

## Chapter 2.12

# A Navigational Aid for Blind Pedestrians Designed with User– and Activity–Centered Approaches

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### ABSTRACT

The two-fold aim of this chapter is to present the design process of an interface for a mobile navigational aid for blind pedestrians and a set of rules for producing route descriptions for these users, as well as the methodology used to develop them, rooted in a user- and activity-centered approach. We first present the state of the art of wearable verbal navigational aids and what might still be lacking in their conception, and propose a reusable user- and activity-centered approach designed to complement already existing and future systems. Case studies fitting into this approach are next presented: route descriptions produced by blind pedestrians were analyzed; the production rules were extracted and tested in urban areas. Results

reveal these rules, the specific database features, the required user profiles, and the precision of localization necessary for assisting blind pedestrians' wayfinding in urban areas. Finally, future trends in mobile guiding tools for the visually impaired are examined.

### INTRODUCTION

Imagine being blind and trying to find your way around a city you have never visited before; that can even be challenging for a sighted person. Wayfinding (the tactics and strategies that guide traveling) is particularly difficult for blind people to achieve, even in our highly structured modern cities. Indeed, though the vast majority of blind

people live in urban environments, most of them are prevented from traveling autonomously in cities. This is especially true in unfamiliar areas due to the lack of adequate and accessible information to guide them (Bentzen, 1997a; Golledge, Klatzky, Loomis, Spiegel, & Tietz, 1998). Though a few wearable navigational aids exist, their usability by blind individuals in real-life situations has not been studied in detail, and uphill field studies have not been performed to identify information necessary to design proper mobile way-finding aids.

Our goal in this chapter is to present the state of the art of wearable and auditory navigational aids (devices and research projects), identify what might still be lacking in their conception, to propose a user- and activity-centered approach designed to get data necessary to complement already existing and future systems, and finally to provide case studies fitting into this approach. The two-fold objective of this chapter is to present the set of rules for producing verbal instructions and information, and the methodology we have developed for designing the system and the set of rules, based on case studies.

## **NAVIGATIONAL AIDS FOR VISUALLY IMPAIRED PEDESTRIANS**

The idea of developing a wearable computerized guidance system using satellite-based localization (GPS – global positioning system or Galileo) to assist the navigation of visually impaired goes back two decades (Collins, 1985). Such a system is not intended to provide visually impaired persons with detailed information about the immediate environment (e.g., obstacles), but to provide way-finding information and instructions. Thus, the traveler still has to rely on the long cane, the guide dog, or ultrasonic sensing devices for this type of information.

The first verbal and wearable guidance system for visually impaired people was designed back in 1989 (Brunsighan, Strauss, Floyd, & Wheeler,

1989). More recently, a prototype was designed by the MoBIC consortium in England (Petrie, Johnson, Strothotte, Raab, Fritzand, & Michel, 1996). Since then, there have been a multitude of research projects investigating GPS-based navigation systems for visually impaired travelers (e.g., Fruchterman, 1996; Helal, Moore, & Ramachandran, 2001; Holland, Morse, & Gedenryd, 2002; LaPierre, 1998; Makino, Ishii, & Nakashizuka, 1996). A wireless prototype GPS system for the visually impaired is also under development in Europe in the TORMES project by a Spanish company called GMV Sistemas and the ONCE (the National Organization of Spanish Blind people). It is a handheld device using EGNOS satellite technology, created by the European Space Agency (ESA).

These systems are most often built around a technical architecture composed of a geographic information system (GIS), coupled with path computation software, a localization system (GPS alone, or GPS plus a dead reckoning system), a wearable computer, and a human-computer interface, often based on speech synthesis (Gaunet & Briffault, 2001, 2002; Golledge et al., 1998; Loomis, Golledge, & Klatzky, 2001). An alternative type of navigational aid signals the position of landmarks to visually impaired travelers through stereo headphones. It provides a three-dimensional spatial virtual acoustic display for landmark localization, and labels and attributes of landmarks with speech synthesis (see, for example, the personal guidance system designed by the University of California, Santa Barbara research group – Loomis et al., 2001, and the System for Wearable Audio Navigation SWAN developed by Georgia Tech – Walker & Lindsay, 2006).

Though most of these systems have been validated from a strictly technical point of view (i.e., localization, speech synthesis, integration of components, etc.) few effective commercial systems are available. These do not use tactile or 3-D-sound spatial display but voice messages, suggesting at least some technological and us-

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