CUSTOMIZED GIS ENVIRONMENT FOR INTEGRATED MANAGEMENT OF ARCHAEOLOGICAL RESEARCH DATA

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ABSTRACT:

During an Archaeological research for the location of buried archaeological remains, a huge amount of data must be evaluated. The data is in a different form and comes from different sources. Cartographic, geophysical, historical and archaeological data etc. must be processed and combined to each other, in order to lead to safe conclusions. In the above mentioned large amount of information, it must be also added the data, which come out from the processing and examination of aerial and satellite images of the under study area. The last is referred to traces of buried structures which are identified in the images. The optimum management, analysis and correlation of the photogrammetric, cartographic, historical, archaeological and geophysical data are feasible only through the use of a Customized GIS Environment.

1. INTRODUCTION

1.1 General Description

Archaeological researches involve large amount of heterogeneous data sets from multiple sources that may contain both spatial information (raster, vector, tabular data and meta data) and non-spatial such digital documentation (reports, photos, sound recordings and video) as well. Archaeologist needs, for appropriate management and representation of both geographic data and multimedia files within the same interface, imposes the development of the customized GIS environment.

This paper demonstrates the capabilities of a customized GIS environment, that is used from a non GIS expert archaeologist, for the management of a large amount of geographic and multimedia data. This project is based on a specific database structure and eight developed forms which provide geographic data archiving and representation based on the spatial properties of features as well as multimedia playback for spatially referenced documentation data. This development provides an integrated interface for:

a) The massive import of imagery,
b) The linking of selected geographic features to multimedia files,
c) The automated attribution of metadata to raster files,
d) The discrimination among vector data which represents features that "are" and "are not" recognizable over selected imagery,
e) The automatic display of geographic data at any selected area,
f) The selective display of available data over the working view,
g) The selective display of spatially related vector data over selected raster data and
h) The automated playback of linked multimedia in GIS environment.

The described collaboration completed in two Stages:

I. Feature Class Definition and Data
II. Development of the Customized tools in the GIS Environment.

2. FEATURE CLASS DEFINITION AND DATA

The archaeological research of the study area consists of a heterogeneous data-set that contains three major categories of data types:

1. Vector Data
2. Raster Data
3. Multimedia Data

2.1 Vector Data

Vector Data describe administrative boundaries, the coast line, urban limits, buildings (structures), soil data, coverage data and archaeological traces. Archaeologists can recognize specific traces on raster data which are categorized in three main Feature Classes.

Buried Traces

Buried Traces, because of their linear, or surface representation, are categorized as compound entities. The descriptive properties that assigned on this feature class, the geometry shape of the trace, the typology, the time period that belongs and the multimedia status are shown on the Table 1.

Feature Class: Buried Traces				
Geometry type: Compound				
Attributes	**Primary Key**	**Name**	**Data Type**	**Description**
	TRUE	ID	Integer	Unique ID
	FALSE	Geometry_Type	Integer	Geometry Type
	FALSE	Category	Integer	Trace Category
	FALSE	Chrono_type	Integer	Trace age
	FALSE	Multimedia_Status	Integer	Trace Status of multimedia documentation

Table 1. Buried Traces - Attribute Definition.

The geometric type of the trace is defined in the system by the geometry of each entity. While in G.I.S., functions that automatically define the geometry type exist, in this particular system the geometry type is defined as attribute data thus making it easier to administrate by users not completely accustomed to G.I.S. (archaeologists).

The values for the geometry attribute are the ones shown in the Table below (Table 2. PICK_LIST_GEOMETRY_TYPE). Also the ability to add more values according to the needs of the research at hand is provided.

ID	DESCRIPTION
1	Linear
2	Curves
3	Rectangular
4	Circular

Table 2. Values of Traces Geometric Type.

The type of a buried structure trace defines if it consists of a road, tomb residue (relics), residential residue (relics) etc. The values of the attribute are shown in Table 3 (PICK_LIST_CATEGORY).

ID	DESCRIPTION
1	Road
2	Tomb Relics
3	Residential Relics
4	Unknown

Table 3. Values for traces Typology attribute.

The trace age defines and records the chronology of the trace's existence. The periods and the values of the attribute are shown in Table 4 that follows (PICK_LIST_CHRONO_TYPE).

ID	DESCRIPTION
1	Contemporary
2	Prehistoric
3	Archaic
4	Classic
5	Hellenistic
6	Roman
7	Byzantine
8	Metabyzantine – Ottoman

Table 4. The selected Periods for the attribute Chrono_type

The attributes described for the buried structures, have exactly the same schema with the rest of the trace entities.

Extant Structures

Extant Structures exactly as the Buried Traces, designed to have the same attribute Data and they are also defined as compound features. The attribute definition for this Feature Class has been analytically described on Table 5.

Feature Class: Extant Structures				
Geometry type: Combound				
	Primary Key	**Name**	**Data Type**	**Description**
Attributes	TRUE	ID	Integer	Unique ID of Extant Constructions
	FALSE	Geometry_Type	Integer	Geometry Type
	FALSE	Category	Integer	Trace Category
	FALSE	Chrono_type	Integer	Trace age
	FALSE	Multimedia_Status	Integer	Trace Status of multimedia documentation

Table 5. Extant Structures - Attribute Definition

Random Shape Traces

Random shape Traces have the same attribute Definition as the above feature Classes but on these there is no need to define the geometry type.

2.2 Raster Data

Raster Data for this research area, include aerial photos, aged from 1945 to 1996, at scales from 1:6000 to 1:42000, satellite images, scanned historical maps, aged from 1901 to 1945, at scales 1:20000 to 1:200000, scanned topographic maps (scale 1:50000), scanned topographic diagrams, aged from 1925 to 1987 (scale 1:5000) and scanned geological maps.

All these image types are stored in the system as a uniform entity called GEODATA. In parallel with this central table for storing images, two more tables are created specifically for the storage of attribute data not common in any of the image categories.

Raster data attribute definition consist of image type (TYPE), scale (SCALE) and creation date (DATE).The reference time is for satellite images, the time of reception is for aerial photos and syntax time is for maps. Conclusively the schema of the table is presented below in Table 6.

Feature Class: GEODATA				
Geometry type: Raster				
	Primary Key	**Name**	**Data Type**	**Description**
Attributes	TRUE	ID	Integer	Unique Image ID
	FALSE	Scale	nvarchar	Scale ID
	FALSE	Date	nvarchar	Date
	FALSE	Type	nvarchar	Image Type
	FALSE	Description	nvarchar	Description
	FALSE	Filename	nvarchar	Filename

Table 6. Geodata - Attribute Definition

The different image types mentioned in the original classification of the spatial data are divided by the TYPE attribute. Each image type has a specific representation id and the equivalent description (Table 7).

The basic rule applied during the input of new data types is that the representation id must consist of 7 alphanumeric digits used for automating procedures.

As it is obvious, the unique codes at this particular case have specified length (seven characters). So the input of new image types requires the input of a seven digit id.

ID	DESCRIPTION
00G5000	Topo 1:5000
0G50000	Topo 1:50000
00QBIRD	QUICKBIRD
0AERIAL	AERIAL PHOTOS
GEOLMAP	GEOLOGICAL MAPS
HISTMAP	HISTORICAL MAPS

Table 7. Unique ID's for Image Types and their Description

Image scale recorded in the Database as a unique id and its description (Table 8).

ID	DESCRIPTION
0001000	1:1000
0002000	1:2000
0005000	1:5000
0050000	1:50000
0020000	1:20000
0200000	1:200000
0006000	1:6000
0007000	1:7000
0015000	1:15000

Table 8. Unique ID's for the used Scales of Images

2.3 Multimedia Data (Documentation)

Traces, declared archaeological places and the places of unknown historical settlements, for their complete representation are followed with specific multimedia documentation (Video, Sound, Images).

Three tables have generated for this aim. The first table used for Video documentation (TR_VIDEO), the second for sound (TR_SOUND) and the third for Image (TR_IMAGES).

Feature Class: TR_VIDEO				
Geometry type: None				
Attributes	Primary Key	Name	Data Type	Description
	TRUE	ID	integer	Unique ID
	FALSE	ID_FEATURES	nvarchar	Unique ID from Specific Trace
	FALSE	MEDIAFILE	nvarchar	Multimedia File

Table 9. Multimedia Table (Video)-Attribute Definition

3. DEVELOPMENT OF THE CUSTOMIZED TOOLS IN THE GIS ENVIRONMENT.

The first step that an archaeologist has to take working on this specific GIS environment is to import massively imagery for trace recognition process (Fig. 9.a) and after that vector digitizing of the recognized traces (fig .9.b).

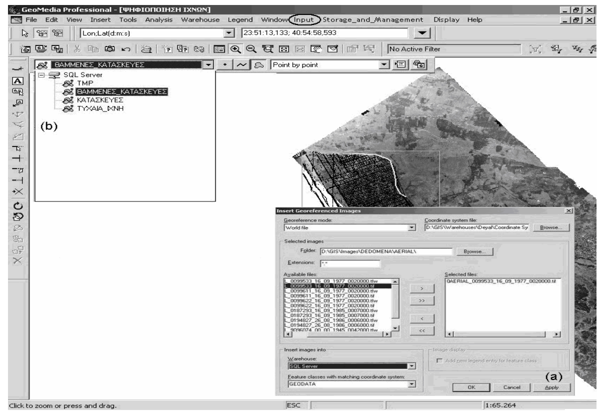

Figure 9. Functions are used for data input through two GeoMedia commands (a, b).

Massive input of raster data and vector digitizing are provided from original GeoMedia tools.

After the trace recognition traces descriptive properties have to be updated (Fig. 10.a).Also the discrimination among vector data which represents features that "are" and "are not" recognizable over selected imagery (Fig. 10.b) and a tool for multimedia documentation associating media files (photos, audio, video) to vector data (c) are developed functions.

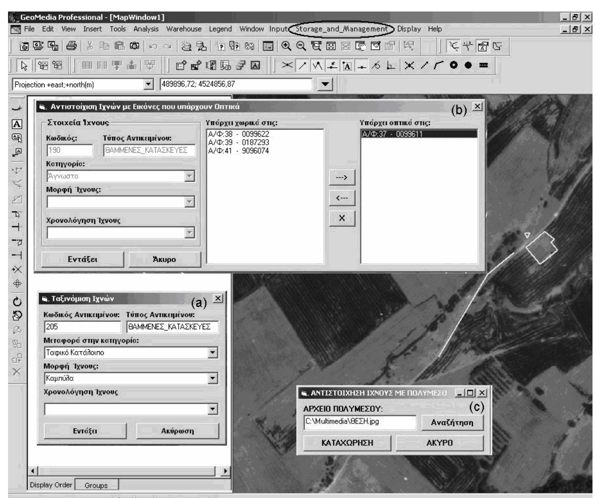

Figure 10. Developed forms for the management of descriptive properties (a) ,for the definition of optical and spatial relationship between selected vectors and images (b) and for the association of multimedia files to traces.

The above forms update the descriptive properties of input data (raster or vector) linking attribute's values with related table indexes of the data-base while the attribution of raster metadata is done automatically, based on a predefined manner for the file names (raster files without appropriate name require that the user inserts the attribute values manually).File names of raster data to be imported, has to conform with the following format in order to automate the attribution of metadata (Fig. 11):

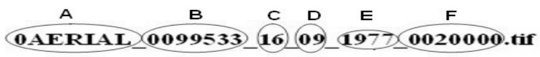

Figure 11. File name format for the automated attribution of metadata to raster files (a: Image Type ID, b:Image ID, c: Day, d: Month, e: Year, f: Scale).

Image type ID (Fig. 11. a) describes the type of image (scanned map, airphoto, satellite image), Image ID (Fig. 11. b) is a code number for each image, Day (Fig. 11. c), Month (Fig. 11. d) and Year (Fig. 11. e) describe the date and Scale (Fig. 11. f) refers to the denominator of the scale.

All the functions are described provides the capability archaeologists to manipulate easily traces and raster data. The study of an area becomes even more easier with a set of functions that is used for displaying data interactively and include forms for the automatic display of geographic data in any selected area (Fig. 12.a), the selective display of available raster data over the working view (Fig. 12.b), the selective display of spatially related archaeological traces over selected raster data (Fig. 12.c) and the automated playback of linked multimedia files in GeoMedia's environment (Fig. 12.d).

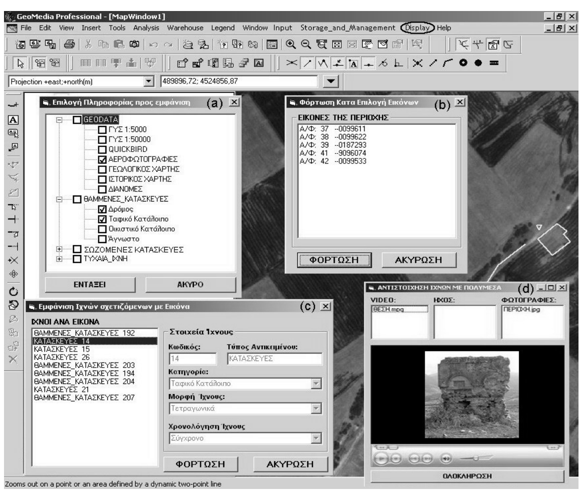

Figure 12. The display operations are controlled by a) a selection form, b) a form for displaying desired image based on selected position, c) a form for displaying vector data related to selected image and d) a window for automated multimedia playback.

The functions of the above three categories are organized respectively in three new menu items at GeoMedia 's menu bar (Fig. 9,10,12) as well as the according toolbox, from which the described operations can be executed.

4. CONCLUSIONS

The majority of raster data is used from Archaeologists to recognize traces that exist over subsequent time periods (evolution of the area).

In the same time, archaeological traces (vector data) although spatially related with overlapping raster data, they are not visible (or recognizable) on every image (e.g. a new archaeological finding appears on the post- excavation air photos but not on the old historical maps).In such cases the developed interface allows this discrimination and lets the archaeologist to define relationships that are based on the recognition of geographic features (vector data) on an image (which are already spatially related). Through the above new kind of relationship, geographic features without temporal properties are related to time-stamped imagery.

Many traces through archaeologist research documented with multimedia files. In such cases multimedia association and playback provides a more detailed description of examined features. Attributing geographic features with multimedia files (additionally to standard information) facilitates their description and understanding from researchers and inexperienced users (viewers).

To conclude, the presented customization brings together common operations from different software (GIS, DB management, multimedia) that provide an integrated interface for archaeologists.

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