

# IMPLEMENTATION OF CAMPUS CULTURAL HERITAGE DATABASE WITH SUPPORT OF PHOTOGRAMMETRY

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## Abstract:

*Documentation and visualization of cultural heritages have created an interesting scope through computer technology developments. Three dimensional (3D) digital models of cultural heritages are implemented with photogrammetry and accurately measurements are made from photographs in the computer environment. The 3D models are stored and accessed in GIS environment, so its sustainability was more effective. In this paper, photogrammetry and GIS were used by being integrated. The geodatabase in which the features of cultural heritages in YTÜ Davutpaşa Campus were created. 3D model of the historical water reservoir was prepared with photogrammetry and the model was transferred to the GIS environment. It is thought that the designed data model and GIS will contribute to protection of cultural heritages.*

## 1. INTRODUCTION

Many old university campuses are located in or near to cultural heritage areas. Because of requirements or the philosophy of living in close quarters with history, historical buildings have been used for education and accommodation as in urban area. İstanbul Technical University's Taşkışla and Maçka, İstanbul University's Beyazıt, Yıldız Technical University's (YTU) Yıldız and Davutpaşa Campuses and old universities around the world were samples of this situation. Projects on the conservation, preservation and presentation of natural and cultural heritages have increased recently and the results such as 3D models have become increasingly important on parallel to technology. 3D historical building models which have been visited in computer environment; have visual or both visual and metric (photo-realistic) features have gained importance [1]. Similarly, utilization of campus information systems has become common [2, 3, 4].

3D building models is an indispensable tool for the documentation of heritage which one of the foremost stages of protection of cultural and natural heritages. Facade plans, restoration plans etc. are easily be transferred from 3D models. If documentation depends on metric measurements, it is not difficult to re-create building, at least to do it in electronic environment [5]. In addition to historical buildings, the metric and textural features of other static or dynamic objects, have been collected by using photogrammetry for years [6, 7, 8, 9, 10].

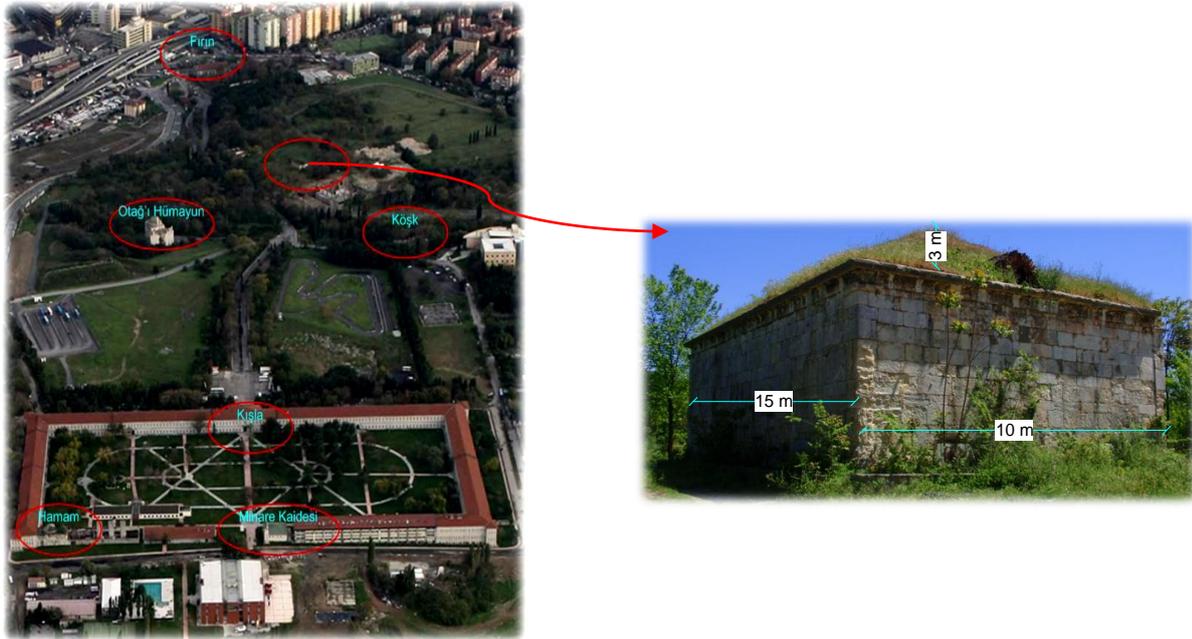
With the transfer of 3D model to GIS environment; textural and metric information are provided to many activities such as planning, navigation, construction etc. In this study, a geodatabase design and implementation were carried out for historical buildings in YTU Davutpaşa Campus, besides one of the buildings were 3D modeled with close range photogrammetry [11].

## 2. STUDY AREA AND MATERIAL

YTU Davutpaşa Campus was established in an area that many historical buildings. It is said that the history of the military settlement in the area where the old Davutpaşa Military Barracks used to be goes back to the

Byzantine era, and that the army camped here during the conquest of Istanbul and the imperial tent of Sultan Mehmed was set up here. The area sustained this function in the Ottoman era, and after the 15th century became an area serving the palace and military ceremonies. The Davutpaşa Barracks were built for the Asakir-i Mansure-i Muhammediye (the Victorious Muhammadan Troops) after Mahmud II (1808-1839) fully disbanded the Janissary Corps. The architect of the building is Krikor Balyan, and construction began in 1826-27 and was finalized in 1831-32. The barracks were renovated and used as shelter for refugees during the Balkan War and a military hospital was opened in the building during World War I which would continue to serve until 1920. The Davutpaşa Barracks retained their original function until modern times, when in 1999 their military duty was annulled and they were assigned to Yıldız Technical University. [12].

Historical buildings in campus are military barrack, hammam, bakery, water reservoir, Mehmed Paşa Palace, minaret ground and Otağ-I Hümayun (Figure 1). In barrack building, students have education in close quarters with history. The restoration of Otağ-I Hümayun was completed in 2010. The water reservoir which was 3D modeled with photogrammetry in this study, has a single-floor building. The walls were constructed with the method of stone-cutting and they were designed to isolate the voice in accordance with its purpose. In northeastern and southwestern sides there are aspiration windows for each [13].



**Figure 1:** Cultural Heritages at the Campus

In this study; base maps which have been produced with the photogrammetric method and ortophotos with 1/1000 scale, were obtained with ITRF2005 datum, UTM 3<sup>o</sup> coordinate system and tiff, dgn formats. The ground control points (GCP) were established around of the object and signed on the object were measured by Topcon GPT-2009 Total Station. GCPs on the land were measured with reflector, the others were measured without reflector. In order to create 3D model of object, photographs which were taken with convergent angles and the PhotoModeler (PM) software was used. Photographs were taken with wide angle option by using the camera “Olympus  $\mu$  1010” which is regarded as of middle quality. Images were obtained in 3648 x 2736 pixel dimensions and jpeg format. As a result of calibration with PM, image dimension is 6.23 x 4.67 mm, pixel is 1.7  $\mu$ , focal distance is 6.47 mm. It is a camera which shoots with normal angle in focal length used.

### 3. METHOD

The stages below were followed in the preparation of campus historical database and 3D model with photogrammetric method.

- Design of cultural heritage geodatabase and collecting of non-graphical data.

- Acknowledgement of object and its surrounding, observation of geodesic infrastructure, camera and data.
- Design of measurement and photography on the land.
- Calibration of the camera.
- Signing of GCPs and coordinate measurement
- Preparation of 3D model with photogrammetric method
- Installation of geodatabase in GIS environment.
- Interrogation and preparation of visual products.

In the design of geodatabase, firstly, current design and systems were investigated. Database was designed after considering current situation, interrogation and visual products. Non-graphical data about historical buildings were obtained from old photographs, internet and libraries, conveyed to digital environment. Graphical data which includes historical features and other elements were created in the form designed from current maps.

Since the polygon points in campus are far from the object, four GCPs were installed around object and arbitrary coordinates were given to the first point, all the system was connected to it. GCP's to be measured from polygon points were designed and signed for the four sides of object. Locations of GCPs were marked in the photograph outputs taken for reference and points were given numbers. In the marking, considering the facts that points are not fixed on the same line and regarding photographs, it was paid attention to be 4 common GCP in each photograph. Coordinates of GCPs were measured directly with measurements done without reflector from polygon points. Coordinates of points detected with local coordinate system were transformed into ITRF2005 datum, UTM 3<sup>o</sup> coordinate system with available data and affine transformation. Point numbers and coordinates were prepared as “.txt” file to be used in PM program.

Photographs were taken on a stand; camera locations forming a circle around the object, it was paid special attention to the fine details of objects and to include at least four GCPs. Most of them being convergent, 12 photographs taken also parallel to object were used for 3D modeling in PM environment. As a result of various experiments, points matching on this object proved unsuccessful, errors were large amount. It was decided to form the model with only photographs among those taken parallel to each walls of object.

In the process in PM environment, corner and central points of each walls were marked and processed in the system and vrml files was saved for each walls. For 3D modeling of the roof, point measurements were carried out for 12 photographs although not as correct as it must be. Points were transformed into dxf format. Vrml files and 3D roof points were processed by using ArcGIS-ArcScene environment. 3D points were triangulated (TIN) to construct of the roof, the roof image which was cutted from aerial image was draped onto the surface. Vrml files were transformed into “multipatch” features and 3D model of the area was completed with other objects.

## **4. RESULTS**

### **4.1. THE DESIGN OF CULTURAL HERITAGE DATABASE**

Features were designed to represent in geodatabase with geometric elements below (Figure 2):

- Building
- Tree
- Road
- Border
- Elevation point
- Historic features
  - Rampart, wall etc.; line
  - Monument, column etc.; point
  - Buildings; polygon
- Digital elevation model (DEM) from border and elevation points
- Object's digital roof model from roof polygon and 3D points
- Orthoimages

System's graphical data may be loaded from orthoimages, maps, construction plans or special measurements. When mapping was done with study field, it was detected that historical features was digitized in base map's building layer. The relationship attribute between data tables was "cultural heritage code".

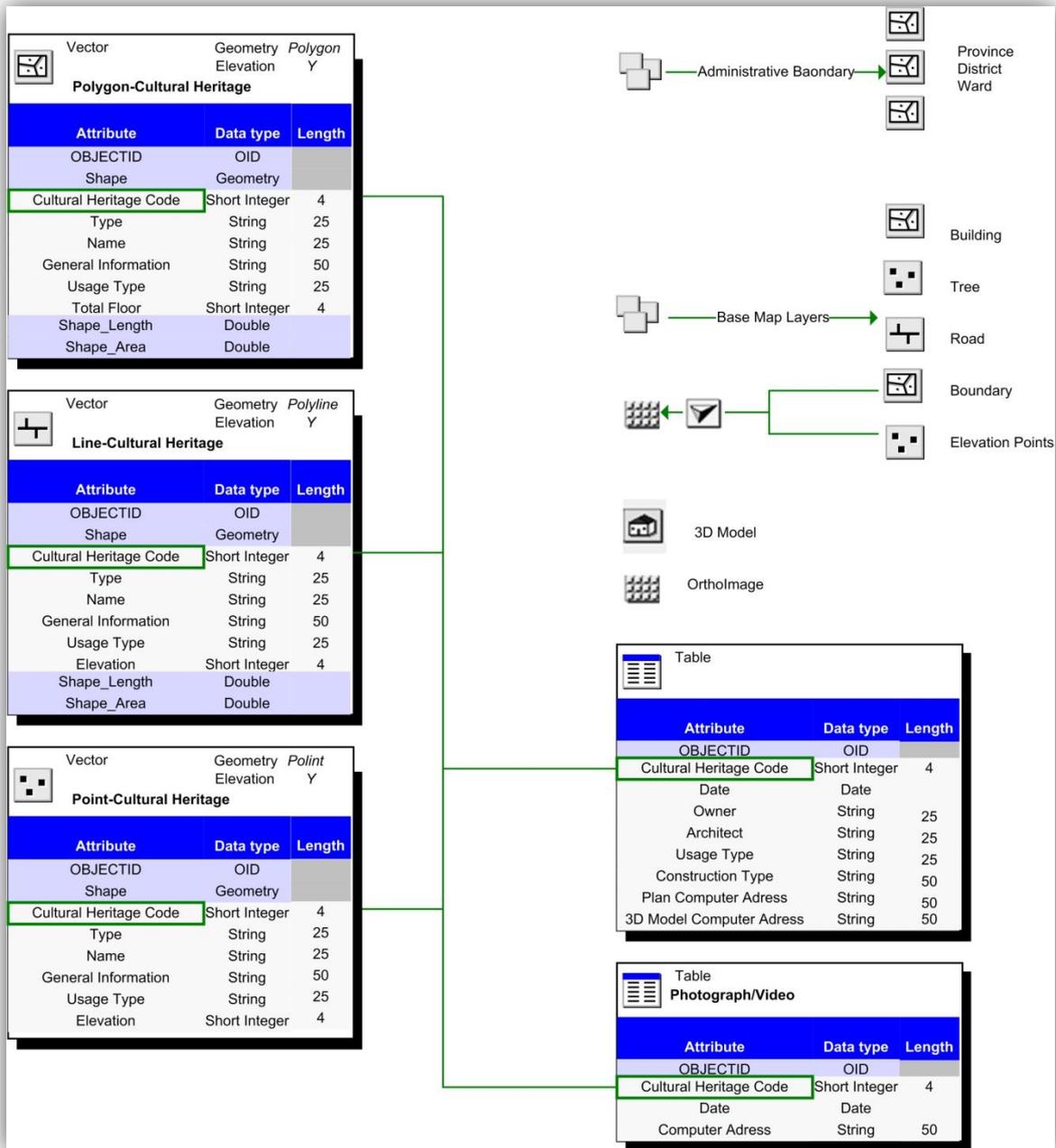


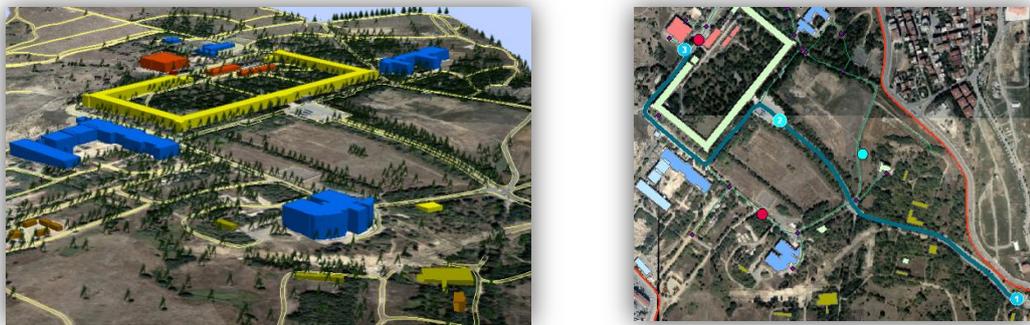
Figure 2: Geodatabase Structure

#### 4.2. 3D MODEL

When Vrmf files and roof model of the object was imported into ArcScene environment, the image in Figure 3 was obtained. When the model is integrated with other data in GIS environment, queries about historical buildings were given in Figure 4.



**Figure 3:** Historical Water Reservuar- 3D Model



**Figure 4:** System Views

## 5. CONCLUSIONS

With the GIS and 3D object model which was completed within the scope of project; a common GIS-photogrammetry product was created for those working for the protection of cultural heritage and future studies and for related projects.

Correct, rapid and economic methods of photogrammetry were integrated with effective utilization of 3D GIS in planning, project designing and architectural fields and ultimate integration was enabled. That the information system created within study is open to updating has made project active and that it is used for future protection and planning studies is an indispensable fact of such types of information systems.

GIS-photogrammetry pair (also laser scanning) stands out as the most suitable method among current methods in the documentation and visualization of historical buildings. GIS-based historical building database study of this project which is designed in a way that is open to development and enrichment in every way is expected not to be restricted with only academic studies but to be stimulus for other studies.

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