GIS driven Internet Multimedia Databases for Multiple Archaeological Excavations in Greece and the region of South-Eastern Europe

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Abstract: - Considering the problems in archaeological data recording and analysis, the Department of Informatics of the Aristotle University of Thessaloniki (AUTh) in collaboration with AUTh's Department of History and Archaeology in the framework of the SOCRATES-MINERVA SEEArchWeb project has developed a system for recording multiple excavations driven by GIS services, based on a flexible multimedia database. The system provides all its services over the Internet. Its innovation lies in the fact that it is promoting a generic template supporting data from different excavations while older implementations were custom made for the specific method implemented in each excavation. Emphasis is also given to the development of instructional models organizing the existing educational resources of the system.

Key-Words: Multiple Archaeological Excavation Databases, GIS, Web Courses.

1 Introduction

Under the prism of the recent advances in Information and Communication Technologies (ICTs), in Geographical Information Systems (GIS) and their application on diverse fields, like Ethnogeography and Archaeology, the need for resource management has lead to the creation of tools that facilitate the integration of a variety of data sources and types, the maintenance and the management of inventories, the visualization of data and related information using dynamic maps, and the decision making about resource management [1]. For the recording and the management of excavation data, each archaeologist used thus different approaches, designs and technologies for the creation of his repositories. This has lead to an absence of recording standards for excavation data, and consequently the lack of understanding of the differences in disciplinary "cultures" constrains mutually determined solutions.

Recent GIS technologies have given the capability for data-mining from the spatial data which is crucial in Archaeology. However those separate implementations were inaccessible by a wide range of users and most GIS implementations were exclusive for each excavation.

Considering these problems, we have developed a highly sophisticated and versatile spatially organized database management system unifying archaeological data interpretations.
A new flexible and structured database was designed for a wide range of archaeological excavations. This database is GIS driven facilitating the visualization and analysis of data, providing its services over the Internet.

2 System Overview

The overall system architecture implements a 3-tier interface, depicted in Fig. 1. The Internet layer, apart of its client-server services supports a wide range spatial data applications and interfaces.

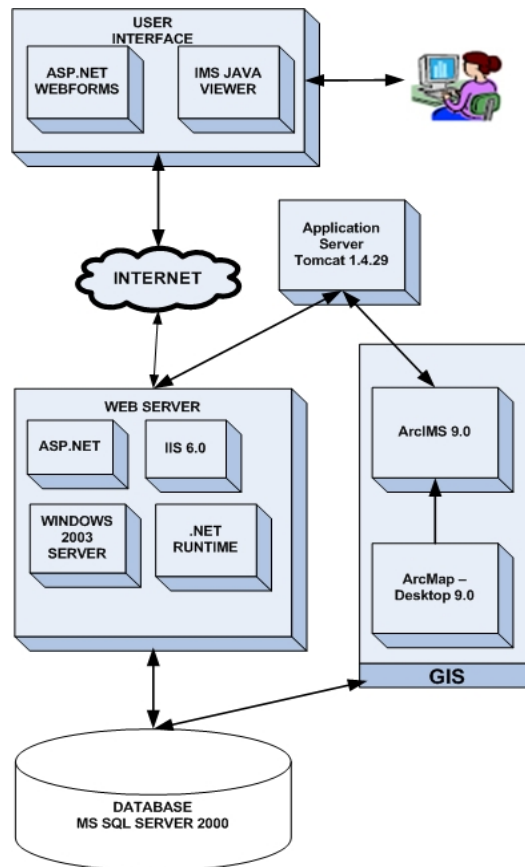Open source and proprietary software tools were used for the implementation, as seen in the hierarchy of Fig. 1.

Fig.1. System Architecture.

3 The Database Layer

Due to the differences in the way of recording excavation data, the working methodology and the interpretation of artifacts from the archaeologists of various excavations, a flexible and relational database had to be developed, to solve these and other problems of archaeological feature extraction and management. The term "feature" covers many meanings, ranging from pattern or detail treatments up to physical forms and low-level geometric components [2].

3.1 Design

The database was designed to provide the capability of recording any data desired by the archaeologists, declaring freely new attributes for any entity of the database. This ensures the capability of recording multiple excavations, where artifacts and deposits have different attributes; even if they belong to the same archaeological category (e.g. ceramics), based on the needs of the archaeological excavation. This is achieved without the need of changing the database (e.g. alter tables, add columns and other Data Definition Language [DDL] entries), keeping the integrity of the database structure, design and organization.

The flexibility of this approach also provides the archaeologist the capability of keeping their existing way of recording data, without imposing a standard model for data recording, ensuring at the same time the support of existing archaeological data and its transfer to the system. It also provides the capability of enriching easily existing data records (adding attributes) or revising data specifications (alter attributes). More details on Data Management are presented in §3.2.

The database adopts the normalization rules for tables in order to alleviate and even obliterate modification, import and deletion anomalies.
The database consists of the following primary entities:

- Archaeologist
- Construct
  (spatial - constructs/ architectures)
- Deposit
  (samples, e.g. C14)
- Excavation
  (excavation definition)
- Layer
  (spatial - layers/ levels)
- Location
  (excavation location)
- Object
  (objects, artifacts, findings)
- Phase
  (chronological - time periods)
- Section
  (sections/ cuts)

Emphasis is given to the Section entity which is the key for organizing the information of an archaeological excavation. In an excavation sections constitute the pieces of soil that have been removed during the excavation progress, defining the spatial and chronological characteristics of the artifacts/samples that have been found in it.

This fact allows further system evolvement based on the organizational characteristics of the section entity, providing ways of solving future alterations that may occur by the advance of technology in archaeological excavations, such as 3D laser scanning or other digitizing systems and services.

3.2 Data Management

As previously mentioned, the system is flexible in the creation of new attributes and thus flexible in the recording of data. This is achieved by creating tables

for each entity, that have only the absolutely essential fields for the recording of data in the database, including a primary key for each record of the entity. More than that, each entity has at least two tables - attributes and data. The following example shows how this is implemented (Tables I and II).

Table I. Attribute Table.

Attribute ID	Attribute
1	Color
2	Weight

Table II. Data Table.

Object ID	Attribute ID	Data	Unit
1	1	Red	
1	2	4.87	Kg

To show the benefits of this approach an example of how data used to be recorded is shown in the following record of Table III.

Table III. Nonflexible DDL structures.

Object ID	Weight	Colour	Material
1	4.87 kg	Red	Ceramic

From the aforementioned examples it becomes clear that the creation of new attributes is possible without changing the database (in this example add columns), but only adding new lines in the existing tables. The relational database infrastructure becomes also clear from these examples [3].

The system has its own "Primary Keys" for each entity allowing full functionality and integrity of the database regardless of the archaeologists working procedures and data organization. Table IV shows an example of how archaeologists can still use their own keys to organize their data, without messing with the system's database primary keys.

**Table IV**. Primary key and data descriptors.

Object ID	Custom ID
1	12-B-1112
2	13-B-1112

Of course the system doesn't bother the archaeologist with its complex infrastructure providing simplified views of the database for data management (e.g. record, alter, and query data).

The system has also the capability of recording multimedia data and especially digital images because of their common use in archaeological excavations.

For the recording of geographical and topographical data, the same previous mentioned approach for entities was adopted giving archaeologists the needed flexibility.

However for the implementation of the GIS
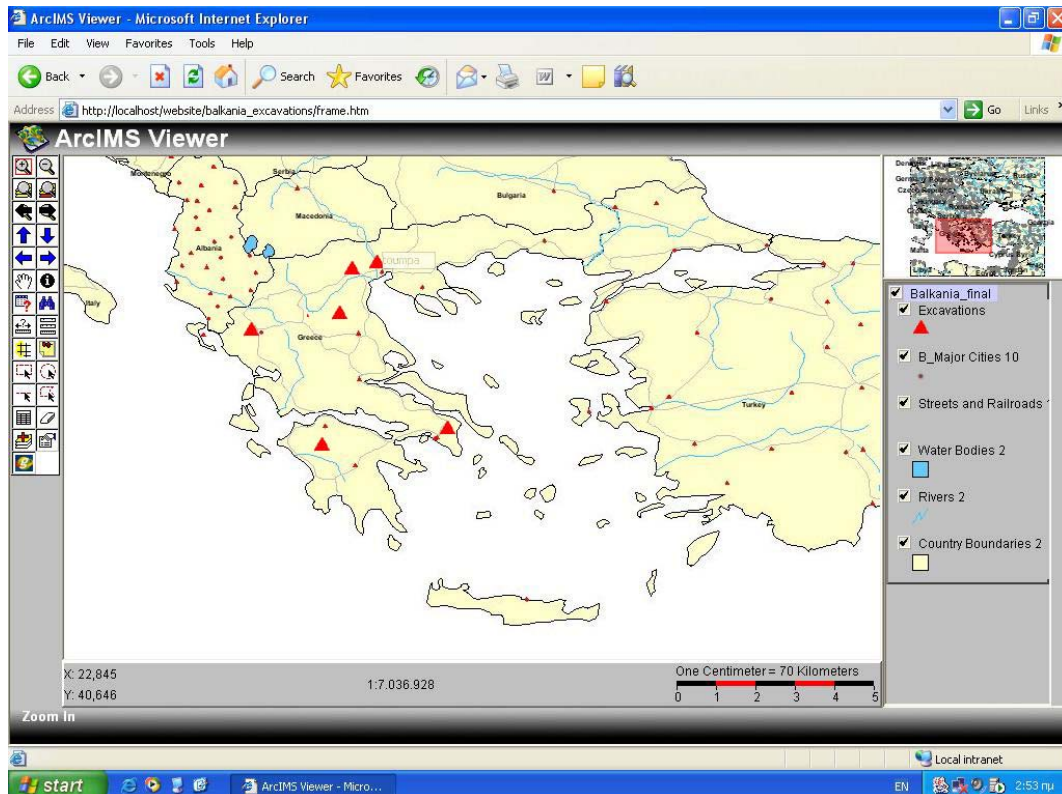
Fig. 2. The user interface of the ArcIMS viewer.

service for multiple excavations, the "Latitude/Longitude" coordinate system was adopted, considering the widespread use of the GPS devices.

4 The GIS Layer

The idea of utilizing a GIS system for archaeological excavation data has already been used by many archaeologists. Each one follows a different way to visualize the spatial data. In the SEEArchWeb project a unified model has been implemented to support the various layers of presentation of each need that may occur. There are multiple layers corresponding to various data. Each layer can be viewed alone or in combination with others. Every selection from the different layers gives the map different layout (Fig 2).

The design of the database on which GIS stands, allows the dynamic presentation of the excavation spatial data from multiple excavations. It can also support chronological queries presented on space. The queries are easy to form by the user and the interface is easy to use. The results are displayed on the map. The GIS makes it easier to retrieve complex visual data with visual queries, which is a more comprehensive way to manage data [4].

The map interface can be customized (zoom in –out etc.). There are also different utilities (e.g. distance measurement tools) so that the user can interpret the spatial data in a better way. The latest GIS software (ArcMap 9.0, ArcIMS 9.0) was used to implement the system. The digitized spatial data created with ArcMap are presented in the internet through ArcIMS [5]. Being so general, this system can help the processing of a huge range of data from a wider space and the export of conclusions (consequently knowledge) on wider regions.

5 The Internet Access Layer

The system has been developed to provide its services over the internet, making them available to a wide range of users. It provides simple and complex queries for searching the DB, including queries on the attributes defined by the archaeologists. There are also queries for insert, edit, delete functions and for chronological and spatial analyses. Web form queries are not static but active, populated directly from the DB dynamically, evolving automatically with each attribute or data entry.

Multimedia data, and especially image files, can be easily and remote managed, allowing users to access them directly from search result in the data grids. Data grid search results are connected dynamically to related information, saving time for the users. The security issue has been dealt with, by storing user data on the database server, including user logins and passwords, asp.net form authentication and cookie authentication.

The system also provides GIS services (for multiple excavations) remotely. Therefore there is no need for users to obtain GIS software packages, except to download and install once the IMS Viewer. With the IMS viewer every system no matter its hardware configuration can utilize the GIS benefits. The presentation of multiple excavation data over the Internet is an innovation. Although there various projects demonstrating state of the art GIS driven implementations [6][7] has features not previously presented in South Eastern Europe Archaeology.

Emphasis is also given in the creation of web interfaces so that the whole system has a user-friendly design.

6 Future Work

The flexibility of the system design makes it possible to support further implementations. One feature we would like to see in a future implementation is the use of mobile devices (PDAs, Smart Phones) to capture excavation data (images, coordinates etc) on the field, uploading them directly to the system with the use of mobile GIS services.

Also, the usability of the system can be improved by designing the user interface even more friendlier using visual helpers (e.g. such as visual queries). We would also like to see a even more improved functionality adding queries for improved analysis of data.

7 Acknowledgments

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