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Selected research issues in geovisualization of building interiors for the LBS

Dariusz Gotlib [a,*], Jakub Łobodecki [a], Paweł Kowalski [a]

[a] *Warsaw University of Technology, Faculty of Geodesy and Cartography, 1st Author - dariusz.gotlib@pw.edu.pl, 2nd Author - jakub.lobodecki@pw.edu.pl , 3th Author - pawel.kowalski@pw.edu.pl*

* Corresponding author

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Abstract:
While outdoor applications already have well-established ways to visualize data and proven user interfaces, indoor LBS applications require further research and experimentation. The importance of this issue is pointed out by the authors of the LBS Research Agenda (Huang, H. et al. 2018). The same article notes that there are advances "towards more 'natural' and non-intrusive user interfaces for LBS, particularly on the aspects of representation forms (e.g. visual, auditory, and tactile), interface technologies and devices (e.g. smartphones and smartwatches), interaction modality (e.g. touch, gesture, and gaze-based), and context awareness". These issues are being addressed in a growing number of research papers and implementations. There are still not many publications in the field of indoor geovisualization methods. A literature review on indoor cartography was presented by Chen and Clarke (2020). An attempt to define selected qualities of mobile maps for indoor navigation was undertaken by Gotlib (2019). A lot of research and implementation experiments concern the use of AR visualization in indoor navigation applications, as exemplified by Ma et. all (2021). However, there is still a need to continue researching and developing methods for cartographic presentation of building interiors.

This type of research was also conducted at the Warsaw University of Technology (WUT/PW) as part of the "Warsaw University of Technology as an Ambassador of Innovation for Accessibility" project. Although the project's main goal was to support people with disabilities by applying the principle of universal design, efforts were made to provide an appropriate interface and visuals for all user groups of navigation applications. Based on previous research experience, as well as the specific requirements of the project, six related applications were developed to form a cohesive system: "PW Navi", "Audio-Map PW", "Geoportal PW," "Map PW", "Geo-Trainer PW", "SION PW". The applications serve slightly different purposes and user groups but are united by a common presentation of the interior of buildings. PW Navi is used for navigation and uses Bluetooth low-energy Beacons and GNSS technology for positioning. PW Audio-Map acts as the electronic equivalent of tactile maps for blind people and uses QR codes and NFC for positioning. The PW Geoportal can be run on web browsers and so-called "information kiosks" placed in frequently visited areas (Figure 1).

Figure 1. View of geovisualization of buildings with the proposed interface for handling floors and reading space descriptions. A screenshot from the "Geoportal PW".

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A subset of WUT's Geoportal features is available in a smartphone mobile application called "PW Map". This solution locates people based on QR and NFC codes placed on the building's doors. "Audio-Map PW", on the other hand, is an innovative solution that acts as an electronic equivalent of tactile maps for the blind and visually impaired. The user can choose between two modes of operation – map viewing mode and learning mode. "PW Geo-Trainer" application is a spatial orientation training tool using the Unreal Engine game engine, allowing people with disabilities to familiarize themselves with the space of PW buildings before visiting them (virtual walks). The core of all the applications mentioned above is the PW Building Accessibility Maps, which are 2D and 3D models of buildings made using spatial information systems (GIS) technology. A special "SION PW" application is used to edit the data.

The research shows that single applications may not be enough, and systems of related applications performing different tasks and targeting different user groups with different needs can be created. However, they all need correct cartographic data visualization and an optimal user interface.

During the project, several important cartographic research and development issues were identified:

1) Cartographic visualization of building interiors and routes
2) Standardization of how object names are entered
3) Construction of application logic and user interface controlling the display of floors
4) Method of presenting text, voice, and video (sign language) descriptions of buildings, rooms, and landmarks

In terms of cartographic visualization, different variants of the colour scale approach to room labelling were analyzed depending on the selected attributes (thematic map), different variants of signature design were compared (including highlighting places relevant to people with disabilities), and a new way of presenting the routes designated in buildings was proposed. The route is presented differently in its parts depending on the floor through which it passes and the so-called active floor.

As part of the second research issue, attention was drawn to the very strong influence of how the names of objects (buildings, rooms, entrances, PoI) are written on the application's performance. A way of standardizing the name in at least two variants was proposed - for searching and labelling objects.

In the context of user interface design and application logic, it turned out to be crucial to design a convenient way to activate the view of individual floors while browsing the map and switch the view of floors. The issue is complex, among other things, because it should be considered that sometimes buildings are connected, although the layout of the floors is not identical. Also, a fact is the irregularity of floors, especially in the formation of building extensions and modern structures. Therefore, a special panel for switching floors with the possibility of combining them into groups was proposed. In addition, if the planned route runs through several floors, markings are introduced on the panel to read on which floor the route ends and on which it begins. Unique markings for places adapted for people with disabilities have also been introduced.

The last issue analyzed was optimising the voice interface and voice reading of spatial information. Proprietary solutions were proposed linking to existing tools such as TalkBack in Android.

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