3D Virtual Campus - FCUL: an integrated system for university services management

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Abstract

The need for 3D geospatial data and the three-dimensional modelling of urban environments has steadily increased in the last decade as GIS applications improve their 2.5D and 3D spatial representation capabilities. This work presents the sequence of tasks performed for the construction of a virtual 3D model of the Faculty of Sciences of the University of Lisbon (FCUL) giving also some perspectives for future work based on the current needs of using such a platform, with emphasis on issues related to emergency building plans.

Two main phases comprise this work: the definition of a methodology for modelling the exterior of buildings, aiming the development of a three-dimensional virtual photorealistic model of the Faculty, and the definition of a set of procedures for modelling their interior, for a visual and interactive exploration enriching the digital 3D environments. These two phases occurred at different periods of time, due to the nature of the needs for each one, and consequently, the technology used was different in each one as well as the procedures. Migrating from CAD technology to GIS technology, described on this paper, was one of the most time-consuming tasks in the process, but necessary for the final product. The final 3D model (exterior and interior of buildings) produced is currently being tested for several applications where the need for 3D is a requirement, namely the evacuation of multi-storey buildings in emergency situations.

Keywords: Virtual campus, 3D models, GIS, 3D geospatial database

1 Introduction

Spatial analysis of two-dimensional data presents limitations and is no longer sufficient to meet the needs of GIS specialists, mainly when it is intended to analyse a certain phenomenon with three-dimensional behaviour, as is the case of noise pollution, air pollution or floods. To suppress these needs, the demand for information contained in three-dimensional city models is becoming increasingly evident.

The world is three-dimensional and the physical phenomena that occur in it as well. The spatial variability of certain phenomena with the Z factor is often neglected in the bi-dimensional analysis, being the tri-dimensional approach an excellent value for the planning and management of public spaces (Scianna and Ammoscato, 2010; Kolbe et al, 2005). In this context, the project here presented, although in an initial phase of the construction of the geospatial database, aims to demonstrate the potential of using a virtual 3D model for service management in particular in the area of emergency, regarding the evacuation of buildings and the emergency infrastructures management. For this purpose, the campus of the Faculty of Sciences of the University of Lisbon is used as test site.

2 3D Model

All eight buildings that are part of the faculty campus were interactively generated using the modelling software from Google, at the time, Google SketchUp 8. Starting from the building footprints, obtained by aerial photogrammetry, and the height information measured in stereo models, the buildings were extruded and all their architectural details, such as balconies and windows, were later added based on CAD plans or photographs. The 3D models created with SketchUp were then exported to Collada (.dae) and latter imported into GIS environment as multipatch. The georeferencing process and the integration with the Digital Terrain Model completed the first phase of the project and was the basis for the 3D model of the exterior of the campus buildings (Pereira, 2012) (Figure 1).

Figure 1: Two different exterior perspectives of the 3D Virtual Campus – FCUL.

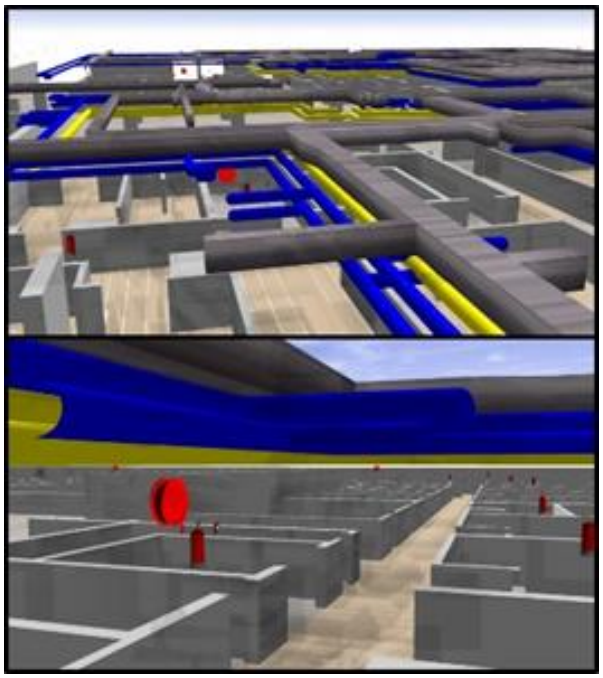
To model the interior of the buildings, the architectural design plans were used in CAD format, and georeferenced to the footprint of the respective buildings (Lima, 2016) (Figure 2). All information in CAD format was the only one existing in the technical services of the Faculty since the construction of the campus, and as such, it was necessary its treatment, in particular some editing work, for a correct integration in GIS environment. Already corrected and edited, each floor was modelled in three dimensions, based on the elevation of each floor. The infrastructures were also georeferenced, in a first phase, to the CAD plans and only later they were modelled in three dimensions. In order to associate non-graphical information for all infrastructures and flooring data, a properly structured geospatial database had to be developed. The 3D platform developed is currently managed by ESRI CityEngine software, whose modelling encompasses geometric and semantic components that meet the needs of a university campus, such as FCUL.

Figure 2: A perspective of the exterior (above) and interior (below) of one of the buildings (C8) of the campus.

3 Work in progress

Currently, some applications are being developed that make use of this 3D platform, beyond the obvious exploitation in 3D virtual environment. An integrated emergency management system, is one of this project priorities. As such, all the infrastructures related to emergency (fire extinguishers, smoke detectors, fire doors, etc.) are being generated in the geospatial database which allows a better and more efficient management carried out by the technical services (e.g. a proper maintenance of all infrastructures taking into account, for example, the expiring date, the date of the last maintenance, the person responsible for maintenance, etc.) (Figure 3).

Figure 3: Some infrastructures generated in the 3D geodatabase, namely the water pipes (above) and some emergency equipment (below)



In addition, over this 3D platform, some applications for mobile devices have been developed to allow technicians to properly collect information about each emergency device, which will contribute to the completeness of the geospatial database, keeping it constantly updated. Solutions for 3D optimal routing, aiming the definition of emergency routes to evacuate people from buildings, are being also studied in a truly three-dimensional perspective considering the connection between floors of the same building in situations where the elevators cannot be used.

Acknowledgments

This work is supported by the project FCT UID / GEO / 50019/2013 - Dom Luiz Institute.

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