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A Highly Versatile & Multi-Sensory Design of an Intelligent E-Cane for the Blinds

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Abstract: The aim is to develop and implement a highly versatile, responsive and multi-sensor based intelligent e-cane for the people suffering from vision disorder. The e-cane is designed in such a manner so as to provide maximum navigation and other necessary information to the blind user keeping in view the difficulties faced by these users while using the conventional cane. The objective is to give blind users the ability to move around in unfamiliar environments, through a user friendly interface. The idea is to provide a simple walking stick equipped with sensors to give an active feedback to the user about the environment. The main controlling element is the microcontroller that takes decision to execute a specific action for a specific situation. Thus the overall aim of the device is to provide a convenient and safe method for the blind to overcome their difficulties in day-to-day life.
Keywords: E-Cane, Microcontroller, Embedded Systems, Ultrasonic Sensors, Blind, Visually Impaired, Mobility Aid, GSM.

Introduction

Studies have examined the usability of smart mobility devices based on technical systems addressing issues related to orientation, navigation, safety, mobility, speed and the optimization of techniques. Despite so many efforts from the last few decades the available electronic mobility aids still do not fully meet the needs of the visually impaired.

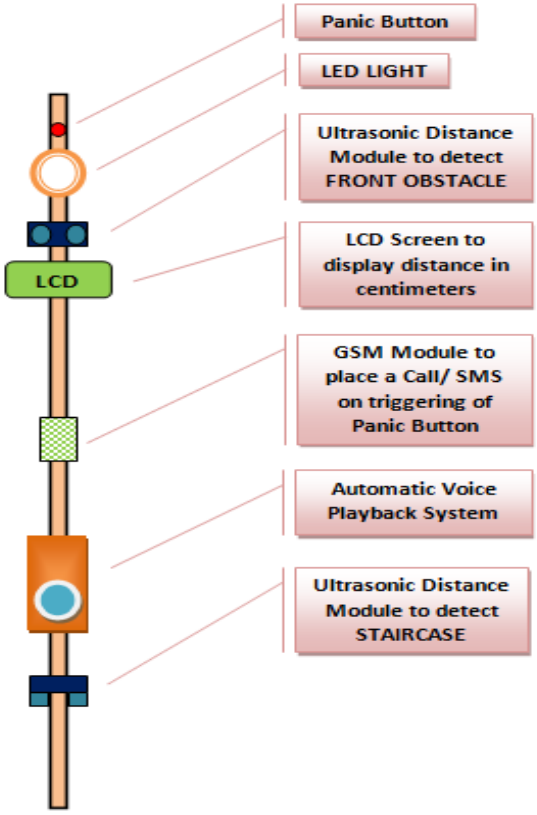

Figure-1: Physical Layout of E-Cane Model

The goal of this research was to identify the needs of visually impaired users and generate design guidelines for intelligent e-canes for users with visual impairments. Using a multi-method approach to design a functional e-cane will help identify potential problems as it allows one method to complement the other. In this way, the compiled results and data reflect a more comprehensive examination of preferences, needs and issues.

Features of Developed System

The implemented system for intelligent multi-sensory based e-cane has been tested in real environment and under diverse conditions to check the various performance issues. The system has been made to possess the below mentioned features:

- It is completely based on the State-of-Art Technology and real time embedded system with multiple sensors and modules has been deployed on the cane itself.
- It is made highly versatile to meet the demands of users and conditions and consider the major safety issues for the user.
- Proper care has been taken to respond the alarming situations during a disaster as well as other panic situations
- It is able to easily detect the various static as well as dynamic obstacles that come in its range to alert the user for safety measures.
- It is made in light weight and is highly portable
- It is made viable so that every class of the society can be benefitted

Methodology Adopted

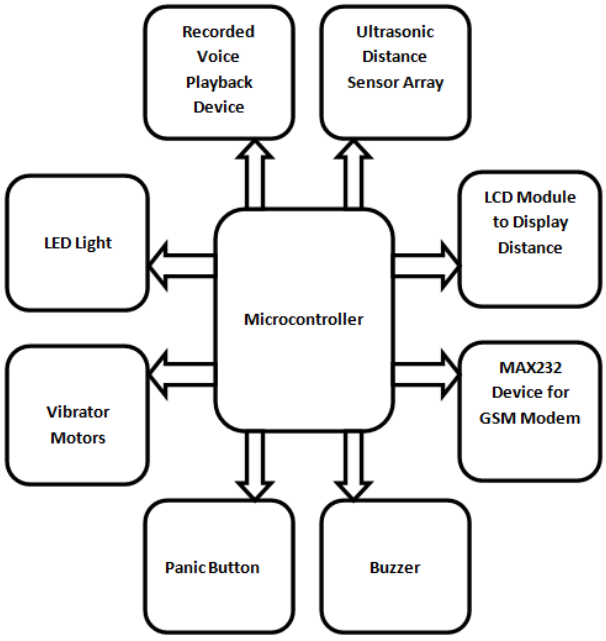

Figure-2: Block Diagram of Implemented System

1. MCU (Microcontroller Unit): It is the main controlling element of the system. All the commands for various actions will be delivered by the microcontroller only. It accepts input in the form of analog or digital signals from push buttons, sensors, modules, etc. and processes them to generate the processed output analog or digital signals to LCD, GSM, Buzzers, etc. The system is built around an eight bit microcontroller i.e. AT89S52 supporting the

following features 40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA, built-in UART module.

2. GSM Modem: Here a GSM modem is being interfaced with the microcontroller AT89s51 for SMS/Call communication. Text message may be sent through the modem by interfacing only three signals of the serial interface of modem with microcontroller i.e. TxD, RxD and GND. AT commands are instructions used to control a modem. AT is the abbreviation of ATtention. Every command line starts with "AT" or "at".

3. Ultrasonic Sensors: Though the IR based sensors are cheap, their working range may vary due change in ambient light and won't give accurate range values. These devices work on a similar principle of sonar or radar which evaluates the target by interpreting the echo from sound or radio waves. It offers excellent range detection with high accuracy and stable readings. The operation of the module is not affected by the sunlight or black material. Most of the ultrasonic sensors are equipped with temperature compensation circuit to avoid changes in readings due to temperature changes. The module transmits an ultrasonic signal, picks up its echo, measures the time elapsed between the two events and outputs a waveform that's high time is modulated by the measured time which is proportional to the distance. The programmer needs to provide a trigger pulse at its TRIG pin and receive the echo signal at ECHO pin to calculate the distance value in centimeters.

4. Voice Playback System: The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Integrated output amplifier, microphone amplifier, and AGC circuits greatly simplify system design. The device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications. Their high level of storage capability is by using its proprietary analog/multilevel storage technology implemented in an advanced Flash non-volatile memory process, where each memory cell can store 256 voltage levels. This technology enables the APR9600 device to reproduce voice signals in their natural form.

Experimental Results

Through the number of experiments, we intended to identify how well users performed a navigation task with a smart cane to assess the objective utility and effectiveness of the device. The accuracy of the performance was measured in terms of the task completion time and collision rates. The task completion time was the amount of time from the starting point until reaching a destination. The collision rate was the number of obstacles that the participant collided with during the navigation task.

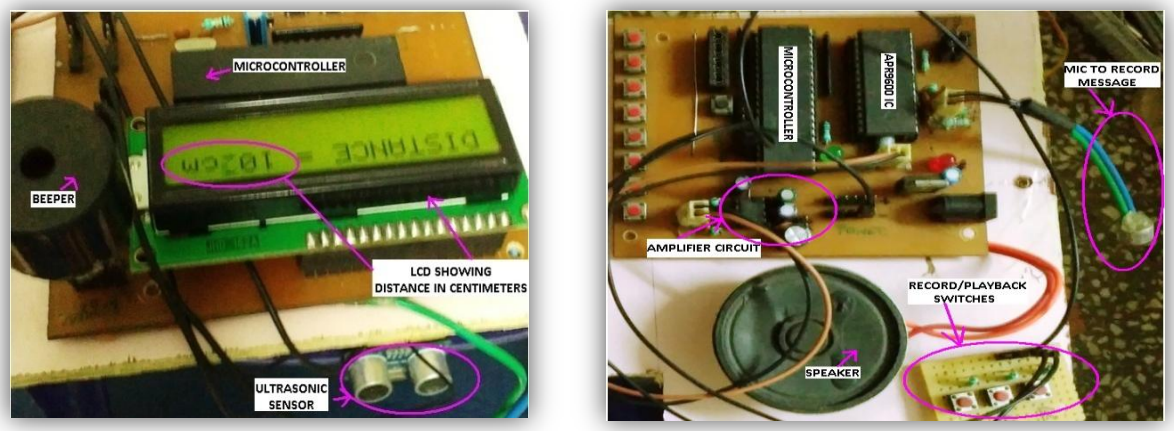

Figure-3: Screenshots of the developed System

Conclusion & Future Scope

The smart white cane is a practically feasible and viable product to carry around like any other walking stick. This could also be considered a crude way of giving the blind a sense of vision. This also reduces the load of caretaker and boost self-confidence while walking around. It can serve as a benchmark in aid for the blind. By focusing on a smart cane with obstacle detection and indication, this research analyzed users' needs and requirements to generate design guidelines for a smart cane. Compared to the traditional white cane, we found that the smart cane is more effective in avoiding obstacles, which influenced the user's higher preference and purchase intention for the smart cane. As the disabled population continues to grow, usable design with guidelines will be a significant factor in understanding the needs of the disabled and improving their quality of life.

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