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Assistance for Visually Impaired People based on Ultrasonic Navigation

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Abstract: ***The assistance system for visually impaired people has been implemented by using ultrasonic principle to provide navigation. The presented system functions in 2 modes of operation that are obstacle recognition mode and fixed path mode. Obstacle detection mode uses grouping of ultrasonic transceivers for solid obstacle detection and water sensor to identify liquid obstacles by employing a microcontroller. The information about the obstacle is sent to the blind person via a voice mode by using android phone through Bluetooth device. In second mode which is preferably a fixed path mode the person is guided from start point to the end point for a particular path. The blind person can swap between the different modes by using the button present on the cane. Global positioning system (GPS) is used to instruct the person to move from one place to other. The projected system delivers whole direction and defence to a blind person for many situations.***

Keywords: ***Ultrasonic Sensor, Water Sensor, Bluetooth, Microcontroller, GPS.***

I.INTRODUCTION

There are around fifteen million people from India who are visually impaired. To navigate from one place to other these people rely on some supportive devices like guide dogs, canes and many more[1]. There are many problems related to navigation for these people. Thus there is a need to develop a system for visually impaired people that would help them to navigate from one site to another with effectiveness and accuracy. The system would assure with the help of a self-governing life to these people. By this system people who are not able to see would become more confident like sighted people [2]. The assistance which is implemented is a navigation cane. Various sensors are employed in the system includes an ultrasonic sensor for detecting soil obstacles. The system focuses on liquid and solid both the objects. The sensor detects the solid object within 90 cm range. The sensor works as a wave transmitter and receiver. The transmitted wave would fall on the obstacle and then received back by the sensor[3]. The system also employs a Bluetooth module which is connected to a microcontroller to generate an alert voice message that is sent to the person after the detection of an obstacle. After getting an indication about the obstacle the person can avoid it easily. Therefore the system provides an ease to visually impaired person to identify what is present in front of them[4]. If we come to a liquid obstacle identification, a water sensor has been used in the system[5].

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The sensor senses the obstacle that is in liquid form and sends signal to a microcontroller associated with the system. An alert voice message would be sent to the person when the sensor comes in contact with the liquid or water. There exists 2 wires in the liquid sensor, and they get shorted after the water contact. This way one can avoid obstacles and can move securely.

One of the literatures discloses about a system that continuously monitors the blind people to direct using static data and dynamic data [6]. The paper also uses Global positioning system (GPS) to get the accuracy in the system. The another paper [7] proposes thought of evolving a stick with a GPS system, that detects the difficulties in front and provides data about the place by using GPS coordinates.

A GPS and TTS is also used in the system. TTS is responsible to convert images into text and then text into speech and GPS is employed to provide correct information related to site[8][9][10].

The second section of the paper discloses about the projected system. Methodology is explained in section third. Fourth section comprises of results obtained by the experiment. At the end, the conclusion of the experiment is mentioned.

II. PRESENT SYSTEM

Figure 1 shows that the system is succeeded by an android application. The application converts the image into text and then text into speech. There is a locking system in the application, it can be unlocked by a voice password. After this there are 2 choices; navigation through GPS and campus navigation. Campus navigation includes 2 modes in it that; one is hurdle detection and other one is fixed root mode. After the selection of choice Bluetooth device is scanned. Microcontroller is coupled with the Bluetooth device. The scanned device is connected to the microcontroller. The system would alert the person using a Bluetooth device and microcontroller. The presented application does all the conversion required to alert the person.

In these 2 modes of application the, default mode is obstacle identification mode and reaming mode is a fixed route mode. The swapping between these 2 modes can be done by a swapping button present on the cane. An ultrasonic sensor is used in the system to identify the solid obstacle and it works in first mode of application. It detects the obstacle within 90 meters of range.

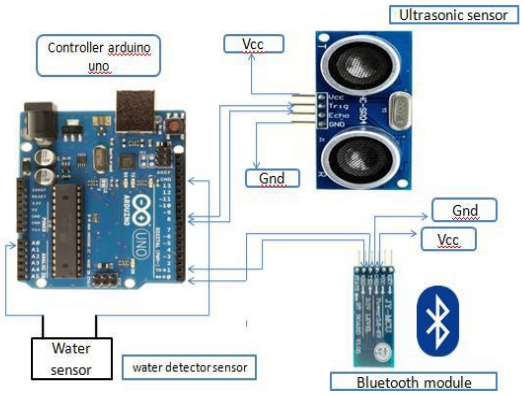

Figure 1 Model of present system

III. METHODOLOGY

A high frequency sound signal would be sent by an ultrasonic sensor which is used in the system for obstacle detection, then the signal would be reflected back to the sensor, is shown in Figure 2. Simulation performance analysis model of ultrasonic transducer for blind person navigation study was reported by us earlier.

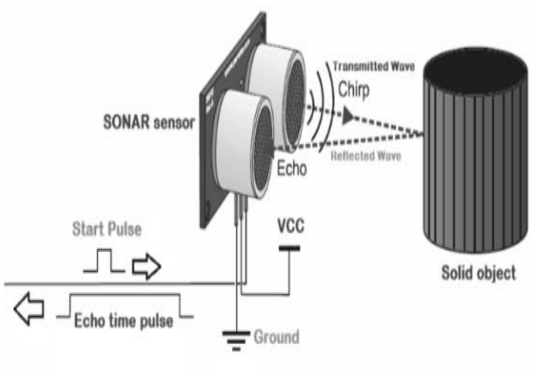

Figure 2 Functioning of an Ultrasonic Sensor employed in the System

Sound travels at almost 340m/s. It relates to around 29.412µs/cm. The formulation to calculate the distance travelled by sound is given by:

$$D = \frac{t \times S}{2} \tag{1}$$

Where, 'D' is distance travelled,
't' is time , 'S' is speed of sound.

"2" is mentioned in this equation 1since the sound would return back and forth. Initially sound wave transmits from source and after striking obstacle surface it returns back to the trans-receivers [11].

$$cm = \frac{(\mu s / 2)}{29} \tag{2}$$

For example, if the time taken by the ultrasonic sound to travel back is 100 microseconds then the distance would be: cm= ((100 / 2) / 29) or around 1.7 cm.

Since a 'water sensor' is also employed in the system to detect the liquid obstacle. When there is a liquid obstacle and the sensor comes into the vicinity of water, then the wires associated with the sensor (two wires) get short circuited. After this an alert would be generated and sent to the respective blind person through a voice message. The sequence generates an analog output and provides the moisture content information. A microcontroller present in the system would receive all this information and then further process it. After this the information would proceed to Bluetooth. There are 2 methods to reset the microcontroller one from hardware and another from software. As there are two modes fixed path route and obstacle detection mode, for swapping between these modes there is a button on the cane, according to requirement of the mode a person can do the swapping. The fixed route mode is usually for indoor purpose wherever the path is fixed. The time to reach the destination in the fixed path mode is saved in the microcontroller. Time is measured by the employment of ultrasonic sensor. It emits a Hf (high-frequency) sound wave and then calculates the time taken to return back the resonance of the sound. According to the time pre-defined in the microcontroller, the person would be alerted to turn. The information is sent to the person on an android device from microcontroller via Bluetooth medium. When the destination has been reached by the person, the person would get a notification. For outdoor purposes GPS navigation is used in the system. Android phone identifies the sounds, searches destination, paths, and suggest the way to the person through a note of voice. The operation of the system presented in the paper is: the initial operation is destination searching via voice identification and TTS. After pushing 'Tap on button', person would say the wanted end point based on the instruction. The 2nd operation is route researching by using 'Google Maps'. After confirmation of destination by the user, the system would show a map based on its current location and the destination. The 3rd operation is the guidance for the person via a speech. By employing an android phone, the route is identified and it initiates guidance by telling the range to travel, and track for each and every part of the way.

IV. RESULTS

The system not only helps in avoiding solid obstacle but also give assurance to avoid liquid obstacles as two sensors are used in the system in combination. A Bluetooth would help the system to provide information to the person. When fixed path mode is selected by the user, the user is guided by the system from the starting point to the end point assisting about correct turns that should be taken. Site of the user is provided by the GPS technology. The user is guided by the speech message to reach the destination. The cane for blind persons with android phone is as represented in both Figure 3 (a) and (b).

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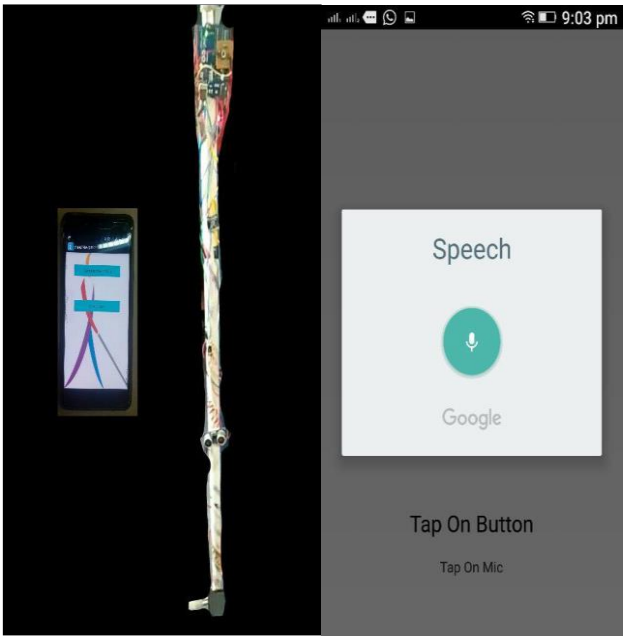

Figure 3 (a) Ultrasonic cane for visually impaired and android mobile (b) Input speech

Figure 4 BlueTooth scanning

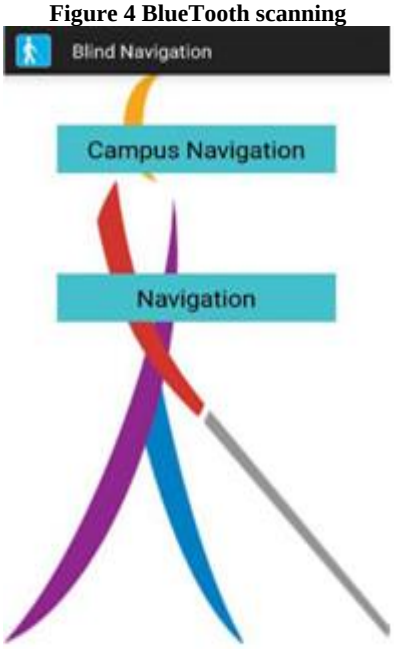

Figure 5 Modes of selection

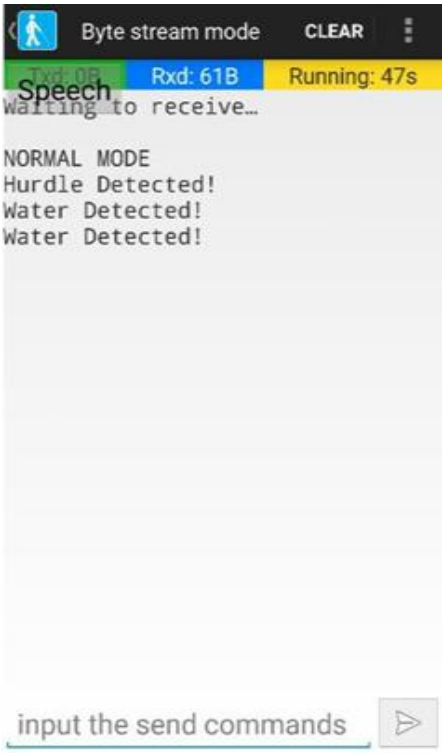

Figure 6 Mode of detecting obstacle

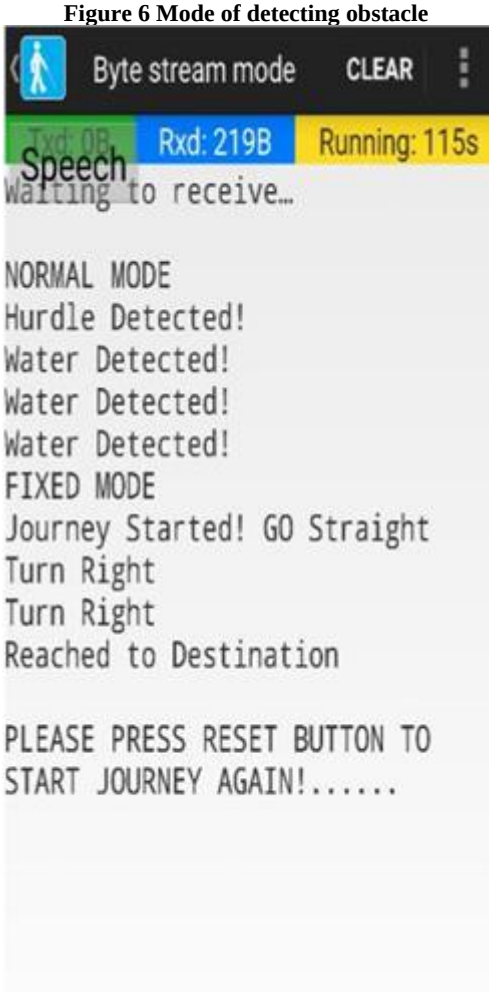

Figure 7 Fixed path mode

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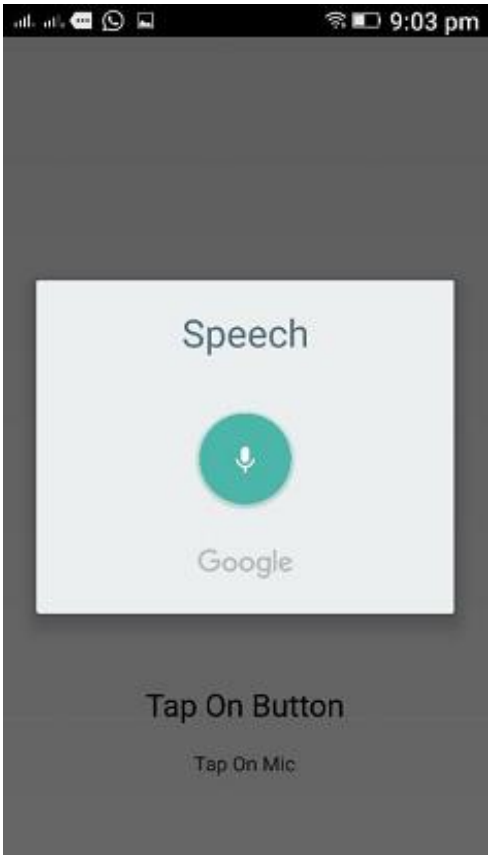

Figure 8 GPS input destination

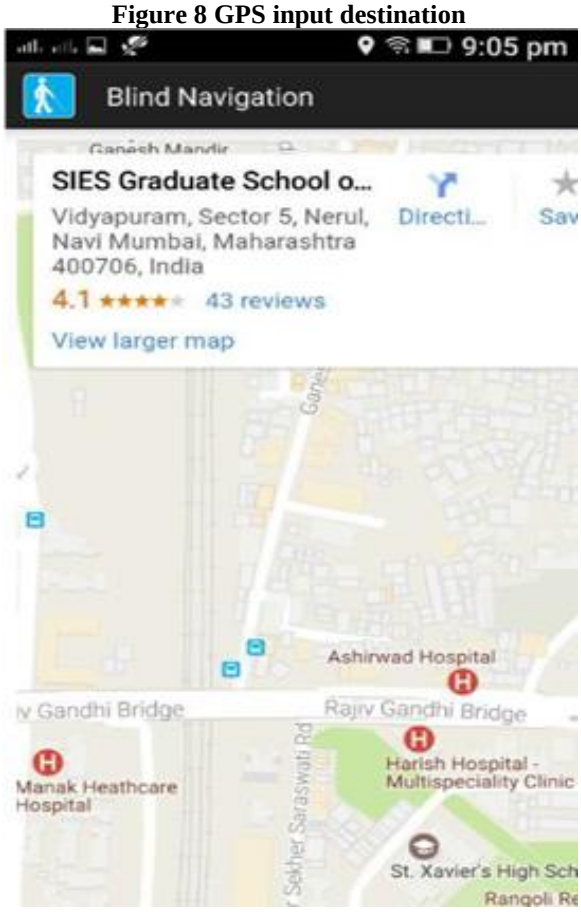

Figure 9 Directions

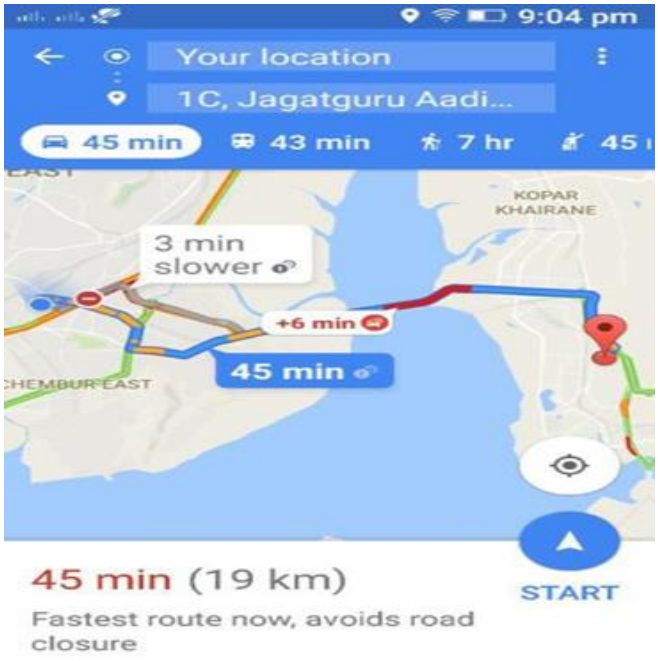

Figure 10 After starting GPS

A microcontroller installed in the system receives and furthers all information to Bluetooth as shown in Figure 4. The blind person navigation system works in two modes campus navigation and navigation which has been indicated in Figure 5. Similarly, during the navigation there is a mode of obstacle detection, where the hurdle/ water obstacles alert is communicated to the blind person through a message as shown in Figure 6. The fixed path mode is particularly used for indoor purpose, where the path is fixed as shown in Figure 7. While in case of outdoor navigation the destination is entered through voice which is in Figure 8 and the "Google Maps" researches the root to the destination as shown in Figure 9. Then the GPS guides the blind person from the current location to the destination with voice mode as indicated in Figure 10.

III. CONCLUSIONS

A system that helps visually impaired people has been designed using ultrasonic navigation to move from one place to other, without depending on others. The designed system is cost efficient and a simple system which is able to solve the problems effectively. The assistant cane would be very helpful to visually impaired people as it provides information via a voice message. The grouping of ultrasonic sensor and water sensor would benefit blind people to escape both solid and liquid obstacles. As the system has two modes one for fixed destination and the other for obstacle detection so the cane is also helpful in providing the information about the fixed route as this mode is especially designed for indoor purpose. Destination according to the choice of the person can be reached by the person due to association of GPS with the system. Therefore the blind assistance cane for the blind person assures the person to walk as self-confidently as a sighted person.

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