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DESIGN AND IMPLEMENTATION OF A MULTI-SENSOR SMART STICK FOR VISUALLY IMPAIRED MOBILITY ASSISTANCE

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Abstract
Blind and visually defective people find it difficult to travel in unfamiliar places where there are many obstructions in their path. To solve this issue, this blind stick is an innovative stick designed for visually disabled people for improved navigation. This IOT proposal aims to an advanced blind stick that allows visually challenged people to navigate with ease using advanced technology. The blind stick is integrated with an ultrasonic sensor along with water sensing and slush sensing features. This proposed system first uses an ultrasonic sensor to detect obstacles ahead using ultrasonic waves. On sensing obstacles, the sensor sends the data collected from the sensor to the microcontroller for processing. This microcontroller then processes this data and calculates if the obstacles are close enough. If the obstacle is close it will send a signal to sound a buzzer. When the blind person gets close to an obstacle, the frequency increases so is sound. The add-on feature is, that it also detects and sounds a different buzzer if it detects water and alerts the person. Moreover, during the rainy season, there is a huge chance for the visually impaired person to slip on the ground due to slush. To solve this issue, this smart stick will also detect the slush in front of them and notify it with the RFID. The buzzer sound will be different for each obstacle. When the object gets near the buzzer sound will increase and gives a different sound. The smart stick helps people to walk in indoors and outdoors independently by identifying the obstacles in front of them.

Keywords:
Buzzer, microcontroller, obstacle, RFID, ultrasonic

1. INTRODUCTION

In today's world eyesight plays a significant part. Blind people face more difficulties to survive around. To decrease the difficulties and to make the person aware of the environmental situations around them, the "Smart Blind Stick" is a device that aims to reduce the difficulties in daily life and makes them walk independently. In a normal day-to-day situation, a blind person waves the blind stick ahead of them to check for any objects or obstacles. The smart stick helps them in detecting any obstacle obstructing the path being taken by the subject. On detection of the obstacle, the magnitude of the distance is assessed by the corresponding value of N stored within the system. The greater value of N corresponding to a greater distance develops a low frequency of sound in the buzzer. While the distance is less than 1 foot the corresponding value of N produces a high frequency of 1KHz. This variation in frequency as heard by the visually impaired person helps him/her to avoid the obstacles coming very close to him/her which is a significant help for the person. This electronic gadget assists visually impaired persons using an ultrasonic sensor to navigate along the road with two different frequency sounds from the buzzers to notify the obstacle distance along the person's path. The intermittent sound indicates the long gap between the obstruction while a continuous sound along with the beep sound indicates the obstacle's distance of less the 30m. Ultrasonic sensors generate high-frequency sound waves and evaluate the echo received back by the sensor for processing. These Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. That signal is sent to the embedded systems which are attached. The water sensor creates a musical sound when there is a slush or watery surface in Infront of the person. When the physical objects with a watery or slushy surface then the continuous beep sound along with the musical sound increases. These audible assistances help the visually impaired person avoid the obstructions coming in front of them.

2. LITERATURE REVIEW

Agarwal et al [1] presented this smart stick, which is made using ultrasonic, moisture detection sensors, Bluetooth, DC Buzzer, LDR sensor, and IR proximity sensor. The proposed system detects obstacles in a particular direction (left, right, front, or down) with the help of an ultrasonic sensor and IR sensor. Moisture sensor will detect the water, LDR is used to detect the darkness of the environment and sends back the voice alert through the android application.

Ghate et al [2] present smart gloves for visually impaired people which detects the obstacles using ultrasonic sensors and alerts the person with the vibrator placed on the stick. The GPS technology is integrated with the microcontroller order for their safety purpose.

Srivastava et al [3] presented smart hand gloves for visually impaired people which identify the obstacles and notify the person with a buzzer. Since the blind cannot read the texts or images, they need someone to assist them in reading. To overcome this issue, this smart glove helps the person read the texts in the image and convert them into the text to speech which results in voice assistance.

Kakada et al [4] presented a smart shoe with a navigation system which is a wearable device that detects obstructions around the environment and notifies the person using a voice note with the help of an android application. The design and implementation of the device are integrated with an ultrasonic sensor and android.

Nor et al [5] presented a smart blind glove for blind people. Over these many years, blind people used a smart blind stick to identify the obstacles in their path. To identify the obstructions in front of them before getting them too close, this smart glove will sense the obstacles and notify them with a buzzer and a vibrator. When the obstacle gets close the sound of the will increases and warns the person. This glove aims to decrease the difficulties in their path by identifying and notifying them.

Naiwrita Dey et al [6] presented the design and implementation of an ultrasonic sensor-based walking stick for a visually impaired person. An ultrasonic sensor module, HC-SR04 is used for obstacle detection in the path of the blind person and a buzzer is used to make the person alert. The proposed system is implemented using a PIC microcontroller. Blind persons can use this walking stick for safe navigation outdoors. It can detect obstacles within a 5 to 35 cm range of distance.

Akkalkot et al [7] presented an Ultrasonic sensor-assisted walking stick developed as an assistive technology for visually impaired people. To avoid obstacles and potholes for the visually impaired people HC-SR04 module, the ultrasonic sensor is used. The sensor would warn the visually impaired people about the obstacles and the pothole by detecting them using an ultrasonic sensor. This implementation is framed using the ATmega328P microcontroller. Visually impaired persons can use this for obstacles and potholes that are within a distance of 2–400 cm or 1–13 ft.

Shruti Dambhare and A.Sakhare (2011) [8] designed an artificial vision and object detection with real-time assistance via GPS to provide an efficient navigation aid for the blind which gives a sense q efficient vision by providing information about the environmental scenario of static and dynamic objects around them.

Alejandro et.al. (2012) [9] designed an assistive technology device called the electronic long cane to serve as a mobility aid for blind and visually impaired people. The system was designed using a haptic sensor to detect obstacles is detected: the cane vibrates or makes a sound. The proposed system detects obstacles above the waistline.

Sathya et al (2020) [10] presented a proposed system containing the ultrasonic sensor, water sensor, voice play backboard, raspberry pi, and speaker. This system detects the obstacle images both indoors and outdoors with the help of images. The Stick measures the distance between the objects and the smart walking stick by using an ultrasonic sensor that senses the physical object. The image is detected using image sensors attached to it. The raspberry pi is the central controller of the system. The images which were sent from the camera are compared with the images stored in the dataset using image processing.

3. MATERIALS AND METHODS

The proposed system uses a microcontroller that has a processor integrated with RAM, an input/output chip, and so on. Atmega 328 embedded microcontroller has 5 voltage regulator IC which converts the input to 5v as shown in Fig.1. It consists of the analog pin from A0 to A5 for input and the digital pin from D0 to D13 for input and output of data. The Atmega is connected to the Arduino

board which is powered with a USB connection or with an external power supply. It consists of ultrasonic sensors which have a trigger and echo pin. The trigger pin in the ultrasonic sensor will collect the data and triggers so that actuation takes place. When this Echo signal is received by the ultrasonic sensor, the gateway pulse drops to a low state. The data is transmitted using RF Transmitter which receives serial data and transmits it wirelessly through its RF antenna.

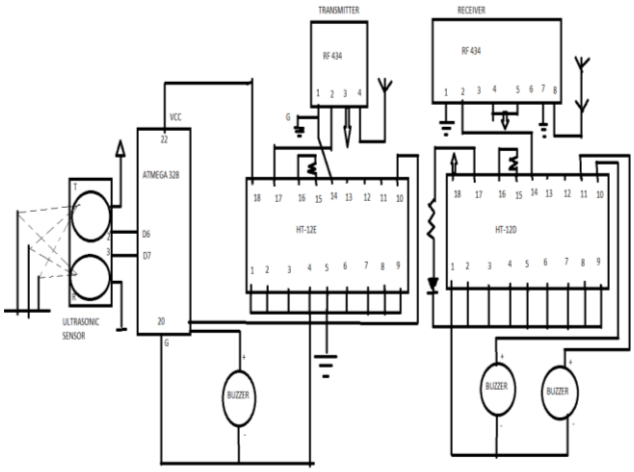

Fig.1. Ultrasonic sensor with RF Transmitter and Receiver

The transmitter occurs at the rate of 1kbps – 10kbps. The RF receiver receives the transmitted data and is operating at the same frequency as that of the transmitter. The battery is used to supply the flow of current to the RF Transmitter and receiver.

4. RESULTS AND DISCUSSION

This proposal falls under the "Sensor-based electronic automation" category. The processor used is Atmega328 which controls the Loudspeaker sound and the buzzer sounds. This embedded system smartly transmits the sensor data from the stick to the visually impaired person. The ultrasonic sensor provides 40kHz high-frequency sound waves that are not audible to the human ears.

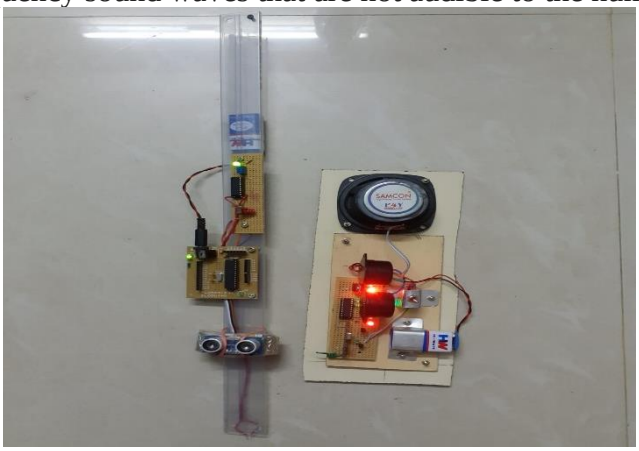

Fig. 2. Smart Blind stick

A buzzer of 8 cycles of 40KHz is generated in the software and sent through the pin D7 to the ultrasonic sensor to transmit sound waves from the sensor output. These soundwaves travel through the air till they meet any obstruction and get reflected by the ultrasonic sensor. When this Echo signal is received by the ultrasonic sensor, the gateway pulse drops to a low state. When the soundwaves are despatched the gateway pulse goes high and remains high, alluring which time the clock pulses of 1microsecond duration trigger the counter, and its count advances from reset position (0000). When the echo is received, the gateway falls to byte '0' and stops the input clock pulse from triggering the counter. Hence the count stops, and its value N is recorded. Thus, the ultrasonic sensor can determine the distance of any obstruction coming in its way. The visually impaired person can judge the distance by hearing the frequency of the output wave generated by the output circuit. For lesser distance, the person will receive a continuous frequency of 1khz, greater distance the frequency will be smaller as

shown in Fig.2. By hearing the frequency, the person can judge the distance of the obstacles and move in an appropriate direction.

5. FUTURE SCOPE

Vision impaired people face a lot of difficulties in their day-to-day life, and they tend to depend on a third person in order to get to know the environment. The proposed system will detect any physical obstruction, watery, or slush surface and notify them with different sounds such as beep sound for the physical obstruction and musical sound for the watery and sluggish surface with the variance in frequencies. The system can be enhanced such that the smart stick will identify what of obstructions in their way as a vehicle, human beings, or wall in their path and notify the person with a voice note. This will help the vision-impaired people get to know the environment easily and will assist the visually impaired with a third eye.

6. CONCLUSION

Though technology has improved in today's world It is difficult for vision-impaired people to face the obstructions in their daily life. The main aim of this proposal is to decrease the unaware surroundings for the vision impaired by providing a smart stick that detects any physical obstruction, watery, or slush surface and notify them with different sounds such as beep sound for the physical obstruction and musical sound for the watery and sluggish surface and the frequency of the sound increases as the obstruction gets too close the person. With the help of this smart stick, blind people can get to know the situations around them and not get misused by other people.

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