Chapter 7
Indoor Navigation and Location-Based Services for Persons with Motor Limitations

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ABSTRACT

Persons with motor limitations constitute a group-challenge when building indoor navigation and Location-Based Services (LBS). The authors present here the systematic approach they have developed that has to be taken into account in the user needs analysis of persons with motor disabilities when an advanced system for indoor navigation and LBS is designed. In the first part the authors present a step-by-step and detailed methodology about the extraction of the user requirements' knowledge in order to develop an indoor navigation and LBS system that provides adequate and usable output to persons with motor limitations. In the second part, after an overview of the existing indoor LBS, the authors present the development of the MNISIKLIS system giving emphasis on the User Interface designed after following the knowledge derived from the first part.

INTRODUCTION

Location Based Services (LBS), which constitute a popular domain of context-aware applications, are defined as the ability to locate the exact position of a mobile user and deliver to him/her specific computer services that are related with his/her location. LBS have a variety of applications that can be offered to the user, such as tracking and way finding. Gluck (Gluck, 1990) defines way finding as "the procedure that is used for the orientation and navigating, in order an individual to navigate from one place to another, especially in very huge and complex environments indoors or outdoors". The user requests to receive information, about his/her current position (where am I?) or about how to get to the desired destination, which are the result of the estimation of the position and orientation of the user by the system.

Personalization of navigation is required in cases where an advanced user experience should be provided or an inclusive design approach is adopted. Indoor navigation and location based services are

DOI: 10.4018/978-1-4666-9845-1.ch007

inherently personalized services and, as such, they depend on the user model in order to make a correct selection of the outputted content. The navigation algorithms ought to take into account the needs/abilities of each user. Thus, the routes, guidance and content offered by such a system to a specific user, as well as the way they are presented, have to be adjusted, according to his/her age, language, and physical or cognitive abilities. Outdoor positioning systems have achieved great success, leading to the development of commercial systems and devices. However, the field of research in indoor LBS has not yet achieved the same success as that of outdoor positioning. That is, there are no wide-spread indoor positioning systems and services available yet. This gives developers the chance to create personalized products that embody accessibility and take user needs and abilities under consideration.

Many experimental systems for indoor pedestrian way finding, focus on the positioning and tracking technologies. This area is very challenging, mainly due to the unsuitability of the mature and widely established outdoor positioning technologies for use in buildings. The Global Positioning System (GPS) is an excellent technology that can be used for the determination of absolute location in outdoor environments, but is almost useless indoors. Furthermore, indoor environments are very different. They combine open and close spaces, have high or low ceiling, are static or dynamic, have metal surfaces, and can be crowded or empty. The morphology of the building is important for the map creation and the tracking system. The diversity of use of buildings is something of interest to the end user, as is the device to be used and the according User Interface (UI). There is a need to find a solution that will give a good level of accuracy, minimum level of error, and that can be scaled in big and complex environments. The first two requirements make such a system reliable, while the last makes its use feasible.

Persons with motor limitations, for example wheelchair users or persons with limited motion in the lower extremities, constitute a “challenge” user class for a navigation system. An additional constraint for these people is that many times their hands are busy, e.g. handling the wheelchair. Also people with upper extremity disabilities may not be able to open doors with ease, push the call button of the elevator or manipulate the portable device with their hands. Their motor abilities and user profile in advance, influence every aspect of an indoor navigation system, from the tracking system to the navigation algorithms and from the user device to the user interface design and content. For example, the tracking system cannot rely on the pacing of such a person, the positioning of the sensors (if any) has to take into consideration his/her height when he/she is on the move, the selection of the navigation path has to be intelligent and flexible, the portable device as well as the user interface have to be usable. It is obvious that only a subset of the possible routes is suitable (e.g. having ramps instead of stairs) and that some destinations of special importance, such as toilets for the disabled, must be highlighted.

Ultimately, indoor navigation and location based services can be seen as a puzzle. Its pieces are the tracking system, the building maps and content, the navigation algorithms, the user devices and interfaces. What connect these pieces together are the user needs and preferences. We present here the systematic approach we have developed that has to be taken into account in the user needs analysis of persons with motor disabilities when an advanced system for indoor navigation and location based services is designed. In the first part we present a step-by-step and detailed methodology about the extraction of the user requirements’ knowledge in order to develop an indoor navigation and location based system that provides adequate and usable output to persons with motor limitations. In the second part, after an overview of the existing indoor LBS, we present the development of the MNISIKLIS (Papataxiarhis et al., 2008) system with emphasis on the User Interface designed after following the knowledge derived from the first part.