Identifying Context-Dependent Orientation Information for Incremental Route Instructions

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Abstract People build up mental maps of their environment and are able to convey spatial information in a way that would support the addressee's spatial orientation. In contrast, wayfinding support systems are not designed to support the users' spatial orientation, but to assist efficient path guidance. This research aims to investigate how orientation information can be conceptually represented and computationally identified in order to support the users' spatial orientation. In future, this understanding could help to rethink the design of wayfinding support systems.

1 Background

The introduction of wayfinding support systems and their acceptance in society has brought a shift in people's wayfinding behavior. Wayfinding support systems are able to precisely identify the users' location and orientation in space and guide them step-by-step to their aspired destination. Thereby, they tend to adopt part of the users' orientation and wayfinding behavior. Whereas in spatial descriptions people naturally include information that would support the addressees spatial orientation, wayfinding support systems do not; the computational step towards automatically identifying this information is challenging.

Several researchers already made the step towards including landmark information into wayfinding instructions (Daniel and Denis, 1998; Denis, 1997; Raubal and Winter, 2002; Richter and Klippel, 2005). There is evidence that people not only include local landmarks in route descriptions, which are located directly at the route and support the local orientation, but also landmarks that are distant to the route and support global orientation (Anacta et al., 2016; Schwering et al., 2013). Further attempts have been made to automatically extract landmarks from VGI data such as

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OpenStreetMap, Foursquare or Twitter (Sester and Dalyot, 2015; Kim et al., 2016). However, the algorithmic problem of automatically identifying the relevant local and global landmarks for the specific context of the users is still unsolved.

Richter and Winter (2014) argued that there is no global measure of landmarkness, but landmarkness might be a property of an object in a specific context. Orientation information, in general, are related to the concept of landmarks and are expected to be highly context-dependent. Dey defined context as "any information that can be used to characterize the situation of an entity" (Dey, 2001, p.5). However, it is still not fully understood how to capture context and model context awareness, because context cannot be captured completely in a formal model (Dey, 2001; Richter and Winter, 2014). Emmanouilidis et al. (2013) followed a practical approach, where they presented a context taxonomy for mobile guides. The taxonomy distinguishes the five categories user, environment, system, social, and service, which are each subdivided into distinct characteristics (Emmanouilidis et al., 2013, p.109). For the specific use case of wayfinding support systems and the task of identifying context dependent orientation information, state-of-the-research is missing a model to formalize and weight context categories.

Richter and Winter (2014) investigated the conceptual aspects of landmarks, i.e. how the cognitive concept of landmarks can be described in a formal data model, and the computational aspects of landmarks, i.e. how landmarks can be computationally observed, stored, and analyzed. Hansen et al. (2006) reviewed the OGC Implementation Specification OpenLS and presented an extension for storing landmarks for cognitive ergonomic route directions. The computational identification of context-dependent orientation information requires the understanding of their conceptual and computational aspects, which has not been investigated in literature before. Similar to the approaches of Richter and Winter (2014) and Hansen et al. (2006), the investigation of the conceptual and computational aspects of orientation information will be a key part of the proposed work.

2 Research Question

The underlying hypothesis of this research is, that it is possible to conceptually represent and computationally identify orientation information for incremental route instructions. Depending on the users' current route context, it is possible to identify spatial information that will shape the users' survey knowledge and thereby support the users' spatial orientation. Following questions will be investigated within the proposed research:

1. What are the required contextual information for an algorithm to identify orientation information for incremental route instructions?
2. How can orientation information for incremental route instructions be conceptually represented?
3. How can orientation information for incremental route instructions be computationally identified?

3 Methods

For the development of the algorithm for identifying orientation information, a requirement analysis will be performed. This will include the review of the required data basis and the specification of the contextual information and dynamic changes in the context. The clear specification of the requirements will be the basis for further methodological steps. Subsequently, the context-dependence of orientation information will be empirically tested.

The central part of the research will be the theoretical investigation of the identification of orientation information. Therefore, a theory for the identification of orientation information candidates and the subsequent refinement will be developed. The theory will be tested through a user study, which aims to test the suitability of different candidates and, on that basis, refine the parameters of the identification.

Depending on the specified requirements and the theoretical basis for the identification of the context-dependent orientation information, the algorithm for identifying orientation information will be developed and implemented. As proof of concept, an existing mobile application will be extended to submits its contextual information to the algorithm and requests the particular orientation information. The orientation information might then be highlighted on a map.

4 Expected Outcomes

As there has been no formal definition of how to conceptually represent orientation information, the investigation of the conceptual aspects of orientation information aims to formally define a data model for orientation information. The result will be a prerequisite for the investigation of the computational aspects of orientation information. Furthermore, it might constitute a general means to conceptually model and represent orientation information.

The step of defining a theory for identifying orientation information aims to develop a new algorithm that is based on the definition of the conceptual aspect of orientation information. The algorithm is expected to identify orientation information that will support the users' spatial orientation by shaping their survey knowledge. It is expected that this approach will significantly increase the spatial knowledge users gain through the usage of orientation information, compared to existing approaches.

5 Further work

Further work might be done in the area of investigating the presentation of the information. The cartographic presentation of spatial information is essential to how it will be perceived and recorded by the users, and it is mainly restricted to the textual and the graphical modality. Within both modalities, it will have to be investigated

how orientation information can be presented to the users, e.g. through schematized maps. In future, it will be necessary to investigate the performance and the users' acceptance of wayfinding support systems that will assist their spatial learning.

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