An Integrated System for Blind Day-to-Day Life Autonomy

Hugo Fernandes
UTAD, Portugal
hugof@utad.pt

José Faria
UTAD, Portugal
jfaria@utad.pt

Hugo Paredes
GECAD/UTAD, Portugal
hparedes@utad.pt

João Barroso
GECAD/UTAD, Portugal
jbarroso@utad.pt

ABSTRACT

The autonomy of blind people in their daily life depends on their knowledge of the surrounding world, and they are aided by keen senses and assistive devices that help them to deduce their surroundings. Existing solutions require that users carry a wide range of devices and, mostly, do not include mechanisms to ensure the autonomy of users in the event of system failure. This paper presents the nav4b system that combines guidance and navigation with object's recognition, extending traditional aids (white cane and smartphone). A working prototype was installed on the UTAD campus to perform experiments with blind users.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces—*Interaction styles*; K.4.2 [**Computers and Society**]: Social Issues—*Assistive technologies for persons with disabilities*

General Terms

Human Factors

Keywords

Mobile technology, assistive technology, blindness.

1. INTRODUCTION

Autonomy can be defined as a *"capacity for detachment, critical reflection, decision making and independent action"* [5]. For making decisions and performing actions, people need to have knowledge about the environment, usually gathered with natural senses. Blind people lack a major surrounding knowledge gatherer: vision. To equalize this shortcoming, blind people developed their other senses, particularly hearing, to create mental models of the environment. Moreover, they attend to known places and usually study the routes previously before moving. Regarding day to day objects, they know their typical location in order to ensure their autonomy. Technology can be used to help blind people in their day-to-day life. Examples of these technologies are: navigation systems, mostly based on GPS and restricted to outdoor usage; audio signage systems, that are limited concerning the availability of information and location accuracy; and the talking labeling system, which requires a specific device for locating objects and does not associate objects to their locations and day-to-day activities.

This paper presents the nav4b system, a technological solution to support the day-to-day life of the blind users. The infrastructure of the system is based on electronic trails and tags,complemented by non-technological solutions to ensure system redundancy and user autonomy in case of system failure. On the core of the infrastructure is the Radio Frequency IDentification (RFID) technology, which is the common technology base of the system. From the blind user's perspective, the system design takes into account ergonomics and ubiquity, using typical blind aids: a white cane, which is instrumented to accommodate the necessary components for interfacing with the infrastructure; a smartphone, hosting the software application that enables the system operation; and bone-conduction headphones, to ensure the transmission of information to the user without hearing interference. A prototype was installed on UTAD campus to perform tests and experiments with blind users.

Copyright is held by the author/owner(s).
ASSETS'11, October 24–26, 2011, Dundee, Scotland, UK.
ACM 978-1-4503-0919-6/11/10.

2. BACKGROUND

In the last decade several projects have emerged aiming to use of RFID technology for the navigation of the blind. The BIGS System, proposed Na[6], includes an infrastructure, the smart floor, and a portable terminal unit. A more complex system was presented by Ding [2] consisting of RFID tags, a portable reader which can be integrated into the white cane, a mobile phone, a Call Center and a central information server. Recently, Chen [1] proposed the inclusion of pre-built RFID tags in blind pathways. Moreover, the SmartVision project aims to develop a system for assisting the blind navigate autonomously, integrating GPS, Wi-Fi, RFID and computer vision technology [3]. In a complementary perspective, the TANIA system, which was originally developed to provide the blind with a navigation device, was extended with an RFID reader or the recognition of tagged objects [7]. The integration of navigation and object recognition was previously explored by Hub et. al[4].

3. NAV4B ARCHITECTURE

To create an integrated system that ensures day-to-day life autonomy of blind people there are a set of requirements that should be taken into account. One of the main requirements of the system regards the recognition of the environment and the surrounding objects that the blind needs in his daily routine, such as a bottle of milk or a box of medicines. The system should be able to distinguish similar objects in

order to give accurate information to the user. Usually objects are placed on a specific spot and do not move. So, if the system has the ability to associate an object to a location, navigation can be provided. Ergo, guidance and navigation are also key requirements. This feature must ensure the ability to guide the blind on a route with accurate information about the environment, including points of interest and interactive objects, such us traffic lights. However, the user should not be overloaded with audio messages which may interfere with his perception of the environment. A last requirement regards the robustness and redundancy of the system, so that in case of technological failure, a minimum level of autonomy can be ensured.
Based on the presented requirements an architecture was developed with two major building blocks: infrastructure and user equipment (Figure 1). Regarding the infrastructure,

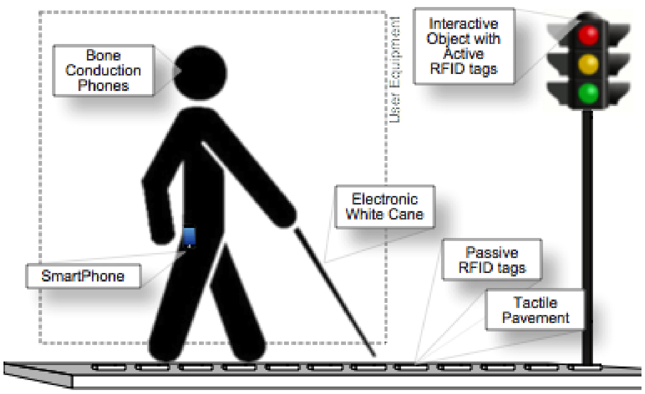

Figure 1: nav4b system architecture

the architecture endows traditional blind aids with passive RFID tags, creating electronic paths in the tactile pavement and electronic identifiers on tagged objects. Additionally, interactive objects can be equipped with active RFID technology to interact with the system. The user equipment consists of three elements that nowadays are typically used by blind people: white cane, SmartPhone and headsets. The white cane is instrumented with: an RFID reader and two antennas, a bluetooth communication module, a control module, a vibration module and power supply (Figure 2). The handgrip of the cane also includes a joystick to control the application installed on the SmartPhone. This application, implemented in the Android platform, is the functional core of the system, receiving information from the RFID readers on the cane. The application implements algorithms to plot routes using a set of maps of the areas housing the infrastructure. The data layer of the application is ensured by a geo-referenced database and connectors to external data sources, such as the SmartPhone agenda. The information

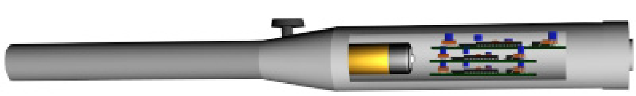

Figure 2: Electronic white cane model

tracking the route is usually transmitted by vibration on the handgrip of the cane. This information can be complemented by audio information for path correction or points of interest, via bone conduction headphones, ensuring the full hearing of the user without restrictions.

4. FINAL REMARKS

The progresses that have been made recently in technology allowed the creation of a system prototype using a common platform based on RFID technology providing autonomy to the blind. However there are some refinements that should be made in the prototype implementation regarding some particular issues on the range of RFID readers. Concerning future developments of the system we expect to carry out experiments with blind users to enhance and refine the prototype, as well as setting guidelines for tag placement, taking into consideration current standards and guidelines for tactile pavement installation.

5. ACKNOWLEDGMENTS

This research was supported by the Portuguese Foundation for Science and Technology (FCT), through the project RIPD/ADA/109690/2009 – BLAVIGATOR: a cheap and reliable navigation aid for the blind.

6. REFERENCES

[1] J. Chen, Z. Li, M. Dong, and X. Wang. Blind path identification system design base on rfid. In *Electrical and Control Engineering (ICECE), 2010 International Conference on*, pages 548 –551, june 2010.

[2] B. Ding, H. Yuan, X. Zang, and L. Jiang. The research on blind navigation system based on rfid. In *Wireless Communications, Networking and Mobile Computing, 2007. WiCom 2007. International Conference on*, pages 2058–2061, 2007.

[3] J. H. du Buf, J. Barroso, J. M. Rodrigues, H. Paredes, M. Farrajota, H. Fernandes, J. JosÃľ, V. Teixeira, and M. Saleiro. The smartvision navigation prototype for blind users. *JDCTA*, 5(5):351–361, 2011.

[4] A. Hub, J. Diepstraten, and T. Ertl. Design and development of an indoor navigation and object identification system for the blind. In *Proceedings of the 6th international ACM SIGACCESS conference on Computers and accessibility*, Assets '04, pages 147–152, New York, NY, USA, 2004. ACM.

[5] D. Little. *Learner Autonomy: Definitions, Issues and Problems*, volume 1. Authentik Language Learning Resources Ltd, Dublin, Ireland, 1991.

[6] J. Na. The blind interactive guide system using rfid-based indoor positioning system. In K. Miesenberger, J. Klaus, W. Zagler, and A. Karshmer, editors, *Computers Helping People with Special Needs*, volume 4061 of *Lecture Notes in Computer Science*, pages 1298–1305. Springer Berlin / Heidelberg, 2006. 10.1007/11788713 187.

[7] B. Schmitz and A. Hub. *Combination of the Navigation System TANIA with RFID-Based Initialization and Object Recognition*, page 2. 2009.