

## PHOTOGRAMMETRIC EVALUATION OF SAINT THEODOROS TRION CHURCH (DERINKUYU KILISESI)

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### ISPRS Commission V

**KEY WORDS:** rolove, photogrammetric evaluation, 3D,

### ABSTRACT:

Cappadocia is a region in central Turkey, largely in Nevşehir Province. The name was traditionally used in Christian sources throughout history and is still widely used as an international tourism concept to define a region of exceptional natural wonders, in particular characterized by fairy chimneys and a unique historical and cultural heritage. The term, as used in tourism, roughly correspondsto present-day Nevşehir Province. Dating back to 4000 BC; the earliest people used to live in Goreme known as Cappadocia, in dwellings dug into the rock. Christianity came to the region, and were constructed a lot of chapels, churches and monasteries. Saint Theodoros Trion church is also one of them and biggest one.

In this study ; photogrammetric measurement of Saint Theodoros Trion church has been completed. Topcon GPT 3007 reflectorless total station has been used for geodetic measurement. 6 traverse net point established at surround of church. Traverse measurement has been completed and later control points on the church surface have been measure to make orientation of photographs. Drawing of the church has been completed at photomodeler photogrammetric software.

### 1. 3D MODELLING AND CLOSE RANGE PHOTOGRAMMETRY

Today, the 3D reconstruction and visualization techniques became very popular and useful methods in the field of digital close range photogrammetry. 3D drawing and saving in different formats have become widespread using 3D reconstruction and visualization. The other advantage of techniques is that the object has been visualized at different points of view. 3D modeling and visualization of historical objects are very sophisticated and complex procedures in the job of documentation of cultural heritage (Kulur 2005). Digital close range photogrammetry is very effective and useful in documentation of cultural heritage.

Digital Close range photogrammetry measures objects directly from photographs or digital images captured with a camera at close range. Digital cameras, visualization and automated image measuring software, and desktop computing power, have made digital close range photogrammetry a useful, practical tool for construction.

The short duration of field work measuring time is a remarkable feature of photogrammetry. Photogrammetric works are normally performed without any contact with the object. For further information see Kraus (1997) and (2000). The use of the methods has spread world-wide due to factors such as the support granted by some international organizations (UNESCO,

ICOMOS and CIPA). Three main types of architectural photogrammetric surveying are to be considered (Carbonell 1989): very accurate photogrammetric surveys, accurate photogrammetric surveys, and fast and simple photogrammetric surveys.

Digital close range photogrammetry is a technique for accurately measuring objects directly from photographs or digital images captured with a camera at close range. Multiple, overlapping images taken from different perspectives, produces measurements that can be used to create accurate 3D models of objects. Knowing the position of camera is not necessary because the geometry of the object is established directly from the images.

Photogrammetry techniques allow to convert images of an object into a 3D model. Using a digital camera with known characteristic (lens focal length, imager size and number of pixels), it is needed a minimum of two pictures of an object. If it can be indicated the same three object points in the two images and it can indicated a known dimension that can determine other 3D points in the images (Atkinson 1996, Easa 1988, Slama 1980).

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## 2. LOCATION OF SAINT THEODOROS TRION CHURCH

Aziz Theodoros Trion Church has been built Nevşehir state Derinkuyu province

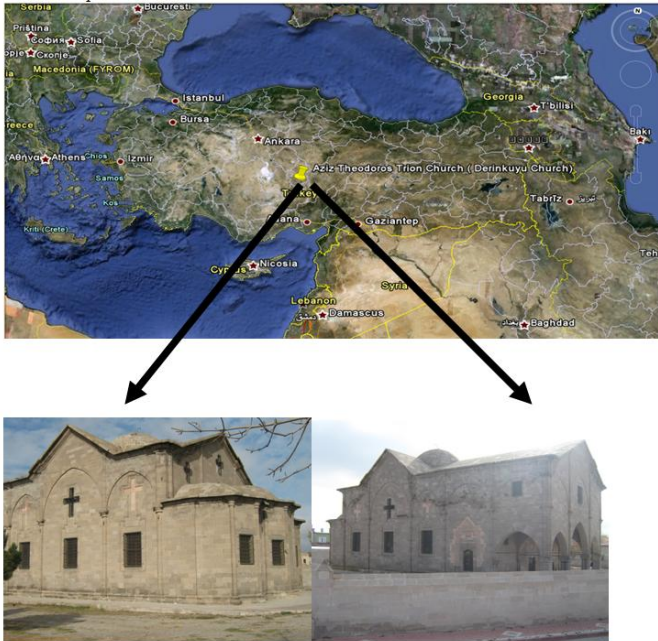


Fig 1 Location of church

## 3. PHOTOGRAMMETRIC STUDIES

### 3.1 Field studies

To be able to make photogrammetric evaluation of SAINT THEODOROS TRION CHURCH traverse points have been established around the church and surveyed at local coordinate system. The geodetically measurement is very important to measure the control marks of the objects and connect all measurements together for 3D modeling. The precision of the all geometrical results is depended the precision of the geodetically measurement of the traverse points. 6 traverse point have been established around the church. Topcon GPT 3007 reflektorless total station have been used to accomplish field measurements.

The Topcon GPT-3000(L)N Series are Pulse Laser Total Stations with a superior non-prism measurement capability. Making use of an updated optical system, the GPT-3000(L)N Series incorporates special techniques to provide accurate, reliable and safe non-prism distance measurement over a range of up to 250 meters. In addition to non-prism measurement, the GPT-3000(L)N Series is of a compact, robust construction with IP66 water and dust protection making it the ideal construction

site surveying instrument. The easy to use software provides complete functionality to carry out all surveying and stake out routines and calculations and to store all data in the instrument itself.

- **Dual-Optical Design**—Reflectorless measuring requires a finely focused beam for pinpoint accuracy. Prisms need a wider pattern to prevent off-center measuring degradation. Topcon's dual-optical system gives you both for the maximum measuring accuracy all the time.
- **Precise Pulse-Laser Reflectorless**—Topcon's pulse-laser "time-of-flight" system eliminates measuring errors caused by the overlapping signals used in phase measuring systems. Accurately measuring corners or through objects such as a chainlink fence is always fast and reliable.
- **Longest Reflectorless Range**—Up to 250m, the longest reflectorless range in its class! Measures up to 3000m with a prism. The dualoptical design allows you the extended range using a class 1 laser— safe for all conditions—making it ideal for use in high-traffic and other heavily populated areas



Fig 2 Topcon 3007 total station

### 3.2 Taking Photographs

Photographic session was executed with Canon A 470 digital camera that we have calibrated in our laboratory with EOS systems Inc. Photomodeler software for calibration, obtaining both the principal distances and the position of the principal point and K1, K2 constants to value the radial symmetric distortion of the lens. This camera produces JPEG images.



Fig 3 Canon A 340

The basic specification of digital camera;

Basic Specifications	
Resolution:	<b>7.10 Megapixels</b>
Lens:	<b>3.40x zoom (38-132mm eq.)</b>
Viewfinder:	<b>LCD</b>
LCD Size:	<b>2.5 inch</b>
ISO:	<b>80-1600</b>
Shutter:	<b>15-1/2000</b>
Max Aperture:	<b>3.0</b>
Mem Type:	<b>SD / SDHC</b>
Battery:	<b>2 x AA</b>

### 3.3 Photogrammetric evaluation

In this study; PhotoModeler software was used. PhotoModeler is a windows based photogrammetry software developed by Eos System Inc. This software has been used to accurately model and measure a physical object from digital images. Figure 4

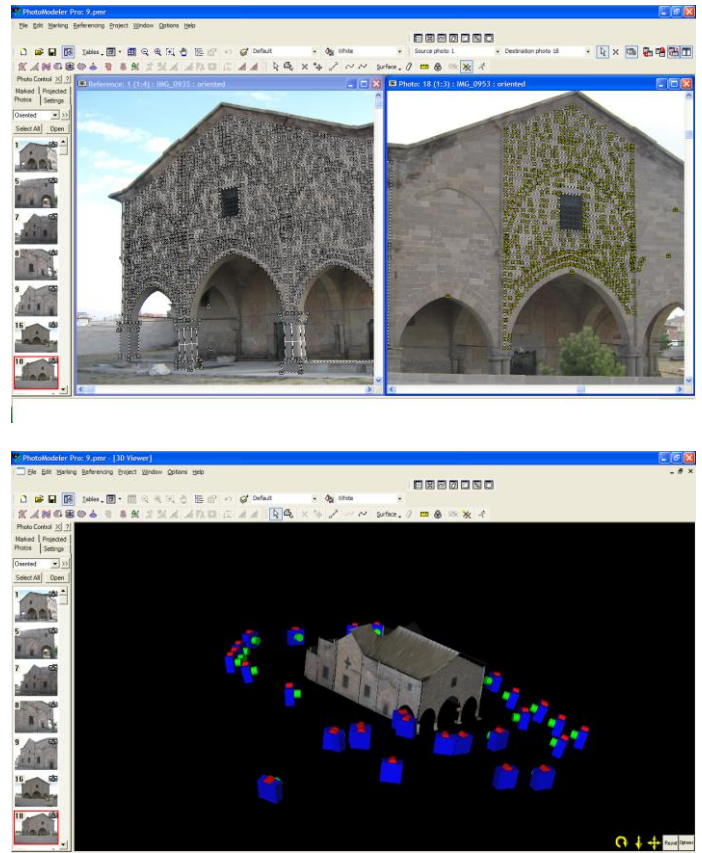


Fig 4 Photogrammetric evaluation.

In PhotoModeler, a 3-D object model consists primarily of a set of spatial points, edges, and/or curves. Surfaces and textures can later be conveniently added to the basic wire frame model to create a realistic solid model (Figure 5).

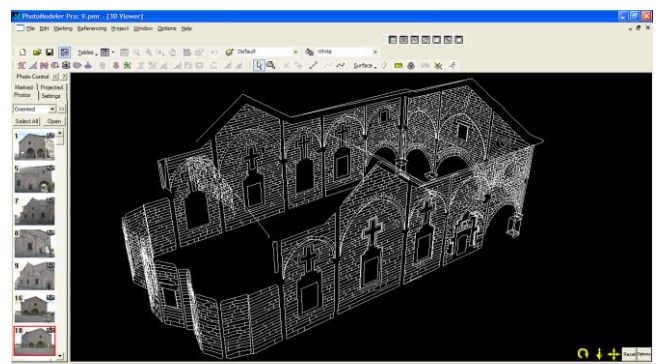
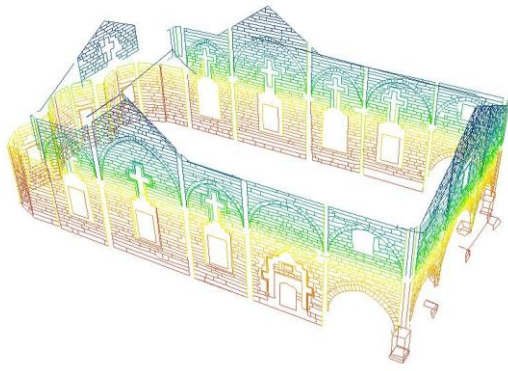
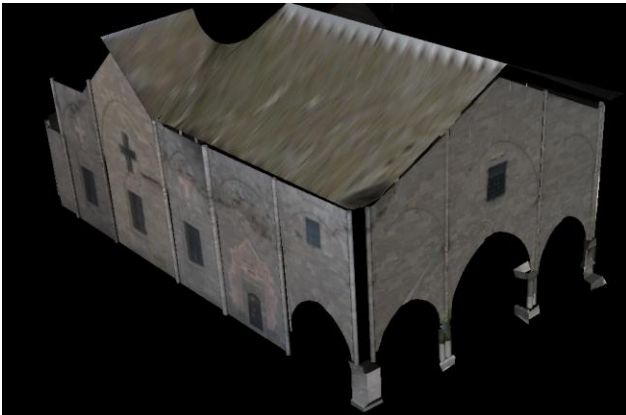


Figure 5, Wireframe of church



**Fig 6, Colored Wireframe of church**

Measurements of distances between two points, lines and points, points and surfaces, etc. can be made using the measurement tool. 3-D models can be exported in DXF format to AutoCAD, VRML format and other well-known formats. Figure 7



**Fig 6 Textured model of church**

#### 4. CONCLUSION

Most of the cultural heritages are about to be destroyed. Recently, photogrammetric methods are being used for documentation of cultural heritages. With this technique, documentation studies can be completed much more economically and at short time with respect to classical methods. Because, photogrammetry uses only mathematical equations and photographs. There is no need for extra technical employees. There is no contact with the object directly. For this reason, it is a reliable method.

In this study, the Historical SAINT THEODOROS TRION CHURCH was measured and evaluated by using Close-Range Photogrammetric methods. A traverse network was established around the SAINT THEODOROS TRION CHURCH to obtain 3D xyz coordinates. About 55 points on the surface of the church were determined with the aid of the control points and these points were coordinated.

The TOPCON reflectorless total station instrument was used to measure the SAINT THEODOROS TRION CHURCH. Photomodeler software was used to obtain 3D models and drawings.

The photographs were taken with a digital camera from 95 points to form a model. These photographs were transferred to photogrammetric software, and then the drawings were obtained in DXF and vrml format. In addition to, a photo-textured model also was obtained.

#### 5. REFERENCES

Atkinson, K.B., Close Range Photogrammetry and Machine Vision, Whittles Publishing, Scotland, 1996.

Carbonell M. Architectural photogrammetry. In: Karara HM, editor. Non-topographic photogrammetry. Falls Church, Virginia: ASPRS; 1989. p. 321–47.

Easa, S.M., “Estimating Pit Excavation Volume Using Nonlinear Ground Profile” Journal of Surveying Engineering, Vol. 114,( 2), (1988), p. 71

Kraus K. Photogrammetry. Fundamentals and Standard processes, vol. 2. Köln, Germany: Dümmler; 1997

Kraus K. Photogrammetry. Fundamentals and Standard processes, vol. 1. Köln, Germany: Dümmler; 2000.

Kulur, S., Yilmazturk, F., 3D-reconstruction of small historical objects to exhibit in virtual museum by means of digital photogrammetry, CIPA 2005 XX. International Symposium, International Cooperation to Save the World's Cultural Heritage, 26 Sep.–01 Oct. 2005, Torino, Italy.

Slama, C.C., The Manual of Photogrammetry, 4th Edn. American Society of Photogrammetrists, Falls Church, VA, 1980.