Laser Scanning Versus Photogrammetry Combined with Manual Post-modeling in Stecak Digitization

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Abstract

Stecci are hand carved medieval Bosnian gravestones considered as valuable cultural heritage objects. One of the best ways for their preservation is digitization. In this paper we compare digitization results and procedures for one of the most famous stecci - The Stecak from Donja Zgosca. The object was first digitized using a Minolta 910 laser scanner. Later we created the

3D model from photos using photogrammetry and improved it in 3ds max. We present advantages and drawbacks of these two procedures and characteristics of the obtained models. Results of this comparison will be used in future digitization projects.

Introduction

Cultural heritage within its set of materiality, traditions and knowledge helps us to better understand the past itself. Therefore it is very important to preserve these monuments in a way we see them now for next generations. Thus, new technologies can be very helpful. Today we are able to create virtual model of a real object using various techniques. We used two different techniques in our research, expensive technique of laser scanning and much cheaper, but also good technique for acquisition of 3D models from 2D images, photogrammetry. We also made a step forward and introduced some improvements of the model achieved using photogrammetry , what we will see in more details later in this paper.

Stecci are hand carved medieval Bosnian gravestones. We applied both techniques on The Stecak from Donja Zgosca, and got some interesting results. This stecak originates from the second half of 14th century. It has a great importance for Bosnian history because it is assumed that the Bosnian king Stjepan II, who died in 1353, was buried under this stecak. This monument is currently located in the botanical garden of the BH National Museum in Sarajevo.

In many cases, like with The Stecak from Donja Zgosca, the traditional modeling (for example manual modeling using 3ds Max or Maya) would require much more work and effort, and the final result would not be satisfactory. The model created using these methods would not be sufficiently accurate. It would not contain enough information about the real object. This is why we use methods such as 3D laser scanning, which produces a virtual model with high accuracy. In the first part of our research we used a Minolta 910 laser scanner, borrowed from our project partners, the University of Bristol, UK.

In the second part of our research, we used photogrammetry technique for virtual reconstruction of the stecak. In this project we used the Photomodeler software for implementation of photogrammetry technique with manual approach of creating 3D model. The model was later improved in 3ds max software.

The paper is organized as follows: the Section 2 gives a short overview of the related work in similar projects, in the Section 3 we describe the laser scanning approach, applied on the stecak. In the Section 4 we describe the process pipeline of photogrammetry combined with manual 3D post-modeling of the stecak model, and steps for its implementation. In the Section 5 we compare results achieved using these two approaches, and describe advantages and drawbacks of both techniques. In the Section 6 we present conclusions based on our experience from this project, and illustrate reasons why to use one technique instead of another in future projects.

Figure 1: *The Stecak from Donja Zgosca*

Laser Scanning technique

Laser scanners provide a method of capturing accurate information about object's surfaces. The stecak was scanned with a Minolta 910 laser scanner. It is a scanner for close range and indoor applications. This scanner has accuracy of less than a millimeter. Individual scans, created by laser scanning method, were later connected together in a polygonal mesh by using the Stitcher software tool provided with the laser scanner. After mergin scanned mashes in one "watertight" mesh, model was imported in Maya software, where new material on object was applied.

Figure 2: *The model of the stecak before material application (left); Final model of the stecak after material application in Maya (right)*

We used MeshLab tool for optimizing the stecak's model created by laser scanner. Figure 3 shows the unoptimized version of the model in MeshLab environment.

Unoptimized version of the stecak's model in MeshLab environment.

Figure 3: *Unoptimized version of the stecak's model in MeshLab environment.*

Photogrammetry technique

Photogrammetry technique was used for recovering 3D information from the stecak's photos, taken on site. The photos are imported in Photomodeler and we used manual photogrammetry approach for 3D model creation. Figure 4. shows the final model of stecak created in Photomodeler using manual photogrammetry technique. We can see that stecak's surfaces are mainly flat and we used post-modeling in 3ds Max, as next step to make relief on stecak flat

surfaces.

Figure 4: *The final model of stecak created using Photomodeler.*

Photogrammetry technique in combination

with post-modeling in 3ds Max

Images below presents the final model of The Stecak from Donja Zgosca created using photogrammetry method, and later improved in 3ds Max software. This is maximum achieved quality of model improved using post-modeling process.

Figure 5: *The model of stecak created using photogrammetry and later improved in 3ds Max - View 1*

Figure 6: *The model of stecak created using photogrammetry and later improved in 3ds Max - View 2*

Figure 7: *The model of stecak created using photogrammetry and later improved in 3ds Max - View 3*

Figure 8: *The model of stecak created using photogrammetry and later improved in 3ds Max - View 4*

Comparison of laser scanning and photogrammetry technique combined with manual post-modeling

We compared these two techniques by various factors. Some of the achieved results of this comparison are shown in the table below.

Comparison of	LS technique	PP technique

two techniques		
Budget	High budget, expensive laser scanner	Low budget, cheap digital cameras
Geometry	High level of details	Low level of details
Textures	Problem with getting textures by night. Used only geometry, with radiance effects on the model's surfaces	Photo textures with high level of details
Operations taken automatically	The object's meshes generated using scanner	Automatic processing of marked data in Photomodeler software
Operations taken manually	Laser scanning. Editing and improving the model's meshes in Maya and Stitcher	Taking photos on site. Marking and referencing elements in Photomodeler
Accuracy level of model's geometry	High level of geometry details	Satisfying level of accuracy model in Photomodeler. Low level of estimated surface geometry details in 3ds Max
Optimizing	Not easy to optimize. For best results, hard work in manual optimizing is required	Easy to optimize. Models created in Photomodeler have very light geometry. Improved models in 3ds Max can be optimized easily in this software
Level of achieved realism	Geometry by itself offers good level of realism. In addition with good textures, the result is excellent	Very good level of photorealism. The model looks very natural to human eye
Human efforts	Overall small amount of included human efforts. If model's meshes have to be manually improved, human efforts can be much higher	Manual modeling requires a lot of human efforts in Photomodeler. Efforts in 3ds Max are usually low, but can be higher if high detailed mesh is needed
Required knowledge level	Laser scanning is not difficult to learn. Operator need to have earlier knowledge of 3D modeling and editing in order to know how to use similar programs. Editing	Photomodeler is much easier to learn than programs like Maya or 3ds Max. Essential knowledge of calibration, marking and referencing can be achieved very quickly

	model in Maya, requires essential knowledge of this software	
Required experience level	Laser scanning process on site can be learned in a few hours. Experience of working in 3D CAD applications is desirable. Experience in working with Maya is needed	Only experienced operator can achieve well and accurate results in Photomodeler. Later improving in 3ds Max requires some experience of working in 3ds Max or similar CAD software

Figure 9: *Comparison of LS (laser scanning) and PP (photogrammetry in combination with manual post-modeling) techniques by various factors*

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Digital catalog of Stecaks

We used the obtained model as a part of our project "Digital Catalogue of Stecaks". This project is a virtual museum of stecci from the collection of the National Museum of Bosnia and Herzegovina. The models created using photogrammetry combined with post-modeling work well considering all limitations of this online application.

You can visit **Digital catalog of Stecaks** website, for more information about this project and virtual models of stecci.