Towards Interactive 3D City Models on the Web

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ABSTRACT

A ubiquitous accessibility of data over the Web nowadays is very common. Although the Web, 3D graphics, and geographic data are crossing their ways, common applications are typically based on technologies that are rather esoteric to most web-developers. Nevertheless, in the last couple of months, some efforts towards a seamless integration of 3D graphics into common Web browsers have been performed. Regarding the data of such applications, they are mostly proprietary and commercial data, which are collected by professional cartographers or surveyors. Nevertheless, following the Web 2.0 approach, within the last five years the trend of Volunteered Geographic Information (VGI) became popular, describing an ever expanding range of users who voluntarily and collaboratively collect geographic data. Trying to merge the mentioned trends and desires, within this paper the authors present a way to transform the crowdsourced OpenStreetMap data into a 3D city model. Contrary to other existing approaches towards OpenStreetMap 3D, they combine emerging and established Web technologies, allowing an easy consumption in arbitrary web browsers. The applied technologies are easy to learn and understand by the web community and allow for quick prototyping, and creating mash-ups with further spatially enabled Web 2.0 data.

Keywords: 3D City Models, Crowdsourced Geodata, Extensible Markup Language 3D (XML3D), Openstreetmap (OSM), Volunteered Geographic Information (VGI), Web-Based Cartography

INTRODUCTION

The Internet itself and the resulting technologies have gained a lot of impact on the way how modern software, applications, and business models work. This makes a wider and easier access to information and applications possible, as users do not have to install specialized software for specific tasks, but instead use their favorite web browser. With the availability of mobile broadband connections and powerful mobile devices, it almost doesn’t even matter whether the browser is running on a desktop machine or on some kind of mobile device.

At the same time, the development of computer graphics in the last few decades has led to modern graphics hardware which is able to display highly-realistic environments on a variety of devices in real-time. Additionally, developments like WebGL (Khronos Group, 2011) have brought this functionality to the Web on a large scale.

Focusing on the area of virtual 3D models for both urban and rural areas, there are many different applications from different applica-
tion fields such as urban planning (Shiode, 2001), (Döllner et al., 2006) or environmental simulations and facility management (Kolbe, 2009). Furthermore, a three-dimensional representation of the World over the Web allows an easy consumption and investigation of spatial and geographic features for the broad public. A very popular example for such a world browser is Google Earth, but there are two major disadvantages: (1) additional software needs to be installed on the client and (2) the data is proprietary, thus restricted to licenses and expensive. Regarding the former disadvantage, an application should function without the need of any further software or plugins because this is likely to address the broad public. Regarding the latter disadvantage, there is a different data source for geographic data, namely OpenStreetMap, which on the one hand contains various kinds of data and on the other hand is open and free to use for everybody. Additionally, people do not only map the world in OSM but also publish their photographs along with Global Positioning System (GPS) coordinates, send twitter information from specific locations, or publish their movements and “check-in” at a real world venue on the web. That is, one can observe that there is quite a number of information with meaningful spatial data about the real world, which can be used for a free and open world browser.

In this paper, it is demonstrated that the step from real world data towards interactive 3D city models in the web browser is easily possible, based on a combination of both emerging technologies, such as XML3D (Sons et al., 2010), and OpenStreetMap, and established, self-contained and widely-available Web components. Such a combination has a number of advantages, as it makes the integration of 3D city models in the browser much simpler for web-developers, as no special knowledge in the areas of graphics or system architecture is required other than Web technologies. The approach is highly flexible in order to support further data sources, also known as mash-up, as the chosen technology allows adding or replacing components easily.

The rest of this paper is organized as follows: the next section provides an overview on the related work and data sources, and furthermore motivates our choice of technologies. The selected technologies are then described in more detail in the proceeding section. Thereafter an exemplary application is illustrated. Furthermore, limitations and future work are elaborated. A brief conclusion then finalizes the paper.

RELATED WORK

In this section, the necessary components for a visualization of 3D city models on the Web are discussed. The first subsection covers 3D graphics technologies for the web, while the second subsection describes the OpenStreetMap project which is used as a data source for generating the required 3D geometry.

3D Graphics on the Web

There are several approaches for creating and integrating 3D content into the Web browser: One is to use a plug-in that renders an external document into a certain area of the web document like VRML (http://www.vrml.org), X3D (Web3D, 2008), or Java3D (Java3d.java.net). However, this requires the creation of at least two separate but dependent documents, which at most have access to each other through the plug-in specific API only and thus conceptually breaks with today’s web technology. Furthermore, such formats require additional software which needs to be installed on the client’s device, which can be considered as a barrier for the usage of such applications. The other possibility is the utilization of methods which are well integrated in today’s web standards or adaptable to those. Since this is state-of-the-art for current web applications, the here conducted work will only investigate on such technologies, thus skip related work on proprietary 3D plug-ins.

Talking about browser-integrated 3D technology, this instantly leads to WebGL which is developed by the Khronos group as a part of the proposed HTML5 standard. It is already
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