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INTERACTING WITH 17TH CENTURY FORTRESSES ON DARDANELLES THROUGH WEB-BASED GEO-VISUALIZATION

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Abstract

3D modeling of the real-world and the real-phenomena presents opportunities of scientific exploration and visualization that are not possible in 2D. Additionally some information is best experienced three dimensionally such as documentation and research of historical sites and structures. Typically these types of applications require intensive interaction, animation, and user participation and exploration beyond what is capable with a page-, text-, or image-based format. The paper presents "GeoHistoryVirtualInterface" as an interactive geo-visualization component of the GIS project of "life history of the fortresses" and its approach to query, modify and interact with geographic data model and database, "GeoHistoryRepository". Furthermore, the paper examines how VRML, JAVA, EAI, CGI and GUI technologies are applied to design and implementation of 3D GIS on WWW environment.

INTRODUCTION

Recently, Virtual Geographic Information System (GIS) based on three dimensional (3D) geo-processing methodology with navigable 3D graphics, and Internet environment have opened an exiting research area for "Geographic Information Science and Technology (GISc&T)". While, some 2D GIS's softwares running on World Wide Web (WWW) is appearing in GIS worldwide commercial market, but their functionalities are not satisfied with advanced GIS requirement due to less spatial analysis functions and weakness of 3D data modeling. However, recent innovative technologies being gradually developed on the WWW allow client-server alternatives of 3D GIS to be studied and state-of-the-art surveying instruments such as Global Positioning System (GPS) receivers, laser scanners, Total Positioning System (TPS) instruments and photogrammetric techniques, are providing a wealth of information that makes the third dimension possible in mapping. A 3D GIS should be a system capable of maintaining and analyzing 3D spatial and thematic properties of real geographic objects. (Kim et al., 1998; Zlatanova, 1999; Koehnen, 2002) Therefore, Web-based 3D Geo-Visualization issues on GISc&T can play a significant role in development of new GIS application field and provision of more advanced decision-making methodologies. To design and implement that the strategic linkage of Java and VRML is first regarded.

Java-VRML based 3D Web-GIS on the multi-tier client/server architecture can build geographic features of 3D real world, stimulate deep sense of real world, simulate 3D spatial analysis and promote the usability and navigability of the system.

Some information is best experienced three dimensionally such as documentation and research of historical sites and structures. There are two Ottoman fortresses in the

Dardanelles region of Turkey, called *Seddülbahir* and *Kumkale*. They were both built in the mid seventeenth century (1656-1659) at the entrance to the Aegean, on either side of the Straits by Turhan Sultan, the mother of the Ottoman Sultan, *Mehmet IV*. The goal of the joint research project, (among the Division of Geodesy, Istanbul Technical University (ITU) and the Department of History, Koc University, Istanbul) is the documentation of these two Ottoman fortresses using an interactive multimedia supported Geographic Information System (GIS).

In this paper how classical GIS applications combine with eligible multimedia applications in order to generate a more user-friendly, visually oriented and attractive information system is demonstrated. In this way the paper also presents "GeoHistoryVirtualInterface" as an interactive geo-visualization component of the GIS project of "life history of the fortresses" and its approach to query, modify and interact with geographic data model and database, "GeoHistoryRepository". Furthermore, the paper examines how VRML, JAVA, EAI, CGI and GUI technologies are applied to design and implementation of 3D GIS on WWW environment. The focus of the paper is on humorous narrative, great historical documentation and ease of propagation.

BUILDING 3D GEOGRAPHIC SCENES IN VRML\GeoVRML

That "GeoHistoryVirtualInterface" is being developed to build an architecturally-accurate 3D model in a computer-generated environment which specifies 3D virtual re-construction of the fortresses and the objects in the fortresses enables a user to interact with the objects in the scenes. Virtual Tour Guide, called GeoHistory tutor, in the "GeoHistoryVirtualInterface" is being designed to talk to visitors in English pointing out historical, artistic and architectural facts of the objects.

Developers in the project is approaching "GeoHistoryVirtualInterface" to come up with key features such as animation, simulation, realtime interaction, multimedia (image, movie, sound), behavior etc. in accordance with users' purposes involving historical archiving, preservation, cultural awareness and educational. It is a challenging work to build this artificial three-dimensional visual model which is a most cutting edge technology utilized by a multidisciplinary team and other users.

"GeoHistoryVirtualInterface", which is a Graphic User Interface (GUI), uses 3D internet modeling language VRML\GeoVRML to create and reproduce some accurately modeled 3D scenes that could be viewed over the web and to explore the potential of 3D visualization of reality. If the feature selected by user has related image and/or sound data, they can be displayed and played using the GUI.

Virtual Reality Modeling Language (VRML) is used as a 3D scene description language, an effective 3D interchange format and a simple, multiplatform language for publishing 3D Web pages via browserplugins. It is a technology that integrates three dimensions, two dimensions, text, and multimedia into a coherent model. VRML provides an open, extensible, industry-standard language for describing interactive 3D objects and worlds delivered across the Internet. The VRML file which takes the form of a human-readable text file (plain text file) describing a 3D scene can be distributed over the internet and parsed by a VRML browser program which sensually renders the document into an interactive form. VRML browser is a program that reads a VRML file and displays the geometry, lighting, and animation as a 3D world. VRML which is a highly structured dynamic 3D scene description language is a high level object-oriented language for the

description of scenes and the behavior of objects. VRML also allows "Script nodes" by which the developer can add external programs (typically written in Java or JavaScript) to extend its functionality. The current VRML specification is VRML97. The specification has been ratified by the International Standards Organization (ISO), where it is referred to as ISO/IEC DIS 14772-1, or (informally) as VRML 97. (URL1, 2002)

Geographic VRML (GeoVRML), as an extension to VRML, has addressed issues specific to geographic data that VRML does not. The desire is to enable geo-referenced data, such as maps and 3D terrain models, to be viewed over the web by a user with a standard VRML plug-in for their web browser. (URL1, 2002)

Some semantics such as hierarchical transformations, light sources, viewpoints, geometry, animation, fog, material properties, and texture mapping are being integrated to the scenes of the fortresses and the objects in the fortresses. Additionally, real time navigation techniques through "GeoHistoryVirtualInterface" such as fly-over, walk through are being designed to promote the interactivity.

JAVA-VRML FUNCTIONALITY

The VRML language has the potential to describe the behavior of objects, provide links to other documents on the Web, represent interrelations that can be used to retrieve and visualize 3D spatial information and thus serve as an interface to 3D GIS. (Zlatanova, 1999)

"GeoHistoryVirtualInterace" uses programming Java in combination with VRML for 3D modeling, rendering, and dynamic interaction capabilities *(provided by VRML)*, complete programming capabilities, and network access *(provided by JAVA)*, which extends the ability to interact with the model and to animate objects within the scene really only limited by the creators imagination.

"GeoHistoryVirtualInterface", which is an "External Authoring Interface (EAI)" linking Java applets or applications to the 3D VRML/GeoVRML scene, is an interactive user interface between the encapsulating HTML browser and the embedded VRML browser, and is used as a dynamic geo-visualization tool through the Internet. It provides to access nodes and event structure from outside of VRML browser instead of comprehensive node access within VRML browser via a Script node that is another alternative using "Script Authoring Interface (SAI)". This interactivity enables Java applet to build and update dynamically the data in VRML, and in turn, the applet's data can also be dynamically updated through the VRML interface.

The connection between the data in Java applet and the nodes in the geo-spatial world in VRML file is implemented by EAI. The changes in Java applet can affects the 3D geo-spatial world built in VRML file form. And the event occurred in VRML world can be detected and processed in Java applet side. 3D spatial analysis such as selection, 3D buffering, and near can be performed on Java applet, and its result is visualized in VRML world. The result may also be presented in textual (numerical) or graphical form in "GeoHistoryVirtualInterface" as a GUI.

Multimedia data such as text, sound and images is also linked to 3D geographical features in a somewhat application level in GUI, "GeoHistoryVirtualInterface", and it is partly similar to basic concepts within 3D hypermap.

DATABASE-VRML FUNCTIONALITY

The increased complexity of tasks in many applications seeks for an integration of 3D spatial and thematic data and mutual relationships. Existing systems either fall short to deal with 3D geometry (2D GIS) or lack extended spatial and thematic analysis. For example, queries such as “show which buildings in the fortresses architectural changes”, “show how digital terrain models of the fortresses changed through World War I”, “show all important architectural features on the second floor of the south-east tower in the fortress of *Kumkale*” still can not be accomplished by any of the commercially available systems. In this respect, many authors consider a 3D GIS, which maintains and analyzes 3D topology, spatial and thematic information of real geographic objects, the successful solution. (Zlatanova, 1999)

“GeoHistoryRepository” being developed based on object-oriented database management systems provides a database programming interface (DBAPI) which is generated by Common Gateway Interface (CGI) scripts to extend a database with user defined data types, and functions such as VRML and to allow database access from within “GeoHistoryVirtualInterface”. VRML documents are used to portray 3D graphics (spatial data). The approach for the integration of database technology and VRML let the users to query, modify and interact with remote spatial databases in the concept of 3D GIS. The multi-tier client-server architecture provides to complete queries, visualize results and explore 3D models.

The user has access to the VRML document with a click option and can visually choose an object (e.g. turkish bath). The first click on the door of the Turkish bath will allow the user to enter inside. The second click on the indoor will show the architectural plan and the gravure of main part of Turkish bath. The third click on a button will display the achieve information about the Turkish bath, and so forth. In such an example, network analysis might be realized using CGI scripts in each mouse click. Query-Result sections will be integrated using CGI and Java scripts.

Figure 1 displays how VRML files produced in the project. Figure 2 shows the methodology and technologies used for developing the “GeoHistoryQueryInterface”. Figure 3 presents a capture of “GeoHistoryQueryInterface”.

CONCLUSION

It is too soon for GIS providers to support 3D web mapping since GIS can benefit from 3D. Many have speculated that the 3D world model will supersede and thus replace the popular 2D desktop model as the primary user interface paradigm in the next decade.

In this project high quality 3D data can be easily produced and viewed in a web browser format and useful 3D online libraries of geographic data can be compiled, which can be found at www.seddulbahir-kumkale.com.

Using “GeoHistoryVirtualInterface” 3D GIS data handling and 3D spatial operations can be realized since the “GeoHistoryVirtualInterface” is the engine part of the Web-based 3D GIS application. However, “GeoHistoryVirtualInterface” is not complete yet. A great deal of implementation work is now in progress. “GeoHistoryVirtualInterface” will be well specified, openly available and portable to most platforms on the Internet when it is completed. The pupose is to make “GeoHistoryVirtualInterface” more interactive or informative.

Both the production of maps and the development of the GIS of the fortresses have been realizing in the laboratory of "IGS-ISTA Satellite Observation and Processing Laboratory" in the Division of Geodesy of Istanbul Technical University. Any one who is interested in the project can follow the progress and other publications on the integrated GIS project with the project web address http://www.seddulbahir-kumkale.com.

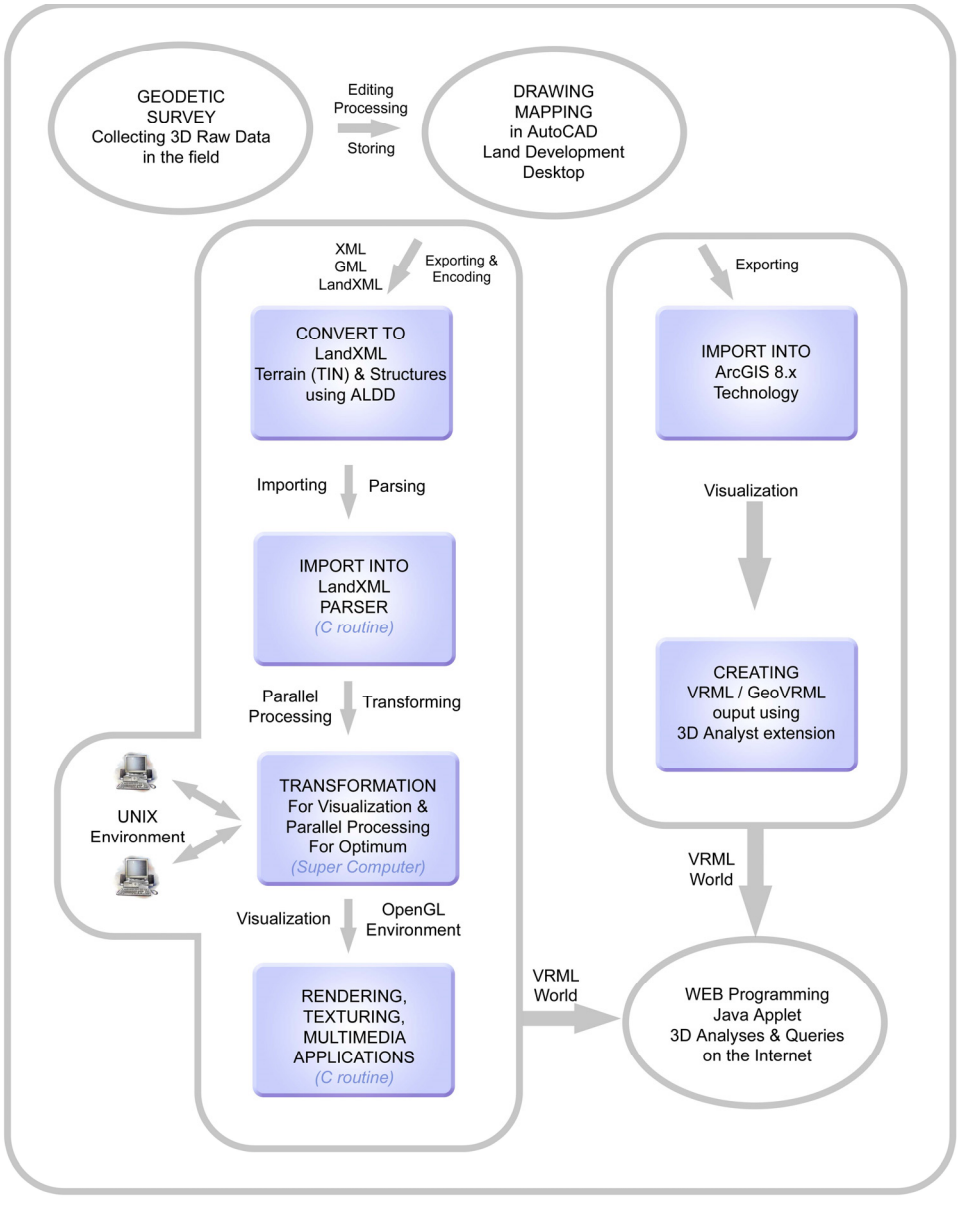

Figure 1: Methods of building VRML files.

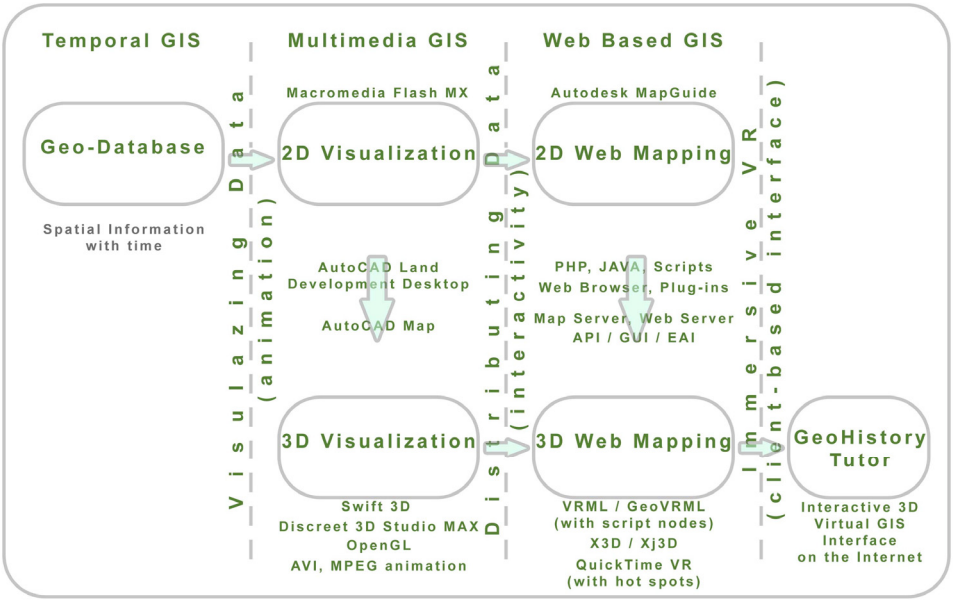

Figure 2: Methodology and technology used for developing “GeoHistoryVirtualInterface”.

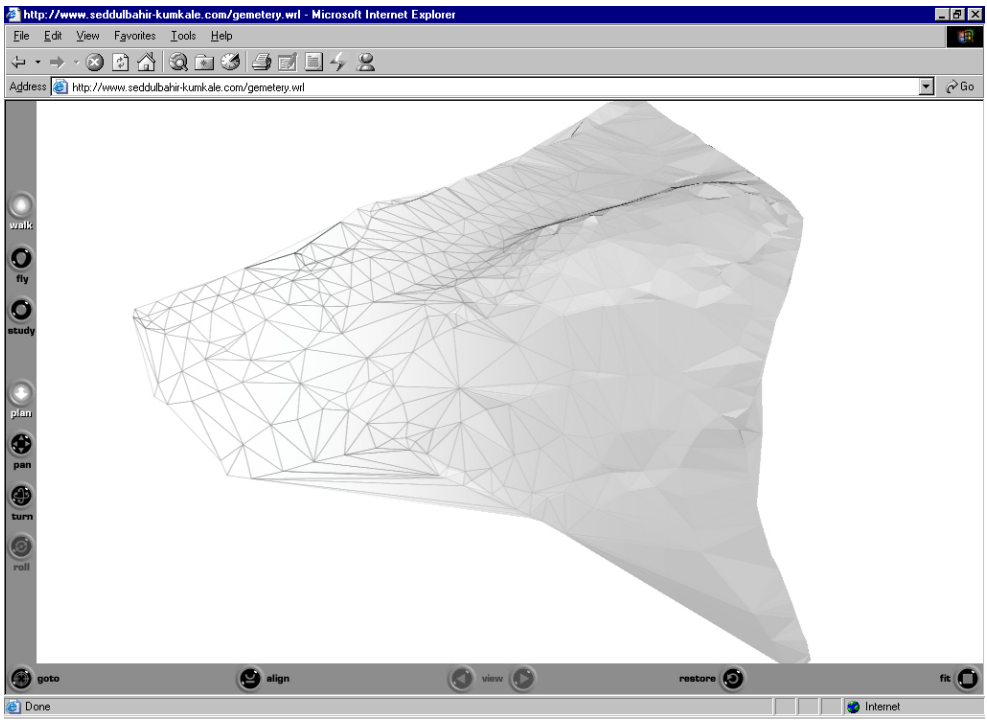

Figure 3: Capture of “GeoHistoryVirtualInterface”.

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