SPECIALIST REPORT

Virtual Model Report of Work Completed

December 2009 – May 2010

Jassim Happa

"Conservation and Documentation of the Wall Paintings at the Red Monastery, Sohag"

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Address: 8700 Crownhill Blvd. Suite 507, San Antonio, TX 78209 Tel: (210) 821-7000

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Red Monastery Virtual Model

Report of Work Completed

On and Off Site

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Purpose of visit to the Red Monastery

- Acquire SLR Photography for texture mapping and documentation purposes.
- Provide a High Dynamic Range (HDR) spherical panoramic record of the site.
- Authentically light a virtual reconstruction of the monastery.
- Supervise Agnes Szymanska and Carlin Yuen in their respective tasks.

Review Report

During my visit to the Red Monastery I collected D-SLR and High Dynamic Range photography (HDR photography is the process of assembling several SLR photographs at various exposures into one image containing a greater range of light), but also provided 3D Maya [1] modeling advice for Carlin Yuen during his stay and modeling of the monastery due to my extensive experience in creating cultural heritage virtual models. I also aided as a photography advisor for Agnes Szymanska and Carlin, which helped them in their respective tasks.

SLR Photography:

Together, Agnes and I collected approximately 7500 unique photographs of the site, primarily in ordinary low dynamic range. These were acquired for three main reasons: documentation of light propagation, documentation of the site, and for texture mapping purposes. Most photographs were acquired for texture mapping, allowing for the virtual model to obtain color by mapping photographs onto its 3D shape, giving it the appearance of the site as it is today. Several of the documentary photographs were color calibrated, and can be color compensated in the future for correct display of the objects. HDR SLR photographs were also acquired from the site, which hold information about the light in the environment. This allows for a heuristic approximation in recreating the same visual perception of the past environment in the virtual scene.

All surfaces were photographed at a perpendicular angle in order to acquire as flat images of the surfaces as possible. Photographs of high quality (for texture mapping purposes) were taken with steady tripods. Images of larger surfaces, such as the nave walls, were taken with several photographs. These were assembled to form super resolution photographs that SLR cameras are unable to acquire with a single photograph. In certain occasions, getting a clear understanding of the 3D shape of the monastery was difficult. A small portion of the photographs were also taken to get a better perspective of the shape of the monastery to aid Carlin in his 3D modeling.

HDR Photography:

A SpheroCAM HDR [2] was used to acquire 52 HDR spherical panoramas; 18 of these with information about how the sun changes over the course of the day that can be used in a virtual context (see Figure 6) to provide photorealistic lighting. The day sequence also allows for future interpolation between the images in a daylight simulation in a virtual model. Figure 1 shows the camera in use and how it was operated.

Figure 1: The camera setup. Left: The camera in the process of capturing an HDR spherical panorama. Right: Example photograph of setting up the equipment.

HDR spherical panoramas are extremely useful in digital documentation as they allow for acquisition of the distant scene to be represented as a sphere. By combining two spherical panoramas at

different heights, real world distances can be measured through photography. This is helpful for archaeologists to measure distances without physically touching the environment. As illustrated in Figure 2; the monastery nave was photographed at different heights, and distance data can be extrapolated from the two photographs. 10 of the 52 spherical images were taken in pairs to allow such measurements. Among these include: the triconch, the nave, the roof of the triconch and the top of the nave.

Figure 2: Example of measurement data in the nave. Left (top and bottom): two spherical panoramas acquired at different heights. Right: By combining the two images together, we can extrapolate distance data between objects in the photograph. Yellow lines indicate example measurements.

All spherical panoramas were captured in HDR; all of which with at least 15 different exposures, some with greater than 20 exposures. During the photography stage, it was necessary to estimate the time taken for the light sources to move in conjunction with the camera to cycle around 360 degrees. If the sun had moved significantly before the end of the photograph, it was necessary to either lower the exposure or resolution. Higher pixel resolutions were favored over illumination for darker areas such as the triconch in order to preserve details more relevant for the archaeologists and art historians. Due to the cloudless, bright skies of Egypt however, this never became a major problem. Figures 3-5 illustrate the various uses of documenting areas like the triconch in HDR.

Figure 3: The dynamic range of illumination is embedded into a single image as illustrated in this cropped version of Figure 5. This image contains 20 exposures allowing for more information about the light to be stored than in a single image.

Figure 4: The presence of sunbeams is difficult to document with traditional SLR photography in a single exposure. Documenting their presence is useful in the relighting stage of the interior triconch as it allows us to compare interior renditions of the scene with acquired photography.

Figure 5: A tone mapped version of the triconch HDR spherical panorama allowing for the simultaneous display of the brightest and darkest areas. The image can be used for 360 degree visualization of the environment and shows light propagation for the scene at a high resolution.

Work Post Site Visit:

We are currently working on a virtual simulation of the monastery. For the purposes of our research at Warwick, we hope to employ the scene for physically-based light transport simulation as the scene is considerably difficult to render due to the amount of inter-reflection of light in the triconch. From a historical research point of view, we aim to add a virtual roof in the nave and various roof models to the triconch in hopes of determining likely rooftops based on propagation of light, interior visual perception and in consultation with the project architects and historians. The model provided by Carlin is primarily based on CAD files, developed for the Red Monastery Project. It was decided for this project to focus on the triconch area, which will be highly detailed and delivered as a 3d model in autumn 2010. Necessary files to view the model will also be provided along with a video of the virtual model with high-fidelity lighting as it stands today.

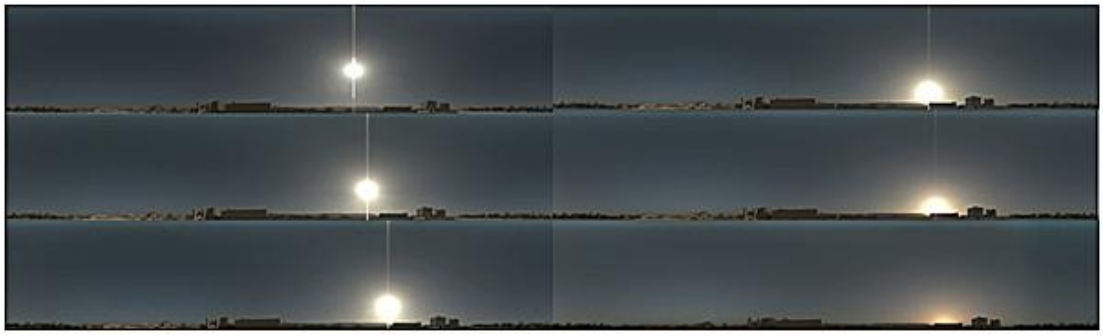

Figure 6: The latter part of the day; sunset. Twilight alters the perception of the sky significantly, and is an important element of the sky to document for visualization purposes.

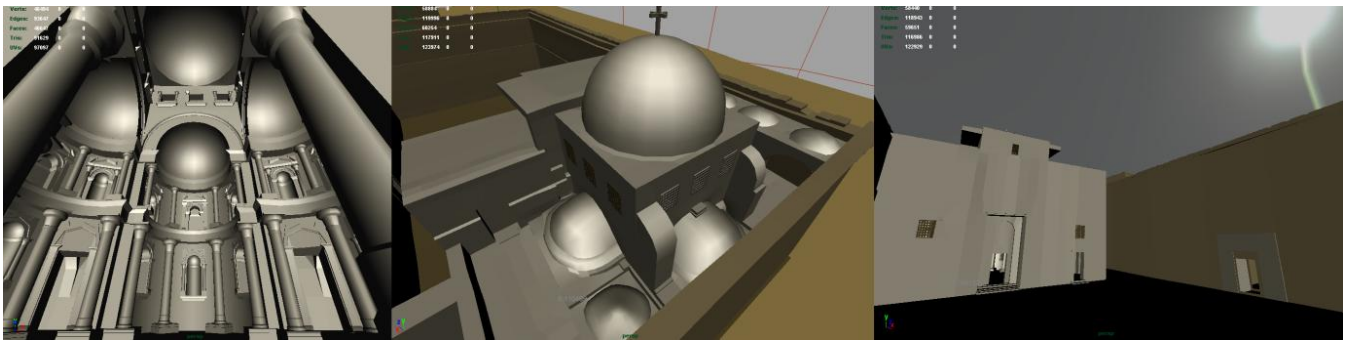

Figure 7: The virtual model as of May 2010.

Conclusion

The purpose of this visit to the Red Monastery was to aid in its virtual reconstruction through various methods to photography-based data documentation. I supervised and assisted Agnes and Carlin in their respective jobs, and acquired a large digital library of photographic material in HDR and traditional SLR. The acquired material is currently being processed with the virtual model by Carlin and will be ready in autumn 2010.

Interior towards the North, between the exterior wall and the triconch façade.

Virtual model, untextured.

References

[1] Autodesk Maya 3D Modelling Software:
http://usa.autodesk.com/adsk/servlet/pc/index?siteID=123112&id=13577897

[2] Spheron SpheroCAM specification Webpage:
http://www.spheron.com/en/intruvision/solutions/spherocam-hdr.html