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RESUME

CONSIDERATIONS ON THEORETICAL RESEARCH AND SOFTWARE IMPLEMENTATION OF VIRTUAL MAPS IN SYSTEMIC ARCHAEOLOGY

Scientific Advisor:
Professor Florin Stănescu, Ph.D.

PhD Candidate:
Ovidiu Domşa

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CONTENTS

1. Argument

Research contained in this thesis is novel, characterised by interdisciplinarity. Activities specific to systemic archaeological are based on implementing methods and techniques belonging to chemistry, topography, geology, computer science, mathematics; all relying on information technology and computer systems together with electronic devices. To understand the topic, we need a very brief overview of the meaning of software aimed at processing archaeological data. Software developed in the last two or three decades have evolved with the development and upgrading computer systems, personal computers and the devices connected to them. Studies developed led to some very useful tools to archaeologists. To complement traditional methods of archaeological research, various software applications are currently used worldwide to a great extent, in Romania they are at the beginning. Depending on specific applications are designed archaeometry, archaeological botany, ceramics, study and restoration sites, geoarchaeology, zooarchaeology, archaeological databases, mapping archaeological, theoretical and mathematical processing of archaeological data, geographic information systems customized for archeology, virtualization components subject to archaeological study.

Developing such applications requires an analysis from two perspectives. The main analysis is done in terms of objectives and purpose that it should achieve from a historical and archaeological point of view. The second issue concerns the detailed principles and specific components of systemic archeology developed at software level.

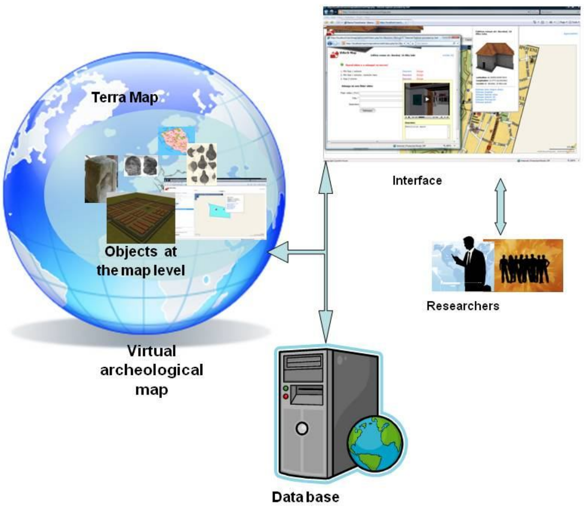


Figure 1. Conceptual diagram, an overview of the components in the virtual archaeological map

The main objective of this paper is to develop a virtual map that will allow archaeologists to place, to compare and study the results of archaeological work with the help of an Internet-accessible application. We used the concept of virtual map in Archaeology starting from some fundamental assumptions. On the one hand it refers to the cartographic location on the map of different elements and on the other hand to the existence of virtual elements consisting of two-dimensional or three-dimensional reconstructions of ancient maps, locations, buildings, artifacts, sites, video clips, images, text, all placed in the current map by the author of research, accompanied by arguments and historical evidence. I called this map "virtual" because in addition to the general appearance of map, it provides a comprehensive information system specific to archeology and accompanied by virtualized elements at map level.

The virtual map is obtained by combining within the same application the interactive map applications offered by Microsoft, Virtual Earth, with an archaeological information system, organized as a specific database, all through graphical interfaces. The structure scheme presented as conceptual diagram in Figure 1 shows the five main components of the map.

Virtual archaeological Map is based on the current map of Earth with the "objects" placed at this level, a database that stores all information from a server level, the application interface being simply visible through applications that help view Web pages by individual users or groups whose identification is based on personal information and password.

The paper also proposes a systemic approach and summary of the following:

a) Creating a collaborative space where research and analysis results of different archaeologists and historians research can compare, examine, accept or counter achieving an overview of each area studied.

b) Theoretical research and models of software implementation concerning the way in which the current area of the map can be replaced or overwritten with flat or three dimensional maps offered in the various investigations, of the same area.

c) Analysis of data structure and definition of database for modeling the virtual map. Database can manage different types of objects like old maps, images, text, 3D buildings, architectural complexes, archaeological sites, applications of three-dimensional visualization and interaction in virtual reality, videos.

d) Studies on methods and techniques for making three-dimensional objects and their placement virtualization as components in the virtual map by identifying the original geographic positions.

e) Theoretical research on the integration of historical evidence to the virtual map, which is exploring ways in which items published on the virtual map are relevant to the historical truth and are measured against similar evidence published by other researchers. This exciting development will allow further by introducing elements of artificial intelligence to analyze the nature of historical truth with the support of a study based on allegations.

Own contribution and the results are evidenced by:

• I prepared detailed analysis and I designed the entire application ViArchMap.

• I defined the basic concepts of the map, as the object, piece type.

• I fully designed the ViArchMap software, consisting of databases, interfaces, server, using specific programming languages (PHP, Java, SQL).

• I did research on the basis of case studies on how the digitization of archaeological information on virtual map using systemic principles of archeology.

• I have studied and developed principles for the relevance of historical truth to materials published on the virtual map.

• We published the virtual map whose material digital or virtual form we developed a 3D reconstruction using applications such as building material since Roman times, epigraphic and sculptural monuments of Ampelum (Zlatna) artifacts.

• I have defined criteria and methods of categorization and typology of artifacts from the archaeological sites in the software.

To materialize these objectives I have chosen some case studies whose primary data I have deemed relevant to models presented in the virtual map. An important issue is the scalability and openness of the design application, so it can easily be supplemented with modules or types of archaeological objects. The paper combines specific systemic archeology presentation sometimes detailed and useful information on aspects of research. Due to the interdisciplinary nature, combining the archaeological research with computer searches, details of components and specialized computer programming were left in the annexes of the paper.

2. Introduction

Technological developments, the spread of innovative ideas and access to a huge amount of data hosted by the Internet generate a rapidly evolving and implementing the materialisation of research. A specialist in history and archeology in the paper is familiar with specific concepts involving archeology systemic use of information technology in primary processing. Preliminary elements are dedicated described principles underlying the development of maps in paper format, two-dimensional and three-dimensional digital format.

Theoretical research that formed the basis for software is based on some case studies of different categories and types of archaeological research. Thus, we submitted to the Roman camp to search Apulum to illustrate the use of 3D reconstructions, Roman Camp at Tibiscum to study old maps in the virtual map, elements of the Roman period in Ampelum to illustrate how to organize map information in the various ways of classifying and retrieving large volumes of data within the categories and typologies studying archaeological sites and archaeological pieces from the Starcevo-Cris culture. Software entitled suggestively ViArch Map, Virtual Archaeological Map of the initials of words, including aspects of basic operations on databases like upload, amend, search and virtual virtualization of the map components. Virtual map is very useful tool to archaeologists with easy access to information, its universality, by its nature open across the authors contributing to the large volume of data and has the possibility of international expansion of archaeological information system (AIS).

Research history, terminology Archaeological importance is reflected by the fact that the study material and spiritual culture of their predecessors, thus contributing to national and world heritage. But there are many tendencies to exaggerate in their interpretation of data or diversion from archaeological reasons, for different purposes. Saving works restore and preserve them in shape as close to reality have a great importance. Large amount of information, failure to complete reconstruction archaeological sites makes interdisciplinarity and collaboration in preservation and restoration work is essential. If the role of mathematicians, physicists, chemists in interdisciplinary collaboration has materialized since the first studies of modern developments, this broad framework brings together engineers, computer scientists, geologists, zoologists, biologists, etc. Their role is to provide tools and technologies able to facilitate the work of restoration, search, preservation and storage of large volume of materials.

This paper is a review of research on the compilation of databases and digitization of archaeological information. This study suggests ways to address modern historical and archaeological studies using software tools developed in collaboration with historians and archaeologist's collective experience, specializing in different times of trial. In this sense the paper aims to combine elements of virtual reality, GIS, GPS and camera reconstruction and development of specific software tools, having a dual role, the research and study on one hand and promotion and recovery of historical resources through historical tourism on the other hand.

Terminology such a process will use the notion of object, whether elements are reconstructed buildings, access roads, landscape, artifacts or beings. Process which seeks to achieve a virtual image in two dimensions, three dimensions or not we define the size of the object further reconstitution.

The studies will address the ways and techniques developed that make virtual digital maps for history and archeology. Besides a theoretical approach on some aspects of digital maps and geographical information systems, much of the descriptions will refer to the media and software tools for description, storage and digital processing of specific information archeology with the presentation of applications we developed it in order to demonstrate that information technology is capable of providing virtual tools to simplify research work, directory and archiving. In this paper we propose a combined approach, based both on evidence, testimony and documents about the settlements that wish to be placed map and time again and as a starting point based on a conceptual model that allows us to examine the extent to which existing methodologies and historical maps can be used in the geographic analysis and design of digital plans to settlements and the possibility that their virtual reconstruction.

The paper presents theoretical and practical especially on how we created a very useful tool in archeology, virtual map, together with the development, completion and offered continuously updated through a friendly interface, modern graphics and of course many with a scientific nature as relevant. Description of the basic components used in the application, which is the outcome of research include descriptive elements on maps, geographical information systems, 3D modeling, research and development of data modeling concepts and how to structure their operations to more efficiently update modification, search, especially visualization. We have combined the elements of archaeological work, computer cartography with two-dimensional and three-dimensional graphics, thus multidisciplinary nature of this work proves the effectiveness of such future studies.

3. Principles of designing and presentation of maps

This chapter presents the theoretical concepts, general or specific, on how to design, development and present classical maps with classification procedures and specific components. Based on these concepts we defined the concept of virtual digital map, the structure and components. In the overall presentation of theoretical elements, in addition to the definition and presentation of general concepts we have developed a new classification of map. Analogues and studies have shown how different maps or archaeological meet requirements to be considered maps.

We studied the effect of scaling on paper-based maps in the mapping, which presents the archaeological objectives Tibiscum map. Map areas includes the geographic area represented by neighboring camp and delimit the map archaeological targets that we put on the virtual map by comparison with the current structure.

Principles used to prepare conventional maps can not be left to develop principles and methodologies to produce a virtual map. Virtual Map is closely linked to principles of developing software, their use with specific computer. An understanding of the terms and defining specific elements must be detailed and well structured for a better understanding of efficiency and especially of the new terminology. Archaeologists will have to classics strides in adopting the new terminology that effectively combine them with classical terminology in order to achieve real progress in the new archaeologists oriented "software archeology" - based on archaeological studies developed using the software. Paragraphs of the paper are intended to define virtual archaeological map structure, which refers to methods of identifying, defining, copyright or other documentary material that can stand on the information placed in the virtual archaeological map.

Digital Virtual Map in systemic archeology is defined by its proprieties such as stored, interrogated and processed by computer. The general structure of a virtual archeology map is based on the following components: map attributes operations on the attributes, map geo-referenced system. We used the accuracy in the following situations: a correlation maps with the image represented as raster image ortho-photographic land surface, choosing appropriate position for placement of georeferenced objects, assuming a reasonable position error, admission of error visualization with zooming, rotating or moving objects in the virtual map. Integration algorithms for vectorization can be done by specialized software (MapCruncher) or own applications.

4. General Concepts of Geographic Information Systems

4.1. Maps and geographical information systems

This paragraph presents the evolution of typologies of maps and how they will integrate with GIS systems. The first sketches of maps were found in Egyptian, Chinese, Canadians, Native Americans made in varied media from bone, tree bark, sand, wood, stone, etc. Rich Romans did nothing theoretical basis of cartographic representation, even if they have prepared maps and routes called necessary in their wars of expansion. Such a map is Tabula Peutingeriana. We note that in this way to express a map more than a mere mention of a complex presentation or roads, access roads. Map idea was to express, in a virtual time, several elements within a system of graphic expression. Defining aspects of buildings or architectural settlements on the route followed, which are representative in that area, small symbols associated with them. It is obvious that with this map, with links based on designations routes followed, and there are detailed written descriptions of the stages. Interpretation of the road followed by broken lines is similar to today's more accurate representation of the walking trails on the map and goings stopping points along a journey, targeting mobile devices used on the roads and towns. These are observable in preparing digital virtual map. It is estimated that in 2010 we find two main categories of Internet communities that depend on the evolution of GIS systems. The first public users will increasingly have easy access to systems and data volumes stored in the various types of GIS, and on the other programmers, developers or managers of GIS systems. The most important problem will become Education for professional use of GIS systems. The idea of ongoing collaboration between users and developers, the cyclical development of such a system and active participation of both users and developers to populate the system, each contribution is equally important.

In this application developed in this thesis I have tried to respect this principle of cyclicity, which we will return to in the section on structural analysis and application.

4.2. Entering data into GIS systems.

Transferring data in digital format requires the use of several techniques by which this information can be captured. The database of a geographic information system is actually a digital map, i.e. a collection of geographic data organized in a form to enable processing by electronic computer. A geographic entity defined by the following: position (where?), expressed by coordinates, attributes (what?), expressed by numeric values, alphanumeric or logical (soil category, name, height, etc.) relations are expressed by numerical data (who is associated?), time (when was the entity observed?) is an important component of historical data, given the specific dynamics of the space in which we live.

4.3. GIS data structures

Nature of spatial data causes a lot of theoretical models, each of which may be more or less adequate description of a class of phenomena. For example, are dealt with more ways to model the surface topographic changes in elevation. They differ in terms of efficiency, depending on the degree of injury of the land. In this section we present various typologies and their data structures, data modeling concepts are necessary in the archaeological database constituted the virtual map. Likewise we analyzed the data source, the truth of their history and presentation. We defined the main methods for obtaining data. The maps are effective means of presentation (usually by means of symbols) has a lot of information about objects, phenomena and the relationship between them. Whatever the mode of representation, accuracy and error handling is a very important issue in reaching accurate maps as close to reality as possible. In this section we examine the accuracy of maps, sources of error and how to integrate the virtual map accurate digitized items as possible.

Cartographic data derived from research in the field and map information from virtual earth so, besides identification of each digitized graphic (object), quantitative data of each item (e.g., object category, name, etc.) were introduced qualitative data (e.g. age, typology, author, category classification study objectives, etc.). To these were added after georeferenced quantitative results, such as perimeter, area, text information, bibliographic. These issues were reiterated in the examples used in case studies.

5. Research and theoretical principles used in developing software application, Viarch Map

5.1. Software technologies and software development environments

Information Technology (IT) or Information and Communications Technology (ICT) is a modern concept which refers to using software, using computer applications for current activities of processing, transmitting, storing and analyzing data and information. The *technology* means the practical application of scientific knowledge in a particular area or a way to accomplish a task. The purpose of this, *software technology* is defined as a set combining different theoretical and practical sciences and cognitive sciences statistical computer to create specific applications development, operating and maintenance agreement, called *software*. The software that I developed in this thesis is based on models of archaeological research and excavations in various categories and types in order to illustrate how the software application is created in systemic archeology. For an understanding of the concepts deployed in the application I used the description of technologies and principles at work and the technical details of programming languages and principles of programming detail we have presented in the Annexes to readers interested in the field.

In the application we combined advanced technologies and programming languages. One of the most modern technologies refers to Microsoft. NET, in which I used C # to access Microsoft's map. Regarding portability at the Internet have integrated PHP and Javascript modules to manage a SQL database. For details on programming elements can be found in Annex guidance material entitled "*Integration of technology with programming languages*".

5.2. Analysis and design of the virtual map

According to current and future requirements of geographical information systems in this paper, we designed a virtual map, similarly structured and conducted with a GIS computer system that is primarily viewing, updating, storing, deleting information about evidence, records and historical truths that can be managed by an approved group of users on the one hand and the public who access the Internet on the other hand. ViArch Maps application is an application software with application to history, archeology, geography, useful as a research tool, such as system documentation and tourist information.

I have described the basic principles from which I started in the structural design stages that application: a conceptual model, generalized graphic symbols on the map, virtual map interpretation to identify components. Cartography has a long tradition of historical study illustrated by a map of reality.

We treated the main differences on the representation of information to a paper map across the digital representation. Historical maps in a virtual sense talking about new concepts adapted to computer terminology such as Databases, data processing standards, standards of disclosure. Classical map is by definition a static element or a number of factors combined in static also. A digital map can be transformed its components are dynamic, supports annotations, changes, corrections whenever necessary. The digital virtual map is itself an object that can be used to define the other virtual maps, so by combining multiple maps municipalities can be obtained without a detailed map of overlapping elements, but only by uniting them.

Another difference between the paper map and digital virtual map, which is of particular relevance in our model of historical records, is the issue of time and space. Time and space problem is solved in the paper referred to by what is called the domain map, or historical evidence to link the temporal area, the fourth dimension when we talk about issues in dimensional.

The application ViArch Map looks very least because of the multitude of windows that allow viewing and that is the same map of Alba Iulia same cartographic landmarks represented in the form of 3D objects and 2D objects attached representation from different periods (Church reconstituted model recovered from the nineteenth century and South Gate Apulum century Roman camp. II Principalis Dextra Gate, proposed reconstitution). The assembly forms a virtual map. Attachments Exhibits of the same issues with objects overlapping maps and other specific elements derived by application ViArch Map.

The paper concludes that maps can not interpretation or presentation of possible variants of historical interpretations, virtual maps, virtual character understood here as such, allow the formal and contextual analysis by alternative representations are accompanied by appropriate notes, through a special presentation.

Most classifications in the history of cartography refers to maps made according to aspects of form, depending on graphic projections, according to the function they have that map and more. However often these categories are not refined enough to describe the variety of maps and drawings used for urban planning and restoration, without mentioning the fact that some forms using combinations of digital and mixed mapping plans for a virtual reconstruction especially for cities. Most attempts so far shows that it is not enough refining existing categories but an n-dimensional approach. Many of these sub-categories remain too rigid to describe the maps and atlases.

If it is so hard to distinguish between these forms we will try to use the classification maps with much more general terms. The idea of creating a method of classification is based on combining the n-dimensions that we associate the following sizes:

1. Latitude (Corresponding measurements or accuracy required by the relevant historical evidence)
2. Longitude
3. Altitude
4. Time (space time, period)
5. Category of historical evidence (These classes of objects we can then refine).
6. Type of category of historical evidence represented by the class type we will specify in digital form that is historical evidence, we are here referring to the text, images, 3D reconstruction, panoramic images, graphs, vectors of position, etc..
7. Measure the relativity of historical evidence represented a scale is defined "error" and the historical evidence that the most relevant will be highlighted and the less relevant will be ignored.
8. Categories of users' rights on how to update information

n. Any amount that may be relevant and can distinguish sizes associated with its maps Subcategories that can be defined by the user (in the sense savvy users) which can be obtained based on historical evidence.

This classification system less rigid virtual digital maps is the model proposed in this paper and implemented the software for, ViArch Map. The contribution made to broadening the conceptual space of a digital map at least I think it is significant in two respects. First by creating a set of "cartographers" that can help define a virtual map. The second issue concerns the user can compare the map on the same map sources and historical evidence about similar analysis can only global or local items of interest.

5.3. Theoretical research on the representation of data objects

This chapter presents some case studies and situations that we have chosen to illustrate the meaning of the treatment, processing and virtualization of each type of object that can be placed in the virtual map application. We defined for this purpose the following categories of items or descriptors as the main components of a virtual map.

a) *Object* is a component of an entity class or classes that can be buildings, artifacts, sites, personalities, etc.

b) *Object type* is how the representation of that object, meaning here the possibility of digitizing the information on the object.

c) *Position* is defined as the GPS coordinates of the object placed on the virtual map.

d) *Autho*r is advised and the person whose signature is validated as being authorized to make changes and additions to the map.

e) *Form* is the component form of a virtual map to change the current appearance of the area studied by superimposing or amendment to simplify and contribute to comparative studies.

5.4. Structural design of application

ViArch Map application is structured around the following levels:

a. Database Level - is structured as a database server-based access control identification name and password, depending on the level of access.

b. User Level - allows access to the application as the user identifier and password.

c. Internet access Level - manage access to a public map, which stores information Microsoft Virtual Map current land surface, with corresponding GPS coordinates. Development application relates currently to manage the current map in the format of the current period, as obtained from satellite images.

d. Interface Level - which allows user friendly dialogue, graphical references.

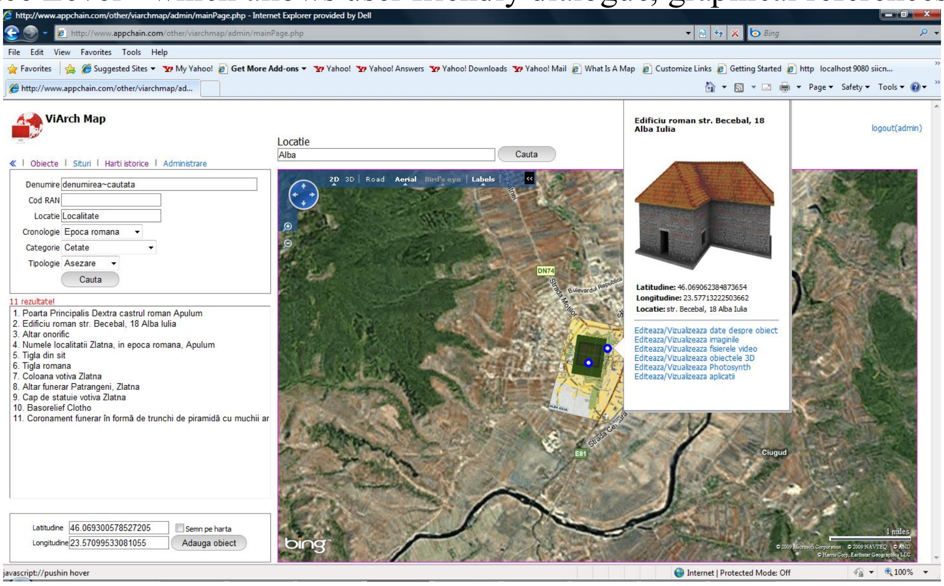


Figure 2. Application interface ViArch Map, with maps, articles, current position on the map together with specifications

The interface includes basic elements such as menu, buttons or selecting options and setting of three distinct areas, bounded by lines at a window or imaginary lines, differentiated by specific data displayed in the region, called frames. Right side of the menu marked 2D, 3D, Road, Aerial, describes a frame, Microsoft Virtual Earth map is taken as the free access to Internet services. In Annexes I developed a comprehensive manual to use application that can be consulted also on the application panel.

6. Research on classical maps to place them on the virtual map. The Roman camp at Tibiscum

In this study we developed especially research conducted at the site Jupa, the Roman Camp at Tibiscum location from which data have been digitized, that published maps of the site and excavations carried out in several stages in the study. I followed these views location superimposed 2D and 3D maps of the region and that Jupa camp location at Tibiscum the possibility of integrating other objects, such as three-dimensional reconstructed barracks at the map.

After an overview of historical issues regarding the studied area I chose to study some maps, some wide others less accurate. The study that I conducted relates primarily to identify and achieve correlation between the information outlined above and the current issue of geographical formations of the Roman Camp area on the location of the various maps Jupa made on site. I refers to an analysis based on two different maps, which we presented in Section 3.1.2 of the paper, some simple sketches of the settlement, other items made to scale or accurate identification.

Aspects that proves that not every map or drawing on paper is relevant when it overlaps or placed in the virtual map, refer to the general plan by placing the map I could not get relevant data, more duplication could not achieve. If we base map on which we place our entire study, that the current virtual map of the Earth surface and plan the positioning Jupa town camp, and the ancient city's vicus Tibiscum can identify with specific systems map that confluence is placed at coordinates 45^0 28' 48" north latitude and 22^0 11' 03" east longitude. For our parts to match the best we had to cover at least two coordinates of the two maps. We selected a second point at the intersection of the two forms of communication between camp and vicus with coordinates 45^0 28' 03" north latitude and 22^0 11' 48" east longitudes. By linking the two positions and to apply a simple scaling algorithm we were able to relatively easily positioned so that the two maps overlap at least two parts. Duplication reported in the paper is a great result because of the inaccuracies with which the map was created on paper, image description quite inaccurate in terms of mapping.

A more rigorous study on placing a virtual map of the old maps more accurately is carried out using MapCruncher application, launched in December 2007 by Microsoft. MapCruncher is an application that allows developers to import or complete maps of existing roads and detailed aerial images that contain specific information. With this feature you can easily compare maps showing the same area but were made and designed by different authors. In Figure 13 What is its usefulness for such duplication?, the map is useful as it gives an overview of where we place the virtual map, more maps, to identify new areas of study or identify the exact coordinates to place the discovery of categories of objects and objects can be identified by comparison researched yet similar. Is interesting to study the river by comparing two images and achieve a simple GPS position marking a point in the vicinity of possible progress on virtual map can then do the same measurements in the field using a simple device for GPS positioning without the required topographic surveys, at surface level measurements from known landmarks. Moreover, once located the positions of artifacts, walls, fragments of walls, buildings or fortifications can be reconstructed and placed in their original positions with a relatively small margin of error.

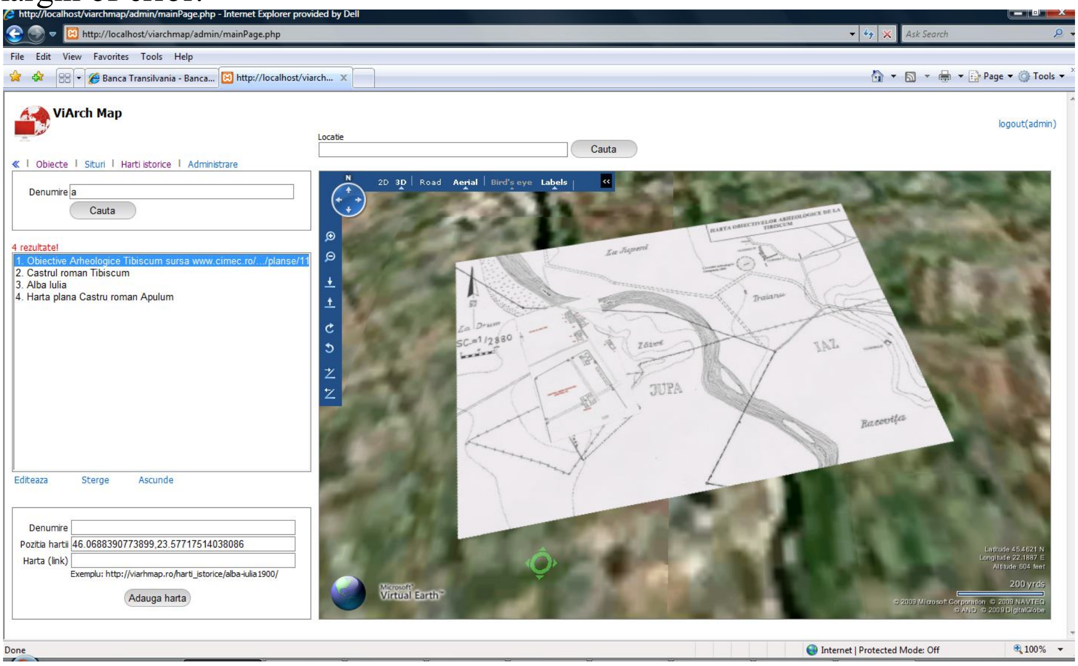


Figure 3. Adding and viewing archaeological map goals from Tibiscum Map in ViArch Map application in conjunction with the Roman Camp map.

We studied the location and vicus camp site in detail, in the various archaeological periods completed by the group of archaeologists led by Doina Benea. It should be noted that once placed objects in the application occurs scalability and visualization is performed at the same level as the original map. This was achieved through the application ViArchMap.

7. Research on virtual objects and interact with them in case study on the Roman Camp at Apulum

That study and conclusions are relate to observations and methodology covered in achieving virtual reconstruction of the Roman camp at Apulum, XIII Gemina Legion camp, in Alba Iulia, using archaeological data and by analogy with the Roman camps in western Europe. Roman Camp of the legion XIII Gemina was in 1998 subject of Apulum book by Vasile Moga, gathering up to that time research on the fortification of the city of Alba Iulia, built by the Romans and used in the period 106-275. Work was concerned to Roman fortification, II-th and III-th century, were analyzed in an archaeological point of view, studied archaeological campaigns conducted within or near the camp, and the results of the excavations carried out by various scientific and economic purposes. In these studies could delineate inside Roman camp and clarify some of the interior parts of the camp.

This paper proposes a software application that allows viewing the interior besides camp, buildings and artifacts, characters and environments interaction with specific age. Software platform is designed so that will allow researchers, regardless of age studied to define their own objects and create their own framework to study the objects or artifacts chosen. Internet access situations to map virtual browsing is done on the application of interactive video clips of short duration, usually with time between 30 seconds and 2-3 minutes. These types of movies are easily accessible on the Internet, are relatively easily achieved by existing technologies and may be associated with the virtual map with events or locations as needed.

8. Studies on the recognition and placement of 3D objects by conventional signs. Roman buildings in Alba Iulia.

The study developed in this section refers to endowing a GIS with all the necessary knowledge to different fields of application especially history, knowing that a valid general endowment is not impossible. In general there are two classes of methods for pattern recognition, unsupervised methods and supervised methods. The unsupervised methods are not training and data sets are not exactly known number of classes. In supervised classification requires a data set for training. Based on these workouts, there is a classification function. Once determined this function will use the classification of elements that were not originally part of the training set.

The structure of virtual maps and GIS integration of graphic elements, the GPS position and any documents that characterize a historic entity to permit introduction of the concept of "archaeological object" component as part of a virtual map point. The archaeological object we mean an entity that is characterized by a set of detailed, specific information stored electronically. Information can be text, image, virtual reconstruction, and video accompanied by specific computer tools for visualization, recognition, recovery or analysis.

We chose as case studies two buildings with different character in that one is part of another larger object, the Roman camp and has no internal description, being made at a low resolution to be integrated at an architectural ensemble and second, Roman house, which is itself an object and that object will be placed on three-dimensional virtual map, which contains descriptions and 3D modeling including object interior.

Roman Camp at Apulum was raised on the third terrace of the river Mures. Dimensions camp - east and west sides are 440 m north and south sides are 430 m camp initially had a phase of earth; excavations documented by the existence of a wave of all the date collected and stored, also compared with similar camps are the main information for camp reconstruction.

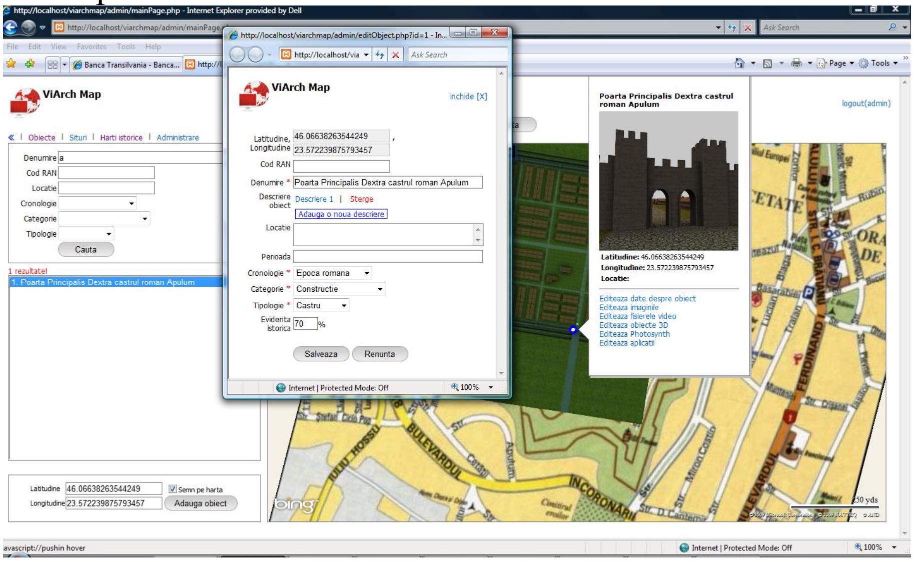


Figure 4. Editing information on the subject of the camp gate Principalis Dextra

Steps to enter or edit the virtual map objects are detailed and specific results are shown in Figure 4 and the drawings in Annexes. Figure 4 is subject to the ViArch Map with Dextra Principalis Gate introduced in specified position on the map to select which allow data editing, viewing them in the window that appears in the center of the image. Published description of each author is listed separately and can be accessed by any user but may be updated, modified only by its author. Similarly proceed to view and update the other attributes of an object, we will detail issues with processing typologies of objects selected as case studies.

As its own, including internal description, which can freely surf-dimensional object, I chose Roman building of which we reconstructed 3D model through the "Urban archeological discovery. Apulum 2007" that I worked with Ilie Lascu, whose data were building the basic elements of reconstruction, which we presented in detail in the paper, as we have been provided. House reconstituted three-dimensional models with textures derived from the research presented, which include interior and facades, textured and textured models to show the plates of the annexes. Films that allow a virtual walk through the inside of the building and are components that can be attached to the virtual map is made and digitized, efficient and portable format in the web applications because of its small size.

Models of large objects above are of great importance to integration into the virtual map. An obviously small scale object poses no major problems. Possibly if the detail of reconstruction is so thorough that the number of polygons needed reconstruction is in the millions, making a hard object in 3D object "workable". Generally small objects such as archaeological artefacts or parts have no problems in placing on the virtual map.

I added a 3D object, which is good for positioning error that we caused it. Positioning error of the edifice is mere seconds. We measured with a PDA device using iGO used to travel to the cities and streets, GPS position location Decebal Street no. 18, to measure the GPS device I got 46^0 04'09"north and 23^0 34'36"east longitude and 46^0 04'09 map coordinate obtained at 60 north latitude and 23^0 34'36"10"east longitude. This depends, however, and the court considered the position in which the building and construction of the points we take as reference points. Regardless of the location of landmarks in the building within the margin of error is 0.1, which is 3 meters from ground level

Introducing virtual three-dimensional objects in the map constitutes a particularly trying to virtualize large areas of buildings, structures or archaeological sites. Since archaeological sites can be viewed as three-dimensional structures whose stratigraphic model can be reconstructed using specific applications, their integration is possible in the map, studies and research will concern the following development application stages.

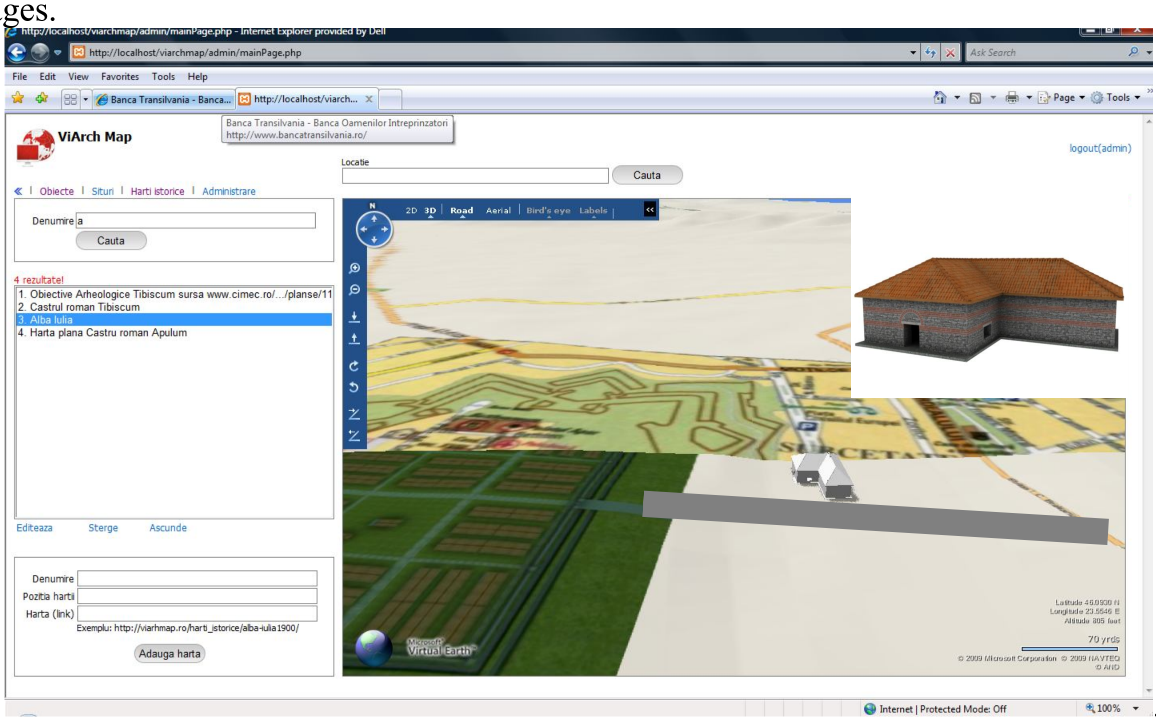


Figure 5.Roman building discovered

Decebal Street no. 18, Alba Iulia, 3D object, textured, placed in the virtual map

Observations made following the introduction of 3D map data, refer to the conclusions that can be drawn only studied a few pictures of 3D components placed on the map. Figure 5 is apparent axis orientation of the access road to the east gate of the Roman camp which can be extended virtually drawn on the image gray figure, the reconstructed Roman edifice which shows that homes were placed near the camp of people wealthy who lived nearby and we can set the access road to the camp by its extension, considering that usually Roman roads were straight.

9. Research on analysis of documents from the Roman period settlement within Zlatna Ampelum, for placing them on the virtual map

Case Study on analysis of documents from the Roman period the territory of the village of Zlatna, Ampelum, their placement and highlighting the virtual map is done by analyzing the sources of this subchapter, the historical truth of the evidence presented. Discovery of documents and the authors with the publication in various forms through a virtual map, and expression of each of archaeological findings in part allowed the overall analysis or examinations in the virtual map. Different typology of research, the relatively small number of authors of discovery, and access to some parts of the museum Zlatna theoretical research led to the choice of these data sources for application-level virtualization ViArch Map. Analysis we conducted based on existing data placed locally and temporal virtual map of the ancient Roman settlement, excavations isolated, evidenced by the discovery of burial slabs, statues, artifacts made of pottery workshops dating from Roman times. An important aspect is that some pieces were found in the homes of people, so we can not say exactly which is the exact location of their discovery buildings or monuments to which they belong. Another reason I chose this area of study findings is the nature of the site, we will place the virtual map archaeological category created for these specific types of objects of archaeological map, certain archaeological sites. In the system we can make the text descriptions, we can post pictures and all kinds of items off described in previous chapters, however defined in a specific, easily identifiable and easily found on the map. To the extent time and space in this paper we limited to a few examples of Roman related documented, placing the town and finds some sites assumed to be the area of Roman settlement Ampelum.

The name of the village and development is approached from the two Latin inscriptions found on the city radius, which is currently at the National Museum of Union, Alba Iulia, as inventory numbers 282 and 284, Roman emperor Septimius monuments dedicated Honorary Severus (193-211), high in the year 200 AD, by ORDO AMPELENSIUM, municipal magistrates of the city council, which shows that the city Ampelum (Zlatna) was elevated to city by emperor because of its economic and commercial importance.

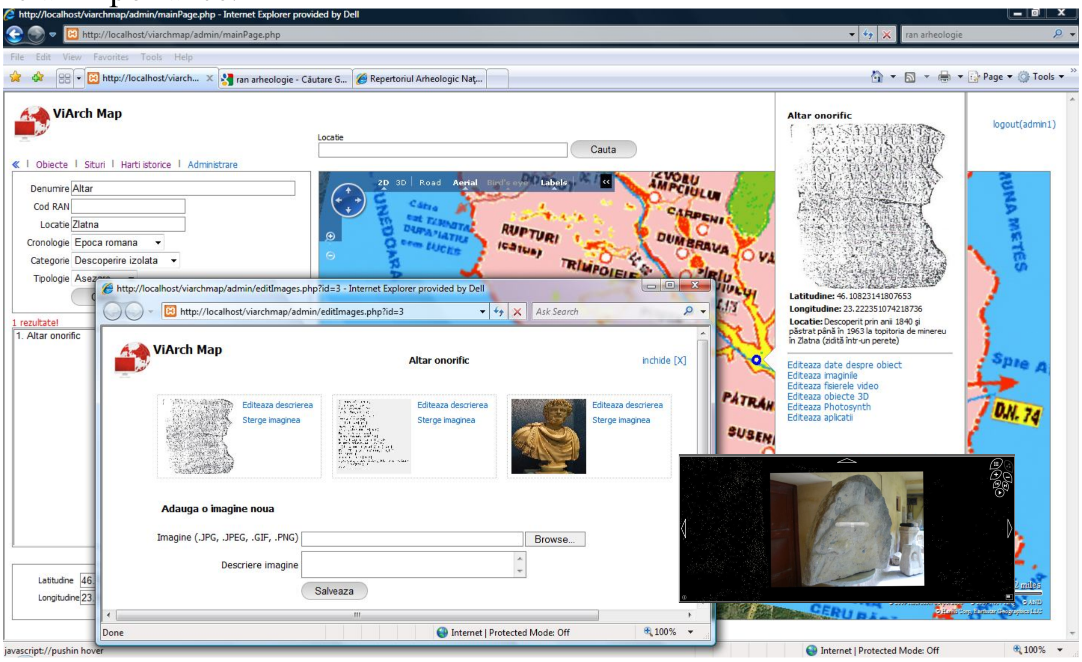


Figure 6 Placing historical evidence maps, inscriptions, funeral cards, votive altars on virtual map

We have taken materials from Monograph IMMN Zlatna Chapters prepared by historical researcher Volker Wollmann. The materials include paper, hereinafter, epigraphic and sculptural monuments from Ampelum, by V. Wollmann and I.T. Lipovan; Three epigraphic monuments from Ampelum, Al. Popa, I. Berciu and R. Pop, Ampelum city of miners, by D. Tudor. All these materials are the result of hard work, full of dedication and competence of the authors mentioned above. For other relationships related to guarding gold mines, during the Roman domination, I have to work with Vasile Moga. I completed the list of Roman historical evidence with the materials by Florian Moldovan, study material, which harmoniously combines elements of ancient history with the language, etymological and ethnographic, showing flourishing city during the Roman rule and an impressive collection of materials gathered together by Professor Domsa Traian.

Results obtained from modeling, storage, data retrieval in the virtual map is evidenced by the many elements that presented by combining different evidence, obtaining a virtual object can be composed of several characteristic elements. In this case we looked at the map and placed an object whose name suggests the overall appearance of evidence, Figure 6. In this framework we have populated the list with descriptions and pictures documenting their source in the map, to which I added some dimensional models of monuments, funeral cards, artifacts, statues, etc. Window that allows you to view information attached to an object allows adding new ones. Author publication each image or information about an object is only able to change them. All others can view or enter their own information, which will belong to the future and may be amended only by them and visible to all users. Exhibits of annexes containing images of a virtual map containing data provided by several authors.

Analysis of visual data, text, graphics, maps or three-dimensional reconstruction is very easy by placing the same area, both in terms of geographical locations and descriptions of different bills, of various authors, with direct access to any information wants to be accessed. The difference between a simple map and a virtual one is clear and can not bear comparison criteria. We can say that virtual map contains a collection of maps with whole chapters of selected books in the field or study area.

Studied documents in the following paragraphs to help locate some archaeological finds, besides the fact that some have disappeared totally unknown or have deteriorated due to improper conditions have been preserved, were located in different positions, not necessarily original. Authors discoveries have placed these documents time and space.

Over time the area has worn different names from Ampelum-Ampeium, Auraria Minor and by the actual name Zlatna. Some authors, referring to toponimic locality, i.e. the origin (etymology) Ampelum name indicates that it is uncertain and controversial, because not yet know exactly where or Dacian origin was brought by the Romans when they came. In conclusion, putting Ampelum (Ampeium) still appears during the Dacians, the Romans took over the name, which used the name of Auraria Minor denominations that have lasted until after the withdrawal.

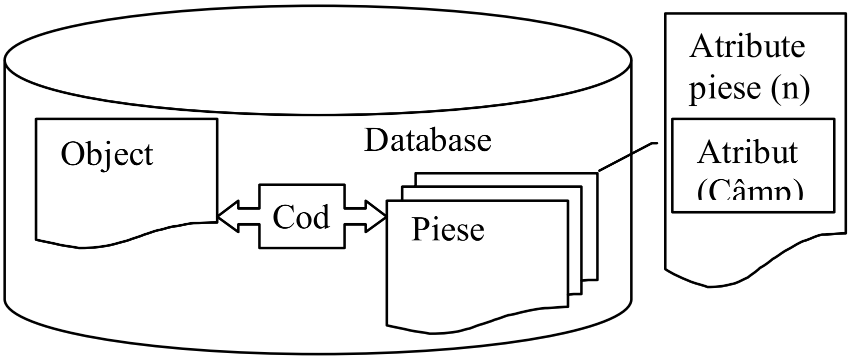
Testimonies presented above are an example where the introductions of a parameter in the virtual map archaeological, historical, measuring the degree of accuracy of various historical or archaeological interpretations. Virtual map for study, research, presentations of the elements described by their discoverer, or their interpretation by other users, will quantify the degree of accuracy of quantities placed on the map. Obviously this degree of honesty, truth, accuracy is very questionable. The truth is that the methods and logic-based artificial intelligence elements to settle, to classify and to assess the truth based on a popular with more conclusive data when the number of documented evidence and arguments is higher than the conflicting testimony of the truth value of those increases.

Archaeological materials are usually in groups of items found in a particular area or an area larger or smaller. We presented a list of archaeological items reviewed and marked with GPS position, place discovery. The list was chosen to illustrate how you can store and retrieve application-level collections of objects with descriptions. Inventory record for each object description document text and picture or pictures that related, together with details of the author or the research findings. Each of these can be reconstructed or three-dimensional model and stored in proper location identification, including specifying the author or publication inventory.

10. Research on typology and search data belonging to archaeological repertoires in virtual map. Case study, pieces of pottery belonging to Starcevo-Cris culture

Modern research methods, abstraction based on digital representation of archaeological data to determine how a specific approach to modeling and retrieving them in a context of different data and different specifications. In previous chapters we have examined and found solutions for virtualization, storage and retrieval of archaeological entities, called objects, which the various characteristics database, text, images, 3D reconstructions, films, maps, reconstructions of classical or virtualization. All they could do because of the object itself or fragments or parts thereof, of historical evidence on which they could be recovered.

Particular case study is based on research conducted diversity of forms and morphological appearance of pottery in Starcevo-Cris culture. Recent proposals to achieve evolutionary typology of forms of early Neolithic pots were advanced by various authors, scoring types in a wider cultural context, chronologically, the entire evolution of Starcevo-Cris culture. Series for typological forms of the culture Precriş pottery broadly appropriate stages IA - IB - IC – IIA, Lazarovici system, can be enriched by the incorporation of unusual types that will be treated uniformly. This is particularly important that the systems typology created a database to allow for updating, amending or re typologies, and all they can be done by specific computer tools. In order to define the main typological series can be used like traditional classical dish, bowl, bowl, plate, tray, pot, etc. Personalized names specific author or most useful in the digital representation includes categories represented by codes in the which, as all the explanations we find the words "synonyms" (that refers to the same type) category. We modeled several series morpho-typological analysis based on different geometrical shapes, color, composition, etc.



The diagram symbolize the way that you can attach an object based on unique one or more parts, with a correlation of type 1: b. N dimensional feature is that once the table, the user can define their own attributes (fields), if it finds that attribute (field) that is needed to describe the piece missing. As can be seen in Annexes coding presented, many types have similar coding systems, combining character with digits or lowercase. This is particularly important point typology of part coding system. Moreover, it is not mandatory to use the coding system, this system was used in the past and looking to simplify accurate information, the Application ViarchMap, tables of correspondence between codes and their explanations will help search both at the code and word level.

The encoding used by archaeologists in preparing analysis and archaeological repertoires at the site commonly used coding system and combinations. At the presentation, add or change data on archaeological pieces from the repertoire of a site, the user is able to fit all objects and parts at a site or to submit data on an individual basis.

ViarchMap application wants to support efforts by archaeologists to have a virtual community similar to Google Earth, but also contain elements of research, archaeological field-specific, closely related to computer science. Helped create such a database and can only be through global cooperation. Huge volume of information, mostly stored on paper, will deteriorate over time. We need more and more archaeologists?

11. Theoretical and practical conclusions. Proposals. Research perspectives

In terms of theoretical and practical the thesis is a first step towards creating a set of methods, means and modern tools of analysis and research in history and archeology, through the use of techniques and technologies offered by computing devices, the integration of three-dimensional and virtual elements into the current two-dimensional studies.

Original elements of the paper are based on the development of two research directions. One research direction is conducted in terms of the typology of archaeological data, documentary sources and how to virtualize that archaeological material. On the other hand I developed and implemented the application in terms of structure, means and methods of software development. The original contribution to the achievement of this work consisted of introducing the concept of virtual archaeological object map and the definition of all the characteristics necessary for its digital processing. To achieve these investigations I have relied on studies and excavations in different areas and of different typologies. In terms of software I used the latest existing applications and I integrated the results obtained into the software application I elaborated, namely ViArch Map.

In this paper we describe the methodologies used to map the integration of several specific types of objects, based on case studies developed. The case studies refer to:

- Modeling and placing a paper-based map onto the digital map through overlay algorithms based on common data and use of specialized applications;
- 3D reconstruction of buildings and the integration of 3D buildings of architectural ensemble as well as 3D-visualisation of objects at the level of the three-dimensional relief of the virtual map;
- Conceptual data modeling in the virtual map and introducing the concept of n-dimensional database, which allows virtually continuous defining and redefining categories, types and chronology of categorization and digitization of objects lists in the system studied.
- The categories and their typologies specific to archeology through virtual mapping.
- Introducing the concept of authoring of materials posted onto the map, associated with the degree of historical truth of published research, degree which can be assessed by other researchers or co-authors of subsequent mapping. This concept entails the concept of virtual open mapping. In this type of collaboration between several archaeologists map to populate with data collection will lead to more rapid large amounts of data. In this regard need not be hiring people to deal specifically with data entry, step in time and financially costly when we digitization of information.

- Study and research in terms of theoretical concepts to archaeological virtualization historical document each piece of research.
- Addressing issues of historical truth, and historical evidence that led to the definition of the degree of historical truth, placed in the virtual map. This will be a topic of great interest in the future by introducing elements of artificial intelligence computing systems which will evaluate, on a large volume of data entered, the truth of historical evidence by using mathematical and computer reasoning.
- Design application and database structure is part of computer science that we developed at both conceptual and implementation level. It is clear that in such applications required extensive collaboration and the use of already developed components, such as Virtual Earth, or in which collaboration between developers is based on the reuse of code modules, so-called free software, with possible development of sophisticated software fully integrated with the reuse of code modules, classes or plug-ins.

What I want to emphasize is the idea of seeing a map in different historical periods, the location of various historic sites and placed in virtual reality on the map surface as scientifically rigorous issues. Therefore comparing a map of the current century with a former one, there can be larger or smaller differences, but in principle the two will not resemble each other because both people and nature can change the face of the earth and mapping can reveal this. In other words many buildings are built, others disappear, nature can change the topography, water courses, and construction layout and finally what there existed years ago today there may be "history" or "actual entity" which will appear in the archaeological virtual map through virtualization.

Research into the use of 3D technologies aims to transform and improve methodologies, in order to study history and archeology. Principles underlying the development of graphics applications, especially those developed for visual programming environments have a very rapid development in computer science. I started working on the idea of such an application 3 years ago when there were virtual maps available to users, such as Microsoft Map and Google Map for cartographic description of the Earth. The idea of placing objects and interact with them at that time was also a challenge and a goal difficult to achieve without a team to work on such principles. In collaboration with colleagues from the doctoral school and having as support a group of students, especially for the production of objects, which can be put on the virtual map, we started designing and implementing the application. The project's outcome was ViArch Map, through the design and development in parallel with the latest discoveries and occurrences in the area managed to take shape and be endorsed by concrete issues as an actual useful application knowledgeable and less knowledgeable users in the field of archeology. The application interface model illustrates the simple, less abstract and relatively few, but consistent elements. In this version, from several points of view, the application is perfect and will in the next release including placing on the surface current of a set of elements, objects, specific historical periods studied correlated with the GPS coordinates of overlap and correlation algorithms 3D three-dimensional surface current and interacting with them by integrating sound or restorations of ambiances.

Archaeological objects have a unique specificity, thus integrating them into the application domain allows their classification, age, chronologies, categories and other criteria in order to facilitate retrievals, especially for creating a collaborative unit and also to can exploit the large amount of information and extract statistics, summaries, conclusions, etc.. The following concerns will move towards adapting to specific locations on the map, studied in various periods including landscape restoration by replacing or superseding images currently accompanying map 3D virtual objects or components specific to the period studied.

In terms of a more rapid, efficient field work and data collection in real time the realization of such applications on mobile devices such as PDAs would be a focal point in the future. This will allow real-time location of objects to be placed on the map in their exact coordinates of the points collected accurately reported, including maintenance of files.

Finally I can say that both the topic dealt with in this paper and the implementation of the application have been thoroughly investigate and carried out, with dedication and motivation, especially considering that I have developed an application that is useful and interesting to all users. The virtual digital maps will be in the future the universal language of communication between users and the outer world, regardless of the epoch or the era with which we want to interact or communicate. We will have the opportunity to re-describe "historical events", allowing for the inclusion of primary and secondary information, in a responsible way, which describe and visaualise different interpretations (reconstructions) of the same event of historical process.

In summary, the digital map made of the ViArch Map software, which visualizes and interact with the components of the map, and on the other hand, the data volume represented by the database comprising all elements, brings forth a utility, a tool for archaeologists to have access to a new storage form, preservation and conservation of the historical past, which does not require huge spaces storage for storage, maintenance and upkeep under special conservation conditions for certain artefacts.

My future research in the field of digital maps for history and archaeology will focus on two important elements. An important aspect pertains to the creation of syntheses and analogies between objects displaying behaviours and aspects similar to ones from identical or different periods or areas. From my point of view, an extremely interesting aspect, which I will study more thoroughly in the future, refers to aspects concerning the truth value of historical proofs in the use of artificial intelligence for the analysis of this aspect.

I consider that the application created on the basis of the studies carried out along this research succeeded achieving the aim for which it was designed in such a way that it affords permanent update and improvement of functions or addition of new modules. It is meant to be a modern tool, freely available, within the reach of any archaeologist who need to process, study and evaluate their work as compared with that of other archaeologists'.

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