International Journal of the Physical Sciences Vol. 5(7), pp. 1086-1092, July 2010
Available online at http://www.academicjournals.org/IJPS
ISSN 1992 - 1950 ©2010 Academic Journals

Full Length Research Paper

An experimental study on preparing photogrammetric rolove plans of antique theatres

Ali Ulvi* and Murat Yakar

Department of Geomatic, Faculty of Engineering and Architecture, University of Selcuk,42031 Konya,Turkey.

Accepted 25 May, 2010

This study was conducted in Knidos antique theater which is located in town of Muğla, Datça, from 2005 to 2007. In this study, Knidos is documented with photogrammetric method and a rolove of the antique theater is prepared. This work will provide sensitivity for possble future restoration activities. The data will be used for protection, restoration and documentation activities of these activities which may decrease the cost of this process. Additionally, the study will offer multidisciplinary data which may be used by practitioners in the field.

Key words: Knidos, rolove photogrammetry, antique theater.

INTRODUCTION

To protect, own the values of and to hand down the historical artifacts to the next generations is a holy mission. Execution of documentation studies is necessary in order to protect and hand down the historical artifacts to the next generations. Because, cultural heritage after being damaged by reason of natural and unnatural causes, in order to be renewed in other words to be restored as the original, needs documentation and relievo plans to be implemented. Relievo is a process of scheming and transection of a cultural heritage in case it has been damaged or ruined for any reason and providing the renewal by performing susceptible measurements.

Relievo is a way of expressing the present situation of a building with scaled drawings (plan, cross sections and drawings). Relievo is not a project but a basic data for the project. Relievo is an opportunity for; investigation of a building, urban texture or archeological remains closely, documentation, evaluation in terms of architectural background and restoration plan to be prepared (Demirkesen et al., 2005).

Terrestrial photogrammetry technique is a method which was used for archeological measurements and documentation of historical artifacts for ages. Photogrammetry, along with the development of digital techniques, became a more efficient and economical method documentation and protection of architectural works. Recently, as a result of improvements on Digital Photogrammetry and Computer technology, reconstructution of buildings as three-dimensional took part amongst current research topics. Day by day modelling a building as three-dimensional has almost become obliga-tory for tourism and urban planning (Suveg and Vosselman, 2000). As well known, aerial images are most suitable database for evaluating and mapping objects. But the high-cost of aircraft campaigns force the scientists and photogrametrists to think about cheaper solutions especially for smaller areas. These solutions are (Leloglu et al., 2003):

- Kite.
- Balloon.
- Remote controlled model helicopter.
- Remote controlled model aircraft.

In some regions on the world, kites have been used for aerial photos in scientific researches. In designing of buildings, parks and roads in Oklahoma City aerial photos taken from kites have been used (Figure 1).

A similar study has been performed in Patara Antique Theater in Patara Antique City (Altan et al., 2003). In this study a balloon which was filled with helium gas and underneath a camera platform was existing (Figure 2). Aerial photos of this area have been taken by means of remote control (Figure 3).

3D photo modelling used in this study is so effective in realizing terrestrial objects that are infact unreachable. Using photo models received from existing objects makes it easy to realize geodetic structures that are complicated.

*Corresponding author. E-mail: aulvi78@gmail.com.

Figure 1. Oklahoma City, (Aber James S. and Aber Susan W. 2002).

Figure 2. Balloon and camera platform (Altan et al., 2004).

In this context; this study has been completed in order to hand down the cultural and historical assets to next generations by making a contribution, supporting inter-professional information exchange between people who perform relievo works and to increase gradually the level of scientific improvements in this area (Altan et al., 2004).

GENERAL DESCRIPTION OF THE REGION

Knidos is located in the outer foreland of the peninsula which is called as “Datça”. This peninsula verges between Aegean Sea in the North and Mediterranean in the south. Knidos is 38 Km. Far from Datça. This region which is a part of Muğla, was located within the borders of Caria Region in ancient history. Existing antique theater has been ruined due to weather conditions and for some other reasons. Knidos had 4 theaters during its prime era. Merely, only two of them have been discovered till now and the bigger one which had a capacity of 20, 000 could not reach today. Parts of it, that were received, unfortunately had a trip to foreign contries’

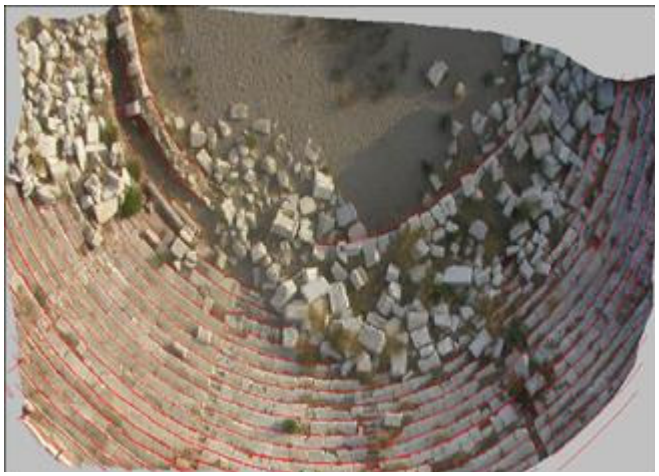

Figure 3. Aerial photo (Altan et al., 2003).

museums and to the houses of coxcomb and antiquary people. Another theater having a capacity of 5,000 has been exposed. This theater which is in the entranceway of the town is a typical Greek theater. Auditorium was based on a slope and orchestra pit was planned as circular. This theater is one of the most archaic theaters in history which has vault entries (Figures 4 and 5).

PHOTOGRAMMETRY

Photogrammetry is a field of science to determine location, dimensions and the shape of an object in the space, utilizing from one two pictures of it. General advantage of this technique that uses measurements performed on pictures is that it gives a clear appearance of the object in detail. Measuring a picture has become practical with the discovery of photography which is an optical technique method relevant to central perspectives to be composed that are inclusively as original. Photographic methods can be easily applied in the areas where other methods can not be used.

We can divide photogrammetry into two parts according to the location of the point which photos are taken.

-Aerial photogrammetry.
-Terrestrial photogrammetry.

Terrestrial photogrammetry

Preliminary applications of photogrammetry is executed in the area of terrestrial photogrammetry. A little while after the discovery of photography, in 1958, Meyden-bauer who was a citizen of Germany, has actualized the repair of a ruined church in accordance with present pictures by combining the measuring technique with

Figure 4. General view of Knidos Antique Theater (www.kyndos.blogspot.com).

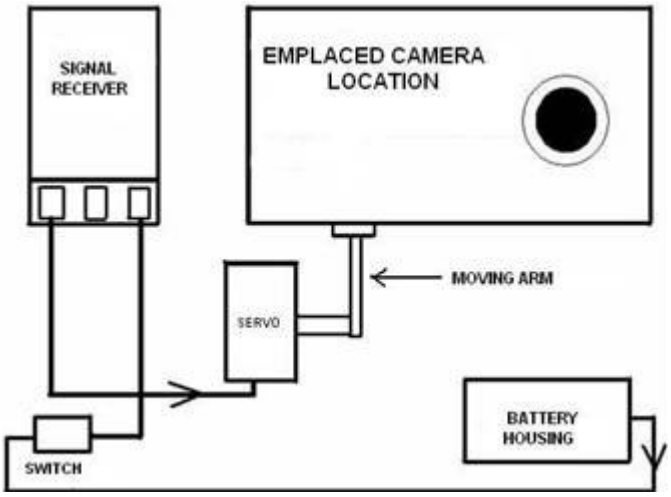

Figure 6. Schematic diagram of the flight unit.

Figure 5. View of Knidos Antique Theater from space.

objective content of the picture.

Application areas of terrestrial photogrammetry

Terrestrial photogrammetry has pretty broad application areas. These areas are; architecture, archeology, industry, metallurgy and deformation measurements, road constructions, water facilities, medicine and veterinary medicine, crimonology, traffic accidents etc., In the point reached on numerical systems application of terrestrial photogrammetry depends on the imagination of a person.

CASE STUDY

Our study consists of two parts being field survey and office work.

Introducing of hardware and software

Equipment

First of all, before starting the field survey, an introduction would be done on the equipment which will contribute and support this study, before utilizing them. Our hardware consists of two parts as of control and flight units.

Control unit: It consists of a remote control system which is in contact with the flight unit by means of radio frequency waves.
Flight unit: It consists of digital camera, battery housing, (on-off) switch, signal receiver and servo. Here, function of the servo is to provide taking pictures by pressing the button of the digital camera (Figures 6 and 7).

Software

Software used in this study is Photomodeler programme. Conceptually it means photograph modeler. Three-dimensional modelling is provided by means of photo-graphs taken from different angles of an object or location/building whose control points are measured with this programme. This programme has been preferred

Figure 7. Illustration of Flight and Control Units.

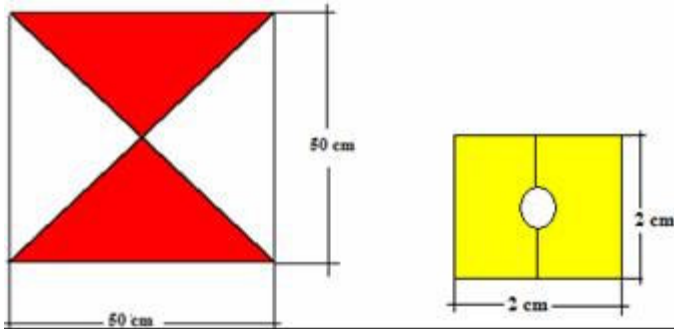

Figure 8. Close view of ground control points used in aerial and terrestrial photographs.

due to its technical specifications which may meet the basic requirements of our study which we shall perform in computer platform, ease in learning, usage and being economical.

Preparation of study

Digital camera has been provided. Also kite work area is being constructed which helps to lift up the flight unit that includes the camera. Diameter of the kite is 120 cm and tail section which balances the kite in the sky is 450 cm. Kite is hexagonal. Material which is painted as white and red in order to be seen more clearly from far and which is manufactured from iron sheet, having dimensions of 50 × 50 cm and to be used as control point in photographs of the theater taken from the space is provided. In terrestrial photographs small labels having dimensions of 2 × 2 cm and which are orange coloured are provided to be used as control point (Figure 8). Electronic total station having trade mark of Topcon is provided in order to measure X, Y and Z values of control points used both in aerial and terrestrial photographs.

Figure 9. Ground control points (Aerial), Knidos Antique Theater, Datça, Muğla.

Figure 10. Ground control points (Terrestrial), Knidos Antique Theater, Datça, Muğla.

Field survey

Establishment of ground control points

Ground control points is consisted of two different control point having same functions. Control points are totally used in aerial and the other is in terrestrial photographs. Quantity of control points is totally three hundred and sixty nine; aerial control points have a sum of twenty four and terrestrial control points is totally three hundred and forty five (Figure 9 and 10).

When establishing ground control points;

- Necessary attention is shown when distributing control points in such a way that they can see each other and also cover the whole work area.

Figure 11. Topcon GPT 3007.

Figure 12. Kodak EasyShare DX4530.

- Care is taken for the control points thrown to the ground in order to surround the work area ideally.
- Also necessary care is taken when performing measurement on points in order that the binocle of the elctronic measuring device can see the object wholly and clearly.

Measurement of control points in the work area

After fixing and levelling the device, binocle of the device is being reset by directing it to the bottom of the reflector which is also directed to a polygon point which is visible. Without moving the device horizontally only binocle has been fixed to the reflector, distance and angles were measured and later on an observation was performed to another polygon point for control. After completing reset procedure and fixing the device horizontally, enough quantity of points are measured in such a way that on the object six point shall be located on every picture and later on measured points were displayed on charts in detail.

Necessary care is taken when determining reference points on the object so that the point can be seen clearly and generally their locations shall be sharp corners. In order to connect the photos and balance them more effectively reference points in aerial photographs as six and in terrestrial ones were being changing between twenty and twenty eight (Figure 11).

Performing photography works

For photo shooting Kodak EasyShare DX4530 digital camera is being used. It has 5.0 megapixel dissolubility, 256 mb memory card and 32 mb of interior memory (Figure 12).

Calibration of this camera is implemented in Selçuk University, Faculty of Engineering and Architecture, Photogrammetry Laboratory. Calibration values are as follow:

Focal lenght	: 8.1292 mm	
Format size	: W: 7.0970	H: 5.3171 mm
Principal point	: X: 3.5599	Y: 2.5789 mm
Lens distortion	: K1: 2.44e-003	P1: 2.177e-005
	K2: -5.881e-005	P2: 9.482e-005
	K3: 0.000e+000	
Image size	: 2580 × 1932	

Later on photo shooting is being performed in the project area (Figure 13, 14 and 15). Figure 16 showing setup for kite aerial photography. A radio transmitter on the ground controls operation of the camera rig. One of the most important subjects when implementing photo shooting is not to play with the zoom adjustment when shooting. Calibration of the camera is implemented by taking a fixed focal length as the base. Because zoom adjustment shall change the focal lenght during evaluation, photos zoomed shall not be used. If ever they need to be used, first of all focal length and zoom value of the camera will be determined and then according to those values a new calibration shall be executed.

Office works

Photographs relevant to the work area and acquired during field survey, X, Y and Z values of measured control points ,with electronic Total Station device and calibration value of the camera has been transferred to Photomodeler programme in order to perform modelling of Knidos Antique Theater as three-dimensional (Figure 17).

Necessary care is taken for the residual values of points created on photographs during marking not to

Figure 13. General view of photo shooting of the theater (Muğla, 2006).

Figure 14. General view of photo shooting of the theater (Muğla, 2006).

Figure 15. General view of photo shooting of the theater (Muğla, 2006).

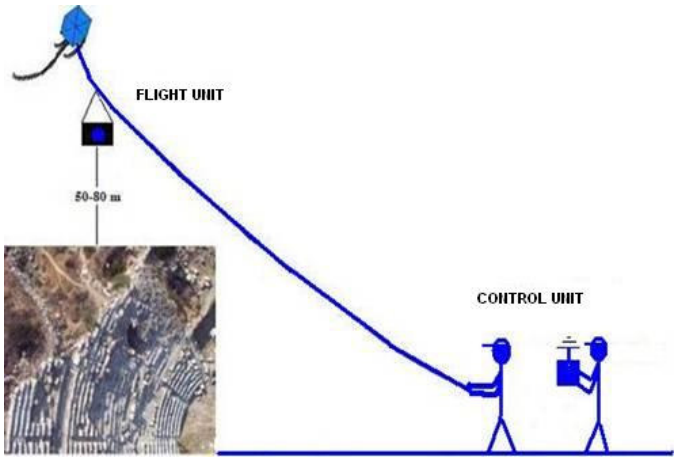

Figure 16. Sample representation of how photo shooting is executed.

Figure 17. Sample of stones being marked and that are belonging to east part of Knidos Antique Theater.

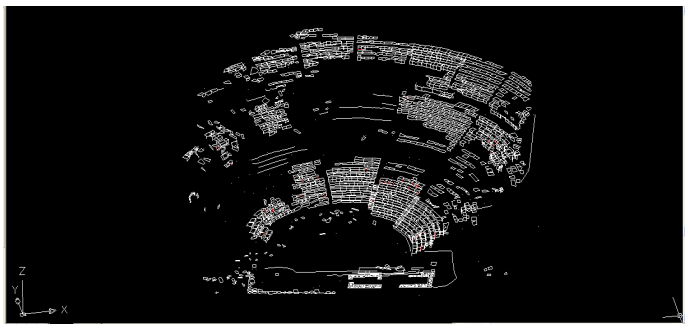

Figure 18. Completed drawing of the theater.

exceed five. If it is over five then an increase in margins of error in drawings is taken into consideration. After completion of drawing processes they were transferred to Autocad programme by changing to DXF format (Figure 18).

Data received after completion of three-dimensional drawings of Knidos Antique Theater is as follows:

Data for drawings of terrestrial photographs :

- Point marking residuals

Total quadratic average error: 1.370 pixel
Maximum : 4.951 pixel
Minimum : 0.001 pixel

Data for drawings of aerial photographs :

- Point marking residuals

Total quadratic average error: 1.690 pixel
Maximum : 4.726 pixel
Minimum : 0.001 pixel
Data for drawings received after combining aerial and terrestrial photographs :

- Point marking residuals

Total quadratic average error: 1.559 pixel
Maximum : 4.951 pixel
Minimum : 0.001 pixel

Conclusion

In this study three-dimensional modelling of Knidos Antique Theater is being performed. When actualizing this modelling work in order to take aerial photographs a kite system is established. Our objective in preferring this kite system is it is more economical when compared with other systems (Balloon system, remote controlled helicopter and aeroplane system). Disadvantage of it is that the theater is located by the sea and in between bosphorus so that wind in this region never stops. Therefore it is hard to control the kite. Accordingly, flight unit hangs around continuously. After completion of photo shooting it has been understood that most of the photos taken were not sufficient enough for implementation of three-dimensional modelling. This caused waste of time. But using this system in less windy regions is a bit hard. In those regions Balloon system, Remote controlled helicopter and aeroplane systems comes into prominence.

People who do want to execute a similar study have to prefer taking into consideration the financial opportunities, advantage and disadvantages and where the work area is located after comparing with other systems.

Eventually, benefiting from all those emerging developments, following topics that were targeted are being concluded; documentation of historical artifacts as photo-grammetric, bringing out relievos of the Antique Theater which is in Knidos as photogrammetric, preparing a more accurate substructure for restoration plans and taking this documentation in order to be used in more suitable conditions, because data received during protection, restoration and documentation will be used later on, then a decrease in the cost shall be provided and finally shall provide data exchange between different disciplines.

ACKNOWLEDGMENT

This study was prepared for Ali ULVI's master thesis.

REFERENCES

Aber JS, Aber SW (2002). Unmanned small-format aerial photography from Kites for acquiring large-scale, high-resolution, Multiview-angle imagery Integrated Remote Sensing at the Global, Regional and Local Scale ISPRS Comission I Mid-Term Symposium in conjunction with Pecora 15/Land Satellite Information IV Conference 10-15 November 2002, Denver, CO USA.

Altan MO, Çelikoyan M, Gerhard K, Toz G (2004). Balloon-Photogrammetry for cultural Heritage, Proceedings of the XXth Congress of ISPRS, Istanbul, Turkey.

Altan MO, Celikoyan TM, Kemper G, Toz G (2003). Evaluation of a Theatre by using low-aititude aerial and Terrestrial Photgrammetry CIPA 2003 XIXth International Symposium, 30 September – 04 October, 2003, Antalya, Turkey.

Demirkesen AC, Ozludemir MT, Demir HM (2005). In Cappadocia Model Protecting Historical and Cultural Heritage and Competency and Responsibilities of Map Engineers in These Processes, TMMOB Chamber of Map and Cadastral Engineers 10th Turkey Map Scientific and Technical Congress March 28 – April 1 2005, Ankara,Turkey.

Suveg I, Vosselman G (2000). 3d Reconstruction of Building Models, Technical University of Delft, The Netherlands Photogrammetry and Remote Sensing, IAPRS, Vol. XXXIII, Amsterdam.

Kemper G, Celikoyan TM, Altan MO, Toz G (2003). Balloon-photogrammetry for cultural heritage, in: 4th International Symposium Remote Sensing of Urban Areas, 27-29 June 2003, Regensburg, Germany.

Leloglu UM, Tunali E, Algun O (2003). Aerial Photos, http://vega.bilten.metu.edu.tr/aerialphoto/, accessed on 12 June, 2003.