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DEVELOPMENT OF A GEOREFERENCED ARCHAEOLOGICAL INFORMATION DATA BASE FOR ELEUTHERNA IN CRETE

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Abstract:

Cultural Heritage Information Management Systems (CHIMS) have been developed in order to achieve the georeference of the items in the Cultural Heritage database. Eleutherna in Crete is one of the most significant archaeological sites in Greece, with. many buildings constructed and destroyed during its long life. Hence, it is easily understandable that this vast archaeological site is complicated and difficult to understand, even by experts. In this paper the development of a Cultural Heritage Management System, called *ARCHAEOsystem*, is described and analyzed. The system has as geographic base a recent orthophoto of the area and for its design several parameters were taken into account. The conceptual design of the data base with the Entity-Relational (E-R) model preceded the development of this object oriented system. This E-R model is described and evaluated for its operability. After the initial experimental operation of the system, eventual practical problems will be identified and confronted. Finally, presentation of future prospects is being attempted and eventual uses of such a system are proposed.

Key words: GIS, digital archaeology, cultural heritage, documentation, monument information system

1. The Eleutherna Archaeological Site

Eleutherna was an ancient city-state in Crete, Greece, situated 25 km southeast of Rethymno. It is located on a narrow NW spur of Mount Ida, the highest mountain in Crete. The site spans between the two modern villages of Eleutherna (W) and Ancient Eleutherna (E) on two hills and the valley in between; it flourished from the dark Ages (11th-8th c. B.C.), a time also narrated in the Homeric epics (Fig. 1). A team of archaeologists from the University of Crete has been in charge of the systematic Eleutherna excavation project, since 1984. Surveys and systematic excavations revealed the city's settlement patterns, sanctuaries and necropoleis, even stone quarries in the surroundings of the Prines hill. Significant, in terms of architecture, are the bridges, one of them with pointed arc still visible.

2. Development of ARCHAEOsystem

The archaeologists of the excavation needed a tool to manage and store all data and findings with the possibility to link them together over time, but also for the exploitation of all conventional documentation actions realized so far. Various systems exist, such as ARCHES, developed jointly by the Getty Conservation Institute and World Monuments Fund (http://archesproject.org/) and ARK (Archaeological Recording Kit) developed by L-P: Archaeology (http://ark.lparchaeology.com/), but the development of a new system, designed especially for the particular excavation, was preferred mainly for three reasons: the flexibility and capability of expansion, the adaptation to the knowledge of the archaeologists-users and the integration of existing digital data.

2.1. Methodology

The *ARCHAEOsystem* DataBase Management System (DBMS) was designed and developed with the following aims: (a) to organize and georeference the existing documentation data acquired during the past 30 years of excavation activity, (b) to enable the integration and interrelation of different data formats, (c) to give the ability of recording and storing new data via user friendly data entry procedures, (d) to visualize the various

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archaeological locations and findings in 2D and 3D space, (e) to enable the creation and export of new information and data and the production of reports and (f) to assist the decision making.

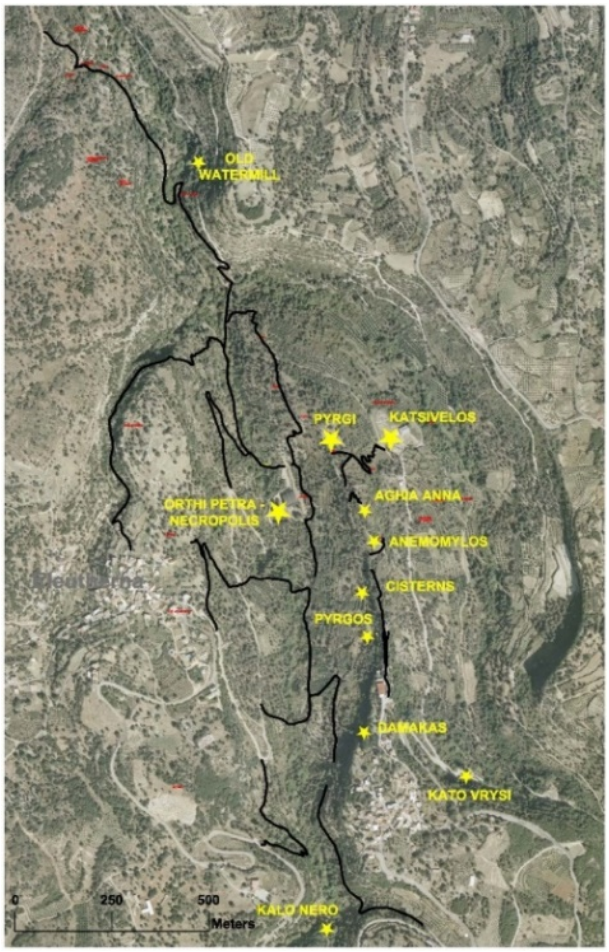

Figure 1: The archaeological site of Eleutherna

Diverse data of archaeological locations and findings, like documentation images, descriptions, scanned and digitized hand sketches, topographic measurements and drawings, orthoimages, 3d models etc. will be integrated into a single database, providing a powerful tool for data management and analysis. Furthermore, when data entry is completed the production of Archaeological maps at several scales will also be possible. Moreover, the *ARCHAEOsystem* will be used for data exchange from the physical data storage to a CAD environment.

For the development of *ARCHAEOsystem* the following actions were considered necessary: a) Establishment of a specific coordinate reference system b) Georeferencing of the existing analogue maps and orthophotos to be used as base geographic material c) Field data acquisition d) Georeferencing of hand-made drawings e) Recording of locations' names f) Production of 3D models of the monuments g) Design and Development of the Data Base Management System, and h) Indicative data entry and test of the system.

Field survey methods and RTK GPS were applied to collect the necessary data using the existing triangulation network, established during previous fieldworks, that was referenced to the Hellenic Geodetic Reference System 1987 (HGRS87 SRID=2100). The handmade drawings, that were of high detail and accuracy and the 3D models, that were produced, were georeferenced in this reference system using the minimum constraints, in order to avoid deformations due to the projection of the reference system and to keep their internal accuracy unaffected.

The base-map of the DBMS is the orthophoto of the area of 0.50m spatial analysis, produced by the National Cadastre & Mapping Agency S.A. in 2007 and three analogue topographic drawings, at a scale of 1:5000, produced by the Hellenic Military Geographical Service (HMGS). The main spatial data that the archaeologists need is the position of all individual monuments and places of interest, which, in the database, are called locations, and the entire network of the main paths and access roads, connecting and allowing access to these locations. Each location has certain essential information, which are considered as data having metadata and must also be stored in the database.

The system offers access to all interested persons, but with different permissions. Experts involved with the excavation have the right to manage or edit the data. The system should easily organize all necessary data and metadata which the Archaeologists need to manage, provide a security system and supply suitable tools for data management and continuous updating and retrieval of data and metadata, pointing to their exact storage location.

2.2. Data Modelling and DBMS Architecture

The Entity-Relationship Model (E-R Model) was used for the representation of the conceptual model. The Relational Model was used for logical modelling and the implementation of the DBMS was performed taking under consideration two main constraints: to ensure the future extensibility of the system and to fully exploit the existing experience and familiarity of the users with the AutoCAD environment. The extensibility of the system is ensured since data is stored in a central database and can be visualized, analyzed and edited in several software – clients (e.g., other GIS like QGis or ArcGIS), while, at the same time, data could be used in different environments (e.g. mobile devices).

The Data Base Management System is based on the Microsoft SQL Server 2008 R2 express version, which allows storage and processing of spatial objects, with the advantage that the whole information, either spatial or thematic, is in the same physical storage location. A special application, named *ARCHAEOsystem*, was developed in Visual Basic .NET using the Integrated Development Environment (IDE) Visual Studio 2010. This application uses .NET Managed Application Program Interface (API) of AutoCAD Map 3D 2012, and allows thematic and spatial data management and visualisation in an integrated environment. The spatial objects stored in the SQL Server are visualised within AutoCAD Map using the open source Feature Data Object (FDO) Data Access Technology. Through FDO Technology, AutoCAD Map is not used in the traditional way of processing CAD objects, but it operates more like an editing and visualizing tool of data stored in another warehouse, in this case the SQL Server. Access to thematic data, stored also in SQL Server, is achieved using the Entity Framework (EF), through the special

application that was developed. EF is an open source Object-Relational Mapping (ORM) framework which converts the database tables to objects in the application programming environment of Microsoft Visual Studio. The architecture of the system is shown in Figure 2.

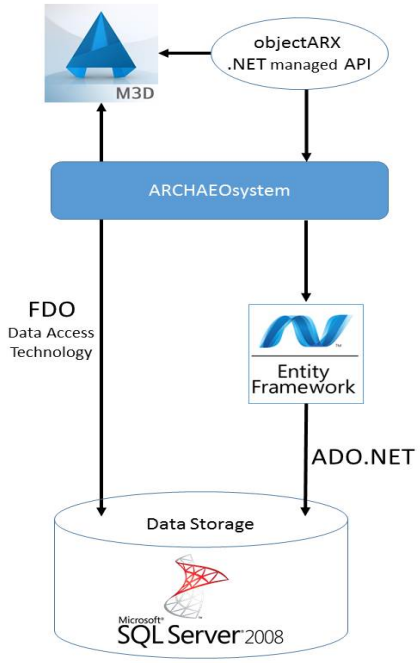

Figure 2: The DBMS Architecture

3. Operation

The user interface of *ARCHAEOsystem* is friendly and easy to use especially by users who are familiar with AutoCAD. Once the appropriate installation is completed, the main window of the system and a toolbar with basic buttons appear within the AutoCAD environment. Then the connection with the database requires login information. The system provides the tools for updating and retrieving operations through the database. The main window of the system is divided into two parts (Fig. 3). During updating of the database, the upper part, provides the tools for creating, updating or deleting a parent location, while the lower one, provides the tools for data entry and retrieval related to the parent location which is selected in the upper part.

The related data could be locations contained in this particular one, other information, images, video, documents, 3d models, etc. Each contained location could be selected as parent location and its related data can be imported in the same way. Data entry is possible with direct selection of CAD objects or by giving the physical storage location of the files. The system is able to identify and record the georeferencing parameters of raster objects, as long as the raster file is associated with the corresponding world file, e.g., a *.tif file with the *.tfw file. During retrieval operations the user has the necessary tools to search data through certain attributes, for example the locations by name or the sketches by author, etc. Once data entry is completed, tools for visualization of selected data could be used. In this way the different mapping alternatives could be produced at this stage. *ARCHAEOsystem* is being updated by the archaeologists of the excavation almost everyday in order to record new data and information. Another main goal is to fill the database with all existing data acquired during the past 30 years of excavation activity.

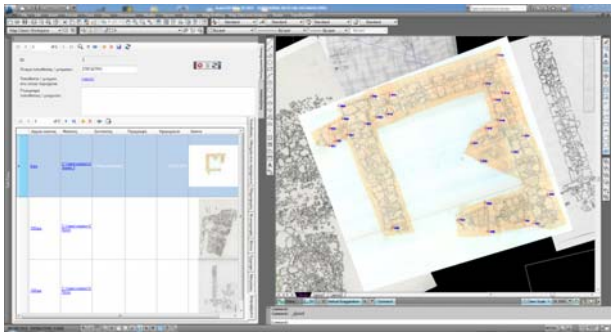

Figure 3: An example of the DBMS interface

4. Evaluation and Concluding Remarks

The *ARCHAEOSystem* developed especially for the excavation of Eleutherna in Crete is actually being used by the responsible archaeologists during the past months with great success. Archaeologists now have a tool of collecting, analysing, managing, and communicating their data. They are able to combine data and through these interrelations to draw more reliable conclusions. Furthermore, the complete overview of the excavation gives the ability to easily grasp the relative position of all findings which makes the analysis and related research easier and more effective. The architecture of the system, where both spatial and thematic data is stored in a database, gives the ability of creating various data views and maps at several scales. It is envisaged that in the future, when the data base has been completely filled, the ARCHEOsystem will become a cross-platform system. This means that it may be loaded to a smartphone and assist experts and visitors to freely navigate and learn about this vast site. Furthermore, a web application will be developed in order for virtual visitors to be able to get familiar with Eleutherna at the ease of their mouse click. It is believed that such a possibility will definitely attract more visitors in the area.

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