Virtual Bosnia and Herzegovina National Museum

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Abstract

Virtual Museums are becoming a way to present and preserve the cultural heritage. Computer graphics technologies such as 3D modelling, laser scanning, virtual reality creation and high fidelity rendering are used to produce the virtual environment that enables the users to discover the history and tradition of the particular culture. Virtual BH National Museum is an attempt to apply and explore this knowledge in presenting the cultural heritage of Bosnia and Herzegovina.
Keywords: virtual reality, 3D modelling, cultural heritage

1   Introduction

Bosnia and Herzegovina is a country very rich with cultural heritage. Virtual museum projects provide a way for communities to "digitally repatriate" precious items of cultural heritage.

The National Museum of Bosnia and Herzegovina is the oldest cultural and scientific institution of modern times in B&H. The Museum was founded in 1884 by native scholars and public figures who at that time formed a modest and small Museum Society [1]. With the support of the government of that time, the Museum was proclaimed in 1888 the State Museum of Bosnia and Herzegovina, and from its first beginnings it immediately functioned as the central institution in Bosnia and Herzegovina in the fields of scientific research, culture, education and publishing. During the past hundred years the Museum has grown into significant branches – Archaeology, Ethnology and Natural History, with a specific Botanical Garden and a special Scientific Library.

The Virtual BH National Museum project started as a pilot project in December 2005 and it is a result of students research work in Computer graphics Course at the Faculty of Electrical Engineering in Sarajevo, BH. It is done in partnership with the Museum that holds important cultural items and it shows what could be expected from the eventual Virtual Museum. At the end, this project should produce special collections of interactive exhibits to be distributed via the Web, on CD-ROMs, and as server-based objects that can be combined with other materials in the instructional or research modules.

The paper describes the pilot project of Virtual National Museum of Bosnia and Herzegovina. Section 2 describes the modelling process, with particular emphasis on the software and modelling techniques in which the models are constructed. In Section 3 process of creating QTVR panoramas is explained. Section 4 describes dealing with 3D models of Stećci (**stećak** – plural **stećci** – specific Bosnian Middle Ages tombstones) in Maya software package. This Section also explains the laser scanning process using the Minolta 910 laser scanner. Section 5 describes the conversion process employed to convert Maya files to VRML. Conclusion and future work are discussed in Section 6.

From the very beginning of this project, as we started the first modellings, not only that we wanted to create very realistic 3D model of BH National Museum but to give the viewers complete feeling of the whole ambience of Bosnian cultural heritage. Especially for those people who are not able to visit these places. Internet and computer graphics technologies that we used give people an opportunity to see and visit these places from their own homes. We wanted viewer not only to see 3D virtual model of the Museum but also to interact with it. That is why we are exporting it to VRML, so people can walk around it, see it from different angles, walk through it, come inside and look around and see some of the exhibitions.

2   Modelling

Inspired by previously created models of Virtual Sarajevo [5] we have decided to go in the same direction. This year we have chosen Alias Maya 7.0 software for 3D modelling of the Museum. From the very beginning our idea was to explore the complete process of 3D modelling in Maya and exporting created models to VRML (Virtual Reality Modelling Language).
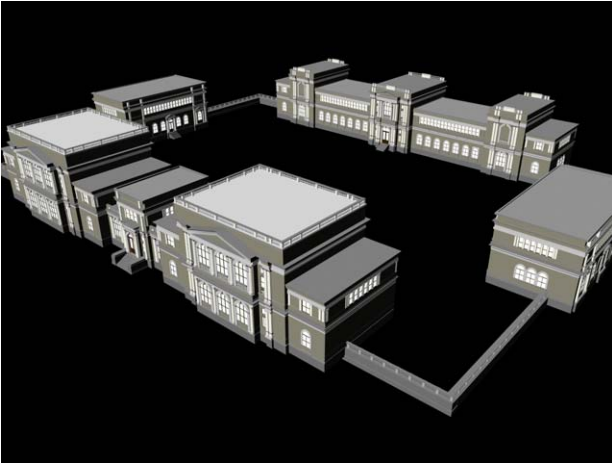
Figure 1.   The Museum complex

The first step of this project was to visit the Museum and get all materials we needed, such as photos of various parts of the Museum complex, ground-plan and measurements. We have created 3D model (Figure 1) using techniques of polygonal and nurbs modelling. Using primitive objects (box, sphere, cylinder, cone, plane etc.) and combining them together, we have managed to create a complex model consisting of several thousands of objects (figure 1).   We have created the basic objects of one building, duplicated them, modified and used for other symmetric parts of the Museum (figure 2.). We tried to use precise measurements so model could be as realistic as possible.
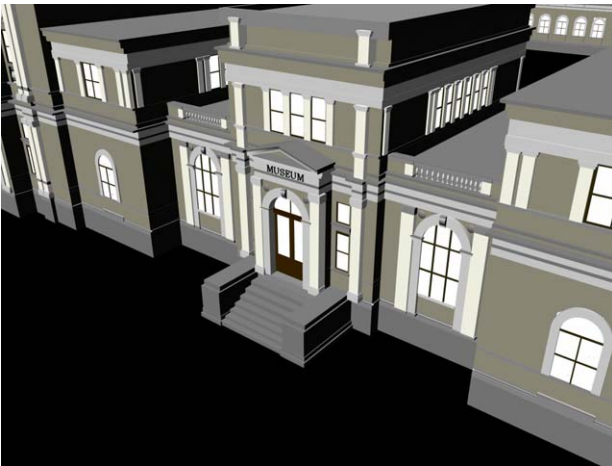

Figure 2.   Entrance view

Unlike previous generations which used attached digital photos as materials we wanted to create our own materials using Maya's basic materials, blinn and lambert, modifying them for our purpose and use digital photos only there where it was really hard to make the substitute material. Complexity and details of our model affected the size of maya binary file (.mb), making it too large for exporting to VRML, thus it will need some optimization. We also made a model of the

Main Hall, as we wanted the viewers to get the complete impression of the whole museum ambience. (figure 4.)
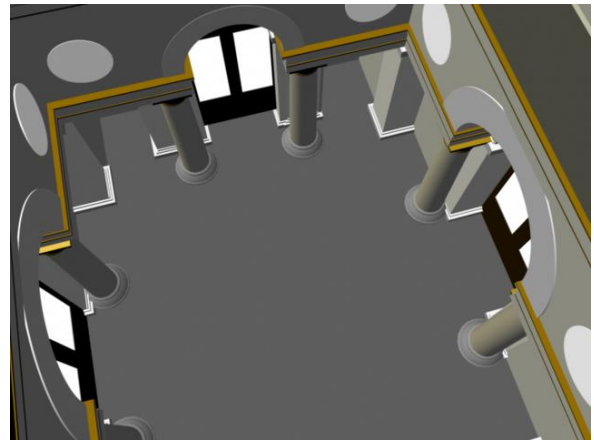

Figure 3.   Front view of the Museum

Figure 4.   Main hall interior

3   Panoramic photos

Adding the panoramic views of different museum departments to the model should provide the sense of reality for the users.

Panoramic view is a set of neighbouring snapshots taken from one point of view and combined into a 360 degree view. It is loaded in a separate window in QuickTime player as a .mov file. The user can manipulate the view using a mouse to move in different directions.

Panorama creation process consists of taking photos using digital camera and linking them in specific software. We used Canon digital camera PC1057. One panoramic photo contains in average 12 snapshots taken from one point of view in 360 degree circle. Most of the panoramas had to be taken several times, during different parts of the day, because the illumination was not satisfying. Interior light in the

departments is not adjusted for photo shooting and we did not have our own professional lights, so we mainly depended on the sunlight.

The next step was to transfer the photos to the computer, optimize them and make small adjustments, correcting some minor flaws. That was easily done in Adobe Photoshop CS2.

For merging photos into panoramic views we used Canon's PhotoStitch 3.1 software. This is a simple procedure: we imported photos for each panorama separately into the software, merged them and exported the panoramic view as a .mov file. Merging is done automatically by the software based on overlapping areas of neighbouring photos, but optionally we can manually adjust the width of overlapping area.

The following pictures (Figures 5, 6, 7) are some of the panoramic views of the Museum departments.

Figure 5.   Department of Ethnology - Bosnian Family House

Figure 6.   Department of Ethnology - Tijjaret Majlis

Figure 7.   Botanical Garden

4   Exhibit models

Stećaks are monumental gravestones which are the best known, and certainly the most valuable monuments of medieval art in Bosnia and Herzegovina.   Regional Museum possesses two exhibitions of Stećaks set out in the open. Nineteen Stećaks have been set up in the botanical garden, so placed to form a small necropolis [1].

Most of the Stećaks in this project are modeled in Maya but some of them (like the Stećak from Donja Zgošća, Figure 8) have so complex decorations which take various geometric, vegetable and architectonic forms that it is clear that, because of limitations in computer resources and the human mind, it is impossible to model objective reality of them precisely at all levels of details.

Figure 8.   Stećak from Donja Zgošća, one of the most beautiful among the Stećaks present in the botanical garden of the BH State Museum in Sarajevo used for laser scanning

The modeling of those kinds of objects and surfaces using modeling packages and artists alone is not sufficiently accurate. That is what digitizing technologies, like high-resolution scanning and laser surface scanning to digitize and build 3D models of objects, are used for. Laser scanners provide a method of capturing accurate information about such complex object's surfaces [4].

4.1 . Laserscanned objects

3D Laser scanning / digitizing is a technology that captures the digital shape of physical objects

In our work we used Minolta 910 [6] laser scanner, Figure 9.

Figure 9.   The Minolta 910 laser scanner is a scanner for close range and indoor applications and has an accuracy of under a millimeter.[2]

Surface shape measurements of the subject are obtained through triangulation, and then converted into a 3D polygon mesh.

In Figure 10 you can see a 3D model of the human face which is laser scanned by Minolta Vivid 910 scanner.

Figure 10. Laser-scanned model of a human face

The VI9i measures 640 x 480 points with one scan, simultaneously acquiring surface shape data and color image data.

After measuring the 3D depth data, the Vivid 910 uses its CCD to capture a 2D image in the same way as a digital camera. The CCD relies on ambient light to illuminate the target. The scanner software then matches points on the photograph to points in the surface mesh and exports the data as a CDM file which contains both the mesh and bitmap, Figure 11.
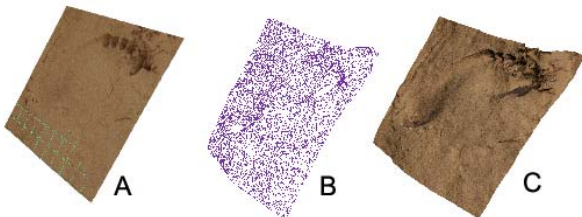

Figure 11. 2D image(A) is mapped onto a 3D mesh(B) and the combined textured model(C) [4]

Since less illuminated scan areas produce better results, the model of Stećak was scanned during the night because of the intense light in that part of the botanical garden during daylight.

Individual scans, created by laser scanning method, are later connected together in a polygonal mesh by using a software stitching tool [3] (Figure 12).

This software tool performs automatic data registration, edits captured scan data (fills holes, decimates, smoothes), merges scans into a single

"watertight" mesh, and exports to a variety of 3D data formats.

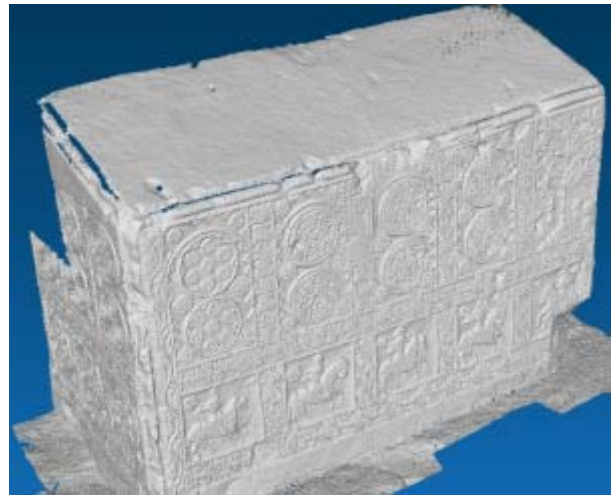Finally the polygon mesh was exported as Maya OBJ file. Figure 13.

Figure 12. Half of the Stećak (without textures). Multiple scans merged into a single using „Stitcher" [2]

Figure 13. Model of Stećak ready for importing into Maya [2]

The computer model of the Stećak that has been scanned was transferred from Stitcher to Maya. The size of the laser scanned model was so large that it needed to be reduced in order to manipulate it in Maya. The model is polygonal mesh made up of vertices. Each vertex is a point in three-dimensional space, so is described by three orthogonal coordinates. The points are joined into faces. Any number of vertices can be joined into a face, but the scanner software only uses between three and five points per face. [4]

Maya has a function to reduce the number of vertices in a polygon model. This function works with polygons created in Maya, but does not work with the polygon meshes from the scanner. A variety of methods were

investigated using a small model of the Stećak (laser scanned souvenir, Figure 14) to try and resolve this problem.
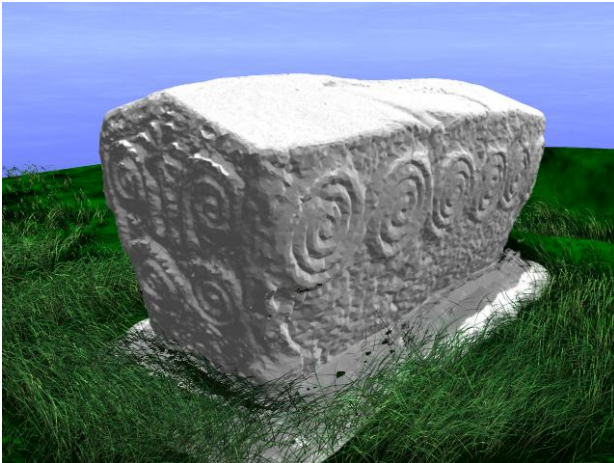

Figure 14. Laser-scanned model of souvenir used for experiment

Neither the OBJ files exported by the scanner or Stitcher can be reduced. The only way to reduce the size of a model was to load the original file in the Stitcher and reduce it there, and then import it back into Maya. This produced slightly inferior models but still with an acceptable quality. Figure 15.
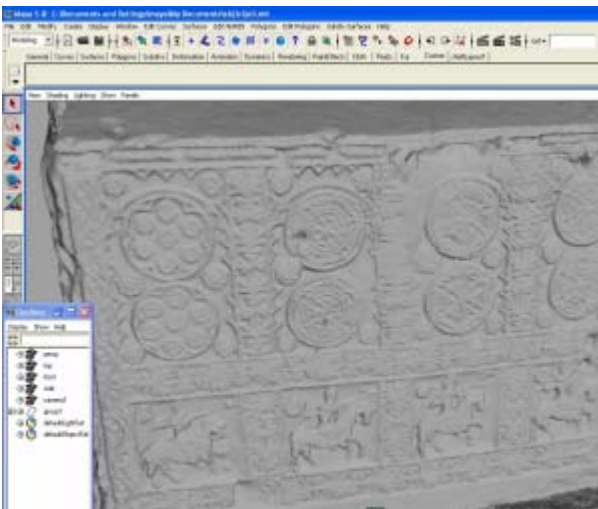

Figure 15. Model of Stećak imported in Maya [2]

At the end, the model in Maya has about 1 330 000 control vertices.
In Figures 16 and 17 are presented the rendered images of the real size Stećak:

Figure 16. Rendered model of the Stećak in wide shot [3]

Figure 17. Rendered model of the Stećak in close-up [3]

4.2. Modelled objects

After taking pictures of the objects, we had to optimize them for further work. Since the pictures were taken during the winter, the biggest problem was the snow. After removing the white snow, using Adobe Photoshop CS2, we have got the needed textures for the models.

The next step was modelling the tombstones (stećci), Figure 18. We have created the objects using techniques of polygonal modeling, with references to the pictures of the real objects. The textures have been applied as a projection on each face of the whole figure. They did not fit quite well, so we needed to modify the figures as well as the textures to achieve a uniform look.

Figure 18. Modelled gravestones

Some additional textures had to be found on the Internet, to fill out the surfaces which were not covered with pictures. In addition, we have found the needed textures for the ground on the Internet. In this case, as well as in the other, we have had to modify the pictures (enhance colors, brightness, contrast and other parameters).

In reality, the tombstones are placed in a botanic garden. The best way to model such complex things like grass and trees is using Maya Paint Effects tool. However, these tools cannot be viewed in VRML player. That is why, at the present time, we are not able to show the rich and colorful plant life in the Garden, Instead we based on the monuments inside it.

5   Export to VRML

As mentioned in Section 2 we have chosen Alias Maya 7.0 software for 3D modelling of the Museum. We used existing Maya's vrml2Export.mll plug-in which enables exporting modelled objects into vrml files. Using standard export options for vrml2 file type we can obtain substantial results. However, losing quality is inevitable.

Complexity and details of 3D model enlarged the maya binary file (.mb), making it difficult to export it to VRML, on computers we used (2GHz CPU, 1GB RAM, 128MB GPU). That is why this model is not made for Internet viewing, but for browsing on the local computers. It was necessary to optimize 3D model itself as much as possible.

Optimisation process consisted of several stages:
1) Removing unnecessary details
At first we wanted to represent a model of the Museum as realistic as possible, adding as many details as we could. This provided a high quality model but very hard to manipulate with. Since the main idea of this project was to enable the user to interact with the model using VRML, lots of details became unnecessary. These details could not be viewed in VRML player, and yet made it hard to move around the VRML scene. That is the reason why we removed those small parts of the model, making it lighter and easier to manipulate with.

2) Polygonal objects only
In the beginning the model consisted of some NURBS objects that made it look smooth, but enlarged the .mb file. We replaced those objects with polygons, and reduced the overall number of polygons. This also reduced the size of the file.

3) Combining and attaching object together
The first version consisted of several thousands objects. Using boolean operations and Polygon->Combine in Maya we combined and attached those objects into several groups.

Before optimisation our vrml files were the size of 145MB for the front building, and somewhat smaller for the other buildings. After optimisation the size of vrml file was reduced to 33MB for the front building, and proportionaly reduced for the others, too.

At this moment the core content of the Virtual Museum is described as:

−   Research-quality high resolution 3D models of museum's pavilions in which the Museum is housed since 1913., presented in VRML with a point-and-click interface, allowing easy navigation through the Museum and linked collections;
−   Panoramic galleries of:
    -   The archaeological department which documents all aspects of human life in Bosnia and Herzegovina from the older Stone Age to the late Middle Ages;
    -   Department of Ethnology which is located in one of the National Museum complex buildings whose interior itself illustrates the appearance of a Bosnian and Herzegovinian traditional urban house;
    -   Department of Natural History which represents the first scientific and cultural organizational unit in Bosnia and Herzegovina in the area of natural history.
−   Special 3D collections of objects with the focus on Stećaks.

One way of optimization is creating multiple vrml files, showing different scenes for different parts of the Museum. Our project consists for now of 3 different vrml scenes (Figure 19):

SCENE 1 :   - outdoor view of the Museum with a touch-sensor placed on the main entrance that opens scene 2

SCENE 2 : - main interior hall with touch-sensors placed on the panels showing different panoramic views of archaeology department, separate touch sensor leading to the scene 3 and a touch sensor to exit (back to scene 1)

SCENE 3 : - botanical garden with modelled and laser-scanned monuments (stećci), panoramic views and touch sensors to panoramic views of different museum departments (ethnographic, nature), separate touch sensors to interior hall (SCENE 2) and to exit.
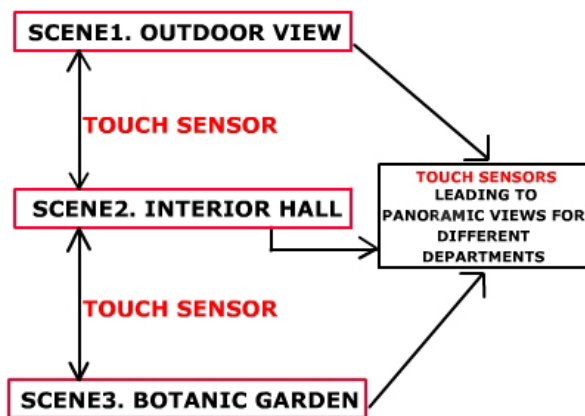

Figure 19. Project scheme

6   Conclusion

Virtual BH Museum should present a starting point for the future Bosnian virtual heritage projects. It shows the possibilities of creating a virtual 3D environment with walkthrough ability and panoramic viewpoints providing the user with accurate impression of the real scene. This is also an opportunity to preserve the heritage objects that might not be available in the future.

In the future this project should be expanded with additional scenes containing various exhibition halls of the Museum. At first we will include the famous Sarajevo Hagaddah, the Jewish book of rites, a collection of biblical stories, prayers and psalms related to Pesah, important Jewish holiday. This is one of the most valuable exhibits in the Museum, written in Spain around 1314.

In general, our future work will concentrate on virtual reconstruction of Bosnian archaeological sites and heritage objects that are destroyed by the war or in a bad condition because of the age. We are building a collection of heritage object models that should be exhibited in the future Bosnian Virtual heritage collection and present our culture to the whole world.

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