3D GIS based on WebGL for the management of underground utilities. The case of institutions

Juan Manuel Jurado Rodríguez
Universidad de Jaén
23071, Campus las Lagunillas, s/n
Jaén, España
jjurado@ujaen.es

Lidia Ortega Alvarado
Universidad de Jaén
23071, Campus las Lagunillas, s/n
Jaén, España
lidia@ujaen.es

Alejandro Graciano Segura
Universidad de Jaén
23071, Campus las Lagunillas, s/n
Jaén, España
graciano@ujaen.es

Francisco Ramón Feito Higueruela
Universidad de Jaén
23071, Campus las Lagunillas, s/n
Jaén, España
ffeito@ujaen.es

Abstract

This work summarizes a web application related to a research project about underground infrastructures. The idea is to visualize, analyse and manage all underground layers inside 3D urban environments. This is possible using WebGL to develop a web application which may be used from mobile devices.

1 Introduction

The year 2017 is historic for the 3D content in the Web. The explosion of virtual reality and augmented reality, the evolution of the Internet and the progress of WebGL allow the development of interesting 3D environments to be published directly in Web3D pages [1]. WebGL [2] is a JavaScript API for rendering 3D graphics based on the OpenGL 2.0 ES specification. It offers 2D and 3D rendering graphics in modern web browser. Nowadays, most of people use different mobile devices which are capable of simulating 3D models and realistic scenes.

World is not flat, so working from 3D perspective gives a real vision to take accurate decisions and express the ideas by a more efficient and effective way. The aim of 3D representation is to research new features to improve the current analysis tools. The management of the underground infrastructures belong to urban spaces is the case of study for this research. In this context, there are several 3D city modelling applications such as City Engine of ESRI [3], GRASS [4] or CityGML [5] of Open Geospatial Consortium. Nevertheless, these frameworks lack of large number of models in order to represent 3D objects like underground infrastructures.

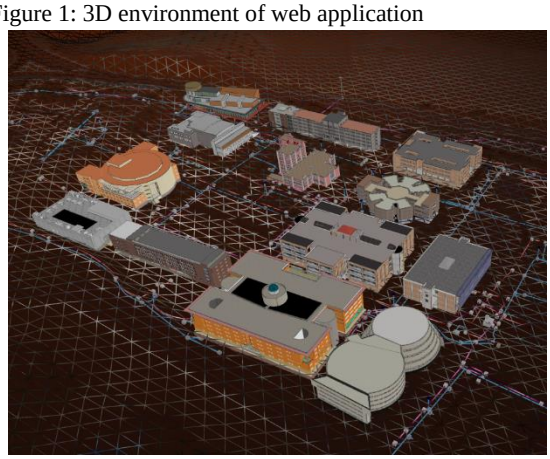
2 Web3D and Smart Cities

The development of applications using computer graphics in websites provides a powerful tool to represent and disseminate 3D scenes. The main objective of this work is to achieve a perfect and accurate knowledge about underground infrastructures by using 3D web technologies. The goal of the current applications is to offer a management of the urban space of the inventory composed by buildings, roads, vegetation, lighting and the rest infrastructures. However, most of them don't integrate all the necessary tools to manage underground infrastructures. This application area is closer to the concept of the Smart Cities. The sustainability, the resource optimization and the correct planning of resources consumption are challenges by the most enterprises and public institutions. In order to achieve these goals, we present an application which provides a fast, visual and simple access to review all parts of the infrastructures.

3 Web Application

The web application is based on WebGL and describes an efficient management of underground infrastructure of the University of Jaén (Figure 1).

Figure 1: 3D environment of web application



The aim of this project is to simplify all tasks made by maintenance enterprise or public administrations. This software uses a spatial database which contains all the information relative to the system and meets the followings specific requirements:

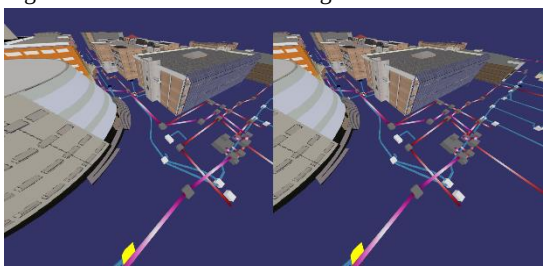
• Integrate whole technical documents about the work made by technician of maintenance team.
• Register all available materials and equipment relative to the repairs about underground infrastructures.
• Save spatial information to get precise geolocations of every element belonging to each topographic infrastructure represented in the 3D environment.
• Provide an interaction with all elements of the scene. By this way, the user can know the current status of infrastructure.

This application offers an extra service to notify incidences. Members of the University of Jaén can alert about unexpected faults of the different services provided. Thus, we establish a fast communication between users and maintenance technician, providing a better reaction capacity. The main advantage of this application is the accessibility. From any web browser, users can use the application using the mobile devices (Figure 2). It allows us to know the location and status of the infrastructures in the university campus.

Figure 2: 3D representation in a mobile device

Another feature of this application involves the view of underground infrastructures through virtual reality. It offers to users a new immersive navigation system. This type of interaction with the 3D scene may help to detect all incidences and allow a real interaction with the virtual world (Figure 3). Thus, this application offers a complete knowledge, with different detail levels, about the underground infrastructures. This VR mode is available from mobile phone using some of VR headset.

Figure 3: The VR scene of underground infrastructures



The development of this application required additional study about the digital elevation model (DTM). The terrain representation is very important because the land relief defines the slope of the underground infrastructures. In order to obtain the Digital Elevation Model (DEM), we have used different information sources. The most relevant is the PNOA project [6] that offers an accurate LiDAR data with a resolution of 50 centimeters. Another important step of this work is focused on the structure of the database. PostgreSQL [7] is the database management system used to store all data of application. In addition, PostGist extension provides spatial and geographical objects for PostGreSQL database. Performing a full conversion of all the input data to the 3D scene is required to perform a detailed study over this map [8].

4 Conclusions

Today, most of the cities add new technologies of Smart Cities to get a better management of their infrastructures. Frequently, the information associated to these installations is based on CAD tools.

Universities campus, hospitals, sport installations are some examples of places where the professionals need tools to manage their infrastructure of the inventory to be integrated with others process of maintenance.

Acknowledgments

This work has been partially supported by the Ministerio de Economía y Competitividad and the European Union (via ERDF funds) through the research project TIN2014- 58218-R

References

[1] Web3D consortium (2017). Open Standards for Real-Time 3D Communication. [Online] Available at: http://www.web3d.org/
[2] Khronos Group (2017). Connection software to Silicon. [Online] Available at: https://www.khronos.org/webgl/
[3] Esri (2016). CityEngine software [Online] Available at: http://www.esri.com/software/cityengine/
[4] GRASS Development Team (2016). GRASS software [Online] Available at: https://grass.osgeo.org/
[5] Thomas H. Kolbe (2012). CityGML [Online] Available at: http://www.citygml.org/
[6] Instituto Geográfico Nacional (IGN) (2014) Proyecto PNOA [Online] Available at: http://pnoa.ign.es/
[7] PostgreSQL (2013) [Online] Available at: http://www.postgresql.org.es/
[8] Sanat Talmaki, Vinnet R. Kamat, Hubo Cai. *Advanced Engineering Informatics*, 27:283-298, 2013