Fusion of Laser Scanning and Photogrammetric Data for the Documentation and VR Visualization of an Archaeological Tomb Complex

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SUMMARY

In this paper, we investigate the complementary use of data acquired using terrestrial laser scanning (TLS) and photogrammetry for a cluster of rock tombs in Sheikh ‘Abd el-Qurna, Western Thebes. We focus on two tombs where the combination of the two methods helps to solve particular challenges. For the first tomb, the geometry was derived from the TLS data, while RGB information was captured photogrammetrically instead of using the integrated scanner camera due to poor illumination inside of the tomb. For the second tomb, the complete geometry of a narrow vertical shaft could only be reconstructed by stitching together models obtained originally from the separate use of both techniques.

We demonstrate the potential of combining the data derived from the two methods to generate a high-resolution model with respect to geometry and texture. To combine the data, the photogrammetric model has to be scaled and aligned to the TLS model. We achieve this by extracting distinctive points in both models and determining their correspondences across the models. The scale is then computed, as the mean ratio of the Euclidean distances between sets of corresponding point pairs in the individual models. Corresponding points are also used to estimate the parameters of the congruency transformation, which is used to align the two models coarsely. The fine alignment is carried out by applying the iterative closest point algorithm (ICP).

For the first scenario, a point cloud derived from about 80 scans was merged with a 3D model reconstructed from roughly 7000 images with 30 megapixel each. The photogrammetric model was computed on a high performance cluster using Agisoft Photoscan. After scaling and aligning, the two models were merged resulting in a colored high-resolution 3D model. For the second scenario,

a photogrammetric model was used to fill the gaps that could not be acquired using TLS due to the geometry of the shaft. The mentioned processing steps (scaling and alignment) are equal for both scenarios.

To visualize the tomb complex on consumer grade computers with photorealistic quality, the high-resolution model and the textures from the images are translated to physically based rendering (PBR) calibrated surfaces. PBR enables rendering of the model with simplified geometry keeping the full visual information. As all images were equally illuminated, there are no shadows in the images and the resulting model contains automatically an albedo texture that can be used in the PBR process. The result is a 3D model and its corresponding shaders that can be viewed e.g. using virtual reality glasses connected to a standard computer.