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A Digital Atlas for the Byzantine and Post Byzantine Churches of Troodos Region (central Cyprus)

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Abstract
This paper presents the results produced during an interstate research project between universities of Greece and Cyprus using Web technologies. The main aim of the Digital Atlas is to create a unique product for the visualization of the cultural heritage of Cyprus, while at the same time to be able to provide information to the end-users.
The region of Mountain Troodos is characterized by one of the largest groups of churches and monasteries of the former Byzantine Empire. The complex of 10 monuments – churches, which are all richly decorated with murals, provides an overview of Byzantine and post-Byzantine painting (frescoes religious paintings) on Cyprus. These churches – monuments where inscribed to the UNESCO list of World Heritage Monuments and attract a large number of tourists every year (over 1 million).

The above application consists of a WebGIS tool, using the ArcGIS Server software. The WebGIS includes a detail 3D reconstruction of the surrounding area of the monuments using grayscale high resolution orthophotos and 3D digital "light" models of the monuments, produced in Google SketchUp software, using non-rigorous topometric methods. Moreover the application includes no-spatial information about the monuments, such as relevant bibliography, photos of the interior and exterior of the monuments and also audiovisual data. Finally this digital tool provides to the end-users a brief, time-stamped, historical background information about the Byzantine and post-Byzantine monuments.

Keywords: WebGIS, 3D model, Cultural Heritage, Digital Atlas

1. Introduction

During the recent years geographical data are available and easily accessible through the World Wide Web in different digital forms. This, together with the development of friendly interfaces to the end-users, such as Web Geographical Information Systems (Web GIS), are the main reasons for the increasing number of applications in different fields using these technologies. The benefit of adopting and developing such Web technologies enables the authors/programmers to maximize the amount of information to the end-users and to share mapping services and applications across the World Wide Web (e.g., BROVELLI and MAGNI 2003; MEYER et al. 2007; BARAK et al. 2009).

Contemporary techniques and methods of Computer Graphics, Virtual Reality and Multimedia Technology on one hand and Information Technology and Computer Science on the other, can be integrated in Web GIS technologies, in order to act as a uniform digital tool for documentation, protection and preservation of Cultural Heritage (PETRESCU 2007; AGOSTO et al. 2007)

This paper presents the "Digital Atlas of the Byzantine and Post Byzantines Churches of Troodos Region", which was produced during an interstate research project ("Aphrodite") between universities of Greece and Cyprus. The main aim of the Digital Atlas is to create a unique product for the visualization of the cultural heritage of the island, while at the same time to be able to provide information to the end-users though World Wide Web technologies.

2. Case study area

The case study of the Project is located at the Troodos Region, central Cyprus. The region of Mountain Troodos is characterized by one of the largest groups of churches and monasteries of the former Byzantine Empire. The complex of 10 monuments – churches, which are all richly decorated with murals, provides an overview of Byzantine and post-Byzantine painting (frescoes religious paintings) on Cyprus. These churches – monuments where inscribed to the UNESCO list of World Heritage Monuments and attract more than 1 million visitors/tourists every year.

Figure 1: *Central area of Cyprus where Byzantine and Post Byzantine Churches are located.*

Figure 2: *Photos of the monuments of Troodos region.*

3. Methodology

The overall methodology applied in this project is as follows (AGAPIOU et al. 2008): a) Data acquisition (geographical data; photos; bibliography; 3D measurements a.o.), b) Database design and software choice, c) Data processing and data analysis, d) Web GIS files implementation and e) Web GIS performances tests, software and data.

The different types of data that are needed to be managed for Cultural Heritage purposes are not only geographical or, as MEYER et al. (2007) refer to, as geolocalized data. There are also, historical, architectural, photographical and textual data that belongs to the "interpretation context" of each monument. The management of a database using an Information System acts as a digital storage of all these data types.

The Digital Atlas of Byzantine and Post Byzantines churches application consists of a WebGIS tool, using the ArcGIS Server software. This WebGIS includes a detail 3D reconstruction of the surrounding area of the monuments using grayscale high resolution orthophotos, a digital elevation model (DEM) of an accuracy of ± 2m and 3D digital "light" models of the monuments, produced in Google SketchUp software, after applying topometric methods for measurements. Moreover the application includes no-spatial information about the monuments, such as relevant bibliography, photos of the interior and exterior of the monuments and also audiovisual data. Finally this digital tool provides to the end-users a brief, time-stamped, historical background information about the Byzantine and post-Byzantine monuments (figure 3).

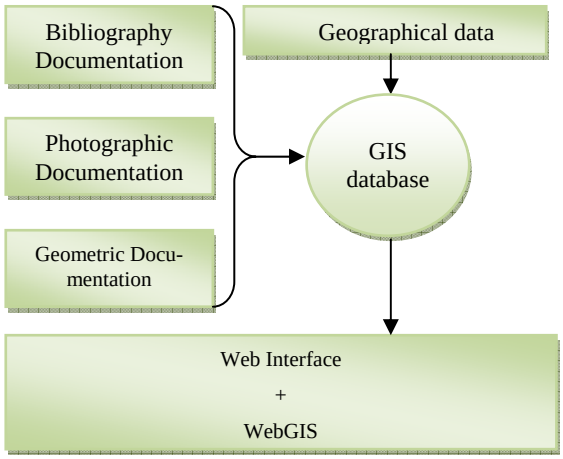

Figure 3: *Diagram of the methodology applied in the project.*

4. Implementation

For the "Digital Atlas" needs, geometric documentation was carried out using low cost methods. Indeed Google SketchUp software was used in order to produce 3D models of all the Byzantines monuments with auxiliary measurements of distances and height differences (figure 4).

The texture of each monument was extracted from recently taken digital close range images. Main characteristics of each church (wooden doors, arches, UNESCO World Cultural Heritage label) were isolated and photographed in detail, in order to achieve a more realistic result. For the rest of the church's texture "a sample material" was used. The model's size had to remain low (i.e. lower than 10 Mb) in order the real time rendering on the web to be feasible.

Moreover two MS Access databases were created for the supporting of the information system. Firstly an entity-relation (ER) table was developed in order to be able to correspond to the numerous needs of the "Digital Atlas" geometric documentation. Afterwards a data-

base was implemented in order to record the more than 400 books found to be relevant with these 10 monuments. User friendly interfaces were created in order to enable data entry to these databases (figure 5). The databases were decided to be accessed only by a small group of users, since: a) it was considered as quite heavy to expose to the web due to the large size of the files necessary to operate and b) it was continual changed by the new information added.

The databases were designed in a way that is easily maintainable and scalable, and enables the wide spread of knowledge regarding the Byzantine and Post Byzantine Churches of Cyprus.

Figure 4: *3D models of the monuments were built using low cost methods in Google Sketch Up software.*

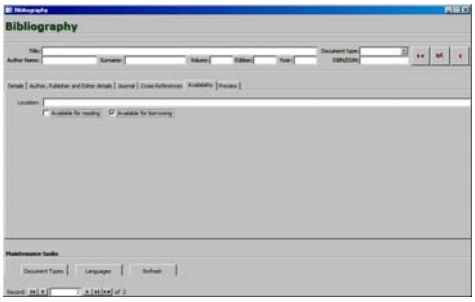

Figure 5: *Database interface build in MS Access.*

Furthermore a web site was created in order to disseminate the final results of the project. The front page of the web site (http://www.byzantinecyprus.com/) highlights the main products of the project "Aphrodite" regarding the monuments of Troodos region (figure 6).

The images taken have been categorized according to each monument (figure 7). The end user while looking the images can read the historical background information about the Byzantine and post-Byzantine monuments.

Figure 6: *Web Site of the Byzantine Churches of Cyprus.*

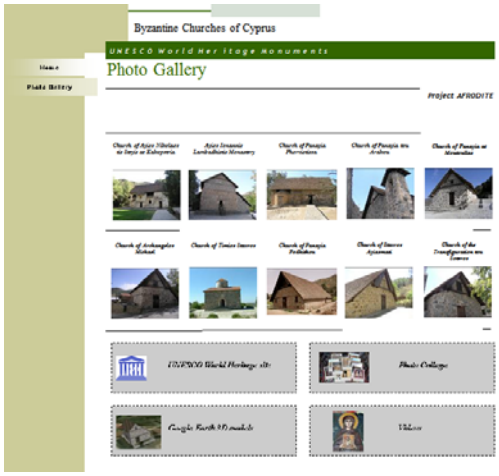

Figure 7: *Photographs with a brief historical background of the monuments.*

The 3D models created using the Google Sketch Up software and the audiovisual data (videos) created for the Byzantine Churches of Troodos region can be easily found in the home page of the site (figure 8). These models can be viewed in many popular 2.5D or 3D viewers freely available on the Web (e.g., Google Earth; Google Maps; ArcGIS Globe; Bing Maps).

Figure 8: *3D models and audiovisual products.*

The 3D models where georeferenced in the DEM of the Troodos region, which was created in the ArcGIS v9.3 software. The gray scale orthophotos of the area were then draped over the DEM in the 3D Analyst software for a more realistic result. For further details about these procedures see AGAPIOU et al. (2008).

Finally a WebGIS was created using ArcGIS Server software which is a GIS package made by ESRI to provide Web-oriented spatial data services (http://www.esri.com/software/arcgis/arcgisserver).

With ArcGIS Server, one can connect people with the spatial and attribute information they need for Cultural Heritage monuments, such as the Byzantine Churches of Cyprus. Moreover the WebGIS application is a simplify access to the services, data, and imagery, from all the people with only requirement a network connection.

The web application in the ArcGIS Server is a quite simple step by step procedure where the developer can design the web application. The mapping feature of the WebGIS includes tools for creating rich browser-based Web mapping applications.

Once the service is ready, the web application can be published to the web. The result was a 2D dynamic map (which can be expanded in 3D) where the end user can easily fly over the area of interest and focus on a specific monument (figure 9).

Figure 9: *WebGIS environment as published.*

The WebGIS enable the user to change the background of the monuments to the grayscale orthophotos.

Queries and spatial information can be extracted using the tools provided in the WebGIS environment (figure 10).

Figure 10: *Queries and attribute information in the WebGIS environment.*

5. Conclusions

This paper attempts to highlight some of the current technologies which can be used for the documentation of Cultural Heritage and dissemination of easily accessible 3D information of monuments. Indeed low cost techniques and free (or low cost) software may be used for the collection, storage and promotion of Cultural Heritage. World Wide Web may be used as a digital window from the developers/authors for sharing e-information Cultural Heritage all over the world.

Easy-use and friendly databases where anyone can search and locate a book or article of interest can be performed using ER databases, such as Microsoft Access. Also, 3D modelling of Cultural Heritage monuments can be as accurate as possible (few cm) using free software, such as Google Sketch Up.

Although WebGIS software may be expensive, researches can have a major discount or free demos for a long period for their purposes. Moreover WebGIS may be designed in 3D free viewers, such as Google Earth.

These products integrated in the World Wide Web can maximize the cultural information to the end users and also to offer them a new digital experience, such as a virtual visit to the monuments.

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