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Design of e-shoe for Visually Impaired by Using RFID Technology

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Abstract

It is a known fact that blind people find it extremely difficult to detect their way through obstacles and stairs. Using a white stick to detect the obstacles had been an age old method, which cannot provide complete solution. In order to overcome this problem, an obstacle detecting shoe is developed. It senses the obstacle through ultrasonic sensors and alerts the user through the message. The ultrasonic waves transmitted are reflected by the obstacles and echo is received by the ultrasonic receiver, where the distance is calculated by using a microprocessor. The RFID system is used to assist the blind people. When the reader located on the shoe moves on to a specific tag, unique tag ID is sent to the reader. While in the case of walking in traffic, RF Link Transmitter/receiver is used for traffic signal detection and for passing instructions to the user through voice messages. A timer is used to detect the wet areas and helps the blind to avoid slippery.

Keywords: *Ultrasonic Sensors, RFID Tags, Microcontroller, RF Link Transmitter/receiver, 555 Timer, Voice Module*

INTRODUCTION

Living even a single day without eyesight is unimaginable! But there are many people in the world who do not have proper vision. Some may be blind and some may have other visual disorders. They find it hard even to do their daily chores. For such people, working like any other ordinary person is nothing less than a dream.

Many hundreds of millions of people are estimated to be visually impaired worldwide: 39 million are blind and 246 have low vision. About 90% of the world's visually impaired live in developing countries and almost equal percentage of people is living in extreme poverty. Many international organisations such as World Blind Union (WBU), International Council for Education of People with Visual Impairment (ICEVI), United Nations (UN) are coming together to educate the blind [1],[2].

The living conditions of blind people can be improved if they are educated and given an opportunity to earn their living. They will be benefitted if they are allowed to work in industries, educational institutions and other work places. Since times immemorial, people have been trying to invent aids that can help the blind in moving around, the first one being white cane. People used to just move around with the white cane, moving it here and there so that they would know if an obstacle is present. But this method works well only when the obstacles are too near and most of the times it becomes impossible to avoid them. Later on electronic engineers developed devices known as the Electronic Travel Aids (ETAs).

The main aim of this paper is to provide help to the visually impaired people to work in any place by equipping a shoe using microprocessor, ultrasonic sensors,

RFID tags that can detect the obstacles in the path of the user and also give certain instructions to the user based on the detected obstacle. The obstacle sensing is accomplished using RFID tags and the necessary instructions can be played based on the RFID tag detected by the reader using the predefined instructions stored in the voice library of the microprocessor.

THE PROPOSED SYSTEM

The proposed system is shown in fig.1. It mainly consists of Microprocessor, 3-Ultrasonic sensors, RFID Tag, RFID Reader, RF Link Transmitter/Receiver, 555 Timer and speaker. The sensors continuously detect the obstacles on front, left and right sides and send the information to the microprocessor where the distance is calculated. RFID tags convey the information about the obstacles to the microprocessor via reader and send information to user through the speaker

The system consists of four units, namely Proximity Sensing (Obstacle Detection) Unit and Navigation Unit, Traffic Signal Detection Unit, Water Detection Unit.

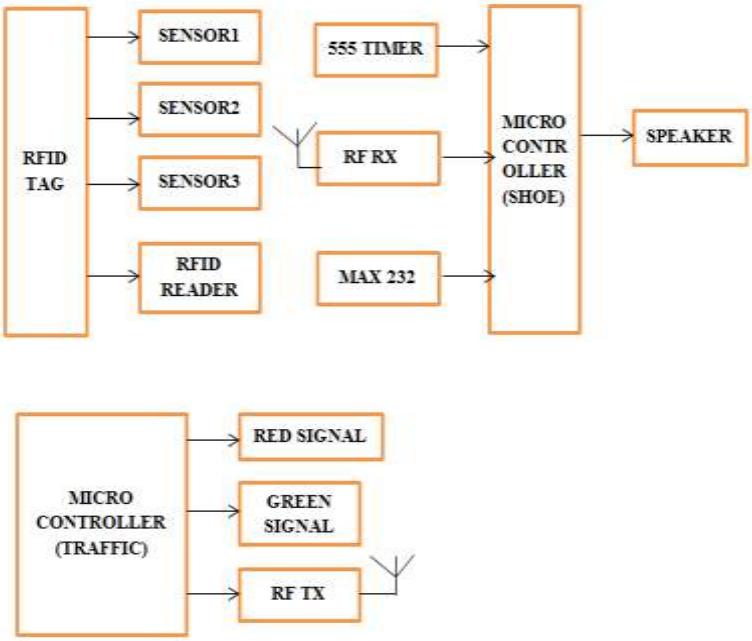

Fig. 1. Block Diagram of the Prototype

Navigation Unit

The navigation unit in figure 2 contains the pre-installed guidelines for the way-finding of the user. The pre-recorded instructions guide the visually impaired user to find his/her way. The RFID tag along with the reader is known as RFID system which is the major part of the navigation unit. When the reader placed on the shoe moves to a specific tag, unique tag ID is sent to the reader. The tag ID is transmitted to the microcontroller through the serial port using RS-232 protocols. Corresponding to the ID received, the microprocessor reads data and corresponding voice is played back to the user through head phones. Thus the directions for the specific location are made available to the user [3].

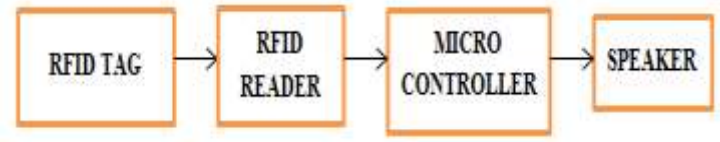

Fig. 2. Block Diagram of Navigation Unit

Proximity Sensing Unit:

The Proximity sensing unit, also known as the obstacle detection unit, is used to detect unexpected or moving objects on the user's path. The figure 3 represents the proximity sensing unit. The signal is generated from the microprocessor, which is fed to the ultrasonic transmitter. The transmitter emits ultrasonic waves, which are reflected back by obstacle in the user's path. The echo received by the ultrasonic receiver is a weak signal and is hence fed to the two stage amplifier where the gain is sufficiently improved. The amplified signal is given to a comparator to convert the analog signal to a TTL signal compatible with the microprocessor pins.

The TTL signal from the microcontroller is fed to the driver circuit (MAX232) converted to a 5V signal to drive the transmitter.

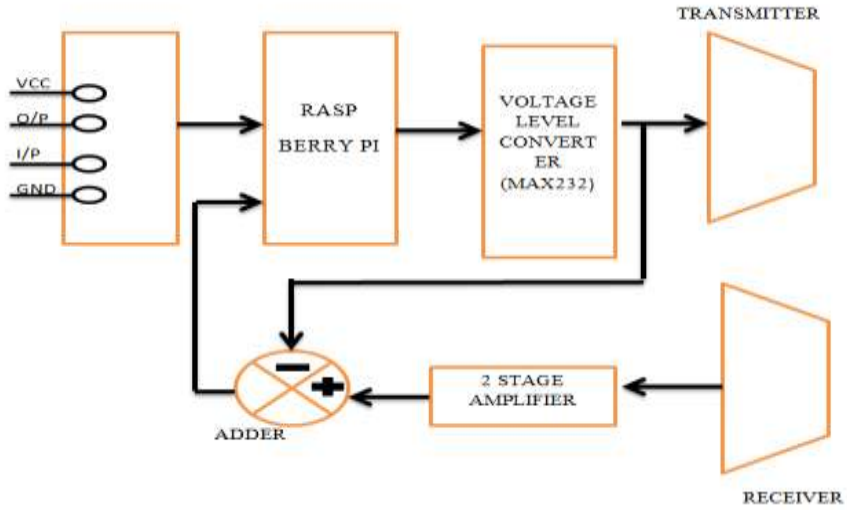

Fig. 3. Block Diagram of Proximity Sensing Unit

Traffic Signal Detection Unit:

In traffic signal detection, wireless RF Link Transmitters are used. These work with 434MHz Receivers. RF Link Transmitters are placed at traffic poles, whereas receivers are placed at the user. Both the transmitter and receiver work at common frequencies. Transmitter sends traffic signals to the receiver up to 500ft range. The signals received are processed using microprocessor and corresponding instructions are played back to the user.

Water Detection Unit

The 555 timer IC is the heart of water detection unit. For sensing the water, two conducting wires are used, which are connected to trigger and ground pins of the 555 timer. When the trigger input of 555 timer is more than 1/3 of Vcc, the output pulse begins. The width of the trigger input depends upon RC time constant of the network, which contains capacitor(C) and resistor(R). When the voltage on the capacitor equals 2/3 of V_{cc}, the output pulse ends. The width of the output pulse can be adjusted to specific application by

adjusting the values of capacitor and resistor. The time taken to charge C to 2/3 of the supply voltage, which is known as output pulse width of time t, is given by the formula

$t = RC \text{ Ln } (3) \cong 1.1RC$

where t is in seconds, R is in ohms, C is in farads.

The output of 555 timer goes high, when water is sensed. The output of the 555 timer is connected to microprocessor, where the information is processed and activates the voice module. The speech messages about water detection are conveyed to the user.

SYSTEM DESIGN

Using LPC-2148 Launch Pad

The system is designed using LPC2148 launch pad which is ARM based architecture. The launch pad consists of 64 pins out of which 47 are used as GPIO pins. The system is tested by using 3 sensors which are used to detect the obstacles from front, right and left side. The sensors sense the obstacles and give the information to microcontroller where the distance is calculated and instructions are given to the user through voice module (APR33A3). The RFID tags are used for identification purpose. The tag information is stored in voice module to playback to the user.

Since the voice module has capability of storing 8 messages only, another voice module is required for storing tag information.

Using Arduino Uno

The system is designed using the Arduino Uno microcontroller which is based on the ATmega328. The microcontroller contains 20 pins out of which 14 are GPIO pins. Out of 14 pins, 6 pins are used for sensor connections and 2 pins are used for voice module connection that is the pin requirement is sufficient. Arduino Uno occupies less space and easily fits into the shoe and its cost is less when compared to the ARM.

Using Raspberry Pi3

The system is designed using Raspberry Pi 3 that contains BCM2837 SoC. It has 40 pins out of which 26 are GPIO pins. Raspberry Pi together with keyboard and mouse operates as a standard PC [6]. Unlike other microcontrollers, it has inbuilt voice module, which eliminates extra circuitry for voice module and the pin requirement is also sufficient. It can be easily fit in to the shoe and it is cost effective. Since it is a Quad Core processor, processing time is low and user can get the information of obstacles very quick.

WORKING

The working of the shoe can be divided into four parts: the sensors, the RFID system, Traffic Signal Detection system, and Water Detection system. All the systems are independent and work on their own accord. All the systems are placed on the shoe and are connected to the Raspberry Pi 3 microprocessor.

There are three ultrasonic sensors connected to the system and placed on the front, left and right side of the shoe. These sensors are used to detect the obstacles in the path of the user and to intimate the same. The range of the sensors increases with increase in distance. A program is written for the microprocessor to play a specific audio if an obstacle is encountered [5].

Ultrasonic sensor has a trigger and an echo pin. As soon as the TRIG pin goes HIGH and then LOW (for a period of not less than 10µs) the internal clocks start ticking. Eight (8) cycles of 40KHz audio are sent out of the transmitter and it starts counting how long it takes for the echo to arrive and the ECHO pin is used to detect the echo

signal and based on the time taken for the echo signal to arrive, the distance is calculated. The formula for distance calculation in ultrasonic sensor is:
Distance= (speed x time) / 2
where the distance is divided by two since the signal travels twice the distance before reaching the ultrasonic sensors.

The RFID system comprises of RFID reader module and RFID tags. The reader module is connected to the microprocessor whereas the various tags are placed on various obstacles. In a basic RFID system, tags are attached to all items that are to be tracked. These tags are made from a tiny tag-chip, sometimes called an integrated circuit (IC), that is, it is connected to an antenna that can be built into many different kinds of tags including apparel hang tags, labels and security tags, as well as a wide variety of industrial asset tags. The tag chip contains memory which stores the product's electronic product code (EPC) and other variable information so that it can be read and tracked by RFID readers anywhere.

An RFID reader is a network connected device (fixed or mobile) with an antenna that sends power, data and commands to the tags. The RFID reader acts like an access point so that the tags' data can be made available to the user [7].

The Raspberry Pi has an inbuilt voice library and one can store large number of voice messages in it. When a specific tag is identified by the reader, it sends the signal to the microprocessor and the message corresponding to that tag is played. In this manner, pre-defined instructions for the user can be stored. Using these instructions, directions can be given to the user as to where to move when the obstacle is detected.

In Traffic Signal Detection unit the Radio Frequency Link Transmitters and Receivers are used. These work with 434 MHz Radio Signal. The transmitter is placed at the traffic signal and the receiver is placed at the user. Whenever user approaches the traffic signal, the transmitter receives serial data and transmits it wirelessly through its antenna connected to pin4. The transmission occurs at a rate of 1kbps - 10 kbps. The transmitted data is received by a receiver and it gives alert to the user about the traffic signals so that it allows blind people to walk in traffic safely.

Water detection unit allows blind people to know about wet areas and helps to avoid slippery. The 555 timer is used for water detection. Two conducting wires are used to sense water, out of which one is connected to trigger pin of 555 timer and other is connected to ground. The output pin is connected to microprocessor. Whenever water is sensed, output pin gets activated and it gives information to the microprocessor which further activates the voice module, so that a message signal is conveyed to the blind person.

RESULT

The proposed system shown in figure 4 is designed using Raspberry Pi, Ultrasonic Sensors, RFID tags, RF Link Transmitter/Receiver and 555 timer. Sensors are used for the detection of the obstacles, where the RFID tags are used for obstacle identification and distance is measured through Raspberry Pi. The demonstration is carried out by a person, assuming how a visually impaired person would feel. In this demonstration, 20 RFID tags are taken and placed in a location where the blind people are working and a predefined path is set so that the user can get information of surrounding environment through voice messages where he/she can work. Here the users get the tag information when the reader comes with in a distance of 10cms.

Fig. 4. Prototype of Proposed System

The sensors can detect the obstacles up to 150cms but due to the fear of getting interfered with the messages played by RFID tags, distance of more than 5 cm and less than 20 cm are set. While in case of moving in traffic, RF transmitter sends information about the traffic signals to the receiver and gives instructions to the user. For water detection, electrodes are placed at the bottom of the shoe and whenever water is sensed it conveys information to the user through voice messages.

CONCLUSION

The proposed system introduces a new concept of Electronic Shoe for Visually Impaired which makes it more convenient for blind people to travel.

In earlier ETA, the main drawback is their complex nature. They are not easily portable and hence their practicality is limited. The prototype designed in this paper is simple, portable, convenient and cost effective. This facilitates the user to move around freely without any hassles. This will enable the blind person to step in the outside world and work like any common man. This system can be extended to use in all common places since the tags can be easily installed and they are cost effective when manufactured in bulk.

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