Digital Visualization of the Medieval Church at Sopoćani, Serbia

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Introduction

Throughout the 13th century, a series of Serbian churches in the Western Balkans were adorned with what may be described as "fictive" mosaics. The backgrounds of the wall paintings gracing the interiors of these buildings were covered with gold leaf and patterned to mimic mosaic cubes—an expensive and fragile form of decoration of which only traces now survive.

Objective and Methodology

The primary goal of this research project is to digitally visualize the original interior of the church of the Holy Trinity (c. 1265) of Sopoćani, the best preserved among these monuments. Specifically, the aim is to create a 3D virtual-reality replica of the interior, which will provide the modern viewer with the visual experience once enjoyed by the medieval visitor to the church.

Of the different sections of the church, the paintings within the nave and sanctuary (Figure 2) are the best preserved and therefore, this project will focus on these two sections.

The following methodology outlined will be used to create the 3D virtual-reality replica:

1. **Restoration and gilding of preserved wall paintings**
2. **Converting the 3D point cloud scan into a mesh**
3. **Cleaning, texturing and lighting the mesh**
4. **Creating a virtual interactive visualization**

Figure 1. *Church of the Holy Trinity (c. 1265) of Sopoćani*

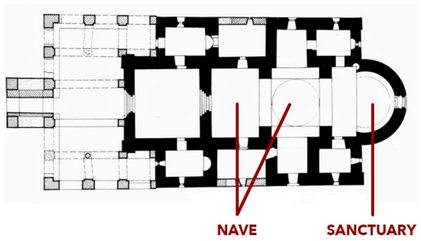


Figure 2. *Labelled Floor plan*

Part 1: Restoration and Gilding of preserved mosaics

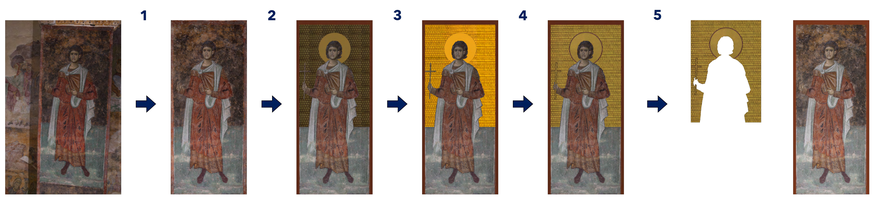
In this first part, I used a large photo collection of the interior of the church, specifically those of the Nave and Sanctuary to create digital restorations of the paintings with fictive mosaics.

The process for each painting is broken down in Figure 4. Notable aspects included using Adobe Photoshop to create accurate and natural mosaic gilding patterns under the guidance of Dr. Drpić, as well as finer details such as the crosses and halos. Further, the saturation and contrast of the paintings themselves were adjusted to best resemble the vibrance they would have had in medieval times.

In all, I processed twelve figure paintings that were on the north and south-west pillars of the nave, along with two large multi-figure compositions.

Figure 3. All digitally restored and gilded paintings

Figure 4. *Digital restoration and gilding process*



Key

1. Perspective Correction

2. Gilding Rough Concept

3. Gilding Improved Natural Texture

4. Colour correction

5. Final separated gilding and painting

Part 2: Converting the 3D point cloud scan into a mesh

What is a point cloud?

"A point cloud is basically a set of data points in a 3D coordinate system, commonly defined by x, y, and z coordinates." [2]

Then what is a mesh?

A mesh is 3D model consisting not of points but of polygons, and is what is used in 3D modelling and texturing.

Dr. Drpić and his collaborators used two 3D scanners, the Leica ScanStation p20 and RTC360, to create a point cloud scan of the church.

For the project, we needed a 3D visualization of the church that we could both modify and retexture, meaning we needed a mesh and hence, I used a 'point cloud-to-mesh' conversion software known as *Pointfuse* to create this mesh.

Figure 5. *Untextured mesh of the Church*

Part 3: Cleaning, texturing and lighting the mesh

In this part, I used the 3D modelling and animation software *Maya* to clean up, texture and add lighting conditions to the mesh.

Due to the technical limitations of scanning equipment, the point cloud was bound to have errors, for instance, small holes in the walls, that were resultantly transferred to the mesh.

Cleaning involved patching up these anomalies in addition to removing structures that were captured in the scan such as people, and also furnishings such as a chandelier that did not exist in the church during medieval times.

As for texturing, the main focus was to map the digital painting restorations of part 1 onto the mesh in their correct positions and with accurate materials. For instance, I applied and adjusted a gold surface texture to the gildings of all the paintings to properly simulate how they would have interacted with the lighting conditions of the church.

Finally, lighting conditions during this stage were simulated through digital sky and area lights in Maya through adjusting their qualities such as exposure, intensity, colour temperature and spread.

Figure 6. Renders of the textured mesh in Maya

Part 4: Creating a virtual interactive visualization

In this final part, I did a final clean up of the completed mesh in Part 3 before exporting from Maya into the 3D environment and game development engine *Unity*.

Here, I used the *First Person AIO asset* [3] *to make it possible for the viewer to walk through the Nave and Sanctuary* of the church freely, so as to best recreate the virtual medieval viewer's experience.

In addition, I programmed a Unity C# script that allowed for an orbiting sun with adjustable speed. This means the viewer is able to experience the church in all lighting conditions of the day/night cycle.

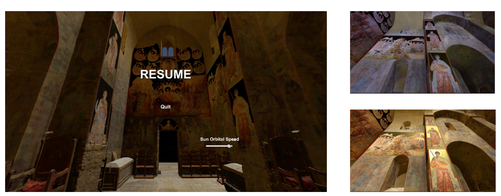


Figure 7. Interactive visualization of the church *(Left image: Pause menu with Sun orbital speed setting)*

Conclusion and Future

Through this PURM project, I was able to learn the context and historical significance of the church of the Holy Trinity (c. 1265) of Sopoćani and its various paintings in addition to forwarding my skills in digital art and photo editing, 3D modelling and finally scripting. I will continue this project with Dr. Drpic as an independent study where we will work to increase the accuracy of the virtual visualization through new untouched aspects such as recreating not only the gilding but also the stained glass through preserved and studied fragments.

Acknowledgements

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2. ***Chee Kai Chua, Chee How Wong, Wai Yee Yeong, Chapter Four - Software and Data Format***
3. ***Aidan Graves, First Person AIO Unity Asset Creator***
4. ***Dr. Norman Badler***