

3D CULTURAL HERITAGE DOCUMENTATION USING DATA FROM DIFFERENT SOURCES

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ABSTRACT

Documentation methods of the cultural heritage sites are an important tool for monitoring and preserving monuments, structures, sites, etc. Photogrammetric documentation methods are well suited for such purposes. The photogrammetric methods include terrestrial, aerial and remote sensing techniques. Turkey owns many cultural heritage sites originating from the first human settlements in Çatalhöyük and Alacahöyük and civilizations of Byzantine, Seljuk and Ottoman etc. 3D modeling and digital recording of historical buildings in several locations of Turkey have been conducted and still continuing. These works showed the necessity of using data from different sources for a city having a very large spatial extension such as Safranbolu old city. Aerial and space images can be used together to produce the digital elevation model (DEM) of the area. Local objects such as houses, mosques, fountains, etc. should be modeled by terrestrial photogrammetric methods. Thus we have to integrate of multiresolution character. In this study the 1/1000 scaled cadastral maps of the Safranbolu old city produced by geodetic methods are used. As the next step of the project the existing 1/5000 scaled digitized topographic maps are vectorized in order to obtain the contour lines and positions of the historic houses in the old city. Thus a DEM of the interested area was available. These two maps are integrated to represent the area in it's entirely despite having differing scales. Another comparison with the existing maps is carried out via IKONOS space image of Safranbolu city. The image was rectified by ground control points chosen in 1/5000 scaled maps. Orthoimage is acquired by DEM created using 1/5000 scaled standard maps. A realistic 3D model of the old city is derived by integrating the ortho-image and the available DEM.

1. INTRODUCTION

The cultural heritage sites of countries are to be protected and will be kept for next generations. UNESCO (United Nations Educational, Scientific and Cultural Organization) helps the countries on this matter by taking the important sites into the list of world cultural heritage sites. Such an action draws public attention in the particular country as well as in the world's community. Sustainability of the site and presenting the heritage in its original form can be provided by well documenting the interested area.

Turkey has a broad spectrum of cultural heritage sites originating from the first human settlements in Çatalhöyük and Alacahöyük and civilizations of Byzantine, Seljuk and Ottoman etc. The nine cultural sites in Turkey are included in the protection list of UNESCO and one of them is Safranbolu cultural heritage city. It is located in the transition from the inner Anatolian to the Western Black Sea region. The city's historical roots in the Ottoman Empire date back to the 13th century. Safranbolu has a remarkable wooden culture and has characteristics of Turkish structure art to date. Many Turkish wooden and stone structure art examples can be traced in fountains, roads, walls, Turkish baths, mosques etc. in the old city. (Ergin, 2003)

The aim of this study is to build a base information system for the documentation of the Safranbolu old city. For this purpose, digital data from different sources with different resolutions are brought together in GIS.

2. STUDYFIELD AND ITS IMPORTANCE

The city of Safranbolu contains well-preserved items of many civilizations (Roman, Byzantine, Seljuk and Ottoman). It is a city which preserves all its values, monuments, sites, groups of buildings, and an historic shopping area. There is a great homogeneity between these elements. It is a typical Ottoman city that has survived to the present day. Safranbolu was placed in the world Cultural Heritage list by UNESCO in appreciation of the successful efforts in the preservation of its heritage as a whole. The city has deserved its real name for its cultural houses. It also displays an interesting interaction between the topography and the historic settlement. The architectural forms of the buildings and the streets are illustrative of their period.

Safranbolu consists of four distinct districts - the market place area of the inner city, known as Çukur (The Hole), the area of Kiranköy, Bağlar (The Vineyards), and an area of more recent settlement outside the historic area. The city has about 2000 traces that are being protected in the natural tissue as an expression of the historical and cultural wealth. Rock Graves, mounds, Caravanserai and Turkish Baths, The Old Mosques, Shopping Districts, Water Vaults, Fountains, Tombs and Historical Houses are some of the traces that have survived. Figure 1. (Ergin, 2005)

Safranbolu is located in inner western black sea region and 41° 16' North latitude, 32° 41' East longitude. Figure 2. Safranbolu has won its first fame with its buildings that have a traditional and special architecture. These houses are wonderful architecture samples that show Turkish society life of 18th and 19th centuries. These splendid houses which carry the effects of

crowded family structure, economic wealth and local climate properties are defined as "five sided architecture" because of their roofs.



Figure 1. Architecture buildings at the interested area of Safranbolu.



Figure 2 Location of Safranbolu



Figure 3. Different cultural examples of Safranbolu

Safranbolu houses are the buildings with 2-3 floors, 6-8 rooms, balconies, and lots of windows in every room. In these buildings; esthetical use of stone, unbelievable quality of wood work, ornaments of wall and ceilings, pools inside the houses, stairs and door knockers. Figure 3.

The interested area is chosen from a part of Safranbolu which includes the area of the inner city. This area includes a lot of the old architectural buildings such as Cinci Caravanserai, Cinci Turkish Bath, Clock Tower, The Old Government Building, The Old Jail, Köprülü Mehmet Pasha Mosque and İzzet Mehmet Pasha Mosque etc.

3. DEM GENERATION AND TEXTURE

In this study, we used 1/1000 scale cadastral maps of the Safranbolu old city produced by geodetic methods. These maps are converted to raster images on an A0 scanner. Firstly, all the details on map are digitized and thus a vector map produced. Figure 4a. We further vectorized the existing 1/5000 digitized topographic maps in order to obtain the contour lines and the historic houses in the old city. Figure 4b. Thus a DEM of the area was available. Datum transformation is performed between two data sets since they have different coordinate system definitions. Positional comparison was necessary throughout the overlapping parts in order to analyze temporal changes. Two maps are integrated to represent the area in its entirety despite differing scales.



Figure 4. (a) Vectorized 1:1000 scale old map
(b) Vectorized 1:5000 scale map

Another supplementation to existing maps is carried out via IKONOS space image of Safranbolu city. The image was rectified by ground control points chosen in 1/5000 scale maps. Orthoimage is acquired by DEM created using 1/5000 standard maps. Figure 5. A realistic 3D textured model of the old city is derived by integrating the ortho-image and the available DEM. Figure 6 (Marangoz.A.M, et al.,2006)



Figure 5. IKONOS pan-sharpened image of Safranbolu study area.



Figure 6. Textured model of study area with Ikonos pan-sharpened image.

4. TERRESTRIAL PHOTOGRAMMETRIC WORKS

A low-cost digital camera Canon Powershot A530 used for the terrestrial images is calibrated prior to its implementation in the project. Figure 7. (Külür:S.,1999) Images of facades of a house are taken by this camera. Some window sizes are measured in order to scale the model properly. The 3D model of the house is obtained by processing several images. A realistic model of the house is accomplished by texturing under a CAD environment. This model is combined with the produced DEM of the area. Graphical documents such as architectural drawings and other semantic information about the house are collected and represented in a GIS environment. Figure 8. Our research on Safranbolu case shows that data integration of different resources and techniques with multiresolution images is possible. This can be used for representing the cultural heritage site and for preserving it. The application has been the pilot case study for digital recording and 3D modeling of wide heritage areas in Turkey.

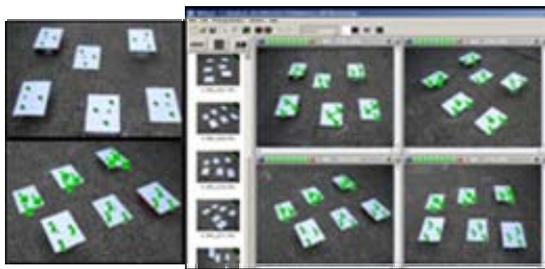


Figure7. Calibration using Bundle Adjustment



Figure 8. Existing CAD drawings of Safranbolu old houses

Using Mapinfo software the digital documentations and 3D models of the historical buildings, streets and fountains can be stored in an information system and queries about this objects can be done. Figure 9



Figure 9. 3D Modeling Pasha Konağı

5. GIS MANAGEMENT

To present the project more efficiently and being usefull to the users an information system has been established as a pilot Project. As the first step of the Project topology on the existing maps are build and the informations about the historical buildings are transferred to tables. Mapinfo software has been used for this purpose. Additionally, CAD drawings of some buildings are brought together to be able to use them . The 3D modells and the photogrammetric modells are designed to be used whenever needed.in the GIS media.Figure 10. As building relations I-Witness and a CAD software used together with mapinfo. (Safranbis,2005).



Figure 14. GIS Eexample Pasha Konağı

6. CONCLUSION

The 3D models of the objects are obtained by processing several images. A realistic model of the house can be determined by texturing under a CAD environment. This model is then combined with the produced DEM of the object. Graphical documents such as architectural drawings and other semantic information about the house are collected and represented in a GIS environment. Our research on Safranbolu case shows that data integration of different resources and techniques with multiresolution images is possible. This can be used for representing the cultural heritage site and for preserving it. The application is a pilot case study for digital recording and 3D modeling of wide heritage areas in Turkey.

Application of these techniques should meet the needs of precision for the representation of the selected object. For this purpose, it would be suitable to investigate the relationship between the accuracy of the 3D model and the object. The

concept of multi-resolution can be identified with respect to the scale of representation in geometry of the object. (Grün,2002)

The terrestrial photogrammetric works are the third step of the project. The test field for the terrestrial works is chosen from a part of Safranbolu which includes the area of the inner city. This area includes a lot of the old architectural buildings as Cinci Caravanserai, Cinci Turkish Bath, Clock Tower, The Old Government Building, The Old Jail, Köprülü Mehmet Pasha Mosque and İzzet Mehmet Pasha Mosque etc. A low-cost digital camera is used for this works. This camera is calibrated using a testfield, which is stated in the laboratory of the Technical University of Istanbul prior to its implementation in the project. Images of facades of houses and other historical structures are taken using this calibrated low cost camera. Some terrestrial measurements like window sizes have been done in order to scale the model properly.

The next step of the Project is to exhibit these obtained models in VRML format on internet. By this way many visitors all over in the world will be able to visit the cultural heritage of Turkey and will have the opportunity to query each kind of graphical and semantic information about these cultural heritage sites.

REFERENCES

Ergin, Ö., Akçin, H., Karakiş, S., Şahin, H. "Geleneksel Safranbolu Mimarisinin Kayıt Altına Alınmasına Yönelik Cbs Uygulaması: Safranbis", 10. Meeting of Chamber of Surveying and Cadastre Engineers, Ankara, 28 March-1 April, 2005, Ankara.

Ergin, Ö., "Tarihsel Koruma Bölgelerinde Mekansal Bilgi Sistemi ve Safranbolu Uygulaması". Msc. Thesis, ZKÜ FBE, 2003, Zonguldak.

Gruen, A., Wang, X., 2002:"Integration of landscape and city modeling: The pre-hispanic site Xochicalco." International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, Int. Workshop "Visualization and Animation of Landscape", Kunming, China, 26 Febr.-1 March, 2002, Vol. 34, Part5/W3, on CD-Rom

Külür,S., Eine optimierte Passpunktanordnung für die schnelle Erfassung von räumlichen Objekten mittels digitaler terrestrischer Photogrammetrie, Photogrammetrie Fernerkundung Geoinformation (PFG) Sayı 3, S.195-200, 1999

Marangoz, A.M., Oruç, M., Karakiş, S., Şahin, H., "Comparison of Pixel-Based and Object-Oriented Classification Using Ikonos Imagery for Automatic Building Extraction-Safranbolu Testfield", Fifth International Symposium "Turkish-German Joint Geodetic Days", Berlin Technical University, 28-31 March 2006, Germany

Marangoz, A.M., Karakiş, S., Oruç, M., Şahin, H., Sefercik, U.G., Topan, H., Büyüksalih, G., "3D Cultural Heritage Documentation of Safranbolu Test Site Using High Resolution Satellite Imagery", 1st Workshop of the EARSeL Special Interest Group Urban Remote Sensing "URBAN REMOTE SENSING CHALLENGES & SOLUTIONS", 2-3 March 2006, Berlin Adlershof, Germany.

Processing of High-resolution Satellite Imagery. In Proc. of ASPRS Annual Meeting, Baltimore, MD, USA, 7-11 March (on CD-ROM).

Safranbis", 10. Meeting of Chamber of Surveying and Cadastre Engineers, Ankara, 28 March-1 April, 2005, Ankara.