3D Visualization of Urban Data Based on CityGML with WebGL

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ABSTRACT

Due to the advances in computer graphics and improved network speed it is now possible to navigate in 3D virtual world in real time. Until now, technologies employed require to install standalone application or plugins on navigators. The arrival of HTML 5 brings news solutions to visualize 3D data in a browser with WebGL. Several globe projects have proven that such technologies can be employed. Unfortunately, demonstrations are often based on proprietary formats to exchange or to store data. In this work, we propose to use CityGML: a standard provided by the Open Geospatial Consortium. CityGML files are imported in our Environment Editor. With several tools that we present in this paper, data are processed and stored. A client server application is also presented to permit the visualization of geometry and semantic in a navigator.

Keywords: *3D Urban Modeling, City-Geography Markup Language (CityGML), Geographic Information Systems (GIS), Interoperability, Open Geospatial Consortium (OGC), Visualization, Web, Web-Services*

1. INTRODUCTION

Emerging from the Open Geospatial Consortium (OGC), CityGML is a recent standard dedicated to the representation and exchange of urban data. This standard allows agglomerating data including 2D/3D geometric and semantic data via XML formalism. With a growing popularity, many research and development have been proposed. For instance Autodesk or Bentley have proposed software solutions to support CityGML format as Bentley Map or LandXplorer. However, these solutions require the installation of software on a client computer or plugin on navigators in order to open the files.

DOI: 10.4018/ij3dim.2012070101

In this paper, the goal is to use HTML 5 and in particular WebGL to create a thin client which means there will be no installation on the client. WebGL is a cross-platform, royalty-free API used to create 3D graphics in a Web browser. Based on OpenGL ES 2.0, WebGL uses the OpenGL shading language, GLSL, and offers the familiarity of the standard OpenGL API. As it runs in the HTML5 Canvas element, WebGL has full integration with all Document Object Model (DOM) interfaces (Khronos Group, 2012). WebGL is a DOM API, which means that it can be used from any DOM-compatible language (JavaScript, Java, etc.). Major browser vendors Google (Chrome), Opera (Opera), Mozilla (Firefox), and Apple (Safari) are members of the Khronos consortium's WebGL

Working Group, along with many other 3D graphics developers. WebGL offers a number of advantages, among them:

- An API that is based on a familiar and widely accepted 3D graphics standard.
- Cross-browser and cross-platform compatibility.
- Tight integration with HTML content, including layered compositing, interaction with other HTML elements, and use of the standard HTML event handling mechanisms.
- Hardware-accelerated 3D graphics for the browser environment.
- A scripting environment that makes it easy to prototype 3D graphics (no compilations are needed).

With the 3D geometry visualization, another important point is to keep the possibility to query semantics information linked with the geometry. This work has been initiated in a larger project named 3DPIE (3D Portrayal Interoperability Experiment) and proposed by OGC (n.d.) where we are involved. In this paper, after a brief state of the art, we will present our Environment Editor where data are prepared and exported to our server. Then we will describe our solution from the server and client sides. We will finish by showing some results extracted from our WebGL application.

2. 3D MODELING AND VISUALIZATION OF URBAN DATA

2.1. Digital City Models and City GML

Three-dimensional urban city models are used by the economy and public administration for different purposes, e.g., environmental simulations or facility management (Kolbe, 2009), (Czerwinski, 2006), emergency response (Kolbe, 2008b). Thereby, the field of application evolved from traditional applications such as network planning, typically requiring pure geometric models with low level-of-detail, to advanced applications in areas such as tourism. That is, the requirements of city models heavily increased, meaning that besides geometric information there is also a strong need for semantic information and data update (Goetz, 2012).

User communities can take advantage of using standards to develop application schemas that follow the rules and reuse the components defined in the abstract standards. An XML Schema encoding following the GML grammar can then be derived from the application schema and serves as the basis for data exchange. These approaches were for example followed during the development of CityGML. OGC published CityGML 1.0 in 2008 (Kolbe et al., 2008a). CityGML specifies a standardized application schema for 3D city models (Hagedorn et al., 2007), from which a GML 3.1.1 encoding is derived. CityGML is therefore both a conceptual model and an encoding, enabling syntactic and semantic interoperability.

For our project, interesting key features (Kolbe, 2009) are:

1. Thematic modeling: the model covers a wide range of city objects, including but not limited to buildings, transportation facilities, water bodies, vegetation, terrain, land use, city furniture, etc.
2. Multi-scale modeling: CityGML supports five levels of details (LOD). This mechanism facilitates the integration of 2D (at LOD0) and 3D datasets at different scales representing the same real-world entities. The same feature can be represented with different geometries at each scale. CityGML also provides an aggregation and decomposition association between objects that can be used to indicate that an object at a lower LOD has been decomposed into two or more objects at a higher LOD. These LODs also enable applications or simulation models to process the data at the most suitable scale.

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