Documenting and visualizing deterioration of monuments on a 3D environment

Projection of 2D documentation drawings on a 3D SfM model

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Introduction

Team and objective of research

The following research was realised under the Postgraduate Programme "Space, Design and Built Environment", in the School of Architecture at the Technical University of Crete, for the 3D visualization of structural damages and deteriorations of an ottoman hammam using common software and hardware. The goal is to use interactive 3D models for non-pervasive studies of historical monuments in Cultural Heritage.

Historical information

The listed monument, is located 4 km south of the city of Chania, Crete, in the settlement of Mournies (35 ° 28'56.6 "N 24 ° 00'39.5" E), in an old privately owned area. The building hosted a Turkish hammam and has a great historical and architectural interest, as well as an impressive amount of decorative and morphological elements. Constructively, it is made of a semi-carved stone masonry, it has a number of damages and deteriorations, and needs immediate restoration. Its construction was quite complex due to the configuration and maintenance of the optimum inside temperature and humidity conditions for the operation of the hammam. The different mortars and coatings used per room relative to the operation of each space have brought different types of deterioration.

Process, tools and methodology

Work on site

Two visits took place on site. On the first visit, the monument was identified and the lack of adequate natural indoor lighting for the subsequent photography was recorded. On the second visit, photogrammetric capture took place, taking 195 overlapping photographs that were used in the next stage. The photo shooting took place only inside the hamam, as it was impossible on the outside due to lack of accessibility. A Canon EOS 450D camera and a LED strip of about 3m, 6400K, 10.8 w / m, 1000 lumens / m for interior lighting, were used. The largest area illuminated with the above equipment had dimensions of 3mX3m and an average height of 4m.

Creation of 2D documentation drawings

The next stage of the process was the virtual 3D reconstruction, using SfM in Agisoft Photoscan software. The .obj file that was produced, was inserted to 3ds Max and the unnecessary geometry was cleaned. 2D orthographic views of all the interior faces of the building and the resonance were extracted through sections made in the model. The images that were produced were subsequently used as backgrounds for recording the deteriorations.

Two procedures were used to create 2D deterioration visualizations: a) the first one involved the production of .dwg drawings through Autodesk Autocad, where the 2D interior facades were imported as a background, and the layers of the deteriorations were designed using the appropriate hatches (Fig. 1a). b) the second

procedure, focused on the same recording by importing the backgrounds in Adobe Photoshop and processing the visualization of the deteriorations layering separately (Fig. 1b).

a   *b*

Fig. 1. 2D deterioration visualizations: a) Autodesk Autocad, b) Adobe Photoshop

Creation of 3D documentation drawings

Fig. 2. The final result in the Photoshop 3D environment

In order to create a 3D display of the building's deterioration, Photoshop was used in its 3D environment. After the Agisoft Photoscan .obj file was imported in Photoshop, the following steps took place:

1. The material of the model was replaced by the .jpg file which was exported as texture file from Agisoft.
2. The texture .psb file was edited with added layers in order to store changes made on the texture of the .obj file.
3. Returning at the .obj file, the camera was aligned to the desirable section plane in order to view the same internal views of the model.

4. Afterwards, the desired layer that has been created as a 2D documentation, was imported as an .eps format through the .dwg file and placed relative to the camera view.

5. At the end the different layers with the deteriorations were merged down in order to project the damages on the 3D model material.

The same procedure can be followed for every different deterioration and for every interior view. The final result (Fig. 2), which includes all the deteriorations, is one .psd file for the 3D model and one .psb file relevant to textures with all deteriorations per layer. Inside the Photoshop 3D environment, one can browse the model and observe all the desired deteriorations by turning on/off the layers from the texture file (.psb).

Internet applications

There are a large number of free web applications for viewing 3D models in WebGL. This research utilizes the Sketchfab platform (www.sketchfab.com) due to its simplicity, speed and ease in changing textures inside the platform, but also because it offers the ability to view the 3D model in VR mode, using cheap viewers or expensive VR headsets. The different deteriorations, which are stored as .jpg files through the .psb texture file, can be uploaded on the 3D model inside Sketchfab, under the Materials tab in 3D Settings. By switching between different .jpg files as textures in the materials, one is able to navigate through the different deteriorations inside Sketchfab's 3D model. The final models are available at the following links:

https://skfb.ly/UMvP, https://skfb.ly/UZqE

Issues

During the whole process a number of issues arose. When editing in Photoshop 3D the bump of the space does not allow for the complete matching of the two-dimensional with the three-dimensional backgrounds and creates some losses and deformations of the final visualization of the deteriorations. These deformations are intensified in the case of study by the geometry of the hemispheric domes and generally the convex surfaces of the monument. Also, the fact that the building is housed by domes, has created overlaps of deterioration visualization during the implementation of the "Merge Down" command, since parts of the dome in the reflected ceiling plan coincide with parts of the dome on the internal aspects. The result was the display of unnecessary information and double lines.

Results – Evaluation

This method proved to be a fast, low cost and flexible technique for documenting and visualizing deterioration of monuments on a 3D environment. Lack of high accuracy and high resolution does not allow this process to be suitable for a detailed analysis. Nevertheless, it offers a valuable visualization tool for a non-pervasive study of historical monuments and their different kind of deteriorations.

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