MODELING OF THE TEMPLE OF APOLLO SMINTHEUS USING PHOTOGRAMMETRY AND VIRTUAL REALTY

E. Ö. Avşar [a,*], Z. Duran[a], O. Akyol[a], G. Toz[a]

ITU, Civil Eng. Faculty, Photogrammetry Division -
(avsarem@itu.edu.tr)

Commission V, WG V/2

KEY WORDS: Close range photogrammetry, Modelling, Terrestrial photogrammetry, Visualization, Cultural heritage, Virtual reality

ABSTRACT:

Most of the non topographic application of photogrammetry is related to architectural photogrammetry. Common use of photogrammetry is sketches prepared for the restoration projects of architectural monuments. New technologies and techniques for data acquisition (CCD cameras, Photo-CD, photoscanners), data processing (computer vision), structuring and representation (CAD, simulation, animation, visualization) and archiving, retrieval and analysis (spatial information systems) are leading to novel systems, processing methods and results. The improvement of methods for surveying historical monuments and sites is an important contribution to recording and perceptual monitoring of cultural heritage, to preservation and restoration of any valuable architectural or other cultural monument, object or site, as a support to architectural, archaeological and other art-historical research. Cultural heritage is a testimony of past human activity, and, as such, cultural heritage objects exhibit great variety in their nature, size and complexity; from small artifacts and museum items to cultural landscapes, from historic buildings and ancient monuments to city centers and archaeological sites. Cultural heritage around the globe suffers from wars, natural disasters and human negligence. The importance of cultural heritage documentation is well recognized and there is an increasing pressure to document our heritage both nationally and internationally. To save the cultural heritage in its original form will enable us to see the damages which can occur later. If documentation is kept precisely, the restoration process will be much more correct. Anatolia has been the cradle of many civilizations for thousands of years. Therefore there are many important monuments architecturally and culturally. Many of these monuments both from the pre-historical times, from the Seljuqi or Byzantine and Ottoman periods have been preserved. The temple of Apollo Smintheus is a unique construction of the Hellenistic Age in Anatolia because the scenes from Homer's Iliad are depicted in its ornamentation (frieze reliefs and columnae caelatae). In this study; it is aimed to model the temple from digital images by means of terrestrial photogrammetric techniques.

1. INTRODUCTION

Due to new developments in semi-conductor and sensor technology and due to increasingly economical and efficient computer performance, architectural photogrammetry has developed into a fully digital technology in the last years. Since the beginning of the 1990's digital cameras with resolutions that are comparable with film-based Medium Format cameras have been available (Kersten, Acevedo Pardo, Lindstaedt, 2001). Nowadays the generation of a 3D model is mainly achieved using non-contact systems based on light waves, in particular using active or passive sensors (Guarnieria, Remondino, Vettore). Today complete and detailed 3D object reconstruction is increasingly performed by methods of digital architectural photogrammetry (Kersten, Acevedo Pardo, Lindstaedt, 2001). It is very important that new technologies and knowledge is developed to protect, to strengthen and to restore these buildings and most important of all to understand these buildings within the scope of archaeology, structure and architecture as a total. Giving the priority to the documentation of the buildings is very important to save the heritage. To save the cultural heritage in its original form will enable us to see the damages which can occur later. If documentation is kept precisely, the restoration process will be much more correct.

In this study; it is aimed to obtain 2D and 3D coordinates of each column of the temple of Apollo Smintheus from digital images by means of terrestrial photogrammetric techniques. These coordinates were used to prepare sketches of the columns in different scales. Those data also used to forming virtual model of the temple. This model indicates the capability of these techniques in preserving and documentation of cultural heritage, which is very difficult and time consuming with the conventional methods.

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).

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.

2. TEMPLE OF APOLLO SMINTHEUS

Apollo Smintheus Temple, where first episode of Iliad epic emerged, is situated in the south-west corner of Biga Peninsula. It is within the boundaries of the city of Canakkale and in the municipality of Gulpinar which was called "Kulahli" until 1920's. The temple is located in the garden plot of the town which is nourished by spring waters. This could be the reason why the temple was erected in this site in ancient times where plenty of water existed. The people of Alexandria Troas had come to consult the oracle of Apollo and the god needed water for prophecy. It was constructed during the second century B. C.

The temple was first discovered by the traveler Jean Baptista Le Chevalier in 1785 as he was traveling from Lecton (Babakale) to Alexandria Troas, and identified as Ionic in style of architecture. Later, in 1853, the English admiral R.N. Spratt visited the temple and described it as an Ionic pseudo-dipteral temple of Apollo. In 1866, R. Pullan excavated the temple for two months. In 1966, Hans Weber illustrated some of the fragments and the frieze of the building in an article. The Archaeological Museum of Çanakkale had surveys in 1971-73 in this region. Since 1980, formal excavations and restoration in and around the temple have been carried out by archaeologists under the directorship of Dr. Özgünel from University of Ankara.

The temple dated to the second half of the second century BC. With its reliefs, whose stories are coming from the Iliad of Homer, Temple of Apollo Smintheus is the single example of the Ionic style of the Troas region of Turkey. In this temple the pseudo-dipteral plan was used by a student of the famous Anatolian architect Hermogens of Alabanda. The temple had 8 columns on front and back and 14 on each of its long sides. Its stylobate measured 23.20m x 41.65m rising up on an eleven-stepped krepidoma.

Figure 2. The scene of Hector's wife lament

Figure 3. Acroterion (part of the roof) of the temple

Figure 1. Location of the Apollo Smintheus Temple

3. METHODS USED

For documentation of the cultural heritage, Photogrammetry plays very important role. Photogrammetry is the most economical and effective technique to obtain true 3D coordinates, which is required for documentation of historical monuments. Close range Photogrammetry, is the most convenient technique for documentation among the others.

In this study; from different distances, more than 150 photographs of the columns of the temple were taken by a Canon EOS 350D digital camera with a 28mm lens. The camera is 8 mega pixels. Before taking photographs camera was calibrated in the test field of Photogrammetry Division of Istanbul Technical University. The calibrated focal length of the camera is 28.709788 mm.

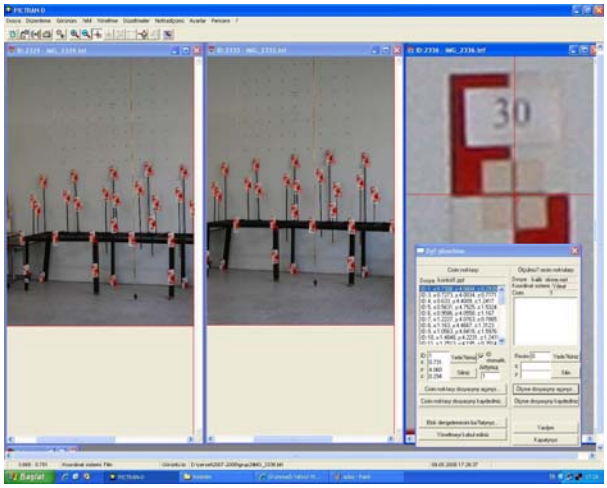

Figure 4. Test Field and Calibration Process

33 control points were mounted on the columns and measured by Topcon GTS-225 total station from 5 polygons and their coordinates were calculated according the equations of intersection method. A local coordinate system was defined and coordinate were calculated.

15 photographs were selected to evaluate the columns. Photogrammetric evaluation was carried out using Pictran digital photogrammetric software.

More than 10000 points on the three columns and the steps were evaluated. After the evaluation necessary edits of file were done using AutoCAD Software. The modeling and rendering is on process and will be published.

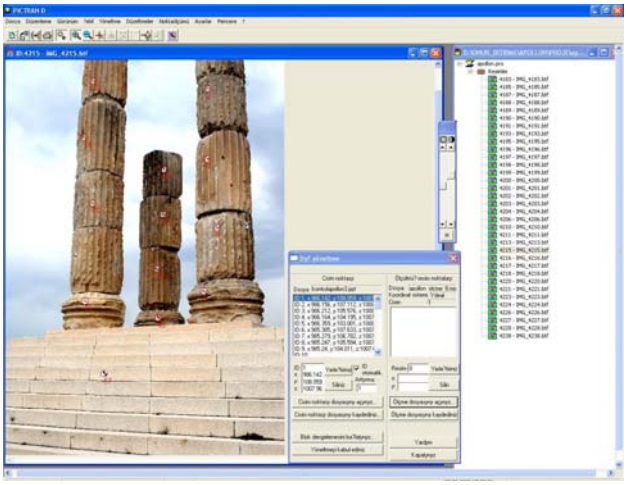

Figure 5. Control Points

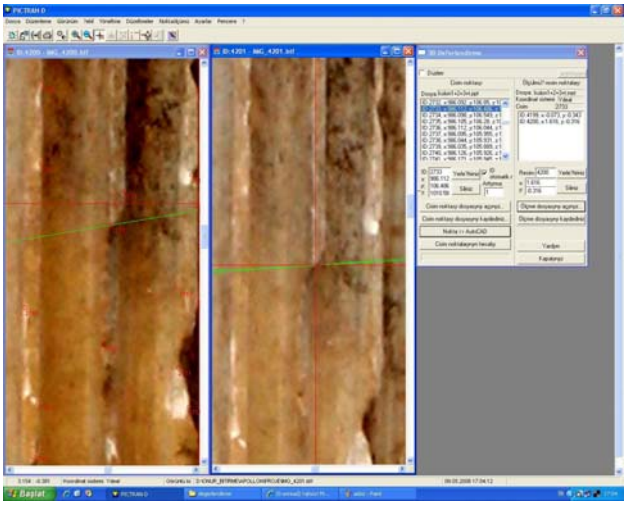

Figure 6. Evaluation

Camera	Canon EOS 350D
Image Sensor	22.2 x 14.8 mm CMOS sensor, RGB Color Filter Array
Pixel	8.2 million total pixels 8.0 million effective pixels
Frame Size	3456 x 2304 (L), 2496 x 1664 (M), 1728 x 1152 (S)
Format	RAW, RAW + JPEG Large/Fine *, JPEG (EXIF 2.21) - Fine, Normal
Lens Mount	Canon EF / EF-S lens mount, 1.6x field of view crop
ISO Sensitivity	ISO 100, 200, 400, 800, 1600
Weight	Body (no batt or CF): 490 g (1.1 lb)

Table 1. Technical Specification of Canon EOS 350D

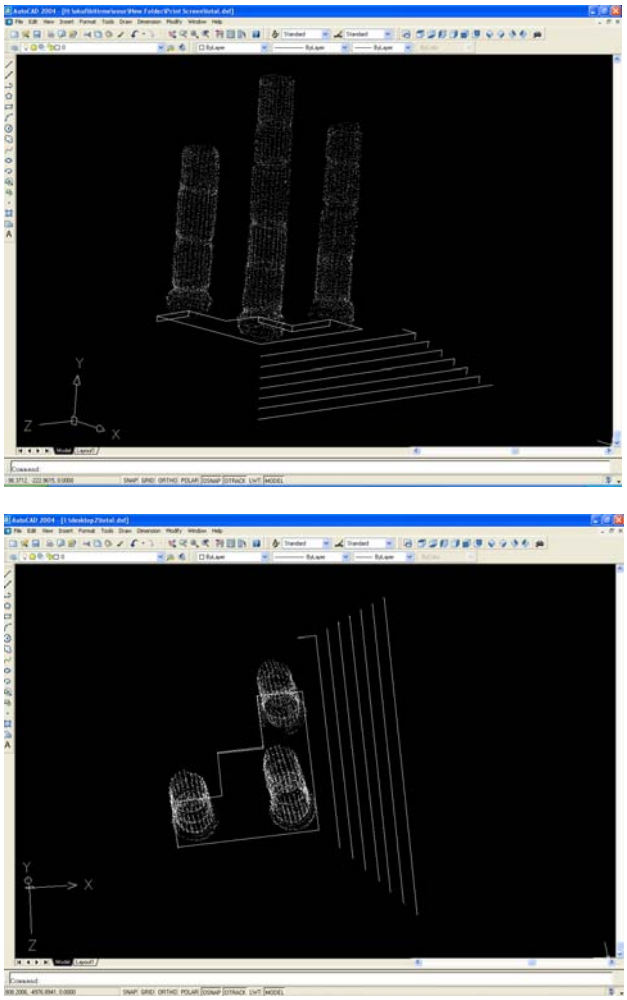

Figure 7. Points clouds in AutoCAD

4. RESULTS AND CONCLUSION

Developments techniques in computer technologies caused to use new tools, which can be used for saving the cultural heritage and nature easily. Photogrammetry is the most convenient tool for documentation of historical heritage. Accurate coordinate values are produced by this method faster than any other technique. Due to limitless information contained by the photograph, they might be used to understand the current status of the historical monuments. 3D models are becoming the most popular visualization techniques for the cultural heritage

Clear and detailed information about the current situation of the cultural heritage can easily be obtained from the 3D models. Restoration project can be prepared and finished restoration projects can be compared with existing situation using 3D model of cultural heritage. (Avsar, Aydar, Seker, 2006).

In this study 3D model of the standing column of the temple of Apollo Smintheus was realized using obtained coordinates from photogrammetric technique. Due to the intercommunication problems laser scanning of the aimed parts cannot be carried out yet. Visualization and texturing is carrying on.

REFERENCESS

Avşar E. Ö., Aydar U., Şeker D. Z., Virtual Reconstruction of a Semi Destroyed Historical Bridge, Fifth Turkish – German Joint Geodetic Days, Technical University Berlin, Germany: 28-31 March, 2006

Carey, R., Bell, G., The Annotated VRML 2.0 Reference Manual, Addison Wesley Developers Press, 1997.

Dorffner, L. and Forkert, G, 1998, Generation and Visualization Of 3D Photo-Models Using Hybrid Block Adjustment with Assumptions on the Object Shape, ISPRS Journal Photogrammetry and Remote Sensing, Vol.53, pp.369-378.

Duran, Z., 2003. Documentation of Cultural Heritage by Means of Photogrammetric Methods and GIS, PhD, ITU Institute for Science and Technology, 2003, Istanbul, Turkey

Grussenmeyer, P., Hanke, K., Streıleın, A. Architectural photogrammetry. Chapter in «Digital Photogrammetry», edited by M. KASSER and Y. EGELS, Taylor & Francis (2002), pp. 300-339.

Guarnieri A., Remondino F., Vettore A., Digital photogrammetry and TLS data fusion applied to Cultural Heritage 3D modeling International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol. XXXVI, part 5. ISPRS Commission V Symposium, Dresden, Germany, 2006.

Kersten, T., Pardo, C.A., Lindstaedt, M., 3D acquisition modelling and visualization of north German castles by digital architectural Photogrammetry, Proc. ISPRS XXth Congress, Istanbul, Turkey, 2004.

Ogleby, C.L., 1999. From Rubble to Virtual Reality: Photogrammetry and the Virtual World of Ancient Ayutthaya, Thailand, *Photogrammetric Record*, 16(94): 651–670.

Patias P., Cultural Heritage Documentation. International Summer School “Digital Recording and 3D Modeling”, Aghios Nikolaos, Crete, Greece, 24-29 April 2006

Slama C. C. (Ed.), 1980. Manual of Photogrammetry. Fourth Edition, ASPRS, Falls Church, Virginia, pp.196-207.

www.babakale.com