DRAPED AERIAL PHOTOS AND 3D GIS ON THE INTERNET

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ABSTRACT

To provide 3D GIS data on the Internet, 3D GIS java engine and java3D-VRML connectivity methods are required. 3D data structures are researched and applied for spatial analysis for subsurface modeling. There are two models use in this research, a surface model and an octree model. The surface model is mainly used for visualization, while the octree model is used for spatial operations due to its efficient Boolean operations. In the surface model, functions such as datum, special layer selection, attribute queries and various cutting functions are available

The Virtual Reality Modeling Language (VRML) is a standard language for describing interactive 3-D objects and worlds delivered across the Internet. It is a language for description of interactive simulations - virtual worlds connected via Internet and World Wide Web. It allows creating a description of a virtual world, save this description to a file and display virtual world in one of WWW browsers.

This study shows the method of providing 3D GIS on the Internet using VRML model, which consist of DEM data, Draped Aerial Photo, and Java3D API programming. And it is also studied that offering 3D GIS engine on the internet and precise texture mapping using satellite image and aerial photos.

1 INTRODUCTION

1.1 Internet GIS

Recently, distributed and online GIS is requested more and more. Serving dynamic maps over the Internet was an overwhelming challenge. The demand for serving dynamic maps and related data is increasing. Government organizations want to add digital maps to their Web sites as a public service, while commercial organizations need to provide customers with geographic information such as the location of their nearest outlet. Mapping departments want to leverage GIS mapping and analysis capabilities via their Intranet to reach non-GIS specialists responsible for tasks such as routing deliveries, answering customer queries, or managing property. More than simply viewing static maps, users in both instances want to browse, explore, and query active maps.

As for GIS software R&D trend and market of the 21th century, the following things have pointed out: 3-dimensional geo-processing technologies, Internet-based application system development, distributed processing technologies for large volume of spatial information, real-time geo-data processing methodologies, Among them research scope within Internet-based application system or Web-based GIS generally contains core parts of software development such as Internet application, large volume of spatial database handling, real-time spatial data processing, spatial data transfer and transformation, and volumetric display of processing results.

2 VRML – JAVA GIS

2.1 VRML

The Virtual Reality Modeling Language (VRML) is a file format and related access services for describing interactive 3D objects and worlds. VRML is designed to be used on the Internet, intranets, and local client systems. VRML is also intended to be a universal interchange format for integrated 3D graphics and multimedia. VRML may be used in a variety of application areas such as engineering and scientific visualization, multimedia presentations, entertainment and educational titles, web pages, and shared virtual worlds.

VRML is capable of representing static and animated dynamic 3D and multimedia objects with hyperlinks to other media such as text, sounds, movies, and images. VRML browsers, as well as authoring tools for the creation of VRML files, are widely available for many different platforms.

VRML supports an extensibility model that allows new dynamic 3D objects to be defined allowing application communities to develop interoperable extensions to the base standard. There are mappings between VRML objects and commonly used 3D application programmer interface (API) features.

The VRML Scene Authoring Interface (SAI) provides access to VRML worlds both from script nodes within the worlds and from external programs.

The Virtual Reality Modelling Language (VRML) provides a 'standard language for describing interactive 3D objects and worlds delivered across the Internet' (The VRML Repository,). VRML2.0 is becoming a Web standard for VR delivery. It has a strong user support network and it does not require any expensive proprietary modelling software and most 3D modelers now support some form of VRML export. VRML also allows 'Script nodes' by which the developer can add external programs (typically written in Java or Javascript) to extend its functionality.

VRML 2.0 has many shaped nodes, which are useful for representing spatial phenomena, the VRML 2.0 specification was not written primarily for geographic visualization, and is not without impediments to the cartographer.

Many of the problems encountered in developing the virtual interface have required considerable deliberation and assessment of potential repercussions. Some of the most prominent design issues that have arisen are documented below for future reference along with a series of recommendations for using VRML 2.0 to model terrain.

2.2 VRML modeling

2.2.1 Terrain models

VRML supports 2 types of object modeling suitable for elevation data, Indexed FaceSet and ElevationGrid which spatial scientists refer to as TINs and gridded DEMs, respectively, and encompass familiar advantages and disadvantages. However they may also exhibit different display and performance characteristics inherent in the VRML browsers used to display them

3 types of terrain model have been developed in VRML:

- TIN using IndexedFaceSet
- Gridded DEM using ElevationGrid
- Lattice as a special case of IndexedFaceSet

The ElevationGrid node has been designed specifically to build terrain models. To use this node the dimensions of the terrain grid, the cell spacing and an array of height values are supplied.

The advantages of this node are the ease with which the terrain can be modeled, and the smooth visual appearance that can be achieved because of the ability of VRML browsers to interpolate between grid cells. The two main disadvantages are:

- Large arrays of grids (e.g. > 300x300) may be slow to maneuver in virtual space as the node specification hides a complex geometric structure.
- The height values are represented in the y plane with eastings in the x plane and northings in the negative z plane.

IndexedFaceSets are the fundamental method for geometric modeling in VRML. They are defined by a list of x,y,z coordinate points followed by a list of coordinate references that build each face. The advantages include performance increase in many VRML browsers and modeling efficiency gains. The disadvantages include:

- Complexity of constructing the VRML IndexedFaceSet from standard TIN models, requiring transformation before 'placement' in the VRML world.

- Smooth appearance under any spotlighting requires defining all facets in counter clockwise direction. Otherwise switching off the headlight and specifying the world with an emissive color helps smooth the terrain appearance.

Lattices are displayed as IndexedFaceSets and are derived from triangularly divided gridded DEMs, their main advantage for VRML are they are a quick and easy way of producing an IndexedFaceSet from a DEM.

2.2.2 Texture mapping

One of the specifications of the Virtual Field Course is the ability to view and compare different representations of reality. Changing the texture drape on the VRML terrain allows the user to compare different attributes of the landscape. A choice of drapes is given by the prototype Java interface. Choosing a texture name changes the url field in the VRML ImageTexture node.

A disadvantage of the WorldView2 browser is that it generalizes the textured image as displayed on the surface. It is hoped that this problem will be resolved as browsers and computer performance improve. Currently a work- around that has been discussed but not implemented here is to divide the terrain into sub-regions and apply a texture drape for each region. This utilizes level of detail (LOD) node structure that also provides the ability to generalize the view to appropriate levels dependent on viewer proximity. Another possible alternative is the application of individual colors to height cells with the colorPerVertex field in the ElevationGrid node.

Registration of a texture to an ElevationGrid appears better than to an IndexedFaceSet, which wraps the texture around the sides of the object, further work is necessary to resolve this problem.

A non-geographic habit of VRML is that images for texture mapping on ElevationGrids need to be inverted as they are mapped upside-down. In consequence 2 sets of gif files have to be specified in the Virtual Interface program.

Java can be integrated to VRML for interactive user interface, middle ware for GIS server, data parser of VRML.

3 EXAMPLE

3.1 Building GIS Data

This Paper studied recent landslide zone in Pusan Korea. Building and road data is made by Arc-info. And It is converted 3d shape in Arc-view 3d analyst. Aerial ortho photo is graphically matched by Arc view Image Analyst (fig.1). Vrml node is made by VRML-GIS parser program,.

3.2 Programming

Nodes that describe shapes, interpolators, sensors and scripts, linked by routes, which pass messages between nodes, primarily define VRML worlds. Most nodes are of predefined structure containing fields and events that describe their appearance and behavior, however the node set may be extended by use of prototypes and scripts.

The VRML Script node provides a general-purpose node for programming new sensors and interpolators for VRML whereby appearance and behavior of objects in the scene may be modified and defined.

Script nodes contain references to the appropriate Java. class file to call when the script is initialized. The ‘Virtual Interface’ application opens via a ProximitySensor IsActive field when the VRML file is launched.

The script node enables events and nodes to be passed from VRML to Java (EventIn), commands to be sent from Java to VRML (EventOut) and the definition of fields in the VRML file to be used in the Java program. Events, (such as mouse/cursor/keyboard combinations) can be sent from the VRML scene nodes where they are detected to Java programs that react correspondingly. The converse is possible too.

In this Study, Vrml-GIS link parser is made by java. It can generate eventIn and eventOut node for VRML 2.0 format.

3.3 Serving data in Internet

Figure 2 shows the input process of Building and Road data in GIS, It can be exported VRML node link by vrml-gis parser program. Figure 3 shows VRML DEM model on Internet browser. Figure 4 show Draped aerial photo texture mapping on the Internet, and its building and road are clickable link to small data window.

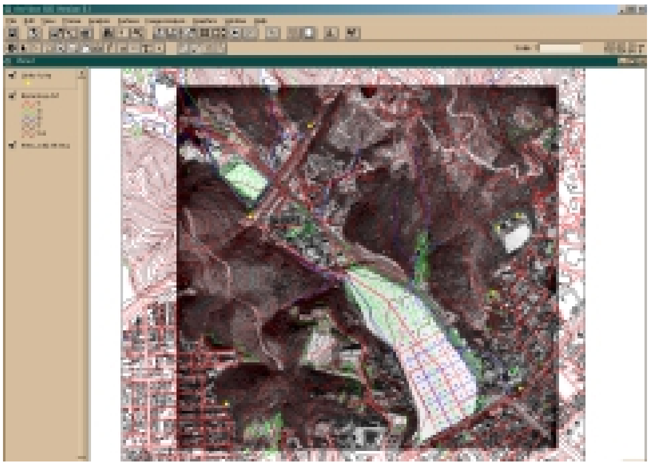

Figure1. Register Control Point

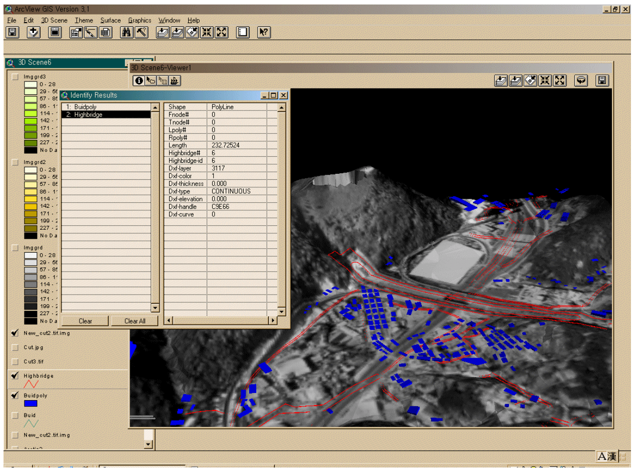

Figure2. Build GIS Data In Arcview

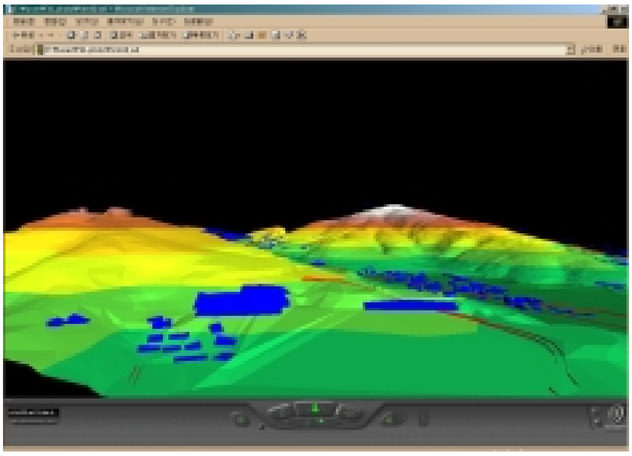

Figure3. Serving Terrain Model in VRML

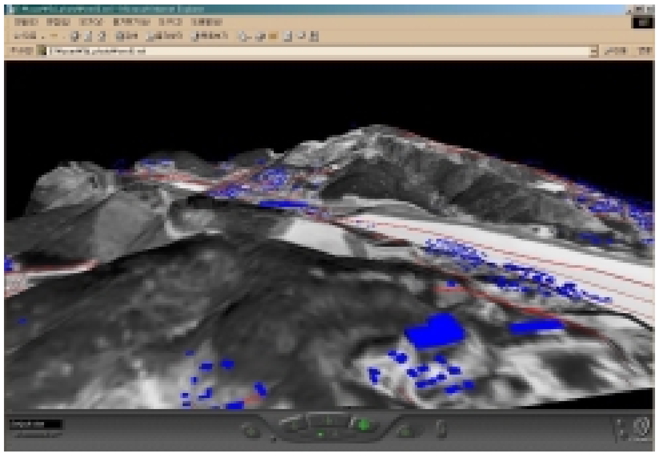

Figure4. Draped Aerial Photo in VRML

4 CONCLUSIONS

In this study we show that
3D GIS can be embodied in 3D spatial Indexing and Interactive GIS interface with VRML-JAVA Connectivity method.
VRML GIS Parser Program can serve draped aerial photos and 3D GIS on Internet.
VRML give optimized method in multi layer terrain and 3D GIS model on internet.
3D VRML stereographic photo can give better and easy methods in photographic interpretation

REFERENCES

ETRI, 1997, Development of 3-dimensional Spatial Analysis Software running on Internet Environment.

Kate Moore, Jason Dykes & Jo Wood, Using Java to interact with geo-referenced VRML within a Virtual Field Course, http://www.geog.le.ac.uk/mek/usingjava.html

KOSTS, 1997, Development of Image Processing and 3-D Terrain Analysis S/W

Ames,L.A, Nadeau, D.R., Moreland, J.L., 1996, *VRML 2.0 Source*book, John Wiley & Sons

Bishop, I., 1994, The role of visual realism in communicating and understanding spatial change and process. In Hearnshaw. H., & Unwin, D., eds, *Visualisation in Geographical Information Systems,* John Wiley & Sons

Mun un dang, Modern Digital Photogrammetry, yu bok mo and Anton F. Schenk, (pp.215-248)

Boyd Davis, S., Lansdown, J. Huxor, A., 1996*, The Design of Virtual Environments,* SIMA Report No. 27

Dykes, J., 1995, Dynamic maps for spatial science: a unified approach to cartographic visualisation, In Parker D. ed, *Innovations 3*, London: Taylor & Francis, pp. 177-187

JavaSoft, Sun Microsystems, The Java Development Kit (JDK), http://java.sun.com:80/products/jdk/

Lea,R., Matsuda, K., Miyashita, K., 1996, *Java for 3D and VRML Worlds*, Indianapolis: New Riders Publishing

Marrin,C., 1996, *Proposal for a VRML 2.0 Informative Annex*, External Application Interface Reference, http://reality.sgi.com/cmarrin/vrml/externalAPI.html/

Martin, D., 1997, Forthcoming paper in Transactions in GIS.
Also http://www.soton.ac.uk/~djm1/gisres.html

Muchaxo, J. "Multi-Scale Representation for Large Territories", *in Procs. of the 1st Conference on Spatial Multimedia and Virtual Reality*, Museum of Water, Lisbon, Portugal, October 18-20,1995 (pp. 61-72)

Neves, N., et al. "Virtual GIS Room", *Procs. of the 1st Conference on Spatial Multimedia and Virtual Reality*, Lisbon, Portugal, October 18-20, 1995 (pp. 45-53)

The VRML Repository, San Diego Supercomputer Centre (SDSC), http://www.sdsc.edu/vrml/repository.html