

New Developments in the use of Spatial Technology in Archaeology, Sample case: Rocha Castle System

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Abstract— The authors have built a system that helps the end users and archeologists in data exploration and analysis excavation in a simple way. This system provides access to the excavation database and automatically updates visualization whenever the database is changed. This enables them to make discoveries that leads to new investigations about the excavation. The authors had to deal with multidimensional representation Data that is concerned with Rocha Castle. Data can be uni-dimensional (e.g. as with the series of time), bi-dimensional (e.g. as with the raster images), tri-dimensional (e.g. as with the scenes and the 3D representation of features). Another category of problems must be solved. This includes issues such as (I) how to integrate a uni and tri representation into the same scenes?, (II) how to adapt the resolution of data to fit them into a particular Level of visualization Details (LOD)?, (III) how to optimize the data storage for efficient recovery and interpolation of data or continuous visualization?, (IV) how to represent some objects in the same coordinates “clear view to the end user?”

Keywords- *Virtual Geographic Environments (VGEs); Spatial Analysis; Information Visualization; Keyhole Markup Language (KML); Geographic Information Science (GIScience).*

I. INTRODUCTION

The Virtual Geographic Environments (VGEs) will benefit from the development of new geographic analysis tools, which benefit and facilitate human understanding of

the geographic world and that will be helpful in solving geographic problems at a deeper level [1].

There are three phases of geographic understanding: the first one is to acquire geographic information; the second phase is to study Geo-objects and their relationships using topological, geometric, or geographic property information; and to further explore advanced geographic laws, the third phase is to analyze changing geographic phenomena and process[2].

The most important scientific issues in respect to Geographic Information Science (GIScience) are the dynamic phenomenon simulation, and the multi-dimensional visualization [3, 4] Thus, the world must have enhanced tools that can be used to help in the domain of "geography"(GIScience).

Hui Lin et al. provides a brief abstract about current state of VGEs, after a ten-year development process containing their evolutionary process, use cases, and distinct features, to provide a clearer image and to enable better user understanding of VGEs. As the author said, there is no doubt that the information bandwidth from the real world to the human brain is maximized. Thus, VGEs would provide us with the possibility to explore and understand the intriguing world more efficiently. Overall, ten years of research has shown much progress on VGEs, including progress on both the theories and the applications. However, limitations

remain. Continued research is still required for the improvement of current VGEs [5].

II. PROBLEMS OF SCIENTIFIC DATA REPRESENTATION

Many problems have emerged in this domain, some of that related about how to represent into the same scene, 1 and 3D representation, and how to adapt the resolution of data to fit them in a specific Level of Detail (LOD). The last one is how optimize the data storage for an efficient recovery and interpolation of data, or for a continuous visualization. And there are many problems that may arise when dealing with many layers, leading to overlapping of these layers when to visualize its, so that's the affect of the display objects in visualizing inconspicuously.

III. TYPE OF ARCHAEOLOGICAL DATA

Spatial data can be simply defined as information that describes the distribution of things upon the surface of the earth. Indeed, any information concerning the location, the shape of, and relationships among, or geographic features are considered as spatial data. [6, 7]. In archeology, we routinely deal with an enormous amount of spatial data, varying in scale from the relative locations of archeological sites upon a continental landmass down to the positions of individual artifacts within an excavated context.

There are two principal GIS data-models in popular use, which are named vector and raster. They differ in how they imagine, store and represent the spatial locations of objects. In the vector model, spatial positions of features are defined by co-ordinate pairs. These can be discrete, taking the form of points (POINT or NODE data); linked together to form discrete sections of a line (ARC or LINE data); linked together to form closed boundaries encompassing an area (AREA or POLYGON data). Attribute data about the individual spatial features is maintained in an external database.

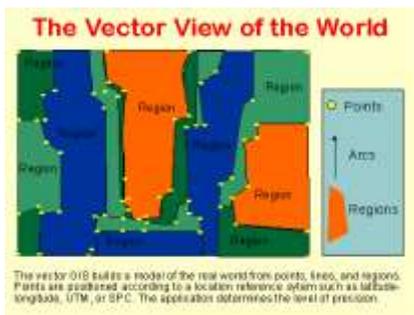


Figure 1. vector Model [8]

In the Raster Model, the spatial description of an object and its related non-spatial attribute are joined into a unified data file. In practice, the region under study is covered by a fine mesh, or matrix, of grid cells and the special ground surface attribute value of interest befalling at the center of each cell point inserted as the value for that cell. It should be seen that while some raster models maintain the assignment of values to various characteristic per discrete cell, others adhere strictly to a single characteristic per cell structure.

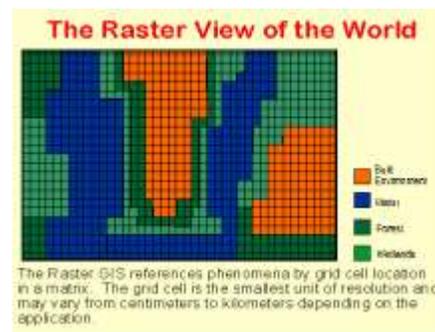


Figure 2. Raster Model [9]

The challenge is when the user has to deal with this data types and represent many pieces in the same position and arise when dealing with many layers, leading to overlapping of these layers when to visualize its, so that's the affect of the display objects in visualizing inconspicuously. In this paper, the authors suggest ways to solve this problem.

IV. ROCHA FORTE CASTLE

This castle will be our case of study. Authors have chosen it because the importance of this historic castle in the province Galicia, It had strategic location and the site where it is still attracting for archeologists. The castle was destroyed in XV century. And From XIX century, several excavations took place.

Castle da Rocha Forte is a ruined fort near Santiago de Compostela , in Galicia, Spain. It was first mentioned in written documents from 1253, but it had probably been built earlier [10].

The castle was situated in a strategic location by road from Padro village to Santiago. Pilgrims followed that route from Portugal. The castle is not on top of a hill as many other forts are, but in a valley where it could control all of the traffic into town [10].

In addition to its purpose for defence, the castle was also a home for the Archbishop, which could provide the men of the local church a shelter from rioting citizens. In 1317, Berenguel de Landoira was nominated as Archbishop. The

residents did not like him and started a rebellion. Archbishop Landoira had all the leaders of the rebellion executed. In the 15th century in Irmandiño wars the castle was damaged badly and it was abandoned. Later, in 1472 the walls were dismantled. During the Franco era the ruins were used as a hideout. In 1962, an electricity pylon was installed to the castle area [10].

The Data of excavation is available and authorized the access to this database through collaboration with The Galician Supercomputing Center (CESGA) as this center for calculation, high benefits, and advanced services communications for the Galician Scientific Community, university academic system and the Superior Counsel of Scientific Research (CSIC). It is located at the University Campus of South Santiago de Compostela. Within CESGA, not only the Government of Galicia but also CSIC, Vigo, USC and UDC are represented, and all of these institutions are highly performed on the day to day activities of the different projects developed at the center[11].

The database is used in this sample the PostgreSQL because have more advantages some of this reliability and stability Different of many exclusive databases; it is extremely popular for organizations to report that PostgreSQL has nevermore, ever crashed for them in several years of high activity operation. Not even once. It just works. Moreover, the Cross-platform PostgreSQL is a possible use for practically every brand of Unix (34 platforms with the freshest stable release), and Windows compatibility is available via the Cygwin framework. Native Windows compatibility is also available with version 8.0 and above. Designed for high volume environments, The Programmer uses a multiple row data storage strategies called MVCC to perform PostgreSQL extremely responsive in high volume environments. The leading proprietary database vendor uses this technology as well, for the same reasons.

In figure 3 explain and describe the work field diagram for database:

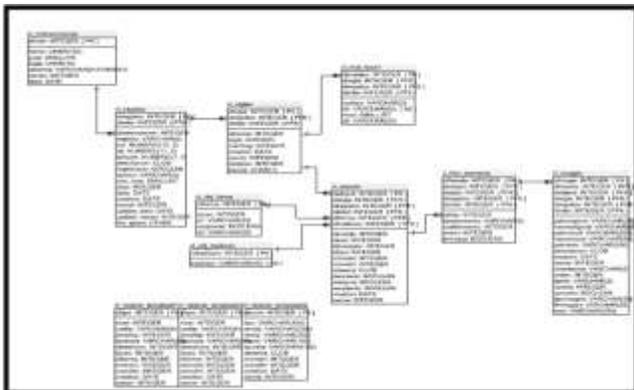


Figure 3. Workfield Diagrams

V. THE SYSTEM ARCHITECTURE

The authors propose with this Paper the development of an advanced visualization system of georeferenced data (geodata) using the graphic engine as the framework for the visualization. The system will work with two different sources for data acquisition: in one hand a database will provide to the system with data from Galician Supercomputing Center (CESGA).

As mentioned above by the authors, the System have to deal with multidimensional representation because data could be one-dimensional (like series of time), two-dimensional (as raster images), three-dimensional (as scenes, or 3D representation of features), and, at least, 4-D, when we include time as an additional dimension. This means that system will have to deal with streaming representation. Another kind of problems will have to be solved: How to integrate into the same scene 1 and 3D representation? How to adapt the resolution of data to fit them in a specific Level of Detail (LOD) of the visualization?

The system we propose to develop is in the line of Virtual Geographic Environment, a new analysis tool to study the geographical environment problems.

As a new form of the geographic analysis tool and also an addition of Michael Batty's virtual geography theory[12], VGEs are a type of typical web- and computer-based geographic environment developed for geographic understanding and problem solving [13, 14]. By mixing geographic knowledge, computer technology, virtual reality technology, geographic information technology, network technology. VGEs are built with the purpose of giving open, digital windows into geographic environments in the physical world, to allow users to 'feel it in person' by a means for expanding the senses and to 'know it behind reality' through geographic phenomena simulation and collaborative geographic experiments[15-21]. Following the VGE structure propose by [5], our VGE should be designed with three of the four components: the data component, the modeling and simulation component, the interactive component. The collaborative component will not be implemented at this stage, as is not necessary at the research level. Thus three main components are responsible for geographic data organization, the implementation of geographic modeling and simulations, interactive channel construction, respectively [1, 19].

The authors make a scientific analysis for select the best graphical engine, to develop theirs framework in which visualize geographical data, Furthermore; virtual geographic outlines can be built to enable both public and scientific researchers to examine geographic phenomena and to address geographic issues[22, 23].

For example, in a VGE built for building environmental analysis users cannot only visualize static scenarios, including data for inside and outside the building, but even they can also visualize temporal evolution of data that will be represented in a novelty way “over” the 3D representation of the building. The user can thus (1) experience the visualized ‘real world’, as is represented by the graphic engine, and explore data associate to this real world (environmental, social, structural, etc.). (2) experience with geographic data from SDIs (meteorological, urban planning, soil uses, etc.) (3) interacts with the environment with new multimodal techniques and displays (Kinect for motion capture, and a cave to have a 3D immersive feeling).

Moreover, general understanding can be earned more efficiently by viewing and experiencing such a digital geographic world than by viewing several figures and tables. As an extension of maps, GIS systems are sourced in computer mapping and spatial database management, with spatial analysis as their essential element [4, 24, 25]. The analytical strategies of GIS systems have developed as much as their mapping capabilities and practical expressions, and their analytical abilities have taken users well beyond mapping[16, 26, 27]. Numerous examples illustrate the successes of GIS systems in both physical and social domains (e.g., [15, 28, 29]). However, analyzing the recently proposed scientific issues concerning GIS science, e.g., that GIS science should develop from being data driven to concept and approach made, from static to dynamic, and from the pattern of display and presentation to process modeling/simulation [3]. Earlier GIS systems still lack the realm of evidence, knowledge and ultimate wisdom to fully assess the earth system[24]. Previous GIS systems must develop in several fields. First, dynamic phenomena occur at every time and Locations in the geographic world (e.g., accordant junctions, rainfall, and vaporization); therefore, it is necessary to model the geographic environment as a dynamic system [30-32].

Lately, virtual environments have shown enormous potential for scientific research [33]. In the geographic analysis and research field, VGEs were proposed as an evolutionary step beyond maps and prior GIS systems for geographic analysis. The expression ‘geographic environment’ has long been agreeable as a description of the surfaces on which human communities exist and expand [34]. The geographic environment besetment each person in his or her life, including in forms "images" and memory.

When design and Building digital windows into geographic environments, i.e., VGEs, for geographic knowledge and problem solving is predictable to overcome the defects of earlier GIS systems on some levels.

As mentioned previously authors In this system, the choosed the Google Earth as the graphic engine. The main purpose of

this because it's wide use and can any simples users use and deal with it. And the smart idea in this system is create dynamic server-side (KML) that is capable of responding to viewer queries and updating itself based on the web services created by authors connected to it directly to server [35].

The most important requirements to apply this system is install the Google Earth application only this is the smart idea any user does not need any additional requirement only can install the layer of Rocha (see figure 4) and then can directly connect and visualize any information you wants.



Figure 4. The website download the Rocha Layer

The authors created the Dynamic interface in the description "Balloon" of the Placemark can the users deal and interact with it(see Figures 5,6), so that is easier for the user to deal with the data without notice any processes because it is all work in the background and only see the visualization results



Figure 5. The Main Placemark

In the (Figure 6) notes the interface that can easy to classification any information needs to visualize it directly when the user press the submit and display button that's going to the server and call the web services created by authors and then go to the script that convert all data to kml files and import into Google Earth as a Layer see (Figure 7).



Figure 6. The Main Interface

In the (Figure 7) can see the result of choices of user and when focus on it, can see the some of the elements in the same coordinates and places (elements "547+548" and "145+146" so it's the problem when to visualize any elements in the same case, it's visualized in complexity and cannot distinguish to see it specially when to have many elements, in the same cases, the user must choose the element wants to visualize (see figure 8).



Figure 7. The Data Visualize



Figure 8. Two Objects in the same coordinates

In the previous figures (7+8) the user noted the problem, and can see it More clearly when visualize more elements

(see figure 9), so the authors suggestion the solution "strategy" depends on the programming of code applies to any database. So that the change is based on the altitude, and the link between elements with a line from which we can distinguish place this element, now see next Figure (figure 10).



Figure 9. more elements visualize in the same place



Figure 10. Objects in the same coordinates (with new visualize)

In this case, any person uses this information and see it can easy observe any objects "elements" need to explain the description of it (see figure 11), here can show the description contains 1_Dimention data includes the information and 2_Dimention data contains the image. All this data store in the Postgresql and retrieve it from web service created by the authors as mentioned earlier.



Figure 11. The information of the elements

VI. 3D MODELS ENVIRONMENT IN GOOGLE EARTH

Now can talk about the 3_dimension, authors did not find any pictures of the castle documented, and through following and coordination reached an image by archeologists from this photo the authors designed a three-dimensional model of the castle using sketch_up program see (figure 12).

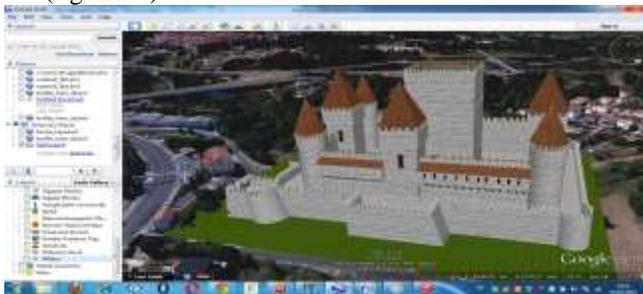


Figure 12. Rocha Castle Model (3_Dimension) The Left Side

The design stage was very difficult because of accuracy of details the castle, for example, they contains of the same wall a straight line and forward slash line also see (Figure 13).

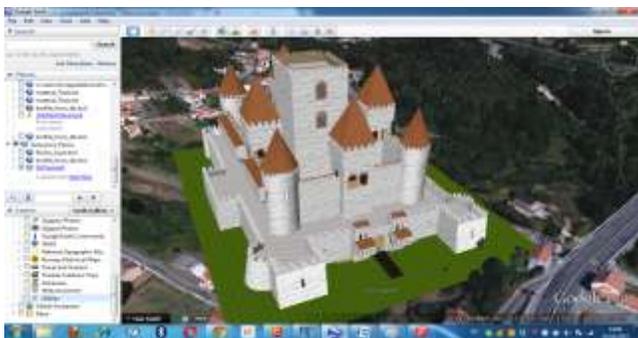


Figure 13. Rocha Castle Model (3_Dimension) Entrance Of Castle

Because the accuracy of the castle design was necessary, so it was necessary attention to detail even reach to this result

of precision that met with the satisfaction of archeologists who excavated see (Figure 14).



Figure 14. Rocha Castle Model (3_Dimension) Towers

ACKNOWLEDGMENT

The authors are thankful for the support of Erasmus Mundus Programme founded by the European Commission EACEA (Education, Audiovisual and Culture Executive Agency), and (CESGA) Galician Supercomputing centre for providing the database.

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