Evaluation of Electronic Haptic Device for Blind and Visually Impaired People: A Case Study

Alejandro R. Garcia Ramirez[1,*] Renato Fonseca Livramento da Silva[2]

Milton Jose Cinelli[3] Alejandro Durán Carrillo de Albornoz[4]

[1]Department of Computation and Engineering, Vale of Itajai University, Itajai-SC 88302-202, Brazil
[2]Department of Design, Federal University of Paraíba, João Pessoa-PB 58059-900, Brazil
[3]Department of Physics, Santa Catarina State University, Florianópolis-SC 88035-001, Brazil
[4]Instituto de Ciencia y Tecnología de Materiales, University of Havana, Havana 10400, Cuba

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Abstract

Blind and visually impaired people face several accessibility and mobility problems due to a lack of information from the environment. The environment information could help visually impaired people to avoid physical barriers and identify alternative ways to reach the desired destination. This work proposes an assistive technology device called the electronic long cane to serve as a mobility aid for blind and visually impaired people. The cane has an ergonomic design and an embedded electronic system, which fits inside the handle of a traditional long cane. The electronic system uses haptic sensing to detect obstacles above the waistline. When an obstacle is detected, the cane vibrates or makes a sound. Experiments are conducted and the interaction between blind and visually impaired people and the urban environment is discussed. Experimental data are processed using a J48 classifier. The obtained confusion matrix output shows a satisfactory validation.

Keywords: Accessibility, Assistive technology, Ergonomic design, Embedded electronics, Haptics, Blind and visually impaired people

1. Introduction

The sense of sight is required to understand constrained urban open spaces as well as dynamic environments in which multiple and simultaneous events occur. Mobility depends on skillfully coordinated actions to avoid obstacles in the immediate path [1]. Most human environments are designed for people without physical handicaps, which does not reflect the situation in actual societies [2]. In general, urban environments provide a lack of a sufficient signalization of, for instance, public phones, mailboxes and twigs of trees, with which a blind or visually impaired person could collide. Accessibility, thus, is an aspect of attempts to change environments in order to take into account physically handicapped people's needs [3]. Access to information about environments is especially essential for blind and visually impaired people [4], since it allows more independent mobility and thus integration into society.

According to Hersh and Johnson [5], several studies have applied available technology to mobility assistive devices, with most effort devoted to assistive technology for avoiding obstacles. Wada et. al [6] proposed a guidance system to the blind based on several sensors mounted on special shoes. On the other hand, Hoyle et al. [7] observed that a traditional long cane, widely used by blind and visually impaired people, does not detect physical obstacles above the waistline. They proposed enhancing mobility by embedding a multi-element ultrasonic sensor to collect spatial data, which are processed to estimate surrounding features and to provide an assessment of potential hazards based on a tactile multiple-stimulus user interface.

Two of the few commercially available electronic canes are Ultracane (Sound Foresight Technology Ltd) and Bat K Sonar (Bay Advanced Technologies Ltd) [8,9]. The proposed electronic long cane and these devices have the same functionality and employ the same ultrasonic sensing, but they differ in ergonomic concepts and costs. The present study adds a simple electronic component based on haptics sensing [10,11] to a traditional long cane to prevent collisions. The electronic system, embedded in the grip, detects obstacles above the waistline and alerts the user via vibration or a sound when an obstacle is detected. This feedback becomes increasingly frequent as the user approaches a physical barrier. Despite its simplicity, the integrated hardware solution improves mobility.

* Corresponding author: Alejandro R. Garcia Ramirez
Tel: +55-48-91029107; Fax: +55-48-32811506
E-mail: garcia.ramirez@gmail.com