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Development of Web-Based GIS for the Cultural Heritage of Safranbolu, Turkey

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Abstract

Heritage and culture are two important components for the historical sites all over the world. Furthermore, cultural heritage is an important term regarding the question of how such historical sites may be valued. Cultural heritage areas of countries have great significance in terms of history, tourism, recognition of the country and economy. Not only having historical heritage is important, but also it is very important to protect and revitalize these sites. For this purpose, UNESCO lists the heritage sites with the aim of helping the countries. In this regard, Turkey has nine historical premises under protection by UNESCO, and one of them is the Safranbolu historical city. The main goal of this study is the 3D modelling of all historical constructions as similar to real status in Safranbolu historical city and the creation of an information system. Firstly, a GIS-based management system has been developed through cultural heritage documentation for this historical city. All registered historical buildings and 3D models of selected buildings that are produced using close range photogrammetric technique are assigned within the database. Data coming from different sources related to these registered buildings were published and distributed via internet by a web-based information system designed specifically for this study.

Keywords: Cultural Heritage, 3D Model, Photogrammetry, Web-based GIS, Safranbolu.

Introduction

Turkey is a land that has been host to a multitude of different civilizations throughout history, with its culture-related qualities for reasons such as its location on migration and trade routes, the linking of Asia and Europe, the fertility of its land and its climate for people's survival. Cultural heritage is jeopardized by time-dependent natural processes and human-induced threats, with prevention actions sometimes being the only remedy (Jones, 1986, Stovel, 1998, Jokilehto, 2000, Kaya, et al., 2008; Wang, 2015, Rainieri et al., 2013, Drdácý, 2007; Agapiou, et al., 2015; Kivilcim & Duran, 2016; Büyüksalih, 2016). Anthropogenic influences, such as surface recession from human contact, are now being

assessed, measured, mapped, and linked within GIS (Paradise, et al., 2012; Ovalı & Şeker, 2017). Documentation and preservation of cultural heritage that co harbour extensive knowledge dating back to centuries ago that needs to be passed down to future generations are indispensable elements (Öniz, et al., 2015; Uslu et al. 2016).

Cultural heritage; is the combination of intangible and tangible products originated from society's knowledge and experiences which are adapted to next generations in various ways of preservation (Öztemiz 2016). Cultural Heritage is known as an invaluable asset of human being, which portrays his achievements over centuries (Hassani 2015). In other words Cultural heritage sites are

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incontestable documents of cultural history of the world. Their thorough study is an obligation of this era to mankind's past and future (Baez and Herrero 2012; Del Saz Salazar and Montagud Marques 2005; Georgopoulos and Ioannidis 2004; Meyer et al. 2007; Vecco 2010; Yılmaz et al. 2007). Substantial historical monuments and monumental groups were covered by UNESCO (Arizpe et al. 2000; Klamer 1999).

Cultural heritages are further subdivided into monuments, groups of buildings, and sites. The cultural heritage is the most important evidence of the past. Unfortunately, Historical artifacts, surviving from the past until today, expose a great deal of destruction, both natural and unnatural (Maras et al. 2016; Erginal, 2017) Thus, it should be taken some protections to control these historical features to the reasons of potential deterioration human reactions (Güney., et al. 2002) Protecting and maintaining historical heritage is an important element in terms of culture and tourism. With the help of the obtained documents, it will be possible to reach to all kinds of information for any work to be done on historical artifacts or areas. An information system created with the use of digital close range photogrammetry and Geographical Information Systems (GIS) will provide an environment that is accessible by researchers or administrators working on and interested in protection of historical artifacts or areas (Georgopoulos and Ioannidis 2004; Bedate et al. 2004). In the recent years, the usage of GIS has been rapidly increasing and it became the main tool for analyzing spatial data in unprecedented number of fields of activities

(Droj, 2010). More and more central and local authorities responsible for cultural heritage embarked on creating complex and integrated information systems, having GIS as one of the main infrastructure component (Petrescu, 2012). Traditional geodetic surveying and conventional architectural representation are typically 2D visualizations of an object that consist of plans, sections, profiles, and rectified images (Yakar & Doğan, 2018). 3D modeling and visualization of historical and cultural heritages is a multi-faceted and complex process. Digital terrestrial photogrammetry is an effective and useful method for documentation of the heritages (Meyer et al. 2007; Bedate et al. 2004; Kuler and Yılmazturk 2005; Sienz et al. 2000), where GIS is widely used (Perez 1999). Cultural heritage digitization and 3D modelling processes are mainly based on laser scanning and digital photogrammetry techniques to produce complete, detailed and photorealistic three-dimensional surveys (Tucci, et al., 2017). Nowadays, web-based GIS applications are the most effective means of communication that add a new dimension to the way of using spatial data on applications and mapping activities (Longley et al. 2001). Turkey is one of the countries that owns many historical artifacts extending from past to present. In Turkey, one of these historical areas under protection of UNESCO is Safranbolu City bearing many historical places as a part of the cultural heritage. UNESCO selected historical Safranbolu settlement to the world heritage list in 1994, and its natural entity has been well conserved since then (Duran 2003; URL-1; Şeker et al. 2010).



Fig. 1. Location and different cultural examples of the study area

The purpose of this study is established an internet based information system and the 3D modelling of all historical constructions as similar to real status in Safranbolu historical city. As a result of achieving the objectives of

the study each user will be provided to reach the data spatial (building location and 3D images) and non-spatial (All verbal information of historical buildings) about the historic town of Safranbolu. Thanks to the project, all the

constructions in Safranbolu were reported enduringly, and similar to architectural features were integrated to this information system. Eventually both Safranbolu and our country will benefit from this study.

The Study Area

In this study, Safranbolu historical city has been selected as the study area. It is located in the inner part of the Western Black Sea Region (Fig. 1). Safranbolu has a wide range of cultural monuments 1300 of which are registered by the officially and under protection. The city of Safranbolu is known as one of the best-preserved city. At this success of the city has brought the title of "Capital protection" to itself. The region was called Paplogonya in the Iliad written by Homer in ancient times. Hittites, Phrygians, Lydians, Persians, the Hellenistic Kingdoms, Romans, The Seljuks, Çobanoğulları, Candaroğulları and the Ottomans established dominance in the region respectively (URL-2; Aksoy and Kus (2001).

3D Modeling of Historical Monuments

As a part of Cultural Heritage enhancement process, the 3D digital modelling of historical

structures play a more and more crucial role for the monitoring of the documentation and restoration phase, mainly looking forward a continuous control in spatial-temporal dimension (Barazzetti et al. 2015; Dore et al. 2015; Oreni et al. 2014; Ludwig et al. 2013).

According to (Scherer 2002), Traditional manual methods, topography, photogrammetry, and scanning can be thought as the four principal methods that are analyzed to compose metric documentation. The preferred method or another one is to rely on some reasons: end use, accuracy required, budget available, and the features of the structure which is reported.

This study involves the stages of 3D modeling of the historical buildings in Safranbolu with appropriate scientific techniques, removes all cadastral and the building data of Safranbolu, designing the GIS within the historical context for the organization of details and presenting the historical application on web-based GIS. For this reason digital photogrammetry method is selected to produce required 3D model of some selected buildings.



Fig. 2. Buildings which produced 3D model

Essential preparations for the photogrammetric evaluation was made after surveying in order to making the three-dimensional models. Photogrammetric assessment has been

completed and 3D structures were modeled for the monuments; Cinci Caravanserai, Kazdağlıoğlu Mosque, the Old Government Building, Kuleli Residence, Paçacıoğlu

Residence, Clock Tower and Karaali Street (Fig. 2). These historical buildings named “Cinci Caranseraı” and “Kazdađlıođlu Mosque” has been selected to evaluate photogrammetric procedures in this study in details. Produced results for the other monuments are related and presented in the system.

The documentation of cultural heritage by photogrammetric method is carried out in two stages, namely land and office works. In the field studies, the objenin coordinate system is defined, the control points marked on the ancient artifacts are measured and photographs of the antique artifacts are taken. In office work, camera calibration is done, pictures are transferred to computer and evaluation is done with photogrammetric software (Uslu 2016).

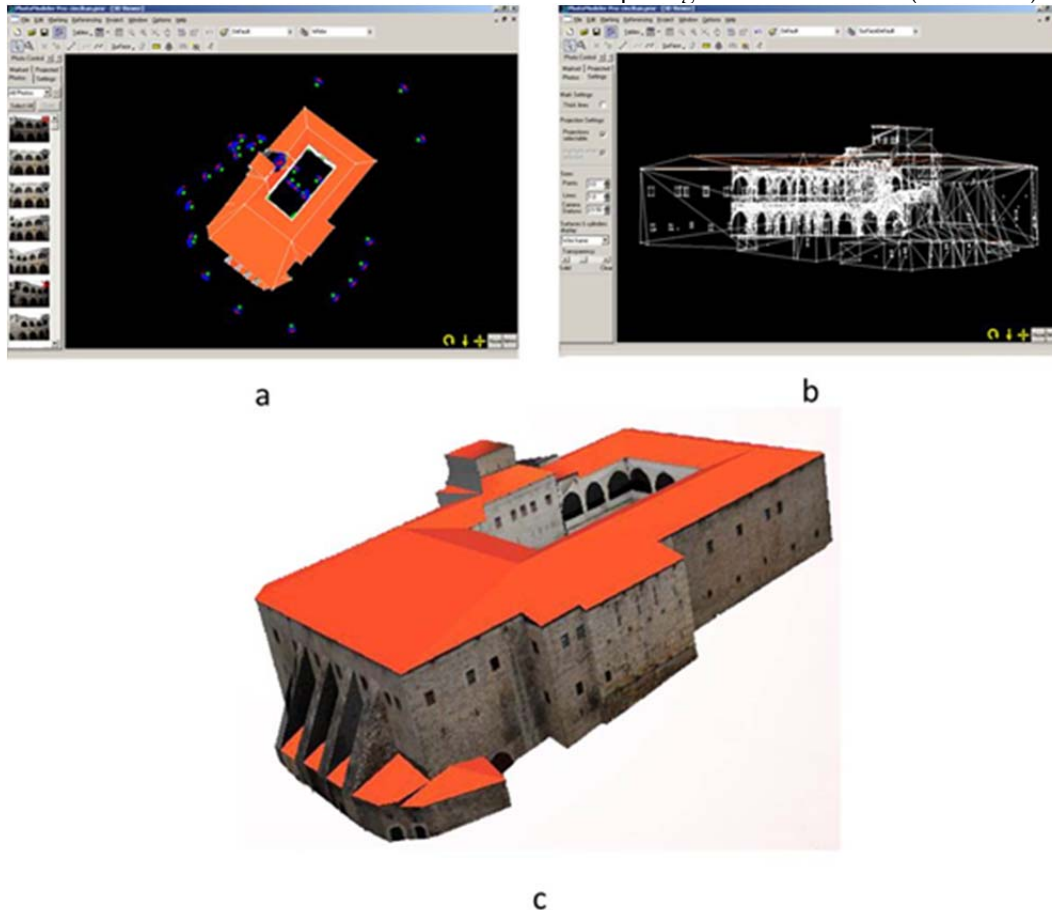


Fig. 3. (a) Photo taking position of the Cinci Caranseraı (b) Drawing of the buildings line (c) The 3D model covered with the photographs of the Cinci Caranseraı..

In studies primarily building which photogrammetric evaluation and followed by the three-dimensional model to be built pictures being taken in accordance with the principles photogrammetric and it is produced in the form of a data point line or area related to the structure with the help of pictures taken, in the later stages of modeling obtained surface may be coated by different surface or with image

textures for objects. Photographs were taken from different views.

After the image taking process is completed, the evaluation process and the creation of the three-dimensional model are starting. Data are texted on the Photomodeler 6.0 version and adjustments were made on the photos. Three– dimensional forms of the building were obtained using the photos from different angles. The application of

Cinci Caravanserai and Kazdağlıoğlu Mosque were completed by covering photos over the obtained product (Fig. 3 and Fig.4.).

Web Based GIS for the Safranbolu Historical City

Advancement of Web-GIS are based on related information which have realms of the example

GIS systems and GIS science, using supports from a larger part of including geography, cartography, modeling, geo-visualization, computer science, and spatial decision-making. Web-based GIS favors the possible for progress in other areas such as spatial analysis and modeling, mobile services, 3D data access and questioning forecasted to examine highly project to the point in the future times.

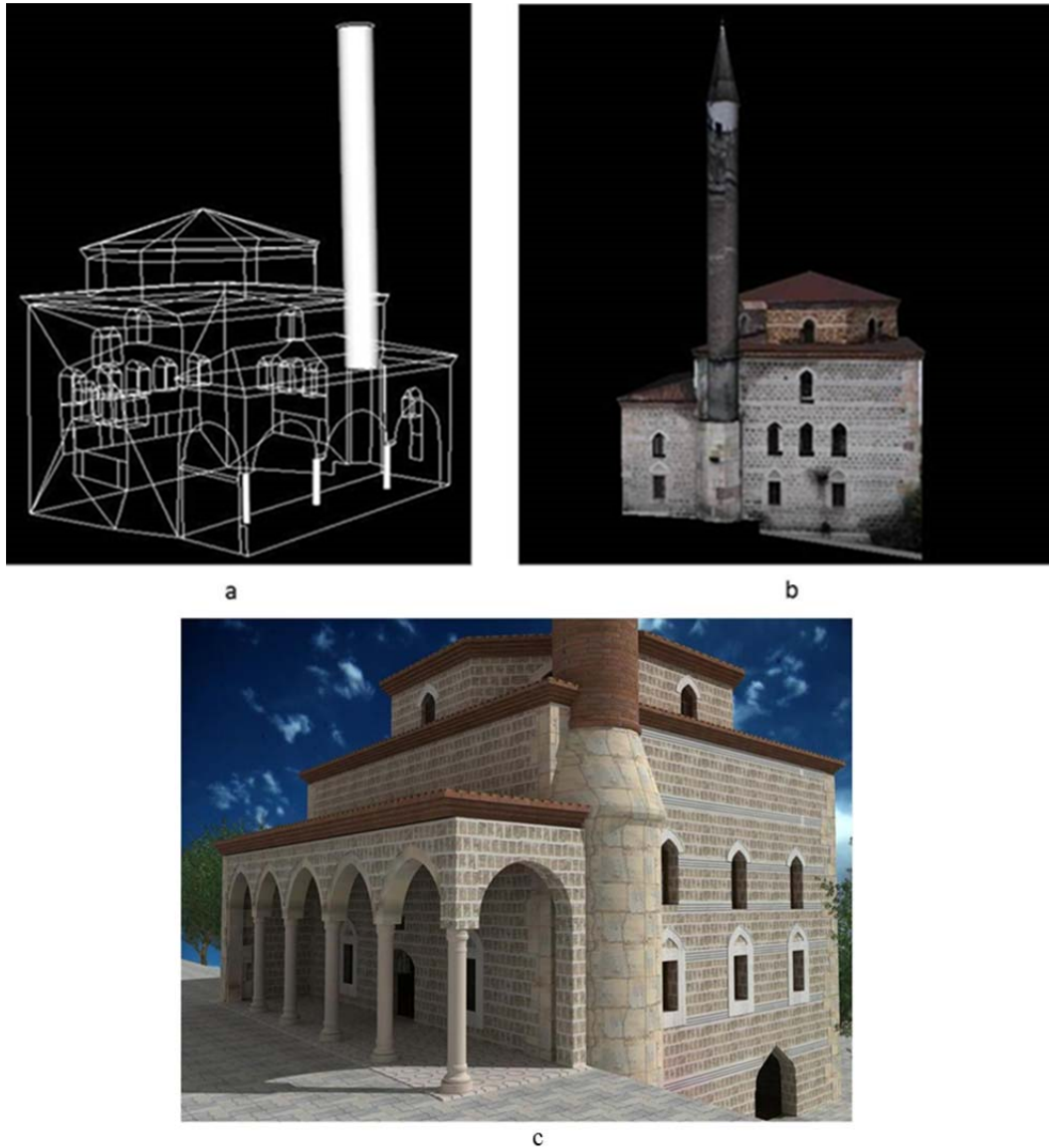


Fig. 4. (a) Drawing of the buildings line (b) The 3D model covered with the photographs (c) view of 3D solid model of Kazdağlıoğlu Mosque

In this study web-based GIS has been design and develop for the Safranbolu cultural

heritage. In the Web-Based GIS of Safranbolu, spatial objects are formed with parcels and

buildings constructed within parcels. These spatial objects are represented with the “polygon” data type in the database. Besides, road is also spatial object are represented with the “line” data type in the database. Other data information is attribute data that is parcels, owner’s information, buildings, roads, address

information etc. 1/1000 scale digital cadastral maps of the Safranbolu obtained from the city municipality in CAD format is used as the main geographic data. The first procedure is transferring from CAD to ArcGIS as the first process. And then, data were evaluated in GIS by creating topological infrastructure.

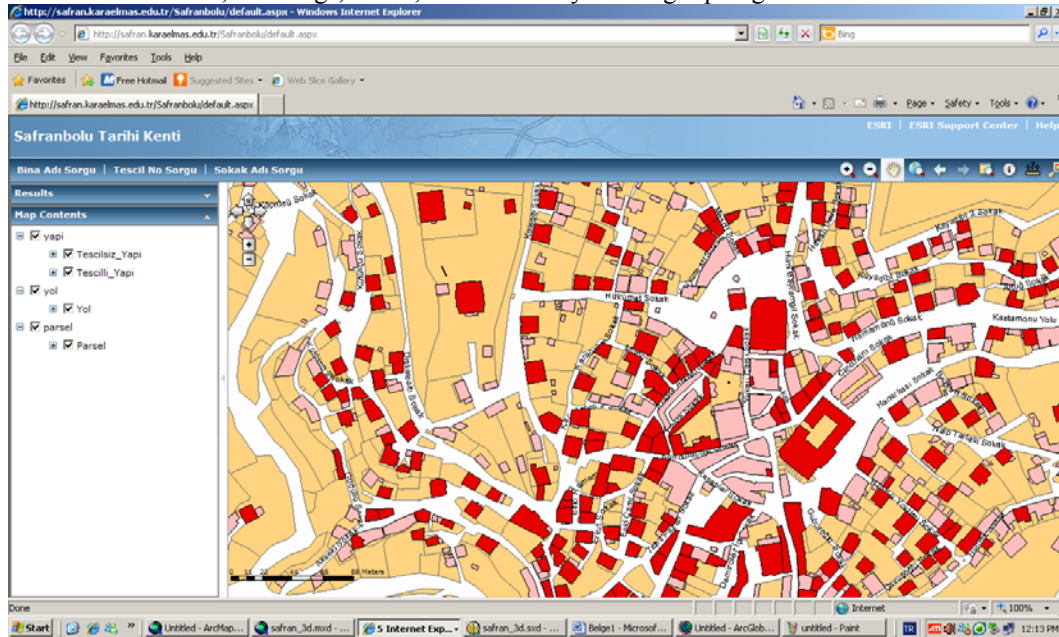


Fig. 5. The view of registered and non-registered buildings in the center of old Safranbolu area.

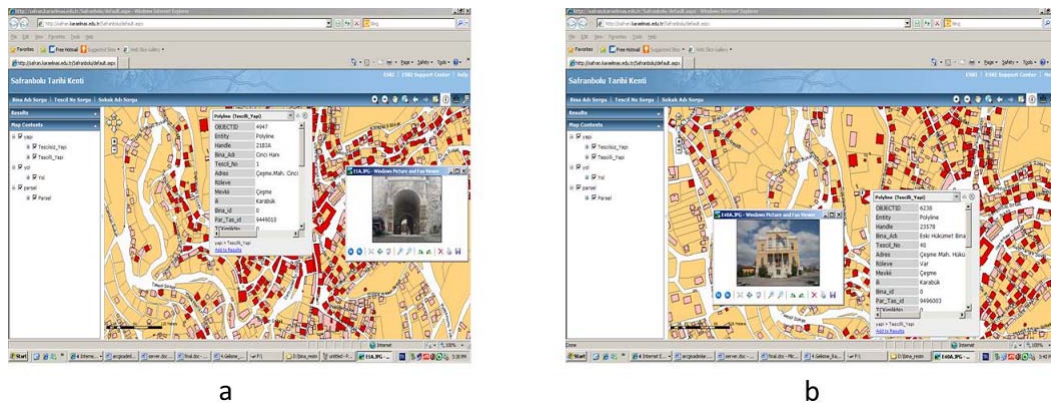


Fig. 6. Views from designed Web based GIS (a) Cinci Caravanserai. (b) The Old Government

The vector map of the old city center part of the Safranbolu city is given in Fig. 5. In this figure, registered and unregistered buildings are shown. Web-based GIS system whose components, development process, working

principle and advantages are discussed with emphasis on the contribution of professional discipline. To use with Web technology (Sebillo et al. 2003) this step can imply to the whole software outputs and services which gives geographic knowledge in various sides to

approach. The given presentation which Web GIS attempts with included profit in the shape of supporting the end user with complete and synthetic, both structural and temporal, that has a environment effect of information within a casual customizable user-friendly graphical combine (Kulawiak et al. 2010). In this study, ArcGIS server is used for Web-GIS applications. ArcGIS Server interfaces using for design and develops of Web-server portal. Information system which provides approach through the Internet which gives reservation in various ways. It can be thought as the list objection and the analyzing objection. The consequence, analysis the consequence of the objection that is counted as the "Results" part. The file of in this part, which works with choosing the building, the order of representation to the confluence or related to the knowledge that can be used (Fig. 6).

Conclusions

Cultural heritage protection and restoration is important topic for the historical monuments. The protection of cultural heritage is a major issue for modern societies, both from economic and cultural viewpoints. Due to Turkey has a lot of registered and unregistered historical sites and monuments which under different threats and they should be documented as soon as possible. Thus, there is an increase demand for the documentation studies using modern tools such as GIS and photogrammetry for these sites.

In this study has been given some outcomes of a case study for GIS, Web-GIS, digital recording and 3D modeling. In this study, first step is design and develop GIS infrastructure. Also, the 3D models of the structures can be come up within highly significance not only gathering acceptable knowledge of the buildings and better observation of their visual. With the characterization, exclusively, it can useful with the factual model to analyze the features better for the users. In the next step of the project, all data (photos, videos, architectural drawings etc.) and models (3D and VRLM) related to selected historical building will be presented on the internet. In our country, such a study has not been carried out before. With this study was presented in the

historic town of Safranbolu and digital cultural archive was created. As a result, tourism, public and municipalities have contributed. By this way many visitors will have a chance all over the world to visit one of the cultural heritages of Turkey and they will also have the opportunity to make different queries about the Safranbolu.

With applications created for this study historical places , which spread to a large part of our country, to protect, to be recorded and transferred to future generations in a sustainable manner is thought to create a window

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