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AN ULTRASONIC SENSORS BASED EMBEDDED CANE FOR VISUALLY IMPAIRED

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Abstract

To explore the world most of the time the visually impaired persons are greatly depend on assistant for navigation. They face difficulties in independent mobility hence they use white canes for support. The white cane, due to its primitive design, is unable to offer the visually impaired a level of independence that is achievable with modern technology. Further, the visually challenged are unable to know the location without sighted assistance as they cannot read the board. This paper implements a low cost Embedded Cane, to address the above problems. The proposed embedded cane detects the knee above obstacles, pits which helps the visually impaired people to navigate carefree, and communicate with the user through voice alerts and vibrations, which in-turn considerably reduces accidents. It also helps the user to identify the location. When an obstacle is detected, signals will be sent to microcontroller unit, which is pre-programmed to calculate the distance and send appropriate signal to wav audio player to play pre-recorded audio message. The vibrating motor will vibrate if the distance of the obstacle is nearby or less than 40 cm distance. RF Receiver helps to find the location in the indoor. Thereby it improves safety for the visually impaired user.

Keywords:

Walking Aid, White Cane, Microcontroller, Embedded Cane, RF Receiver and Ultrasonic Sensors

1. INTRODUCTION

According to world health organization, around 285 million people are affected with visual impairment worldwide. Visual impairment is a severe disability that restricts an individual's ability to integrate into the society. Visual impairment simply led to institutionalization and discrimination from the society. The very nature of the disability is such that it forces the disabled person to depend upon external help even for basic actions. People with visual disabilities are often dependent on humans, trained dogs, or a stick.

The preferred walking aid for visually impaired is the traditional white cane. It was recognized as the standard gear for the visually impaired. The three types of white canes are identification canes, support canes, and long canes [1].

Identification canes are generally more popular with the visually impaired who only want to alert others of their impairment. Support canes are similar to identification canes, in addition they provide more support and balance for the legs and body of the user. Long canes are most visible and compared to other canes they provides the most safety for the user by alerting them of terrain and height changes. When using the white cane, a person will hold one end of the cane and the other end is touching with the ground. It has its own set of problems like it can't detect the obstacles over knee height and it cannot provide geographical surroundings. The white cane user can gather the information by touching the objects by the tip of the cane. The traditional length of a white cane depends on the height of user and it extends from the floor to the person's sternum. White cane can only sense an obstacle up to 1 meter. It is unable to warn the user when there is an obstacle in their path until the user has touched it. Some incidents happen due to visually impaired people; cane did not sense the existence of an obstacle. The incidents might lead to serious injury to them. Those people also face great problems in moving from one place to another in the town and only way for them is guide dogs but they can be useful for about 5-6 years [6] [7].

The proposed system provides embedded cane with ultrasonic sensor, RF receiver, and wav audio player for the visually impaired people. For mobility system, it is equipped with ultrasonic sensor and vibrating motor. Ultrasonic sensor will send the trigger pulse to detect obstacles. When an obstacle is detected, signals will be sent to microcontroller unit, which is pre-programmed to calculate the distance and send appropriate signal to wav audio player to play pre-recorded audio message.

The vibrating motor will vibrate if the distance of the obstacle is nearby or less than 40cm distance. The microcontroller used in this system is Arduino Nano. The prototype of smart cane was developed to increase the mobility for visually impaired people with navigation system. Thus embedded cane helps visually impaired people to navigate carefree and considerably reduces accidents

2. LITERATURE SURVEY

Among the many challenges faced by the visually challenged persons are the constraints of independent mobility in an unfamiliar environment such as sudden depth, or obstacles above waist level or stairs. The white cane enables the user to effectively scan the area in front and detect obstacles on the ground [5]. Its low cost, portability and ease of operation make it an extremely popular navigation aid. However, the cane has two major limitations:

- In a practical setting, it can only be used to detect obstacles up to knee-level [2]. Hence, potentially hazardous obstacles like protruding window panes, raised platforms and horizontal bars go undetected and frequently collides with them.
- The detection range of the cane is restricted to 1-2 feet from the user. Certain obstacles (e.g. a moving vehicle) cannot be detected till they are dangerously close to the person.

A few obstacle detection systems are available in the international market but none of them come at a price that is affordable for people in developing countries. It is no coincidence that a majority of visually handicapped are also poor. Thus, there is a need for a knee-above obstacle detection and warning system that provides distance information through a non-interfering

stimulus and also comes at an affordable price. It is very difficult to the visually impaired people to know about the location inside the institution. So it is difficult for the visually impaired person to get the details of the location. So if the visually impaired person gets the audio information about the indoor location, they can easily access the rooms inside the institution without any sighted assistance.

Sheth et al. [1] proposed smart white cane which is a sophisticated and economic walking aid. Their proposed stick is designed to detect low lying and knee level obstacles. The pre-recorded sound messages and vibrations are used in their methods to alert the users. The system does not have a global positioning method to find the position of' the user using the GPS and guidance to their destination given to the user by voice navigation. The stick does not have the ability to detect moving objects.

Vaibhav et al. [2] designed a light weight, detachable unit comprising of an ultrasonic ranger and vibrator was developed which offers an increased range of 3m and detects obstacles above knee level. Distance information is conveyed to the user through vibratory patterns that vary incrementally with changing obstacle distance. But simply conveying distance information by vibration is not an efficient techniques. It miserably fails in most cases.

Balakrishnan et al. [5], in their work designed and implemented a detachable unit which detect knee-above obstacles. This unit consists of an ultrasonic ranger and a vibrator controlled by an eight bit microcontroller to offer an increased detection range of three meters. This unit is also capable of detecting fast moving obstacles. The battery based device lasts about 15 hours of constant usage before recharging.

The main objective of the proposed system is to develop an affordable knee-above obstacle-detection and warning system for the visually impaired employing ultrasound based ranging to enhance the horizontal and vertical range of the cane. Another objective is to inform about the location in indoor environment.

3. PROPOSED SYSTEM

The proposed system focused to develop an affordable knee-above obstacle-detection and warning system for the visually impaired, employing with ultrasound based ranging to enhance the horizontal and vertical range of the cane. Another objective is to inform about the location in indoor environment. The proposed Embedded Cane consists of 2 modules namely stick module and indoor spot module. The presence of an obstacle and pit in front of the user is identified by using front Ultrasonic Sensor.

The distance is measured in centimeters and corresponding to the distance the user hears distance of the obstacle or depth of the pit respectively in the earphone. If the obstacle is too close, the vibration motor attached vibrates. From indoor spot module, details of the spot are transmitted through RF transmitter and RF receiver in the stick module gets the location detail. Thus the user will get the location information through prerecorded audio. The indoor spot module consists of RF Transmitter connected to a microcontroller. It is controlled by using switches connected to the microcontroller. It is shown in the Fig.1.

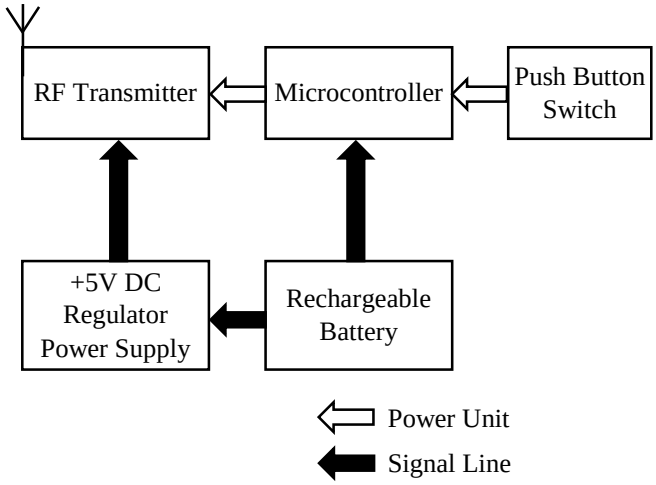

Fig.1. Indoor Location Module

From battery 5V is supplied to the Arduino Nano. The data pin of RF Transmitters connected to digital pin of the Arduino board. The information of the spot is transmitted by the antenna in RF Transmitter to the stick module. The block diagram of the Stick module is shown in Fig.2.

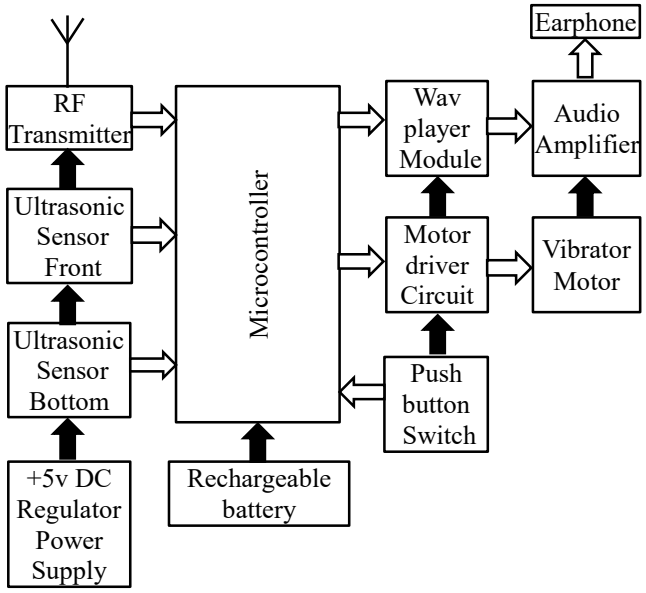

Fig.2. Stick module

Stick module consists of an Arduino Nano board, and which connected to two ultrasonic sensors, RF Receiver and Wav player module, vibrator and push buttons. The front ultrasonic sensor is connected to the board through digital pins 9 and 8, bottom ultrasonic sensor is connected to the board through digital pins 10 and 11. By pressing push buttons we will get the output as prerecorded audio files. Wav player module is connected to the board through receiver and transmitter pins. RF Receiver is connected to the Arduino board through digital pin 4. An audio amplifier is connected to the Wav player module which amplifies the prerecorded audio files and ear phone is connected to the amplifier.

4. DESIGN METHODOLOGY

Though the white canes are widely used it cannot often provides Safe mobility in daily life. They detect only near-by knee level obstacles on the ground. Hence, the user cannot detect raised obstacles and frequently collides with them. The cane can only detect obstacles in few distance, which will become dangerous in case of obstacle like moving vehicles. The intention of this work is to design a low cost, user friendly navigation aid for visually impaired people to detect obstacle above knee level and warn them about the danger in advance. Another objective of Embedded Cane is to help the visually impaired people to alert them where they had reached.

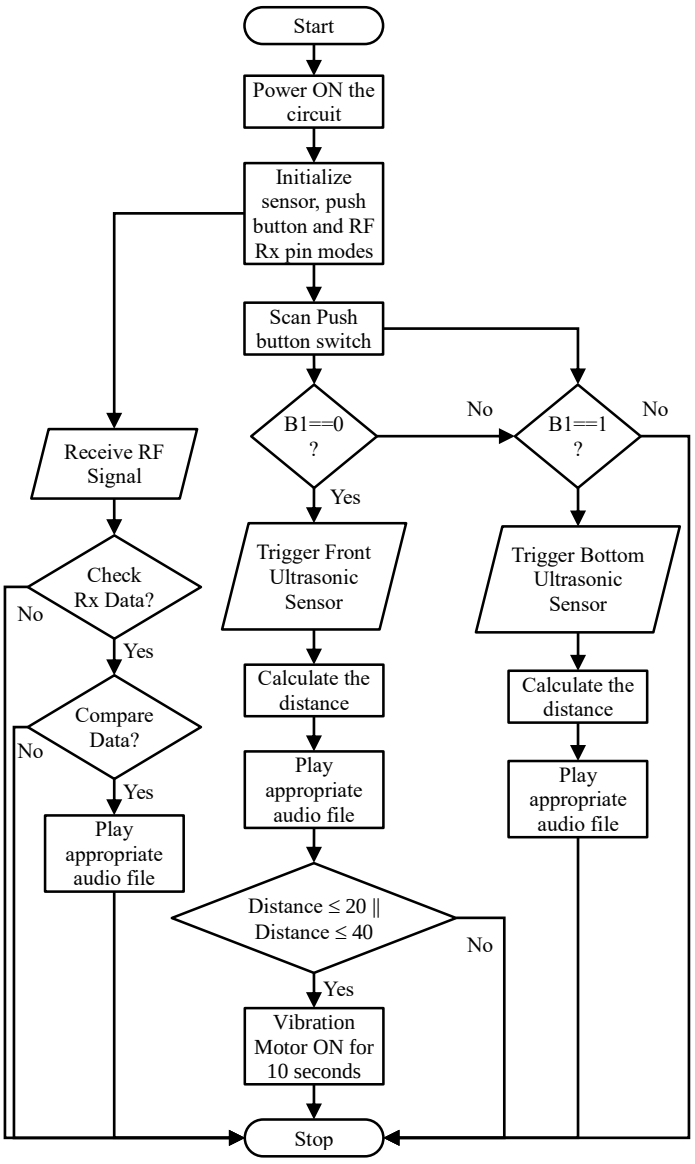

Fig.3. Design methodology

The work is implemented in a way such that, there were 2 keys in the stick. One key is for finding obstacles in front and another key is for finding the pit. The obstacle detection is done by front ultrasonic sensor and pit detection will be done by bottom ultrasonic sensor. RF transmitter in the location module will keep on sending data to the receiver. When the user reaches each location automatically the user will get the prerecorded audio message that he is in the particular location. The audio is played only once when he reaches the particular location. The design methodology of the entire embedded cane is depicted in the following Fig.3.

5. RESULTS AND DISCUSSIONS

Different voice messages are listed in the Table.1 are utilized to alert the user. The following table shows the results of the voice message played by the wav player for different obstacles found by the front ultrasonic sensor.

Table.1. Different voice alerts messages for different obstacles

S. No.	Distance	Voice message	Vibration
1	0-20	Obstacle in 20centimeter. Be careful.	Yes
2	21-40	Obstacle in 40centimeter. Be careful.	Yes
3	41-60	Obstacle in 60centimeter. Be careful.	No
4	61-80	Obstacle in 80centimeter. Be careful.	No
5	81-100	Obstacle in 100centimeter. Be careful.	No
6	101-120	Obstacle in 120centimeter. Be careful.	No
7	121-140	Obstacle in 140centimeter. Be careful.	No
8	141-160	Obstacle in 160centimeter. Be careful.	No
9	161-18	Obstacle in 180centimeter. Be careful.	No
10	181-200	Obstacle in 200centimeter. Be careful.	No

The following Table.2 shows the results of the voice message played by the wav player for different depths found by the bottom ultrasonic sensor.

Table.2. Different voice alerts messages for different depths

S. No.	Distance	Voice message
1	10	A pit ahead of 10 centimeter depth. Be careful.
2	20	A pit ahead of 20 centimeter depth. Be careful.
3	30	A pit ahead of 30 centimeter depth. Be careful.
4	40	A pit ahead of 40 centimeter depth. Be careful.
5	50	A pit ahead of 50 centimeter depth. Be careful.
6	60	A pit ahead of 60 centimeter depth. Be careful.
7	70	A pit ahead of 70 centimeter depth. Be careful.
8	80	A pit ahead of 80 centimeter depth. Be careful.
9	90	A pit ahead of 90 centimeter depth. Be careful.
10	100	A pit ahead of 100centimeter depth. Be careful.

The Table.3 shows the results of the voice message played by the wav player for different locations found by the RF receiver.

Table.3. Results of Voice Message

S. No.	Message
1	Welcome to ESD lab
2	Welcome to DSP lab
3	Welcome to VLSI lab
4	Welcome to Admin

(a)

(b)

(c)

Fig.4. (a) Indoor module (b) Bottom ultrasonic sensor stick module (c) Stick module

The indoor module shown in the Fig.4.(a) contains 4 switches. When we press the switches it will send the information to RF receiver in stick module. In Fig.4.(b) the bottom ultrasonic sensor and front ultrasonic sensor attached to the stick can be seen. In Fig.4.(c), status LED and the handle is shown. When the stick module is working, the status LED blinks.

6. CONCLUSION

The embedded cane's aim is to bring the white cane up to technological modernity while maintaining its affordable price. The Embedded Cane is geared towards an elderly, less affluent demographic group that would demand comfort, accessibility, and affordability from the product. In this paper two systems for the visually impaired are devised, namely, an ultrasound-based cane mounted knee-above obstacle detection and warning system, and an RF based user-triggered spot identification. Using the ultrasonic sensor, Arduino board, vibration motor, RF receiver, wav player inside the Smart Cane greatly increased the object detection range of the white cane, thereby improving the lives of the blind and visually impaired users.

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