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Smart Campus: how we get there? A study case at Federal University of Paraná

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Abstract:

In the world of Big Data, data visualization tools and techniques are essential for analyzing large amounts of information and making data-driven decisions, as data are increasingly used for important management decisions. This also means new ways to represent geospatial information and new ways in which humans interact with and use cartography and geospatial information. Information is also key to the success of a Smart Campus. A Smart Campus is a small-scale version of a Smart City with advanced capabilities that facilitate creativity, social interaction, and intellectual exploration (Ahmed et al. 2020; Villegas-Ch et al. 2020).

Several initiatives worldwide have proposed and developed smart campuses. The Federal University of Paraná CampusMap (UCM - UFPR CampusMap – www.campusmap.ufpr.br) is one such example in Brazil. This project began in 2017 and provides data and GIS functionalities on the structure of the Federal University of Paraná, with the main goal of implementing an environment with information about UFPR indoor and outdoor environments and facilities (Delazari et al. 2019). Currently, UCM provides data on fifteen different campuses located in several cities in the State of Paraná, Brazil. It is possible to search for buildings by the name of the department or institute or search for indoor structures using the name of the room or laboratory. Another functionality provides reports that the University can use to manage its actions. Users can inform changes or incorrect data using a VGI tool. Other functionalities include real-time positioning when using a mobile device, feature measurement, and importing/exporting data.

According to Liang and Chen (2018), a smart campus supports teaching, scientific exploration, and services using the IoT, cloud computing, and geographic information systems. The actual UCM stage of development supports teaching, scientific exploration, and GIS. The next steps involve the use of IoT and cloud computing to achieve the full potential of a smart campus. To achieve this, an application is being developed to provide real-time positioning using GNSS cloud computing. The goal is to investigate the potential of using GNSS raw data positioning obtained from smartphones with a cloud processing system, with strategies to improve the positioning quality to meet the demands related to smart campuses.

The concept of integration among data, environment, users, and interfaces is feasible for reproduction in similar places. One of the current UCM initiatives is to implement the current methodology by collecting spatial data on another university campus. Since 2022, the UCM has been adapted to map a larger area, the Federal University of Amazonas campus at Manaus (state of Amazonas, Brazil), which is located in a forest fragment, inside an environmentally protected area. The main database adaptations range from the characteristics of this environment, with more focus on ecological and tourist features, such as security and monitoring issues, through new possibilities of tools with the incorporation of new navigation maps and interfaces. One of them is concerned with the use of Street View Imagery (SVI) (Biljecki; Koichi, 2021; Cinnamon; Jahiu, 2021) to navigate through the campus area and locate features. The manner in which UCM users can take advantage of this database and integrated interface has been the subject of user experiments.

The UCM proposes indoor and outdoor 3D ambiance representations considering the visual variables of position, shape, size, value, and color hue. Creating representations that are relevant to users is one of the greatest difficulties in 3D visualization. Several issues of symbol perception involve gestalt aspects, configurational aspects, and changes in the scale of these representations from allocentric and egocentric viewpoints and color contrast. In addition, environmental aspects influence users' perceptions of the features and their correlates in the representation. The indoor and outdoor

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representations follow CityGML 3.0. In addition, this project develops a method to evaluate how users perceive changes in representation as they move in real-time indoor and outdoor spaces. The variations in user responses in real environments (in situ) will be analyzed through a comparison with controlled environments (laboratory). In both cases, these propositions are based on research that has been developed at Geodetic Science Graduate Program-UFPR which seeks to identify the way people perceive, understand, and describe in natural language the internal and external campus environments and the routes they use in the campus environment, by comparing routes created using guiding and using wayfinding.

The results of this study seek to provide information about the space through a dataset that encompasses raw images, a database for GIS, and indoor cadastral data. This information will be useful for the sustainable and rational management of university resources, according to the principles of a Smart City. In addition, it is expected to yield results concerning real-time positioning using a smartphone, the potential of SVI for navigation, and the perception of users considering indoor/outdoor navigation.

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