Using GIS Technology for the Documentation of Historical Monuments

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ABSTRACT

Documentation and conservation of historical monuments are becoming inevitable. Digital photogrammetric techniques, now appears as the most efficient and inexpensive way for these purposes. Some alternative solution for these kinds of studies also carried out to save time, money and manpower. In this study as an alternative for documenting of historical monuments GIS technology is used and encountered problems have been discussed.

In this study GIS technology has been chosen for the documentation of the historical sites. Photographs have been taken and then converted into orthogonal images with the help of ARC/INFO GIS software. Two different case studied have been selected. In these studies façades of the historical buildings wanted be drawn and documented. These tasks were done using digital photogrammetric technique but GIS technology has been selected as an alternative solution for documenting. Photographs converted into orthogonal images with the help of ARC/INFO. These orthogonal images are used in the CAD software and details are drawn. The same photographs have been evaluated and two different outputs were compared.

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1. INTRODUCTION

Photogrammetric single image techniques, like the generation of rectified images and orthoimages are well suited for use in architecture and monument preservation. They combine true scale geometric measurements with full image information under quite inexpensive production costs. Especially in the field of architectural orthoimage generation, the combination of image processing with photogrammetric systems provides new solutions.

Historical photographs can be used to visualize the authentic state of historical monuments in a three-dimensional way. In some cases, it isn't possible to build a CAD-model, because there exists no measure information about a destroyed building. But under special conditions it is possible to calculate the camera viewpoint of a historical photograph. With this information an image of the present state of the surrounding area can be taken and laid over the historical image.

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 (Duran and Toz 2001).

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.

In this study GIS technology has been chosen for the documentation of the historical sites. Photographs have been taken and then converted into orthogonal images with the help of ARC/INFO GIS software. Two different case studied have been selected. In these studies façades of the historical buildings wanted be drawn and documented. These tasks were done using digital photogrammetric technique but GIS technology has been selected as an alternative solution for documenting. Photographs converted into orthogonal images with the help of ARC/INFO. These orthogonal images are used in the CAD software and details are drawn. The same photographs have been evaluated and two different outputs were compared. Aim of this study is testing this method for documenting of smooth surfaces such as wall in the case of sufficient control points were measured in the historical sites (Oswald, 1996).

In this study photographs were used which have been taken for two different projects. One of these projects is "*Research Center for Protection of Historical Environment of the Istanbul Historical Peninsula's*" was founded in fall 1998, which was decided to start the work by doing a detailed survey of two buildings in the Fatih district, as the Municipality offered this two buildings to the Center as location for the administration of the center and to accommodate the school for conservation. The first house, called Dimitri- or Cantemir-House. The second building is called Low-House or Parsonage. Both houses are not in the best condition and can be linked through the garden, which is also in a bad condition and very steep. Second projects is related to, two Ottoman fortresses in Dardanelles region called Seddülbahir and Kumkale *"Architectural survey and a documentation project of Seddülbahir and Kumkale fortresses"*. They were both built in the mid seventeenth century (1656-1659) at the entrance to the Dardanelle's, on either side of the straits.

2. CASE STUDY 1

In this study images of historical building, which was called Dimitri House were used. In figure 1, photograph taken from entrance of this building with survey team and studied façade of the building are given. The images of the building facades were taken with Wild P31 and Rolleiflex 6006. (Toz and Wiedemann, 1999). For picture taking process some other different cameras also used such as Zeiss UMK 100. The control points were measured using Pentax total station. The architectural research is based on a detailed survey of the buildings. Detailed manual measurements inside the buildings and geodetic measurements have been carried out.

Figure 1. Survey Team at the entrance and studied façade of the building.

The first step was to measure a closed polygon around the block with the two buildings. The transfer of elevations has been done over all polygon points and most of the free stations. This was of high importance, because elevation differences in the steep environment around the block of more than 25 m. based on this geodetic network the control points and a few points for a site plan has been measured (Fig. 2).

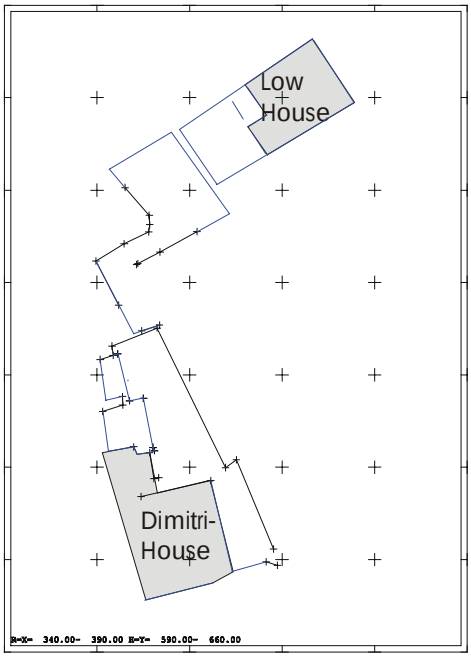

Figure 2. Preliminary site map.

3. PHOTOGRAMMETRIC RESTITUTION

The images are a well-suited storage for the information on the state of the building during the image acquisition phase. The most effective photogrammetric approach is the rectification, as products can be delivered in a short time without a lot of necessary interactive work. As most of the facades of both buildings can be achieved as planar surfaces, rectifications have been done by the simple non-parametric projective approach. (Fig.3).

Figure 3. Rectified image of the facade of Dimitri House by photogrammetric software.

The stereo photogrammetric restitution is the traditional approach for 3D restitutions. It requires highly skilled operators and expensive equipment. The bundle adjustment is the most flexible and precise photogrammetric orientation approach. The interactive measurements are more tedious than the measurements necessary for stereo photogrammetric restitutions but can be done on cheaper hardware. The main drawback of the bundle-based restitution is the requirement for clearly identifiable points. PICTRAN digital photogrammetric software has been used for this purpose.

In a project like the Fatih project an enormous amount of data is acquired during the campaign and during the data processing phase. To manage, process and store the data in a modern environment a relational database is under construction. It is no Geo Information System (GIS), because in the state the data are stored, most of them are not yet referenced to a spatial reference system. But if further adaptations will be established, the database may build one of the cornerstones of a GIS to develop.

In this study GIS software has been used for the rectification process. Using this software same image have been registered and rectified. Rectified image was used as raster data in CAD environment and digitized on the screen. Rectified image and drawn features are given in figure 4. Comparison of data from photogrammetric evaluation and CAD base data is given in the same figure.

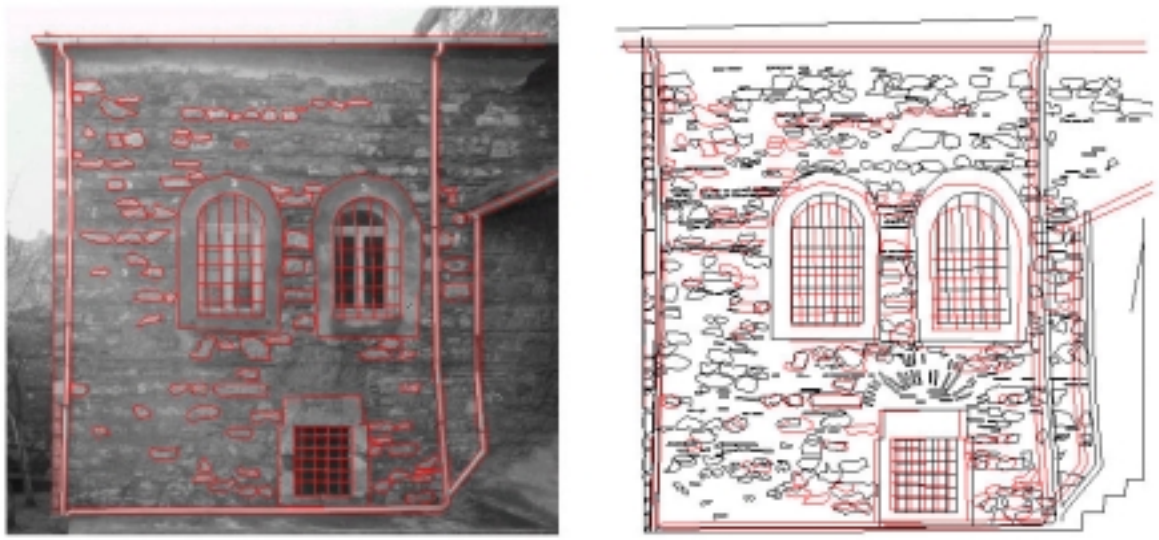

Figure 4. Rectified image and drawn features and comparison of data from photogrammetric evaluation and CAD base data.

4. CASE STUDY-2

The fortresses of Seddülbahir and Kumkale were built in the mid seventeenth century (1656-1659) at the entrance to the Dardanelle's, on either side of straits, by Hatice Turhan Sultan, the mother of the Ottoman sultan, Mehmed IV.(Cenker and Senocak 2000, Ozoner et al. 2001, Celik et al. 2001, Guney 2001, Senocak 1999)

The goal of the project is explore the documentation of two Ottoman Fortresses using multimedia supported Geographic Information System (GIS). Primary purpose of developing GIS of the fortresses is to make the researches of historian in the project team much more effective, visualize, fast, and easy. With this type of information and management system both the present situation of the fortresses and the condition of the fortresses in the past can be recorded and the architectural changes from 17th century to present day can be determined more efficiently. Natural, economical, social, and political events, which have caused structural changes to the fortresses and surrounding buildings and environs, can be researched. Additionally visitors who wish to investigate and officials who wish to preserve the fortresses will begin to take seriously and to find out being user friendly when they run the multimedia supported GIS system on Internet (Guney and Senocak 2001, Guney 2001, Ozoner and Celik 1999).

By this way that joint project integrates knowledge and research from a variety of other disciplines contains, geodesy, land surveying, photogrammetry, architecture, archaeology, Ottoman history, art history, and oral history.

4.1. Geodetic Infrastructure of the Project:

One of the essential requirements of GIS is accurate spatial data; hence, the geodetic network was designed and established covering the entire area of the fortresses and their environs to produce a complete and accurate set of maps and architectural plans of both fortresses. From the beginning two different types of geodetic measurement methods, which consist of satellite and conventional measurements, have been used in combination to utilize more effective. These two techniques have supported each other, by the way measurements can be accomplished in a shorter time and with a fewer staff. The main control points of the geodetic networks were positioned with Global Positioning System (GPS) receivers using static measurement technique. Traverse points were also positioned with GPS but using Stop and Go (SGS) technique. The object points on the walls of the fortresses were measured from the traverse points using total station. Determining the border and the topographical survey of the study area carried out using Real Time Kinematic (RTK) GPS technique. The geodetic survey campaigns were almost accomplished in a series of a summer seasons beginning in July 1997.

The networks for both fortresses connected Turkish National Fundamental Network (TUTGA) by means of a TUTGA point where is around of the fortress of Kumkale with GPS survey. The datum of TUTGA is International Terrestrial Reference Frame-Epoch1996 (ITRF96). Henceforth the coordinates of approximately 15,000 points obtained from the result of processing all kind of geodetic survey computed as the Gauss-Kruger coordinates with central meridian 27° and zone with 3° in the datum of ITRF96. The topographical maps, digital terrain models, architectural plans, etc. were produced based on these grid coordinates.

Working in one common coordinate system (TUTGA) even using different techniques is decreasing the computation for transformation between different coordinate systems. Comparison of the historical sites is thus relatively easy and all calculations can be done

without any datum transformation. Photographs related to study area have been taken with Mamiya RB67 camera. Photos of old mosque have been evaluated by means of digital photogrammetric software. One of the same pair of photographs also rectified similar to previous example and results have been given in figure 5.

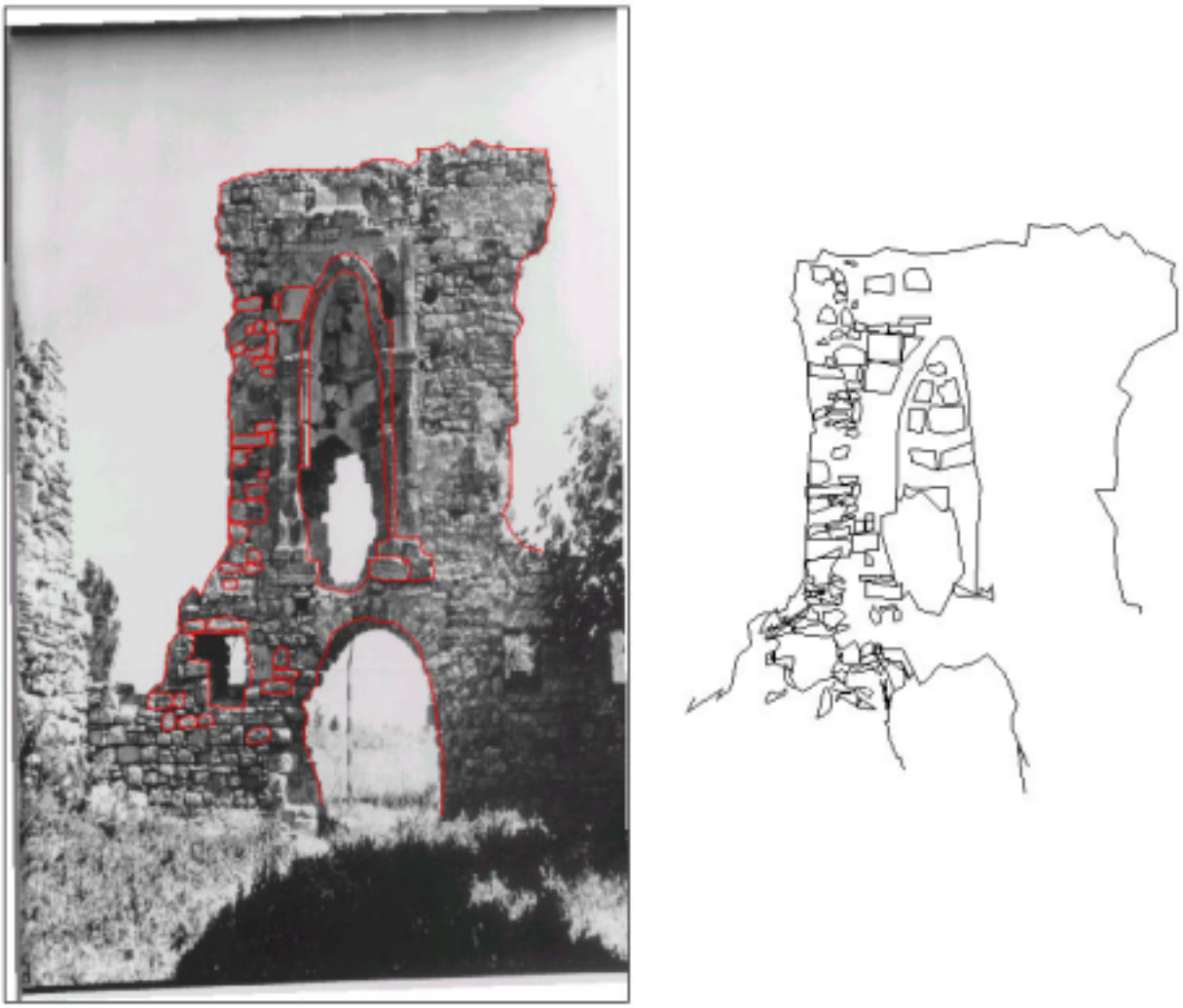

Figure 5. Comparison of photogrammetric evaluation and CAD data of second case study.

5. CONCLUSION

In this study, it is obvious that the difference between photogrammetric evaluation and rectification of photographs within GIS technology is in the level of centimeters. The difference is sufficient for this kind of applications, which high accuracy is not demanded. The photographs have to be taken in normal case and the distribution of the control points on the structure must be well-designed with high accuracy for more advanced works.

It is realized that rectification technique in GIS can be applied safety for taking many photographs fast. These two projects showed that studies required fewer staff and cost is comparatively cheaper.

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