Towards a hierarchical indoor data model from a route perspective

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Abstract. In mobile navigation systems, an appropriate level of detail of the route instructions provided is important for navigation users to understand, memorise, and follow routes. However, few existing indoor navigation systems are capable of providing route instructions with multiple levels of detail. To close this gap, it is critical to model indoor environments with multiple granularities for route instructions to be generated on varying levels of detail. We propose a hierarchical model for route instructions in multi-storey buildings by allowing for representing actions (i.e., turning left or right, and going straight) in conceptualising route instructions. As a proof of concept, a case study is being conducted to present the feasibility of the proposed hierarchical model.

Keywords. Hierarchy, Indoor data model, Route instruction

1. Introduction

When a person, who is termed a route-giver in the route communication contexts, plans and instructs route information, to another person who requests and receives route information (i.e., the route-receiver), the route-giver tends to adapt the level of detail of the given route information to the assumed familiarity of the route receiver (Ziegler et al., 2011; Zhou et al., 2021), and the route complexity (Richter, 2007; Tenbrink, 2012). There are primarily two approaches to generating route instructions with varying levels of detail (LOD): destination descriptions (Tomko and Winter, 2009) and route directions (Klippel, 2003). The former approach makes use of various spatial features to describe the location of destinations, whereas the latter approach aggregates fully detailed turn-by-turn instructions from an

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origin to a destination using various chunking principles. In mobile navigation systems, a hierarchical data model that accounts for the salience or granularity of spatial features is required for the generation of multiple LODs of route instructions (Klippel et al., 2009).

As indoor spaces are significantly distinct from outdoor environments (Worboys, 2011; Winter et al., 2019), there have been a number of studies conducted to model indoor spaces (Afyouni et al., 2012). Some of them (Richter et al., 2011; Stoffel et al., 2008; Liu et al., 2019) attempted to develop hierarchical indoor data models to enable efficient route planning and place descriptions in buildings. However, these models are unable to support route directions at multiple LODs because the underlying basic graph primarily represents individual cellular indoor spaces (e.g., rooms, corridors) as nodes, without embedding the precise geometric information.

In summary, there is a need for a hierarchical indoor data model that supports both destination descriptions and route directions in route instructions with multiple LODs. Accordingly, we propose a route-based hierarchical indoor data model that enables route instructions in multi-storey buildings at multiple LODs. This work-in-progress paper is mainly concerned with conceptualising the hierarchy of indoor spaces in route instructions. A case study is used to demonstrate the usability of the proposed model.

2. Conceptual Model of Indoor Hierarchy

As illustrated in Figure 1, the conceptualised hierarchy for indoor route instructions is composed of seven levels: building, floor, axial, segment, junction, side, and basic. The building level represents individual buildings that contain multiple floors. The floor level captures the movement in the vertical direction of a building. The axial level models the longest straight line in corridor areas. The segment level further details segment components that constitute each axial element of that level. The junction level distinguishes decision points from other positions that are from the same cluster in the segment level. The side level characterises whether portal nodes in a cluster at the junction level are situated on the same or opposite side relative to a corridor section. And the basic level is composed of these specific positions (e.g., doors, POIs) in a building.

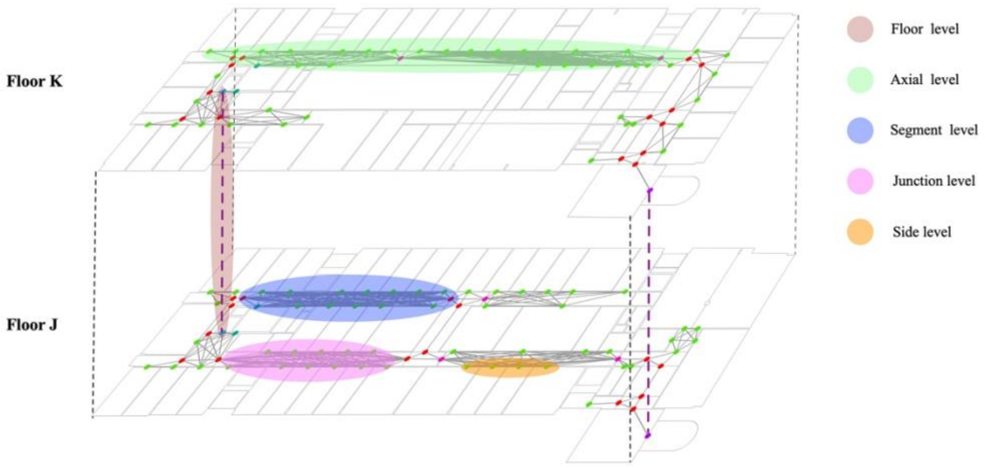

Figure 1. Illustration of the conceptualized hierarchy for indoor spaces from a route perspective.

3. Case Study

We selected the Y25 building at the University of Zurich as the case study for indoor route instructions based on the proposed hierarchical model. Currently, we are developing and testing an algorithm that allows mapping the conceptualised hierarchy to the given building to generate different LODs

4. Conclusion

This work-in-progress paper proposes a hierarchical indoor data model from a route perspective in order to enable the generation of multiple LODs of route instructions. Unlike conventional hierarchical indoor data models, which exclusively focus on the global architectural structure (e.g., floors, wings) of buildings, our model incorporates the local structures used for conceptualising both route directions and place descriptions. In the future, we intend to develop an approach to automatically construct the proposed hierarchy based on the commonly used floor plans. Then, we will conduct case studies to demonstrate the capability of the proposed model to facilitate destination descriptions and route directions in multi-storey buildings.

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