach allows a casual user to easily create virtual reality worlds in any indoor space of arbitrary size and shape without requiring specialized equipment or training.

The aim of the study by Romanelli [6] is to provide a conceptual framework to explore how museums contribute to sustaining intellectual capital and promoting value co-creation moving from designing virtual environments to introducing and managing Big Data to select and follow a data-driven innovation and strategy.

The paper by Lugrin et al [7] presents a novel type of VR application for education and culture: a location-based VR Museum, which is a large-room scale multi-user multi-zone virtual museum. This VR museum was designed to support over 100 simultaneous users, walking in a large tracking system (600 m^2) and sharing a ten times bigger virtual space (7000 m^2) containing indoor and outdoor dinosaur exhibitions. This work is giving an overview of the system and its main features as well as discussing its potential benefits and future evaluation.

Virtual experience of the Geguti Palace is presented in the paper by Ferrari and Medici [8] in order to demonstrate how it's possible to offer a deep understanding of a space from abroad by absorbing reality into a virtual environment. Starting from digital documentation and 3D survey of this medieval royal palace, developed by the Department of Architecture of the University of Ferrara and Tbilisi State Academy of Arts, in collaboration with the National Agency for Cultural Heritage Preservation of Georgia, the paper stresses the VR issue focusing on several hardware devices and software platforms for digital content management. The case study has contributed to

analysis of further exploitations of Virtual Experiences for the Cultural Heritage [8].

CREATING A LIBRARY OF VIRTUAL MODELS

The database, created by the authors, is based on the results of works [9]–[13] and represents a collection of three-dimensional models of cultural and historical heritage objects of the city of Tambov, both existing and completely or partially destroyed.

In this work, OpenSimulator software was used as a platform for creating three-dimensional virtual world [14]. OpenSimulator is an international project with the goal to create an open technologic platform for building three-dimensional virtual worlds similar to Second Life. Innovative development of OpenSimulator goes in a new direction of 3D Web. OpenSimulator project has an open source code (under BSD license) and it is distributed free of charge.

Joomla 1.9 Content Management System (CMS) is used to manage dynamic filling of the database. The core of the Joomla database contains 62 tables: jos_assets; jos_associations; Jos_banner_clients; Jos_banner_tracks; Jos_banners; Jos_categories; jos_contact_details; Jos_content; Jos_content_frontpage; Jos_content_rating, etc. When a user sends a request, the CMS generates final representation of information in HTML format based on the information from the database. Among these tables there are tables that are used directly for storing and presenting data, including content manager (jos_content, jos_content_rating), main page manager (jos_content_frontpage), category manager (#jos_categories). Fragments of the database structure are shown in Figures 1, and a fragment of the model's database of cultural heritage sites is presented in Table 1. Currently, the database includes information on more than 200 objects and their elements.

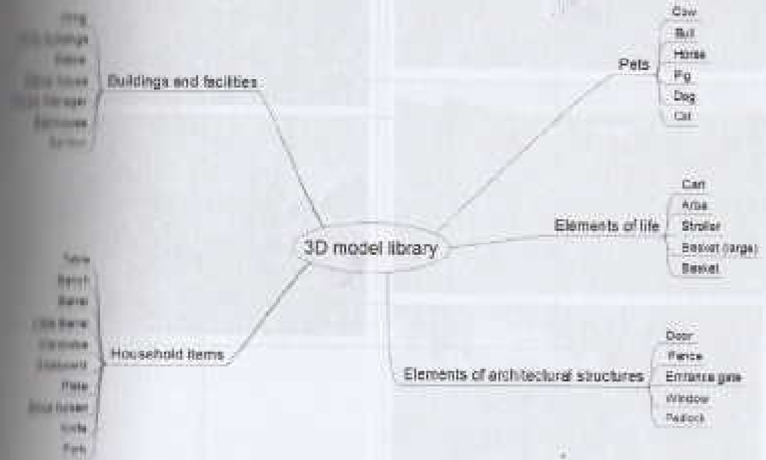

Figure 1. Fragment of the database structure

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Table 1 Fragment of the model's database of cultural heritage objects

Category	Name of the model	Visualization of the model
Buildings and facilities	Manor house	
Buildings and facilities	Wing	
Buildings and facilities	Bathhouse	
Buildings and facilities	Utility buildings	

Category	Name of the model	Visualization of the model
Household items	Table	
Household items	Bench	
Household items	Barrel	
[illegible]	Cow	
[illegible]	Horse	

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Category	Name of the model	Visualization of the model
Pets	Dog	
Elements of life	Cart	
Elements of life	Basket (large)	
Elements of life	Arba	
Elements of architectural structures	Window	

CONCLUSION

The proposed database is a collection of three-dimensional models of cultural and historical heritage objects of memorable places of the Tambov region, existing and completely or partially destroyed, associated with well-known personalities of Russia, whose life and work are connected with the history and development of the Tambov region.

These objects include elements of the noble estate of the XIX - XX century (manor house, utility buildings, wing), elements of architectural structures (doors, windows, gates), elements of life (cart, arba, basket), household items (table, knife, plate), domestic animals (cow, horse, dog). It should be noted, that some real objects have now undergone significant changes up to complete destruction. This database can be used by students, post-graduate students and academic instructors.

The library of three-dimensional models was used to create a virtual museum of urban development history of memorable places of the Tambov region in OpenSimulator and Second Life.

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DEVELOPMENT OF ALGORITHMS AND SOFTWARE FOR THE SEGMENTATION OF OBJECTS ON MULTISCALE IMAGE SEQUENCES OF NANOSTRUCTURES

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[illegible]RACT

[illegible] tasks and provisions of multiscale image processing of nanostructures are [illegible], the feature of which is the use of the concepts of heredity and variability of [illegible]. Heredity refers to the process of preserving traits on a sequence of images of [illegible] as the scale of observation changes. Under variability refers to the process [illegible] signs or the emergence of new signs on a multiscale sequence of images. It is [illegible] images of nanostructures on scales at which there is a sharp change in the [illegible] features (characteristic properties) are of the greatest interest for analysis.

[illegible] and software for object segmentation, contour extraction and skeletonization [illegible] images of nanostructures, as well as their fuzzy counterparts, have been [illegible]. Algorithms for extracting fuzzy features on image sequences have been [illegible] depending on the choice of the membership function. The possibilities of using [illegible] of self-similarity based on a fractal image model are investigated.

[illegible]: image processing, recognition, multiscale analysis, nanostructures.

[illegible]UCTION

[illegible] of image segmentation is relevant now. It can be solved in various ways, for [illegible] by the method of increasing regions, by segmentation by threshold (in the [illegible]) by splitting-merging regions.

[illegible] is one of the main areas in digital image processing and analysis. The [illegible] image segmentation is to find a partition of image f into its component parts [illegible] to the image area, then the segmentation should result in a partition of [illegible] $AR_1, AR_2, \ldots, AR_t$.

[illegible] can be used to perform segmentation: a method of splitting-merging [illegible] areas, threshold segmentation (in the simplest cases), etc. Segmentation [illegible] multi-scale image models are widely used [1,2].

[illegible]/sgem2019/2.1