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Ultrasonic Walking Stick for Visually Challenged People

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***Abstract*: There are so many blind people in the society, who are suffering from exercising the basic things of daily life and that could put lives at risk while travelling. The generally available blind walking sticks are capable of finding obstacle that touch the stick physically. It is helpful to a blind person but we here propose an advanced blond stick system that allows blind person to sense objects before stick touches them. The blind stick is integrated with ultrasonic sensor along with light and water sensing devices. Our proposed project first uses ultrasonic sensor to detect obstacles without touching it using ultrasonic waves. Also it includes gps tracking feature to find lost person along with other useful features. The system uses a microcontroller based circuit to handle the entire system functioning. Our system uses ultrasonic sensor to sense objects within certain range of the person and sounds beeps of a particular type to signal obstacles. Also we use a shorting system to detect water in front of the person. As soon as the front wires of the system dip in water that system signals the blind person by a different beep pattern to signal water in front. We add voice module to give instruction about any obstacles. Now this system also has a light sensing feature to give the blind person a sense of light. It signals the person if there is light or darkness so that he/she can know if it is night or has entered a very dark room/facility. If the person loses the stick the person can use an RF remote so the stick starts beeping and the person can find it. One more important feature of the system is that the system allows the blind person to send out a SMS message with his/her GPS location to the caretaker/relatives/loved ones of the person in case of trouble or being lost.**

***Keywords*: Ultrasonic sensors, intelligent stick, Microcontroller**

1. Introduction

According to the World Health Organisation (WHO) statistics, around 30 billion people are blind on the earth. This project proposes to design and develop a portable unit (stick) for them for easy usage and navigation in public places. The blind stick is integrated with ultrasonic sensor along with light and water sensing. Our proposed project first uses ultrasonic sensors to detect obstacles ahead using ultrasonic waves. On sensing obstacles, the sensor passes this data to the microcontroller. The microcontroller then processes this data and calculates if the obstacle is close enough. If the obstacle is not that close the circuit does nothing. If the obstacle is close the microcontroller sends a signal to sound a buzzer. It also detects and sounds a different buzzer if it detects water and alerts the blind. One more feature is that it allows the blind to detect if there is light or darkness in the room. The system has one more advanced feature integrated to help the blind find their stick if they forget where they kept it. A wireless RF based remote is used for this purpose. Pressing the remote button sounds a buzzer on the stick which helps the blind person to find their stick. Thus this system allows for obstacle detection as well as finding stick if misplaced by visually disabled person.

2. Objective

The main objective is to help visually challenged people to navigate with ease using advance technology. In this technology controlled world, where people strive to live independently, this project proposes an ultrasonic stick for blind people to help them gain personal independence. Since this is economical and not bulky, one can make use of it easily.

3. Literature survey

S. Gangwar (2011) designed a smart stick for blind which can give early warning of an obstacle using Infrared (IR) sensors. After identifying the obstacles, the stick alerts the visually impaired people using vibration signals. However, the smart stick focused only for obstacle detection but it is not assisting for emergency purposes needed by the blind. And also the IR sensors are not really efficient enough because it can detect only the nearest obstacle in short distance.

S.Chew (2012) proposed the smart white cane, called Blind spot that combines GPS technology, social networking and ultrasonic sensors to help visually impaired people to navigate public spaces. The GPS detects the location of the obstacle and alerts the blind to avoid them hitting the obstacle using ultra-sonic sensors. But GPS did not show the efficiency in tracing the location of the obstacles since ultra-sonic tells the distance of the obstacle.

Benjamin etal (2011) had developed a smart stick using laser sensors to detect the obstacles and down curbs. Obstacle detection was signalized by a high pitch BEEP using a microphone. The design of the laser cane is very simple and intuitive. The stick can only detect obstacle, but cannot provide cognitive and psychological support. There exists only beep sound that triggers any obstacle and there is no any assistance to direct them.

Mohd Helmyabd Wahab and Amirul A. Talibetal (2011) developed a cane could communicate with users through voice alert and vibration signal). Ultrasonic sensors are used to detect obstacle in front, since ultrasonic sensors are good in detecting obstacle in few meters range and this information will be sent in the form of voice signal. This voice signal is send via speaker to the user. Here blind people might find it difficult in travelling without any emergency alert rather than having only ultrasonic sensors.

Alejandro R. Garcia Ramirez and Renato Fonseca Livramento da Silvaetal (2012) designed an assistive technology device called the electronic long cane to serve as a mobility aid for blind and visually impaired people. The author implements the cane with an ergonomic design and an embedded electronic system, which fits inside the handle of a traditional long cane. The system was designed using haptic sensors to detect obstacles above the waistline. It works in such a way when an obstacle is detected; the cane vibrates or makes a sound. However, this system only detects obstacle above the waistline.

Joao José, Miguel Farrajota, Joao M.F. Rodrigues (2011) designed a smart stick prototype. It was small in size, cheap and easily wearable navigation aid. This blind stick functions by addressing the global navigation for guiding the user to some destiny and local navigation for negotiating paths, sidewalks and corridors, even with avoidance of static as well as moving obstacles.

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

Project Prakash is a humanitarian mission to help the blind children especially by training them to utilize their brains to learn a set objects around them. In, the stick has a ping sonar sensor to sense the distant objects. It also has a wet detector to detect the water. The micro-controller used is PIC microcontroller. The microcontroller circuit is on the outside of the stick but is protected with a code so its security cannot be breached.

Voice operated outdoor navigation system for visually impaired persons done by Osama Bader ALBarrm International Journal of Latest Trends in Engineering and Technology. Uses a stick equipped with ultra-sonic sensors, GPS and audio output system. The stick contains GPS along with a SD memory card which used to store different locations. The user can use voice commands to input the desired location This system will also provide the speed and the remaining distance to reach the distention.

Central Michigan University (2009) developed an electronic cane for blind people that would provide contextual information on the environment around the user. They used RFID chips which are implanted into street signs, store fronts, similar locations, and the cane reads those and feeds the information back to the user. The device also features an ultrasound sensor to help to detect objects ahead of the cane tip.

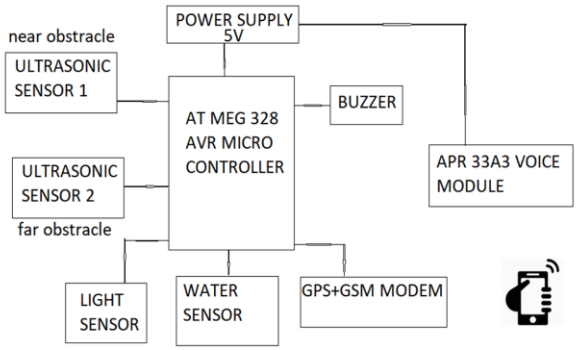

Fig. 1. Block diagram of the system

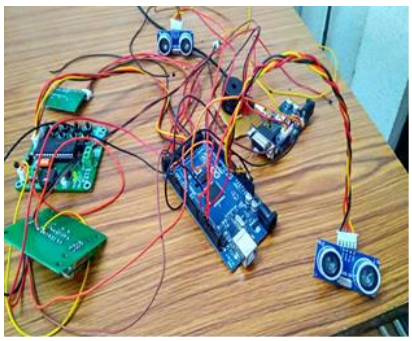

Fig. 2. Connections

4. Methodology

In this system the ultrasonic sensors are used to sense the obstacle (if there is any). The sensors are set a threshold limit if any obstacle is found within that range it gives beep speech through speaker. Obstacles found in different directions are indicated with different pattern beep and speech (Top, Middle, Pit and Water) to identify them easily. The ultrasonic sensors emit soundscapes with frequency lying in ultrasonic spectrum (>20kHz), which is inaudible to human ears. The sound waves hits the obstacle and bounces back to detectors. The ultrasonic sensor is used for detecting objects/obstacles which are in front whereas the two IR sensors are used to detect the obstacles on the sides. After the collection of data the calculations are done according to the formula: uS/58 = centimeters or uS /148 =inch. Once the distance of the obstacle is calculated then the conditions are checked. The signal is then send to microcontroller to operate a buzzer.

The microcontroller reads the distance of the obstacle using sensor and also commands the buzzer. The buzzer beeps once for left side obstacle, twice for front obstacles and thrice for right obstacles. The vibrator is also connected in parallel with the buzzer for vibration sensation.

The light sensor is gives a feedback about the environment. That is, it informs the user if it's day or night or if a particular place is dark or bright. The moisture sensor is used to detect

water pits or any puddles if present. All these signals are then sent to the microcontroller which in turn sends signal to the buzzer thereby alerting the user.

5. Components

Microcontroller: Arduinonano 3.0 Microcontroller Arduino can control the environment by receiving input signals (Digital/Analog) and can effects its surroundings by controlling lights, relays and other devices. The microcontroller on the board is programmed using Arduino software.

Ultrasonic transducers: Generating, detecting & processing ultrasonic signals Ultrasonic sensor is produce the sound waves above the frequency of human hearing and can be used in a different variety of applications such as, sonic rulers, proximity detectors, movement detectors, liquid level measurement. Ultrasonic Sensor Ranging Module HC - SR04. Ultrasonic sensor module HC - SR04 provides 2cm - 400cm non-contact measurement facility, the ranging accuracy can reach to 3mm.

The modules contain ultrasonic transmitters, receiver and control circuit. The basic principle of work: (1) Using IO trigger for at least 10us high level signal, (2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back. (3) IF the signal back, through high level, time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level time×velocity of sound (340M/S)/2.

IR sensor: To detect small size of obstacles: pit, staircase, or stone, as it located at the lower side of the stick. After detecting the small size of obstacles on ground, IR sensor will send the signal to the Arduino, as result it will send a voice instruction for small obstacle available. And at the same time it will enable the buzzer for informing the blind person about presence of obstacles on ground.

Water sensor: A water sensor is located at the base or bottom of the stick to have precaution against the wet surface which it can causing slipping on the floor and thus can hurt. When the water sensor comes in contact of the wet surface, it produces an electrical signal which triggers the Arduino controller. A voice instruction for wet surface is produced and also a buzzer is enabled for alarming against a wet floor.

LDR sensor: Light Dependent Resistor, changes its resistances due to change of the light intensity. During night, LDR will have high resistance and no current pass through it but through a LED connected parallel to it which illuminates and acts as a Flashlight, which can be easily noticed by others. It alerts people about the presence of blind person to let him to pass the way.

Buzzer: A transducer (converts electrical energy into mechanical energy) that typically operates A buzzer is in the lower portion of the audible frequency range of 20 Hz to 20 kHz. This is accomplished by converting an electric, oscillating signal in the audible range, into mechanical energy, in the form of audible waves. Buzzer is used in this research to warn the blind person against obstacle by generating sound proportional to distance from obstacle.

GPS and GSM System: When GSM modem receives a message the microcontroller will process the message with the keyword saved in it. Then, it will get the location of the stick from the GPS modem and transmit the location to the GSM modem in order to respond to the sender. In case of an emergency, the user of the stick can press the emergency button the microcontroller access the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the all saved numbers in the microcontroller The GPS will update the location of the stick and automatically save the location in microcontroller EEPROM memory. If the microcontroller receives the word “code word” (it is set) from the GSM modem, the microcontroller will track the last location from the EPROM and transmit it to the GSM modem which will send an SMS message that states the location for the person to the required number. Addition to that, if the emergency button is pressed the directly the microcontroller will transmit the last location saved in the EEPROM to the GSM modem to send it to all saved number in the microcontroller.

The main component of this system is the Radio-Frequency module which is used to find the stick if it is misplaced around. The transmitter keeps on sending signals upon pressing a key. These signals are received by the receiver which then sends signals to the microcontroller which in turn causes the beeping of the buzzer.

6. Advantages

- The system can be used both indoor and outdoor navigation.
- Blind person’s location can be tracked whenever needed which will ensure additional safety.
- Detects obstacles and alerts the blind person through vibration alert and speech output.

7. Disadvantages

- The system developed here is a moderate budget navigational aid for visually impaired people.
- Minimization in cost leads to compensation in performance.

8. Applications

- Some more applications like vehicle detection, slippery floor, on-coming vehicle detection and fire or smoke alarm can also be included.
- One more application is for the family members to gain access to the blind person’s location through the server whenever needed.
- Also, use of RFID tags will transmit the location information automatically to the PCB unit when the intelligent stick is in its range.

9. Future scope

The system can be supplemented with actual GPS MODULE used in cars and we can provide a vibrator for the partially deaf person. It can be further enhanced by using VLSI technology to design the PCB unit. This makes the system further more compact. A wall following function can also be added so that the user can walk straight along a corridor in an indoor environment.

10. Conclusion

All the studies which had been reviewed show that, there are a number of techniques for making a ultrasonic blind walking stick for blind people. The advantage of the system lies in the fact that it can prove to be a very low cost solution to millions of blind person worldwide. The smart white cane is a practically feasible product and convenient to carry around like any other walking stick. This could also be considered a crude way of giving the blind a sense of vision.

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