Indoor navigation path visualization method considering the spatial characteristics

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Abstract. Facing the complicated indoor space structure, people's demands for indoor location services such as navigation and emergency evacuation are also increasing. Indoor navigation map is an important tool for people to navigate and find way in large public buildings. Navigation path visualization is a key map element that guides users to complete navigation behavior, and its visualization method has attracted more and more attention. The difference between indoor and outdoor path characteristics makes it difficult for outdoor path visualization methods to be fully applicable indoors. It is urgent to propose a navigation path visualization method that meets the characteristics of indoor space in order to better assist users in completing navigation tasks. This paper summarizes the indoor space characteristics, indoor navigation path characteristics and visualization principles, in the future, it is planned to use different methods of overview and user perspective to visualize the indoor navigation path.

Keywords. Spatial characteristics, Path visualization, Indoor navigation map, Indoor location services

1. Introduction

With the gradual improvement of urban infrastructure and building coverage, various super large buildings emerge in endlessly, such as shopping malls, hospitals, airports, high-rise office buildings, exhibition halls, etc.

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Research have shown that humans spend approximately 80% of their time in indoor activities (Klepeis et al. 2001). At present, indoor location services mainly focus on technical research such as positioning and path planning. As the calculation basis and information carrier of indoor location services, indoor navigation maps have received little attention for their own modeling and visualization. In particular, the navigation path is a key map element for the indoor navigation map to guide the user to complete the navigation behavior, and its visualization method is often ignored.

The indoor space structure and function are obviously different from the outdoor. Unlike the outdoor road network which is mainly two-dimensional, the multi-storey connection inside the building makes the indoor road present a three-dimensional spatial structure. Therefore, navigation in indoor environment involves more vertical movement, that is, inter-layer movement (Karimi 2015). At the same time, humans often exhibit a networked topology, that is, "sequential behavior" in the process of navigation and pathfinding (Kuipers 1979). Since the indoor environment does not have an obvious road network structure, most of them are open traffic areas. In this case, how to clearly visualize the indoor navigation path is worthy of in-depth discussion.

2. Analysis of indoor space characteristics

In the field of indoor cartography, Afyouni et al. (2010) defined the building environment where people frequent daily activities such as shopping malls and residential houses as indoor space. Yang et al. (2011) proposed that indoor space is a concept that is relative to the large-scale space in the natural environment. It refers to the inside and below of the building on the ground, which provides enclosed space for human activities, such as various large-scale buildings on the ground and underground parking, etc.

Compared with the outdoor open natural environment, the indoor space is a man-made and relatively closed environment, which mainly contains artificially constructed entities, the indoor space has the following characteristics:

(1) Indoor space presents a multi-layer three-dimensional structure. Due to the horizontal division and vertical connection between floors, the structures of each floor have similarity, consistency and overlap.

(2) Indoor space is restrictive. Some spaces have certain social, time and functional privacy restrictions.

(3) Poor visibility of indoor space. In the horizontal and vertical direction, the indoor space is divided by many walls, rooms, and the floors are

connected by elevators, escalators, and stairs, the user's line of sight is limited.

(4) Indoor space elements are special, densely distributed and highly variable. Affected by various emergencies, behaviors or activities, the layout of the indoor space is frequently changed.

3. Characteristics and visualization principles of indoor navigation path

In map visualization, generally select some elements for mapping based on the characteristics of the cartographic object, the specific purpose of the map, or the specific user object (Ryder 2015). The difference of indoor and outdoor space characteristics makes the path characteristics also show obvious differences.

- Dimensional characteristic

The multi-storey nature of the building makes the indoor space present a three-dimensional structure, and the indoor path, as a passage element connecting each floor, also presents a three-dimensional form.

Visualization principles: For cross-floor indoor paths, 2.5D and 3D are combined to visualize the transition positions and connection relationships between floors.

- Directional characteristic

The indoor path direction is diversified. It not only has the horizontal connection of the front, back, left and right directions, but also the vertical connection of the upper and lower sides.

Visualization principles: For indoor navigation paths, escape routes, etc., appropriate visual variables and visual forms should be designed for such clearly-indicated paths, and correct direction instructions should be given.

- Openness characteristic

In addition to the open passage for the public, some indoor scenes have special passages, such as staff passages, VIP passages, etc.

Visualization principles: For impassable paths, colors that are quite different from the base map should be used to visualize in order to achieve the function of reminding and warning.

- Semantic characteristic

As far as indoor space is concerned, there is no conventional or prescribed semantic description for indoor paths.

Visualization principles: Landmarks are important element for people to communicate route information (Denis 1997, Raubal & Winter 2002). Using landmarks as the semantic information of indoor paths can provide users with accurate location descriptions.

4. Conclusion

This paper studies the indoor navigation path visualization method that takes into account the space characteristics, analyzes the indoor space characteristics, the navigation path characteristics and visualization principles. In the future, it is planned to use different methods of overview and user perspective to visualize the indoor navigation path based on the hierarchical visualization of indoor navigation map elements.

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