PHOTOGRAMMETRIC RECONSTRUCTION AND VIRTUAL PRESENTATION OF MONASTERY OF CHRIST PANTEPOPTES

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ABSTRACT:

The land of present-day Turkey, stretching out between Asia and Europe, has been called the crossroads of history. It has always been the scene of international exchange of culture, art and architecture. Since early days, the traditions of the past, in the social and cultural reflection of various Anatolian Civilizations can still be seen in Turkey and in the remains of historical cities dating from the Neolithic and Early Chalcolithic Ages to mosques, palaces and historical houses of the Ottoman Period.

With are timber houses and winding streets, Fatih is a typical region of old Istanbul. As in most other areas of old Istanbul, fires have caused much devastation in Fatih. The monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) in Fatih was selected to sample building for the case study.

The recording and documentation of the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) has been realized by a combination of state-of-the-art technology: GPS measurements and tacheometry have been applied as well as photogrammetric techniques.

Several methods of visualization have been applied to the data set. Besides the rendering of the photo realistic images with high resolution, video films have been produced and interactive inspection in a virtual reality environment has been derived.

INTRODUCTION

Architecture is a substantial part of our cultural heritage. But whereas other elements of our cultural heritage may be protected by putting them behind a glass in a museum, architectural monuments are widely used and endangered by long term influences like traffic or air pollution or destructive events causing heavy damage like earthquakes, fire or war etc. But by all means when monuments are seriously damaged, or completely destroyed, the amount and quality of any surviving documentation becomes highly important.

Therefore it is necessary to document the actual state of the architectural monuments in a manner, which opens the opportunity to detect continuous damage by change detection techniques and to restore the monument in case of heavy damage. Before starting to acquire new data on the monument already existing data sources have to be obtained, e.g. existing plans of previous restorations, ancient pictures or documentation's of architectural research projects.

The 3D reconstruction of buildings has been an active research topic in Computer Vision as well as in Digital Photogrammetry in recent years. Three-dimensional building models are increasingly necessary for urban planning, tourism, etc. (Suveg and Vosselman, 2000).

Three-dimensional photo-models help us to understand spatial objects, even if they are not accessible for us. Using photo-models from existing objects can make it easier for us to understand complex spatial structures. With the help of methods coming from virtual reality we can link additional information in the form of text or sound sequences to our photo-models. An architect, for example, can generate an interactive three-dimensional information system based on a photo-model, which describes and visualizes an important building [Dorffner and Forkert, 1998].

Visualization efforts in Photogrammetry do not have a long history. In the beginning of 90's the first photogrammetric attempts were mainly focused on the use of CAD software and the generic visualization tools they had to offer. Most of the research efforts at that time were concentrated to automating the data acquisition and processing through Digital Photogrammetry concepts, thus little attention was paid on how to add value to the data.

2. TEXTURE MAPPING AND VISUALIZATION

A three-dimensional photo-model is an object model where the texture information is taken from photographs or other optically working recording systems. It consists of two parts. One part is the three-dimensional object model in which the shape of the object surface is stored. Adjoining surface patches approximates the object itself. The second part is the photo-texture, which is transformed to the patches (Dorffner and Forkert, 1998).

To visualize the derived model the photogrammetric data are converted to VRML (Virtual Reality Modeling Language). VRML is a format for 3D data with features like hierarchical transformations, light sources, viewpoints, geometry, animation, fog, material properties and texture mapping (Carey and Bell, 1997). VRML is an open format that has become popular because of its suitability for publishing 3D data on the World Wide Web. For this reason there is a lot of software available that can handle VRML. This software allows a user-friendly interactive examination and visualization of the data. The conversion to VRML is fully automatic and consists of two parts: geometry conversion and texture mapping. In the geometric part the object coordinates and the topology information are converted. [Heuvel, 1998].

3. PHOTOGRAMMETRY AND CULTURAL HERITAGE

Since the development of the science of photogrammetry, there have been many applications of its techniques and technology in the recording and documentation of monuments and sites of importance. Whilst there may have been a redirection of effort when aerial mapping expanded following the invention of aircraft, there has been a shift again to other measurement applications offered by photogrammetry, especially those in architecture and archaeology. Developments in the sciences of photogrammetry and image processing over the past decade or so have seen an increase in the automation of the data collection process, ranging from high precision industrial applications through to simple solutions for non-traditional users (for example, *3D Builder* and *Photo modeler*). In addition, systems that use imagery from consumer digital and analogue video systems and sequences of images have almost automated the creation of three-dimensional (3D) models (as has the development of 3D laser scanners (Ogleby, 1999).

4. CASE STUDY

The land of present-day Turkey, between Asia and Europe, has been called the crossroads of history. It has always been the scene of international exchange of culture, art and architecture. Since early days, the traditions of the past, in the social and cultural reflection of various Anatolian Civilizations can still be seen in Turkey and in the remains of historical cities dating from the Neolithic and Early Chalcolithic Ages to mosques, palaces and historical houses of the Ottoman Period. (Gülersoy, 1991).

Fatih is situated at the slopes of the fourth hill in the Historic Peninsula in Istanbul. The district starts at the shores of the Golden Horn-Haliç, and extends up the slopes along the Atatürk Boulevard. Retaining walls reaching up to 15 meters are to be found at some spots along the Atatürk Boulevard, as well as dykes and terraces dating from the Byzantine period. These structures present an interesting view in the direction of Galata, Golden Horn, and the Historic Peninsula. (Gülersoy, 2001).

In this study the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) in Fatih was selected to sample building for the case study. Figure 1 show the sample building and study area.

The monastery of Christ Pantepoptes is known to have been either founded or renovated by Anna Dalassena, mother of Alexius I Comnenus (1081-1118). Built on the summit of the City's fourth hill, above the underground cisterns, it commands a magnificent view of the Golden Horn and the Bosphorus. The location explains the name Pantepoptes, i.e. the All-Seeing. The church is of the cross-inscribed type with four columns supporting a dome. Its ground plan is that of a three-aisled church with two narthexes. Though in a state of neglect, the elegantly proportioned building has retained the fine decorative brick work of the exterior, the shallow niches, the arches framing single or triple windows, the arcade of the gallery on the west side, the meander and rosette friezes, as well as sections of the cornices carved with palmettes.

4.1 Photogrammetric Documentation of Monastery of Christ Pantepoptes

Detailed geometric information of the sample building was derived from architectural photogrammetry and geodetic measurements. (El Din, 2000). The images were taken with Rollei D7 metric camera. The images were not taken normal case. The control points (approx. 35) were realized by using geodetic techniques. The control points were measured using Pentax total station.

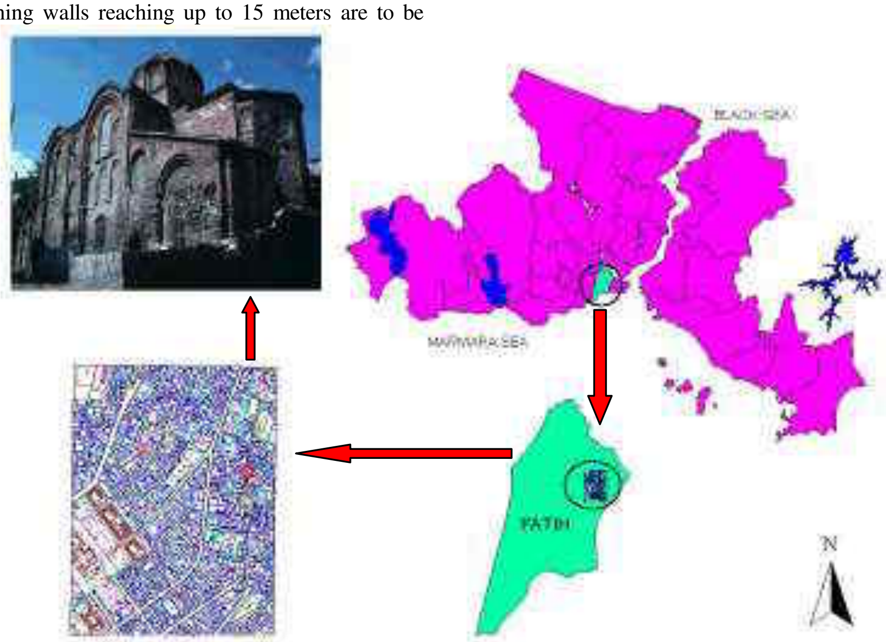

Figure 1. The sample building and study area.

In this step the image coordinates and lines were measured manually each image. The process of tie point measurement has to be done interactively and therefore is very time consuming. Together line measurement the object topology was specified and thereby the coplanarity of the lines bordering a face. This topological information must be stored alongside the point identifiers and coordinates in the data set. In our study we used the low-cost program Photo Modeler by Eos Systems Inc. for point measurement and definition of topology (Eos Systems Inc., 1997). The photogrammetric evaluation was done partly

(Fig. 2). Afterwards creating 3D model can be transferred to DXF format and then merged in AutoCAD. Fig.3 shows 3D wire frame model of the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) (Duran and Toz, 2002).

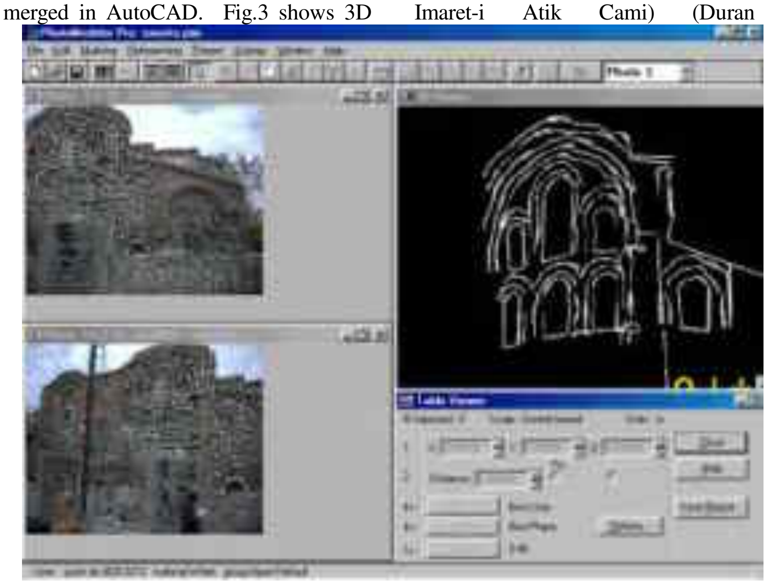

Figure 2. Example of the photogrammetric evaluation

After digital data were merged for 3D modeling in AutoCAD, it was saved as .dxf file. This file was imported into Max. After editing photos of the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) in Adobe Photoshop, they were stacked on surfaces of building by using mapping technique in material editor of 3D StudioMAX. Stacking photos on surface of the monastery made the building seem realistic (Ozaslan and Seker, 2001).

4.2 Rendering and Animation

After creating 3D model and stacking photos on the building, the last step was rendering (Fig. 4). Rendering a scene or scenes (animation) by using 3D StudioMAX is possible. It is possible to export the project into file formats jpg, bmp, eps, tif or into video formats mov, avi, by using 3D StudioMAX's render editor. In this projects lots of scenes were rendered into bmp format and a short animation in avi format was created as an example.

In this project 3D textured model was also created in AutoCAD (Fig. 5).

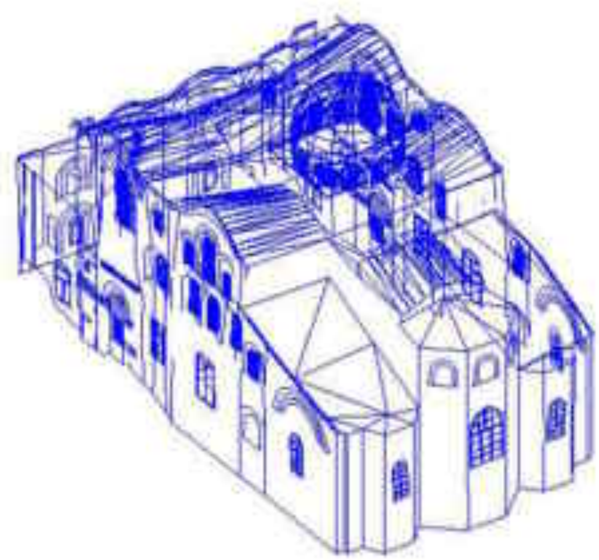

Figure.3 3D wire frame model of the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami)

Figure.4 3D textured model of the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) in 3D Studio MAX.

Figure.5 3D D textured model of the monastery of Christ Pantepoptes (Eski Imaret-i Atik Cami) in AutoCAD.

5. CONCLUSION

The increasing use of close-range photogrammetry techniques for recording historical buildings and objects worldwide motivates the development of new tools for data acquisition and 3D modeling.

3D photo-models are best suited to give a clear and detailed impression of existing situations. For the generation of 3D photo-models digital images are needed.

The texture applied to the three-dimensional object model is, as far as available, taken from the photographs. If three-dimensional photo-models are stored in VRML-format, it is possible to visualize and animate them on the Internet. These models can be used easily for generating an information system.

Therefore, 3D photo-models show up to be a new product in the area of planning and documentation.

It is useful to create 3D models both for planning, projects and also for presentation and visualization. In this study both photogrammetric and geodetic measurements were used together to create 3D model. It was seen that 3D Studio MAX is quite professional for creating 3D models and also for creating animations by using these models. So it is very complex to use MAX and it takes a long time learning to use it functionally.

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