Smart stick using ultrasonic navigation with voice aid for visually impaired

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***Abstract*— Ultrasonic navigation based blind aid is built to guide the visually impaired and blind to walk easily in urban areas. The proposed system operates in two modes namely hurdle detection mode and fixed mode. In the hurdle detection mode, we have used ultrasonic sensor, water sensor, heat sensor and IR sensor to avoid obstacles using arduino. In this mode, the system detects solid and liquid obstacle sending respective instruction to the blind person through voice message via Bluetooth. The fixed mode provides the information and guidance to move from one place to another safely by setting a fixed route in blind stick from source to destination location. In addition to the above features, the system provides instructions to the blind to migrate to various placesusing the GPS system. An android device application is used to send messages via Bluetooth. The proposed system provides complete guidance and protection to a blind person under various circumstances.**

***Keywords*—UltrasonicSensor; Water Sensor; IR Sensor; Heat Sensor; GPS;Arduino; Bluetooth.**

I. INTRODUCTION

Eyes are the most precious gift God has given us. We can see the beautiful nature around us with the help of our eyes. But still there are many people who are not able to see what is around. These blind people are constantly dependent on an assistive device like white cane, guide dogs or other individual to navigate from one location to other. The problem increases when moving from one location to another. Thus we propose an aid for the blind which will help them to carry out daily chores with ease without depending on other individual. This will be a promising aid for support and encouragement to the blind as they struggle for an independent life. This aid is used to help the blind to move as confidently as sighted people.

The system uses Arduino Uno Board which consists of microcontroller Atmega328P-PU. This microcontroller does all the work of detecting signalsfrom different sensors. An ultrasonic sensor is used to detect the solid obstacle. The obstacle within a range of 90cm will be detected. This sensor sends input waves, these waves fall on the surface of solid obstacle and is reflected back to ultrasonic sensor and thus the obstacle is detected. When the obstacle is detected, an audio message is sent to the blindperson's phone with the help of Bluetooth chip mounted on the Arduino. The person can avoid the obstacle on receiving the message. Thus this stick allows the blind person to travel independently without any help.

The stick also allows the blind person to avoid liquid obstacles. Liquid obstacles will be detected by the water sensor which will be at the extreme end of the stick. When the stick comes in contact with liquid, the blind person is notified about the liquid obstacle. When the water sensor is immersed in water the two wires on the sensor get short and signal is sent to the Arduino which sends the data through Bluetooth about the liquid obstacle being detected. In this way the blind person can avoid all the liquid obstacles and travel safely.

IR sensor to detect small obstacles. After detecting the small obstacles on ground, IR sensor

will send the signal to the Arduino, as result it will send avoice instruction for small obstacleavailable. Heat sensor is very sensitive to the heat andcan detect the heat from long distance. If the sensor detects the heat radiation it will sendan electrical signal to the controller and thus voice instruction will be sent to person.

The system also allows the blind person to travel from one source to a destination avoiding all the obstacles. The Arduino with ultrasonic sensor is used for travelling a fixed route. The measurements of fixed route are embedded in the Arduino Uno board and the blind person is notified about the turns through the audio. In order to start the journey the blind person has to change to the fixed path mode with the help of button on the stick. As the person presses the button on the stick the journey starts. After traveling defined distance the person will be notified about the next turn to be taken. On reaching the destination the person is notified in the form of audio. Fixed route helps the blind to travel the same route every day.

The system is also making use of GPS in order provide precise location information of the blind on Android based Smart Phone. The navigation system uses TTS (Text-to- Speech) in order to provide a navigation service through voice. Also, it uses Google Map API to apply map information. All of these voice instructions are given to the blind through an android phone.

The paper is organized as follows: Section II presents the literature review. Proposed system is presented in Section III. Experimental are presented in section IV. Finally, conclusion is shown in Section V.

II. LITERATURE REVIEW

Navigation assistance for visually impaired (NAVI) [3] refers to systems that are able to guide blind people. The idea of the system is designing and developing shoes and portable audio playing device in order to assist blind person to move on different surface and in different path. The sensors used are RGB sensor which is used to detect obstacles depending upon its red, green and blue color level intensities of detected obstacle and IR sensors are connected on shoes at its front, left and right side to accurately detect the position of obstacle.

Blind Assistant Navigation System [5] will guide a blind or visually impaired person to navigate independently inside an enclosed environment such as home. The elements required to perform the guidance process include defining the destinationor target, identifying the current position of the blind person and finally determining the best path to be taken to reach the desired destination. Therefore the system uses networking and server to find the user location and the system needs to be store many different paths to reach the destination. The performance of the system can be improved using GPS, mobile device.

Ultrasonic Navigation System for the visually impaired & blind pedestrians [7] was designed in such a way that it gathers data about the environment via ultrasonic sensors and extracts the visual information from that data. This visual information is then transformed into an audio signal immediately and the blind pedestrian can recognize the environmental information through binaural sound generated by the system [8]. Proteus software is used for circuit implementation and simulation. It has ISIS which is used for circuit designing with simulation and ARES which is used for PCB designing. When a sensor in the data terminal detects any obstacle, the buzzer automatically turns on. Hearing the loud sound of the buzzer the visually impaired person will be able to decide at which side there is an obstacle. These sides can be right, left or front. The above system has basic features for navigation; advanced technology like GPS is not included.

Another system called Voice Assisted Navigation System for the Blind [9] develops a smart and intelligent cane which helps in navigation for the visually impaired people. The navigator system designed will detect an object or obsta cleusing ultrasonic sensors and gives audio instructions for guidance. The signals from the ultrasound sensor are processed by a microcontroller in order to identify sudden changes in the ground gradient and/or an obstacle in front.

The algorithm developed gives a suitable audio instruction depending on the duration of ultrasound travel which in turn is made available by an mp3 module associated with the system. An obstacle as close as 4cm can be detected by this module. Are solution of 15cm of obstacle distance has been designed and achieved. This system also detects potholes on the path. The microcontroller controls the sending and reception of the signals to the other components. The mp3 module plays the required distance clip into the headphones. It uses an SD card as memory for storing the recorded clips. The above system detects obstacles within the range of 15cms but practically this distance was too small to alert the blind.

Many researches are being conducted to build navigation system for blind people [10]. This paper mainly focuses on sensing of environment to detect obstacle to blind person and warning about the obstacle by means of vibration along with voice feedback. The system used IR sensor, RGB sensor [11] and arduino to detect obstacle and for processing. However IR sensors are highly directional and cheaper compared to others but it can use to detect only one type of obstacle like paper[12].

III. PROPOSED SYSTEM

The design model of the proposed system which we have introduced is managed through an android application is as shown in figure 1. The application developed in this paper functions through voice commands. The android application is unlocked after providing the password though voice command. After the app is unlocked there are two options, campus navigation and GPS navigation. Campus navigation is used for two modes: hurdle detection mode and fixed route mode. After selecting the campus navigation option it scans the Bluetooth device that is connected to the arduino Unoboard. The scanned device is connected to the android phone. All the alerts to be given to the blind are sent through the Bluetooth sensor to the android application. The android application converts the text alerts into speech and the blind is notified about the instructions in the form of audio.

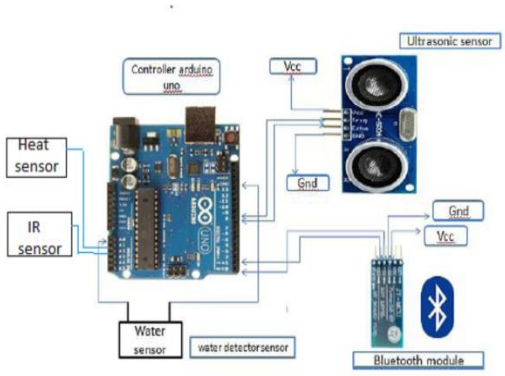

Fig1.Design model of the proposed system

The first default mode is a hurdle detection mode. The second mode is fixed route mode. Blind can switch between these two modes using switch button embedded on the stick. In hurdle detection mode, system uses ultrasonic sensor to detect obstacles in front of the blind in the range of 90cm.

The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound tore flect back as shown in figure 2.

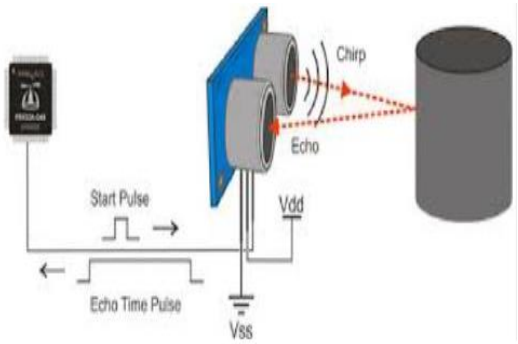

Fig2.Working of ultrasonic sensor

IR sensor to detect small obstacles: pit, staircase, or stone, as it located at the lower side of the stick. After detecting the small obstacles on ground, IR sensor will send the signal to the Arduino, as result it will send a voice instruction for small obstacle available.

Heat sensor is very sensitive to the heat and can detect the heat from long distance. If the sensor detects the heat radiation it will send an electrical

signal to the controller and thus voice instruction will be sent to person.

In addition to obstacle detection, system also uses water sensor to detect water on the road. When water sensor comes in contact with water, the two wires inside the sensor gets short and then the blind is given the instruction that water is detected. The water sensor detects water that completes the circuits on its sensor boards' printed leads. It measures the analog output and provides moisture level.

This all collected data is sent to arduino (consists of ATmega328-PU microcontroller) which is used to process this data. Once this data is processed it will sent to the Bluetooth. The Arduino Uno can be programmed with the Arduino software. Arduino has memory of 32 KB (with 0.5 KB used for the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library). Arduino can be reset by two methods: One is directly from hardware and another method is automatic reset using arduino software program.

For the blind person who travels daily through a route we have fixed route mode. This mode is specially designed for indoor travelling. In order to switch from hurdle detection mode to fixed path mode, a switch button is available. After pressing the button the blind person can switch from hurdle detection mode to fixed path mode. In fixed route mode the time taken by the blind person to reach the destination is fitted in the microcontroller. After travelling for a specified time as programmed in the microcontroller the blind is notified to take a turn as per the route.

The ultrasonic sensor is used to measure the time. It sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. Depending upon the time that is specified in the microcontroller the blind is notified to take a turn. The microcontroller sends the data through Bluetooth to the android device and the blind is notified in the form of audio. After reaching the destination the blind is notified that he has reached the destination.

GPS navigation is used by the blind person to travel in outdoor environment. Smart Phone recognizes the voices, search for destination, routes, and provide the route to the user through voice. The functions of the application developed in this paper are as follows: The first function is to search destination through voice recognition and Google TTS service. After pressing ‘Tap on button’, user will say the wanted destination according to the instruction. The second function is route research using Google Map. After users have confirmed the destination, the application will provide the map after searching for route from the current location of the user to the destination. The third function is to guide the users with voice. Using Smart Phone, it will collect the route to the destination and begins to guide by saying travel range, and direction for each section of the route.

IV. EXPERIMENTAL RESULTS

Solid and liquid obstacles are properly detected using the proposed system. After successful connection to the Bluetooth, the audio instructions about solid or liquid detection are sent to the blind person. Once in fixed route mode, the person is guided from source to destination along with correct turns to be taken. GPS will give the location of the person. It will take the destination place to be reached through voice command and give appropriate directions. The ultrasonic stick for blind is as shown in figure 3. The screen shots of the functions are presented in figure 4-10.

Fig3.Ultrasonicstick for blind and android phone

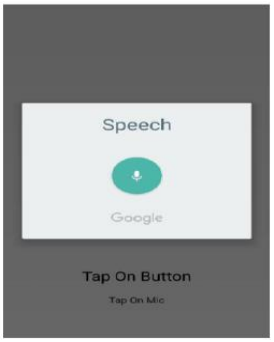

Fig 4.Speech input

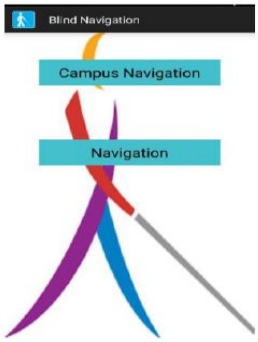

Fig 5.Mode selection

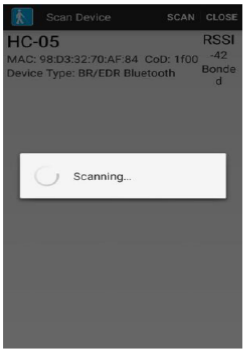

Fig 6.Scanning the Bluetooth device

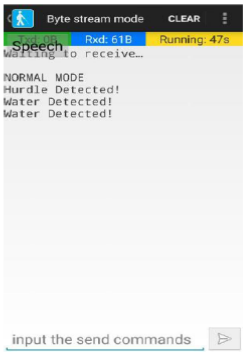

Fig7.Hurdle detection Mode

Fig 8.Fixed mode

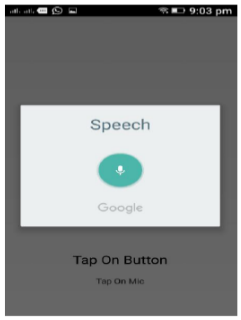

Fig 9.Input destination For GPS

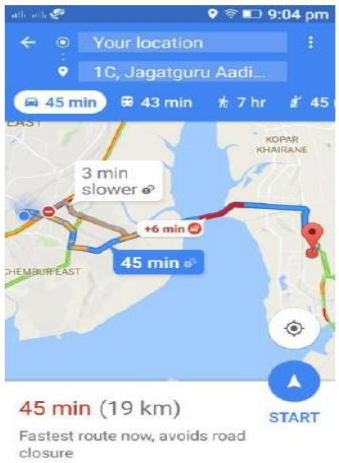

Fig10.GPS started

V.CONCLUSION

An ultrasonic navigation based blind aid is designed for the impaired people to move in unfamiliar environments avoiding obstacles and travelling with ease without depending on any one. The aim of the project is to design and construct a simple and cost effective aid for the blind. The blind aid will help them to move efficiently by receiving notifications from the android phone. The ultrasonic sensor will detect solid obstacles and alert the blind about any obstacle coming on the way. The help of water sensor the blind can walk freely by avoiding water. IR sensor to detect the small obstacles: pits, staircase or stone. Heat sensor is used to sense the heat in the path. A daily route that the blind is taking under closed roof is fixed in the stick. The blind navigation app installed in the blind person's android phone will give him GPS directions so that he can select any destination of his choice. Thus the ultrasonic aid for the blind is a promising help for the person to walk confidently just like a sighted person.

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