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NASA WorldWind: Virtual Globe for an Open Smart City

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1. Abstract

In this paper, we first present the open source framework NASA WorldWind. NASA WorldWind comes with two versions. The Java version is well established in the market and has many customers. There is now a new Web version, Web WorldWind, with many of the same features implemented and is already being used by government agencies, the European Space Agency having standardized on it. We describe here some of the features available in the Web framework. Additionally, we show an interesting application developed with NASA WorldWind and the possibilities it offers in the field of smart cities. Moreover, we illustrate some of the opportunities that this framework provides and the direction the community of people interested in open source for smart cities are following.

2. Introduction

Considering the growth rate of world population and the shift of people from rural to urban areas, sustainability of cities must be addressed. In response to this challenge the concept of a "smart city" has emerged that engages the citizens more directly in addressing the needs of a city. The *Report of the European Smart Cities* provides the following definition: "A Smart City is a city well performing in six characteristics, built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens: mobility, environment, people, living, governance, economy". A suite of transformational Information Technology (IT) tools, called "OpenCitySmart" are purposed to increase the sustainability and quality of urban life, in other words, to support smart cities. In the network of "OpenCitySmart", technologies such as NASA WorldWind Java, Web WorldWind, QGIS, and PoliCrowd2.0 exist. Current projects are using these technologies to serve the needs of smarter cities. The application presented here aims to expand on the existing projects by making these tools even more accessible for citizens via the Web. Among these tools, the ability to use mobile devices is a key point to expand citizen access. With this idea in mind NASA Web WorldWind, developed for JavaScript and HTML5, has been chosen.

3. Virtual Globes

Virtual globes offer the most realistic way to show a map in a manner that represents the actual environment. Virtual globes started expanding in 2003 with the open source version of NASA World Wind and later in 2005 with Google Earth. They provide many ways to explore geographic data and further to interact and visualize various kinds of data. As Declan Butler said: "Google Earth and other virtual globes are set to go beyond representing the world, and start changing it." (D. Butler, 2006).

This escalation in usability of these dynamic maps is further enhanced by applications in numerous areas in addition to smart cities, such as disaster response, crowdsourcing, and many

more fields, in which the data can be shown on a three-dimensional map. We can differentiate virtual globes into two groups, the first is as an application running on our computers, and the second has evolved in the last few years, to be running in a web browser.

Regarding these modern virtual globes, the two most outstanding examples are NASA Web WorldWind and AGI (Analytical Graphics, Inc.) Cesium. These two programs run in modern browsers thanks to the latest technologies for the web: JavaScript, WebGL, and HTML5. They can be used moreover by non-experts thanks to the API (Application Programming Interface) and are readily customized to conveniently meet any number of specific needs.

What is so engaging about these new virtual globes is that, since they run on the Web, the rich context of information presented in its native environment can be easily and readily shared among a community of users, allowing any person to visualize and interact with it.

4. NASA WorldWind

NASA WorldWind was created in 2003 and released under the NASA Open Source Agreement license in 2004. Right from the start it became an important point of reference for the GIS (Geographic Information System) community. Nonetheless, thanks to the features in virtual globes, this GIS visualization capability spread fast among different areas. Thanks to NASA WorldWind, the approach to virtual globes changed, greatly expanding the user community who could utilize virtual globes interacting with geo-data. Unlike other virtual globes, NASA WorldWind provides an API to customize the globe and create any number of applications.

Web WorldWind and Cesium allow people to show many different data. Web WorldWind is more oriented to the geographical aspect, unlike Cesium which is oriented to a more graphical one. Web WorldWind provides many features that any developer can quickly implement by simply following the included examples on the reference website (https://webworldwind.org/). Among the many features are graphical capabilities such as placemarks, text, polygons, shapefiles, and imagery (JPG, PNG, and GeoTIFF). Besides the graphical capabilities, many OGC standards are also implemented such as WMS, WMTS, KML, and Collada. And since it is an open source project, it is available via GitHub (https://github.com/NASAWorldWind/WebWorldWind/). In addition to NASA, The European Space Agency and ThalesGroup have committed several developers to continually advance Web WorldWind, creating and implementing new functionalities to the modular componentry SDK framework.

Web WorldWind can be easily extended by developers and customized without much effort. Thanks to this, many organizations are now able to create any number of applications with it, serving smart cities, urban planning, terrain visualizations and more.

5. WorldWind sample application

One interesting application developed with NASA Web WorldWind is to visualize information collected by citizens on a virtual globe. The information can be reported using either the ODK (OpenDataKit) platform or a cross-platform application called Via Regina. The architecture of the application can be seen in Figure 1. Both applications are developed within the framework of the Via Regina project (http://www.viaregina.eu), which is part of the INTERREG project

(Crossborder Cooperation Operational Programme Italy - Switzerland 2007-2013) developed in close cooperation of Switzerland and Italy. This project promotes rediscovering and enhancing the rich natural, artistic and cultural heritage along Via Regina, overlooking the west coast of Lake Como in the northernmost part of Italy (Antonovic et al., 2015). The platform displays georeferenced data collected as markers and with a simple click shows the information inside a small window (see Figure 2).

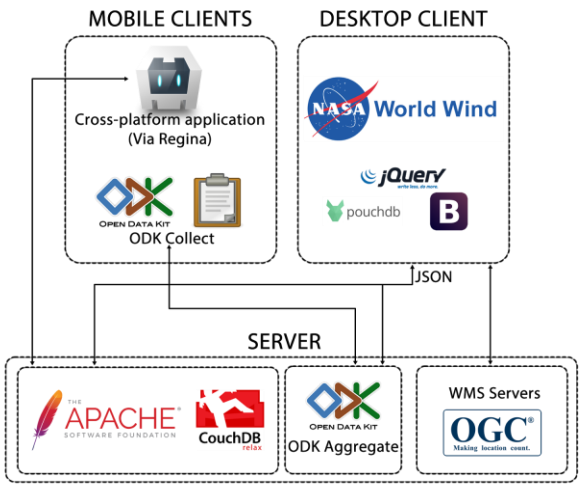

Figure 1. System architecture of the application

Figure 2. An example of queried information

This application can be used by other cities so their citizens can input their information or concerns related to their city, and in this way involve citizens in the local government's decision-making process. The context of the application can be changed easily to fit different purposes by modifying the two applications used to report events.

6. Conclusions

We have seen how GIS tools can be used to empower citizens and foster the development of smart cities. The application developed here exploits one open source tool in the scope of OpenCitySmart. NASA Web WorldWind fits this purpose well, as it facilitates developers to build applications that allow citizens to easily interact with the city and communicate information to their local government as well to other citizens.

Foremost, we have demonstrated the capacity of a powerful Web tool that can be used in many fields and gives developers an opportunity to create numerous applications in the smart city context without much effort.

The Web WorldWind framework, as previously mentioned, continues to evolve, and the number of applications using it in recent years has grown rapidly, in recognition of its unlimited potential to be the point of reference in the field of GIS, especially the smart city one.

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