Smart Environments and LBS to support pedestrian navigation

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1 Introduction

Within the last few years navigation systems have started to conquer the market in the Western World. Especially in outdoor environments location based services play an important role for supporting the wayfinding process. Car drivers have started to trust in the information provided by car navigation systems and even pedestrians are gaining interest in reliable guiding instructions. Nevertheless, this kind of giving directions is not very popular until today. Various reasons are responsible for this scarce usage: e.g. localization accuracy is insufficient for pedestrian's needs in many cases and route suggestions usually rely on road networks and do not meet the demands of walking people, as pedestrians have more degrees of freedom in movement compared to car drivers (Corona & Winter 2001).

Moreover, most of these systems are limited to outdoor areas, whereas wayfinding within buildings has mostly been neglected so far. Merely some museums and exhibitions offer digital guiding services to their customers (Oppermann 2003, Chan et al. 2005). Even though the range of some positioning sensors may be sufficient for navigation tasks, they are rarely available within buildings and hardly fulfil the minimum conditions concerning cost (Dempsey, 2003). Because of the expensive infrastructure the user has to expect high costs when using the system. Moreover the communication of 3D indoor environments on twodimensional screens is a difficult task that influences if the user successfully reaches the target.

Especially in complex buildings, visitors often need guidance and support. One of the main disadvantages inside of buildings affects the sense of orientation: people tend to lose orientation a lot easier within buildings than outdoors (Hohenschuh 2004, Radoczky 2003), especially if not moving along windows. Additionally to navigation support it could be beneficial to supply the user with information that is adapted to the current task. For instance when visiting a shopping centre information about bargains at favoured shops could be displayed, or when strolling around an airport or train station information about departing planes or trains that concern the user could be provided. Instead of passive systems that are installed on the user's device and frequently position them as the user moves along, new technologies originated in ubiquitous computing could enrich guiding systems by including information captured from an active environment. This would mean that the user is perceived by a ubiquitous environment and receives location based information that is suitable for the respective device or is supplied with helpful notes via a public display or similar presentation tools. Additionally to the function of information transmission poles, these smart stations could possibly substitute or complement traditional indoor positioning methods by sending coordinates of the station instead of locating the user. Based on the concept of Active Landmarks, which actively search for the user and build up a spontaneous "ad-hoc network" via an air-interface, a ubiquitous solution, where an information exchange between different objects and devices are accomplished, could be investigated for the use in navigation.

In this paper the evolutionary method of ubiquitous guiding in smart environments is analyzed. As opposed to conventional navigation systems, which are based on preinstalled software, ubiquitous cartography responds to an individual user at his present location in real-time. Interactivity is facilitated and wayfinding aid is more flexible, which provides new opportunities and challenges to the field of cartography and offers new possibilities for research in positioning techniques with alternative sensors.

2 Problems and State of the Art

In the late 1980s Mark Weiser, a Technologist at the Xerox Palo Alto Research Center (PARC), created the term 'Ubiquitous Computing' (Want, 2000). In his disquisition on "The Computer for the 21st Century" (Weiser, 1991) he assumed that in the near future a great number of computers will be omnipresent in our everyday life and that they will soon be interconnected in a ubiquitous network. Especially within the last decade this concept gained more and more importance not only to computer scientists but also to other disciplines, like medicine and care for the elderly (Baard, 2002). Most recently geo-scientists started to discover the possibility to use the omnipresent computer landscape for exploring our spatial environment. Fairbairn (2005) explains the term 'Ubiquitous Cartography' as a technological and social development, made possible by mobile and wireless technologies, that receives, presents, analyses and acts upon map data which is distributed to a user in a remote location. Furthermore he predicts that this new approach to maps will revolutionize the way many people interact with maps. To Ota (2004) "the definition of ubiquitous mapping is that people can access any map at (sic) anywhere and anytime through the information network" (pp.167).

This concept enables a revolutionary opportunity for navigation systems of any kind. Within the last few years a lot of research and development has taken place concerning Location Based Services, which could now be supplemented and expanded with the help of ubiquitous methods, and maybe in the future they could even be replaced. Yet research is still in the early development stage that still meet many new challenges. Positioning and tracking of pedestrians in smart environments function differently from conventional navigation systems, since not only passive systems, that execute positioning on demand, need to be considered. Moreover a combination of active and passive positioning methods should be the basis of a ubiquitous navigation system. Such a multi-sensor system for position determination should therefore be able to include both types of location determination and as a result lead to an improvement of positioning accuracy.

Beside the technical challenges of a ubiquitous system, user friendliness is a major ambition in this context. Due to the diversity of pedestrian navigation strategies and route choice behaviour the user shows specific preferences and requirements concerning spatial information. The improper usage of ubiquitous systems could easily lead to an overload of impressions. A lot of information that might even be completely independent from each other could overstrain the user and hinder effective information extraction. To avoid this effect the aim of such a system should concentrate on providing information about the environment without overstraining the user. It should supply the navigating person with customized information basing on individual mobile behaviour and interests and available facilities in the actual surroundings. At decision points the information should be unmistakably clarified but everywhere else, where guidance is not implicitly necessary, additional information should be provided in an unobtrusive way. User friendliness is therefore the main ambition of this research approach.

The overall research hypothesis is: Navigation in a ubiquitous environment with a combination of active and passive systems enables customized route guiding with various presentation forms and therefore optimizes the wayfinding process. The hypothesis is investigated in three parts.
· Positioning in Ubiquitous Environments: investigates positioning methods in a smart environment in combination with conventional positioning techniques. The optimized position will be sent to the user's device.
· Monitoring the Navigation Behaviour of Pedestrians: typologies will be investigated and based on these findings user profiles will be verified and tested by observing the clients mobility behaviour at certain highly frequented environments.
· Ubiquitous Cartography: determines and filters out suitable route presentation forms, which could either be provided by the ubiquitous environment or by a passive system on the client of the user.

3 Conclusion

This presentation deals with current efforts at the Technical University of Vienna to analyze methods of wayfinding support for pedestrians in mixed indoor and outdoor environments. It is assumed, that methods of ubiquitious cartography in terms of a combination of active and passive systems with various presentation forms can support the wayfinding process. In this context the term ubiquitious cartography follows the definition of Ota (2004), who stated "ubiquitous mapping is that people can access any map at anywhere and anytime through the information network", incorporating also the perspective "includes not only map making but also map use and map communication considering the interaction between map, spatial image, and the real world".

The main research question include the modelling of the behaviour of pedestrians and the possibility of meeting the needs/behaviour by a combination of active and passive systems. The use case includes therefore the usage of mobile devices in combination with short-range sensors and public displays. The main aim is to make the environment "smart", so that adaptively the "smart" environment delivers customised and location-dependent information for a particular user, instead of trying to permanently track and send information from centralized systems.

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