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PHOTOREALISTIC RECONSTRUCTION AND MULTIMEDIA PRESENTATION OF THE MEDIEVAL FORTRESS IN TRAVNIK

Abstract – The Fortress of Old Town in Travnik represents one of the most beautiful and most preserved facilities of medieval Bosnia, on which later historical periods left their specific marks. Combining modern methods of 3D reconstruction with different methods of visualization such as making photorealistic, high-resolution renderings, video-compositing of animated sequences from 3D environment with video sequences that illustrate life in the fortress in the past, building interactive virtual environment integrated into user-friendly, multimedia interface, it was aimed to provide comprehensive user experience and raise awareness about cultural and historical importance of the reconstructed object.
Paper covers all phases in creation of multimedia presentation starting with data collection, planning and design of presentation structure, modeling of the object and the environment, application of photorealistic textures, camera animation, production other planned multimedia content and combining all into final presentation form.

Keywords - virtual heritage, cultural heritage digitalization

1. Introduction

The importance of the protection and reconstruction of archeological sites and monuments as a part of cultural heritage stands in their important characteristic - impossibility to protect those objects from different influences (social and nature) during their long period of existence [1].

The fortress of Old Town in Travnik represents one of the most beautiful and most preserved facilities of the medieval Bosnia, on which later historical periods left their specific marks. As a part of a long term goal of various cultural workers in the city of Travnik to preserve the fortress, prevent its further damaging and restore its initial beauty and importance, the results of this project have an important role in its promotion and popularization.

Combining modern methods of 3D reconstruction with different methods of visualization such as photorealistic, high-resolution renderings, video-compositing of animated sequences from 3D environment with video sequences that illustrate the life in the fortress in the past, building interactive virtual environment integrated into user-friendly, multimedia interface, it was aimed to provide a comprehensive user experience and raise awareness about cultural and historical importance of the reconstructed object.

Resent research in photogrammetric visualization [2] resulted in a great number of software applications for reconstruction of realistic 3D models. Major focus is set on the simplification of 3D modeling process by using photogrammetric concepts of data acquisition and processing. One of the main drawbacks of the virtual environments is their static nature; it is often little or no attention paid to "inhabiting" them, making them alive and interactive. Add-

ing interactivity and using various presentation methods in virtual environments gives another dimension to the reconstruction.

In order to give a meaning to the collected data it is important to employ the multi-disciplinary approach. By joining together Archaeologists, Architects, Computer Scientists and Multimedia Designers, multimedia experience of the end-user is greatly improved [3].

Our intention was to reconstruct photorealistic look of the fortress of Old Town in Travnik in one specific period of its long history, period of the Ottoman Empire and to illustrate the life of its inhabitants along with presenting all other periods in its long history by using different media. By taking the viewers into the virtual reconstruction of the world which existed centuries ago, not only will it give them the chance to witness a specific moment in the history of the fortress but will be an experience of what artists created inspired by that same moment.

Public presentation of the project will be held in the Old Town of Travnik multimedia room. The museum in Travnik will be given all rights to present the material in order to promote and popularize the Old Town and its history. Consequently, all interested cultural organizations in Travnik and Bosnia and Herzegovina will be sent a free copy of the material. This will give a whole new perspective on how cultural heritage can be presented and preserved.

The project has the goal of digital preservation and possibility to share this important example of rich cultural-heritage of Bosnia and Herzegovina with various groups and individuals through off-line and on-line presentations [4]. The final product is an interactive, multimedia CD-ROM with original textual content in both the Bosnian and English languages enriched with audio and video content, number of photographs providing the user with detailed information about the fortress and its history.

These parts are presented to the user by using different presentation technologies (HTML, Flash, CSS, JavaScript, XHTML). For an online presentation, special intention was paid to optimization of the content, especially audio and video elements.

This paper describes the process of content creation for this multimedia presentation. The paper is organized in the following manner: Section 2 describes data collection and presentation design processes, Section 3 talks about modeling of the object and environment, Section 4 is about methods used in texture mapping as important aspect of achieving photorealistic impression, Section 5 is about animation of cameras and rendering process, Section 6 is about using video-compositing in creation of the video content and, finally, Section 7 describes creation of VR environment as a part of presentation.

2. Data Collection And The Presentation Design

A realistic reconstruction of an architectural site assumes collection of all available data about the object including:

- topographic maps
- architectural drawings of previous reconstructions
- archive and recent photographs of the location and object
- sketches illustrating how changes of the object went through the history.

The employees of the Museum in Travnik provided enormous help and access to the scientific library, photo archive, museum artifacts...

Figure1 shows the sketch made by archeologist Đoko Mazalić in 1948.

During the project, the fortress has constantly been photographed, together with all specific elements such as stone gates, openings, original textures and less available parts.

Modeling was based on a reconstruction plan of the Institute for protection of cultural heritage in Bosnia and Herzegovina from 1975.
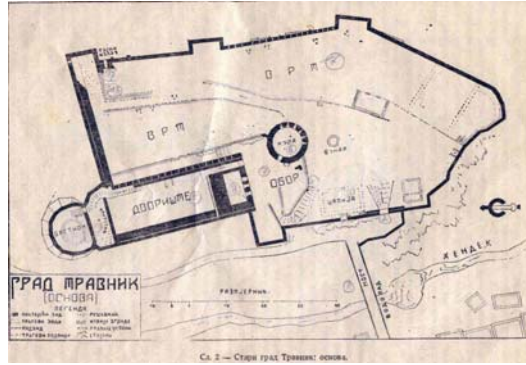
Figure 1. *Old town Travnik: foundation*

In this way, basic reliability was ensured. A major problem was the reconstruction of those objects destroyed over time. Examples are the old houses built in the Bosnian style whose dimensions and location were known, but details such as textures and materials used were modeled upon similar objects that can be found near the fortress or in the Travnik region.

The following tasks were accomplished:
- Selection of books, publications, archive documents, photographs, architectural plans and artifacts related to the fortress
- Copying texts and documents
- Selection and scanning photographs and drawings
- Photographing museum artifacts
- Photographing the fortress
- Graphical editing of photographs

After data collection, the project continued into several directions.

Production team worked on the following tasks: writing textual content about history the fortress, including present events like the process of physical reconstruction of the fortress, design and layout of content for multimedia presentation, recording audio content in the studio.

To present more meaningful explanation about specific parts of the longest period in the history of the fortress, the Ottoman period, 3D environment is combined with live footage. The realization of these video sequences included following tasks: writing synopsis, scenario, selection of the actors, borrowing appropriate costumes, preparing scenography, filming of video material and photo-session with the costumed actors on the location of the fortress.

To avoid technical problems that appeared later in process of video-compositing, attention should be concentrated on following elements:
- Lighting
- Size of background used for green key
- Planning the location where live scenes will be positioned in the 3D model

After the first version of the video sequence was created, musicians started their work on music themes to use as a background sound for video content.

3. Modeling

Available architectural plans helped with problems of proportion and location of objects inside the fortress, as well as with the visualization of the destroyed objects. Modeling software used was 3d Studio Max. Modeling was done in the following phases:

3.1. Modeling of the object. Classical polygonal approach, various modifiers to accomplish specific shapes and predefined set of objects from 3D software application were used for modeling.[5] Using different architectural plans as backgrounds, different objects were formed (basic terrain shape, walls, buildings and details on them).

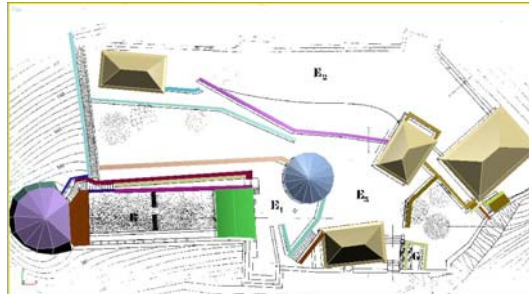Figure 2. shows the model in the initial stage of modeling and drawing on which modeling was based.

Figure 2. *Model in initial phase*

3.2 Terrain modeling. For creation of the basic terrain shape, describing the small area around the fortress, 3ds max Terrain object was used. This object enables creation of the terrain object using isohypses from a topographic map to describe 3D shape of terrain [6].

For the realistic terrain, it was important to describe a larger surface around the fortress. A number of applications for terrain modeling based on DEM (Digital Elevation Model) data is tested. Detailed DEM description of targeted location was unavailable so similar terrain data in USA is used, one of similar shape and height as real location.

From all tested applications, the best results were obtained by using 3DEM application [8], whose main purpose is 3D display and the manipulation of DEM data. This application offers a possibility to specify a part of terrain and export it into the Terragen terrain file for further manipulation in 3ds max. Terragen application is environment generator for creation of photorealistic landscape and animations. It has great compatibility with 3ds max trough TG-Max plug-in [8].

Figure 3 shows the user interface of 3DEM application with imported DEM data.

Figure 3. *3DEM interface*

After creation of .ter file, terrain generation and other elements of environment (terrain, lightning and sky) were created using DreamScape 2 plug-in which proved to be the great so-

lution for generating photorealistic environments. DreamScape Terra is a tool for efficient generating all types of terrain with great number of options. This tool is used for modification imported data to adjust terrain [9]

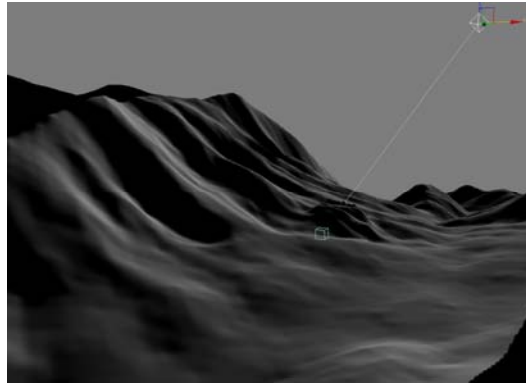Figure 4 shows the final terrain modeled by using modification of imported Terragen file.

Figure 4. *Terrain created with DreamScape*

3.3. Lightning and sky. 3ds max offers certain number of options for lightning of the scene, but using advanced ones makes rendering process more complicated. Realistic rendering of the stone texture was obtained using DreamScape Sun light. This type of light enables creation of complex illumination of environment including a form of GI (Global Illumination) and computing soft shadows and indirect lightning created by DreamScape Sky. DreamScape Sky object enables creation of realistic sky, 3d clouds and projection of shadows to scene elements [9].

Figure 5 shows an example of using effects of DreamScape Sky I DreamScape Sun objects in the environment.

Figure5. *Example of DreamScape Sky i DreamScape Sun effects*

4. Texture Mapping

Textures and materials used in the project are mostly generated from the original textures of the object. The terrain texture was created using DreamScape. This approach ensured photorealistic impression but needed graphic manipulation of large number of photographs and their adjustments to the objects. Textures are mapped using UVW mapping technique. After that, texture baking was done. Texture baking is a process of pre-calculating specific information (e.g. lighting, radiance transfer) and storing it in a texture. Baked textures were

applied to objects again using saved UVW data. [6] The stored UVW data enables application of the same data, with different resolution if needed for real time rendering in the VR environment.

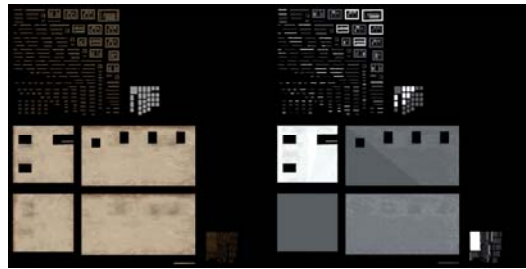Figure 6 shows an example of the textures made using the bake method.

Figure 6. *Example of Diffuse and Light maps of the house*

5. Camera Animation

Different animations of the camera are created for the planned video sequence. It was important to make continual flow between scenes located on different locations in the fortress and enable the user to view from different perspectives. Backgrounds used for video-compositing have being adjusted over time for needs of recorded scenes (camera angle, lighting).

5.1. Rendering. None of the advanced rendering options were used. We tried to make rendering process as simple as possible, ensuring the quality with chosen lights and sky systems. Different video sequences are created to be used in video-compositing phase.

Figure 7 shows rendered frame from animated sequence.

Figure 7. *Rendered frame*

6. Video-Compositing

Video-compositing of rendered animated sequences / backgrounds with the scenes from the life on the fortress was done using the software for video editing - Premiere Pro 2.0 and After Effects. After the keying process [10], video sequences with removed green background are applied as a top layer to the rendered background frames. Scenes are linked with animated sequences, audio background was prepared and music theme was created. Content was subtitled for both Bosnian and English version of the presentation.

The final sequence was exported in both high-quality .avi format used for TV projections as well as Flash Video format (.flv) [11] suitable for online video streaming. This format offers a great compression of file size without compromising the quality. This version is used for the on line presentation as well.

Figure 8 shows filming scenes from the life on the fortress.

Figure 8. *Filming scene*

In the meantime, the rest of content for presentation was prepared:
- Translation of dialogues in the Turkish language for authenticity
- Synchronization of dialogues in the Bosnian, Latin and Turkish language
- Audio production
- Video editing and post-processing
- Translation of the content in English
- Combination of all textual, graphic, video and audio content of multimedia presentation
- Design and printing of CD covers and CD printing
- Finalization of content

7. Virtual Environment

The created model and environment can be used for different purposes, from pre-rendered fly-troughs trough the 3D space or their combination with live video footage to the interactive virtual environments.

Both approaches have advantages and disadvantages. It will depend on the audience and the final purpose of the presentation what will be used.

In the first case, the realistic impression provided by the video sequence has a drawback in controlled conditions user experience.

On the other side, although interactivity of real-time virtual environment offers to the user a possibility to explore and experience the object by himself/herself, realizing its historical and cultural importance, it suffers from slowness, and a lack of realism. [12] The special attention needs to be put on providing the meaningful content, friendly user interface, orientation and user navigation.

For the first stage of this project, we choose to use the first form of presentation - pre-rendered animation combined with the other types of media content. The aim was to get attention of larger audience and emphasize the importance and meaning of this form of presentation of cultural heritage.

Another phase was developing an interactive environment using Quest 3D software. To provide realism with interactivity, we needed to address many issues such as optimization of the models, maps, lightning and sound effects [13]. Quest3D software has great communication with 3ds max application. This software gives many options for output format, from web

to stand alone applications. After finalization of this phase, this content will be included to improve the multimedia presentation.

Figure 9 shows the model imported in Quest3D environment.

Figure 9. *Model in Quest3D*

Figure 10. shows the graphics user interface of the multimedia environment, gallery example.

Figure 9. *Gallery example*

8. Conclusion

The aim of this paper was to show the process of implementation of the multimedia presentation for different purposes (off-line and on-line viewing). Zavičajni museum of Travnik will be given all rights to present the material in order to promote and popularize the Old Town and its history. Consequently, all interested cultural organizations in Travnik and Bosnia and Herzegovina will be sent a free copy of a material. This will give a whole new perspective on how cultural heritage can be presented and preserved.

Besides the off-line presentation, most of the content is available on the Internet at [14]. In this version of the presentation, the achieved results are satisfying. Workflow of the process is documented and can be used in some other similar projects. Experience from this project and all technologies tested will help in implementing the future projects more efficiently. Major focus was creating meaningful content and combining it into one presentation form. In the following period, we will concentrate on the research in the area of developing highly interactive, but realistic VR environment. This includes the work on optimization of virtual en-

vironments outputs (optimizing maps, exported model) so it can be usable for broader public without any technical difficulties.

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