IMPLEMENTATION FOR 3D CARTOGRAPHIC MAPPING

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Abstract

Motivation of this study is on 3D modeling/rendering system architecture and its prototype implementation for 3D mobile and Web 3D application for 3D cartographic mapping. Mobile 3D is a cutting-edge technology. However, platforms and devices for mobile 3D GIS technology manipulating geographic data and information provide some limitations to design and implement. Despite, emerging standard mobile 3D graphic rendering stimulates mobile 3D GIS and 3D cartographic services on hand-held devices. Core functions of mobile 3D GIS by feature-based approach was designed as some modules: data model and design of spatial features, editing and manipulating of 3D landscape objects, generating of geometrically complex type features, supporting of both database and file system, handling of attributes for 3D objects, texture mapping of complex types of 3D objects and digital elevation model. With these functions, an integrated 3D modeling and rendering system was implemented using standard mobile 3D graphic API. As well as this mobile 3D design and implementation, multiple types of geographic features or objects encoded by GML (Geography Markup Language) for the XML-databases building are taken into account of practical applicability for 3D graphic approaches. For this process, it was also carried out to implement GML-processing software with functions for data import, manipulation, and transformation. It is thought that functions handling SVG and X3D from GML or XML database can be used as major components within web-based geospatial data services supporting complex types of transportation application data model. These two implementations such as mobile 3D and web 3D can be easily linked in data communication and sharing for the 3D cartographic modeling dealing with complex types of multiple features on integrated architecture.

Key words: GML, Mobile 3D, OpenGL|ES, Web 3D, X3D

1. INTRODUCTION

Recently, 3D modeling on multi-platform or devices, mobile 3D and web 3D, is regarded as one of the important applications based on the geo-spatial information.

The mobile 3D technology covers with general CG pipeline and pixel pipeline from 3D geometric modeling in 3D model coordinate system to 2D rendering on the projected plane. Ervin and Hasbrouck (2001) overviewed and categorized 3D computer graphic techniques for 3D landscape

modeling. But there are some cases of mobile 3D, though mobile 3D is not a main component of GIS market or applications yet. Rakkolainen and Vainio (2001) and Brachtl *et al*.(2001) developed a mobile browser for 3D simple features and a PDA based 3D navigation system, respectively. Lee and Kim (2006) and Nurminen (2006) developed a 3D mobile authoring and visualization system for complex type features using OpenGL|ES API and a 3D mobile city map named m-LOMA, respectively.

As for web 3D technology for geo-spatial information processing, two main concepts are considered for the purpose of web-based 3D urban application: GML (Geography Markup Language) from OGC (Open Geospatial Consortium, Inc.) and X3D (extensible Web 3D) from Web3D consortium. GML is a markup language that is used to encode both spatial and non-spatial geographic information.

2. APPLIED STANDARD TECHNOLOGIES

2.1 Mobile Graphic API: OPENGL|ES

OPENGL|ES which stands for OPENGL for Embedded Systems is a low-level, lightweight API for advanced embedded graphics using well-defined subset profiles of full OpenGL API (Astle and Durnil, 2004). As 3D graphic pipeline and pixel pipeline processes (Knaus, 2003), OpenGL|ES provides functions for primitives and vertex arrays for 3D geometric modeling, cooridinate functions, color and lighting functions, and buffering and pixel operations. As well, texture processing functions in OpenGL|ES API are enough to implement a certain actual images such as digital photo, aerial images, and satellite images.

2.2 GML (Geography Markup Language)

Geography Markup Language (GML) terms an XML encoding for the transport and storage of geographic information, including both spatial and non-spatial properties of geographic features. It is the key information technology behind the geo-spatial Internet (Ron *et al*., 2004). Using GML, we can deliver geographic information as distinct features, and then control how they are displayed in a web browser. Features, which describe real world entities, are the fundamental objects used in GML. GML features can be concrete and tangible, or abstract and conceptual. As well, GML features are described in terms of their properties, which can include spatial (geometric or topological), temporal or other non-spatiotemporal descriptions of the feature. Rather, GML concrete features must be defined in GML application schemas, which are created by users such as database administrators in Fig. 1 (Ron *et al*., 2004).

2.3 X3D (Extensible 3D Graphics)

X3D is to define various interactive web-based 3D content including web 3D graphics which can be integrated with multimedia across a variety of hardware platforms.

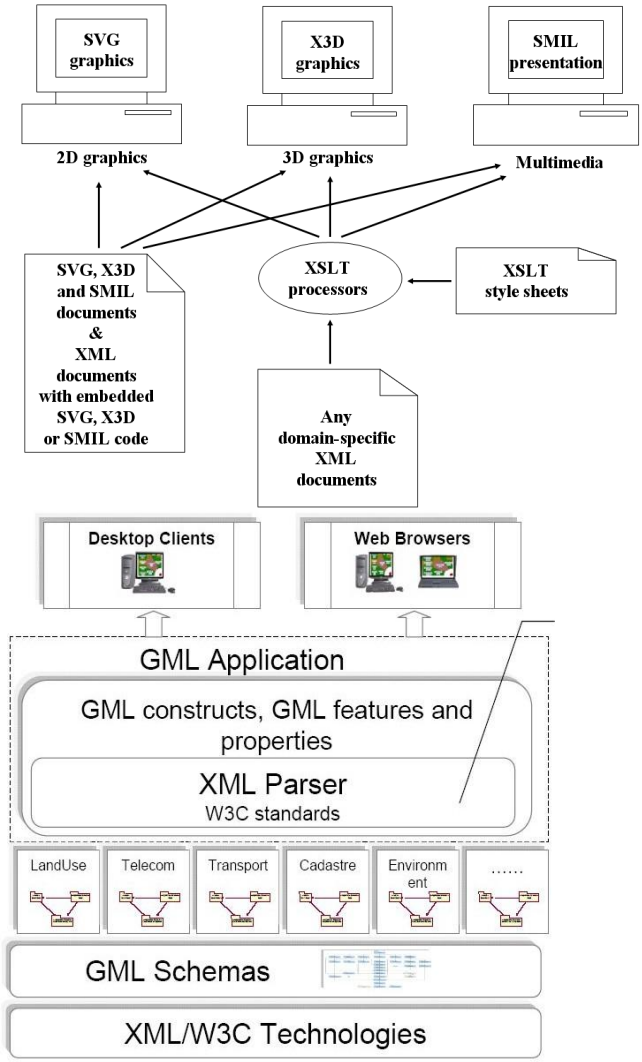


Fig. 1. Frame work model for GML Applications (Ron *et al.*, 2004).

It is regarded as a universal interchange format for integrated 3D graphics and multimedia, since it is represented by the XML.

2.4 APPLIED STANDARD TECHNOLOGIES

This approach is composed of GML database building in server side and three clients (Fig. 3): web client in web browser plugged in X3D viewer such as Octago Player (http://www. octaga.com/), mobile client or general user in mobile browser such as Pocket Cortona or Mobi3D (Nadalutti *et al.*, 2006).

Fig. 2. XML(GML), X3D, and XSLT in web environment (Geroimenko and Chen, 2005).

In this strategy, several 3D urban applications are possible: ① web 3D visulization for 3D urban application through GML database-XLST-X3D, ② mobile 3D visulaization for 3D urban application through GML database-XLST-X3D, ③ mobile 3D application by GML database model to direct OpenGL or OpenGL|ES programming, ④ mobile 3D application for database sharing with web environment by GML database-XLST-X3D-OpenGL|ES, and ⑤ mobile 3D urban feature modeling or authoring system for database builder, mobile operator, and client. These five cases are not needed any other commercialized tools, and GML database also linked with legacy database and other GIS data structure/file formats and image file formats.

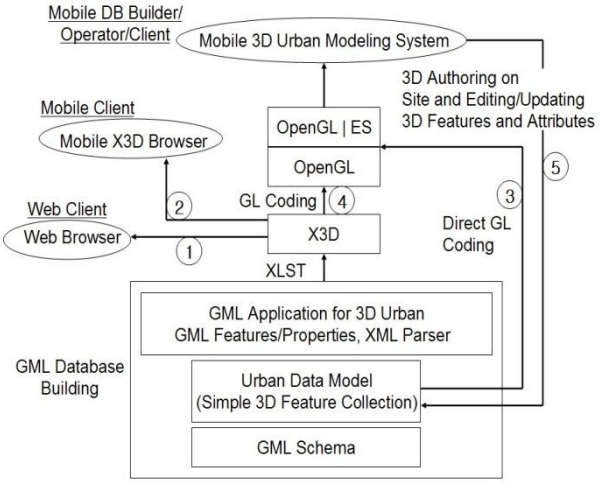
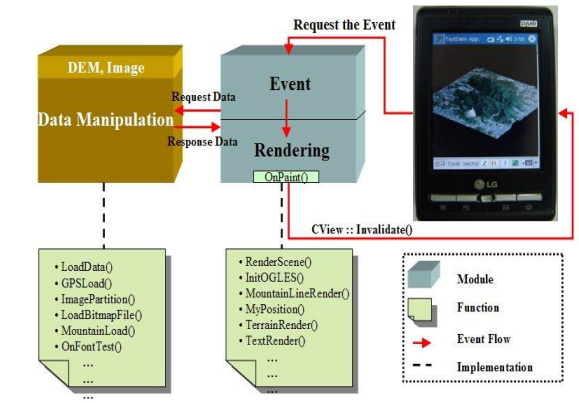


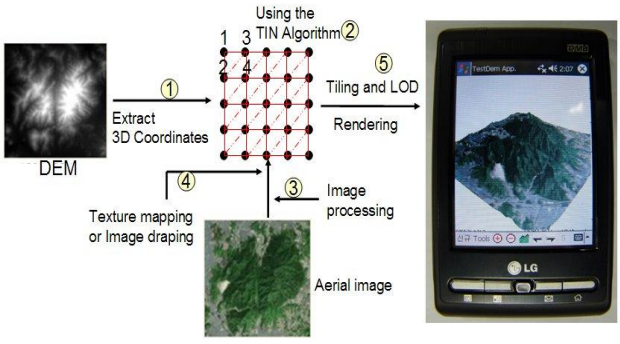
Fig. 3. Application strategy of mobile 3D and Web 3D for 3D visualization application.

3. A PROTOTYPE IMPLEMENTATION

In OPENGL/OPENGL|ES-based 3D moblie application, because this API does not provide its own data structure, a simple 3D data structure, 3D vector model with database attributes, was designed and applied. In general, 3D cartographic models are divided into two categories: terrain components and single/composite features. In terrain modeling, DEM and TIN data can be used in data modeling. TIN (Triangulrated Irregular Network) and LOD (Level of Details) were used in the rendering stage due to its storage space efficiency of complex fragments and texture images (Fig. 4).



(A)



(B)

Fig. 4. 3D visulization of terrain model: (A) OpenGL|ES functions and processes, (B) 3D graphic processing of TIN (Triangularated Irregular Network) and LOD (Level of Details) (Kim and Lee, 2006).

4. CONCLUDING REMARKS

In this study, three standard technologies such as GML, X3D, and OpenGL|ES are used for the purpose of 3D cartographic visualization system for urban application. As the results, a prototype for 3D authoring and visualization system in both web 3D and mobile 3D environments was implemented for more advanced and pratical applications without commercialized tools. However, 3D cartographic data model applied in this work is just a simple test model. In the case of web 3D, X3D graphical processing and scheme is an essential component of smart graphics which could be structured and semantic graphics.

For further works or full featured geo-based applications with mobile and web, the up-to-dated geographic XML specifications such as GML 3.xx and an interchange format or APIs by Khronos group such as COLLADA or OpenKODE are needed to research and implement. Those open specifications are useful to 3D cartographic modeling in the multi-devices or the multi-platform.

REFERENCES

Astle, D. and D. Durnil, 2004. OPENGL|ES Game

Development, Premier Press, 293p.

Brachtl, M., J. Slajs, and P. Slavik, 2001, PDA based navigation system for a 3D environment, Computers and Graphics, 25: 627-634.

Ervin, S. M. and H. H. Hasbrouck, 2001. Landscape Modeling: Digital Techniques for Landscape Visualiztion, McGraw-Hill, 289p.

Hetherington, R., B. Farrimond, S. Presland, 2006. Information rich temporal virtual models using X3D, Computers and Graphics, 30: 287-298.

Kim, S-Y. and K. Lee, 2006. Development of Mobile 3D Terrain Viewer with Texture Mapping of Satellite Images, Korean Journal of Remote Sensing, 22(5): 351-356.

Knaus, C. (ed), 2003. OpenGL ES 1.0 Reference Manual Version 1.0, Silicon Graphics, Inc., 226p.

Lee, K. and S.-Y. Kim, 2006. Development of Mobile 3D Urban Landscape Authoring and Rendering System, Korean Journal of Remote Sensing, 22(3): 1-8.

Nadalutti, D., L. Chittaro, and F. Buttussi, 2006. Rendering of X3D Content on Mobile Devices with OpenGL ES, Proceedings of Web3D 2006: 19-26.

Nurminen, A., 2006. m-LOMA – a Mobile 3D City Map, Proceedings of Web3D 2006: 7-18.

Geroimenko, V. and C. Chen, 2005. Visualizing Information Using SVG and X3D: XML-based Technologies for the XML-based Web, Springer, 298p..

Rakkolainen, I. and T. Vainio, 2001. A 3D City Info for Mobile Users. Computers and Graphics, 25: 619-625.

Ron L., Burggraf, D. S., Trninic, M. and Rae, L., 2004. Geography Markup Language: Foundation for the Geo-Web, Wiley, 388p.

Yan, W., 2006. Integrating Web 2D and 3D Technologies for Architectural Visualization: Applcation of SVG and X3D/VRML in Environmental Behavior Simulation, Proceedings on Web3D, ACM: 37-45.