Intelligent Cane

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Abstract --- **In this paper we present a new system for indoor blind accessibility. The main idea is an intelligent cane which is capable of navigating a fully blind person through the use of Radio Frequency Identification (RFID) technology. The design consists of a modified white cane, containing RFID transponders which receive information from RFID tags in the hallways. The user wears a headset to give commands and receive information. A rumble feature in the cane is used to give the user directional feedback. The design's directional feedback software was simulated and the results show that the software is successful and will competently keep the user on the path to their specified location.**

Index Terms **-- Navigation, Radio navigation, Speech recognition, Speech synthesis, UHF devices.**

I. Introduction

The University of Soeville accessibility committee has requested an electronic solution to the accessibility issues faced by visually or hearing impaired students on campus. We chose to deal specifically with the mobility issues faced by the visually impaired. The design must be capable of providing its full functionality to the user without the assistance of others. The device must also be portable. The success of the design will be measured according to the following criteria:

Maximize the success rate of the device to accomplish its task.

- Minimize cost.
- Maximize safety
- Minimize the time required to complete the task.
- Maximize how accurately the device responds to a user command.
- Minimize the time required by the device to respond to a user command.
- Minimize the difficulty faced by the user when learning to use the device.
- Maximize the ergonomic appeal of the device.
- Maximize the aesthetic appeal of the device.

The design of this device was based on the assumptions that: the user retains none of their visual faculties, and that they maintain the full use of their sense of touch and hearing. Some predominant existing solutions to this problem include GPS systems and echolocation. GPS is inaccurate when used indoors making it an ineffective solution. The echolocation system is used to detect objects in the path of the user, and would not aid in navigating the University's campus. Our design uses RFID technology to help the user navigate indoors on campus. This design is superior to the GPS systems because it is significantly more accurate for indoor settings, but also has capabilities for outdoor use. Although the echolocation system provides the user with more information about their surroundings, it is not capable of navigating the user. Upon completion of this project a simulation of the cane directional feedback software was provided. The cane and RFID sensors were simulated using infrared range finder sensors and an ARM based handyboard.

II. Conceptual Design/Methodology

A. Overall Design

The intelligent cane makes use of RFID technology, a series of small tags that can be read by tag readers in the immediate vicinity to reveal information programmed onto the tag. Placing the tags at regular intervals and at important points in buildings, a tag reader on the cane can follow the series of tags and guide the user to a desired destination. Speech recognition/synthesis through a headset is used to convey commands to and from the user. While the user is in transit to a destination, information about their direction is communicated using vibrational feedback through the cane's handle. Using these technologies, the cane enables users lacking some or all of their visual faculties to be informed of their whereabouts and guided to a destination of their choice, all without any external aid.

B. Major Components

The major components of the device include a white cane, microcontroller, RFID reader, RFID tags, headset, vibrating motor, path finding software, and speech recognition/synthesis software.

III. Detailed Design

A. Microcontroller

To control our device we decided on the High-Performance, 16-bit Digital Signal Controller Model dsPIC33FJ128MC506 [1]. The controller comes equipped with enough inputs and outputs, and onboard memory to properly control our device. The controller can also execute 40 million instructions per second which is fast enough to run the speech recognition and synthesis software, which has the highest requirements of all our software in the design.

B. RFID Reader

The readers we used in the design were Ultra High Frequency (UHF) style that runs in the range of 900 MHz. These allow the microcontroller and the RFID tags to communicate with each other at ranges of up to 20 feet [2].

C. RFID Tags

This project implements the RFX6000 Gen 2 tags by Symbol Technologies. Symbol Technologies' Gen2 tags operate with extremely low power and yet provide long read and write ranges, fast data transfer and high accuracy.

D. Voice Recognition/Synthesis Software

The voice recognition software we will be using to interface with the user is Sensory, Inc.'s FluentSoftTM[3]. The software is designed for small portable systems, and is speaker independent, meaning that no training with the user is required before the software can be properly utilized.

E. Battery

The system requires 3.0 - 3.6V for the microcontroller and enough amperage to power the microcontroller, rumble motor and receivers. The device uses a 6V 600mA lithium ion battery because it delivers sufficient voltage and amperage and is rechargeable in accordance with the system criteria.

F. Rumble Pack

The rumble pack works by vibrating when the microcontroller supplies the vibrating motor with voltage based on its internal programming. The logic of the rumble feature is programmed into the microcontroller.

G. Cane

The cane is the interface for the user. It is designed with an ergonomic grip, component case, cane shaft, and replaceable cane tip as can be seen in Figure 1. The cane is manufactured from carbon fiber, due to its strong, light weight properties and is already a familiar tool to the visually impaired.

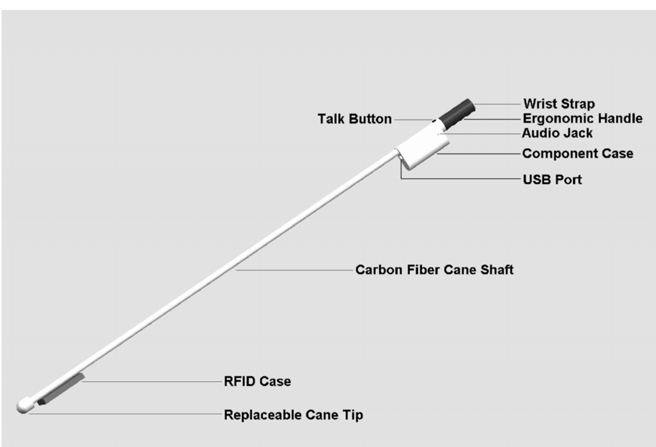

Figure 1: Detailed Cane Design

H. Networking Algorithm

To compute the shortest path between the user's current position and their desired destination we will make use of Dijkstra's Algorithm [4]. Dijkstra's Algorithm is designed to find the shortest possible path, if one exists, between nodes with positive, weighted edges. In our case the nodes will be representing RFID tags, and the weighted edges will be the respective distances between them.

IV. DISCUSSION

Due to the use of voice recognition and synthesis software, the user interface can accept and give relatively complex instructions with less hardware than other methods. It would, for example, be more difficult to request a destination using such devices as a Braille keypad. There exists the potential for interfacing errors when the device is operated in particularly noisy environments. The addition of the rumble feature to give variable feedback to the user through a different sensory system allows us to provide the user with even more non-visual information without bombarding the user with audio cues. It is possible that the user may be confused when trying to manipulate a vibrating cane although the magnitude of vibration will be calibrated with this potential error in mind. In terms of future expansion of the device, the potential for outdoor use exists, as long as the use of RFID tags in the environment is possible. The system could also be expanded to other public buildings, such as government buildings, malls and parks.

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