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Intelligent Navigation System for Blind People with Real Time Tracking

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***Abstract*—Most of the blind people in the world use white canes to go from one place to another. Due to their blindness they are not able to perceive their surroundings. So the mobility of the visually impaired people is limited. Therefore the purpose of this project is to build a navigation system that will be able to guide a visually impaired person safely and with ease, in an indoor and outdoor environment. This goal has been realized through the use of an ultrasonic sensor to determine the range of obstacles and also a microcontroller to act accordingly. The system includes a warning system through voice rendering and through the generation of vibration.**

***Keywords*- Ultrasonic Sensor; Blind Navigation; Obstacle Detection; Vibration; Voice feedback.**

I. INTRODUCTION

India is now home to the world's largest number of blind people. Of the 37 million people across the globe who are blind, over 15 million are from India [1], [2]. Most of these people are from families with very poor economic condition and they rely on other people to help them or use white canes, to roam around. The project proposes a navigation system that includes a white cane capable of detecting obstacles and providing feedback. Since blind people are more efficient in hearing and possesses strong perception than normal people, therefore the system focused on alerting the user through vibration and voice feedback. This novel navigation system is designed for helping the blind people to navigate around safely. User does not need to move the white cane around to detect obstacle like they do with the normal cane. Therefore user can easily walk with the white cane and continuously get information about obstacles around with the help of sonar sensor. Many researches are being conducted on building a navigation system for the visually impaired people. Several researchers [3], [4], [5], [6], [7], [8] address this challenge in indoor and outdoor environment. However most of these approaches have limitations, since this challenge involve many issues (e.g., accuracy, coverage, usability and Interoperability) which are not easy to address with the current technology. Dhruv Jain *et al.* developed a system Roshni [9] that can be used for indoor navigation system for blind person. This system consists of the following functional components: assistance for determining the user's position in a building, a detailed interior map of the building and a mobile application. By pressing keys on the mobile unit, directions concerning position, orientation and navigation can be obtained from the portable system via acoustic messages. A RFID based navigation system proposed by Punit Dharani *et al.* [10]. The system provides a technological solution for the visually impaired to travel through public locations easily using RFID. Parth Mehta *et al.* proposed a novel indoor navigation system for visually impaired people [11] and the paper illustrates a structure which uses the IR sensor and magnetic compass on the VI-Navi handheld device to determine the location and orientation of the user in a fast and a robust manner using a voice enabled GPS inside a closed environment . Tarik Kapi´ *et*c. *al.* [12] proposed a system with a special emphasis on the survey among visually impaired people that resulted in effective information on their perception of their surroundings. Koley *et al.* [13] developed a voice operated outdoor system for visually impaired person. The navigation system makes use of GPS, voice and ultrasonic sensor for obstacle detection. It can notify the users their current location and provide verbal directions for travelling to a remote destination [13]. Though this system provides verbal direction but does not have an obstacle detection and warning feedback. The proposed navigation system in this paper mainly focuses on two components: (i).Sensing of the immediate surrounding environment against obstacles for the visually impaired person and (ii).Warning about the obstacles by means of vibration and voice feedback system. This navigation aid can be an efficient and cutting edge tool for indoor and outdoor environment for visually impaired people. Therefore, the project mission is to carry out the following functions: Detection of obstacles using ultrasonic sensors, Implementation of vibrational alert and voice feedback system using vibrator motor and APR9600 ChipCorder respectively. The system contains three ultrasonic sensors HC-SR04, which will detect the barriers in the path. The control system is developed using ATMEGA16 microcontroller. With the response from the ultrasonic sensors, the distance between the person and the obstacle is measured. Delicate motor circuitry is used to create vibrational alert and APR9600 chip is interfaced to produce a speech output, so that the person can know the direction of the obstacle and sense its distance. So the overall system goal is to construct a portable, simple, less costly device that will help visually impaired people to move in unfamiliar environment.

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II. SYSTEM ARCHITECHTURE

This project is realized with the generation of vibration and through the voice module. The Fig. 1 shows the block diagram of stick unit which is handled by the blind people. It performs the obstacle detection and alerts the blind people. It consists of three ultrasonic sensors [14] HC-SR04, which continuously sends and receives the ultrasonic waves, the timing of the echo signal has been observed by the ATMEGA16 controller. The distance between the person and obstacle is observed by the ATMEGA16 controller using the ultrasonic sensor.

III. DESIGN FLOW OF THE SYSTEM

When the system is turned ON, It continuously checks for obstacles in three directions by sending ultra sound. If there are no obstacles, the system continues its search but if there is, the vibrator motor of the respective side will turn on and speech output will notify the user by speech notification.

Fig.3 shows the diagram that outlines the navigation aid's workflow.

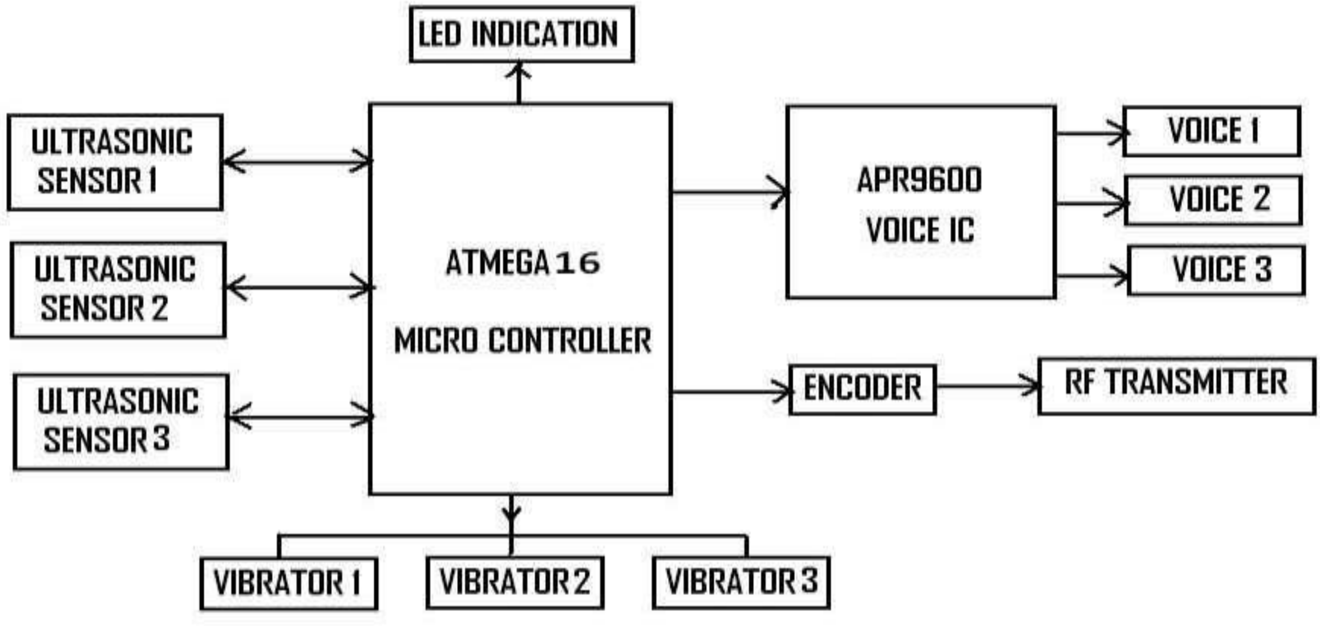

Fig. 1 Block Diagram of Stick unit

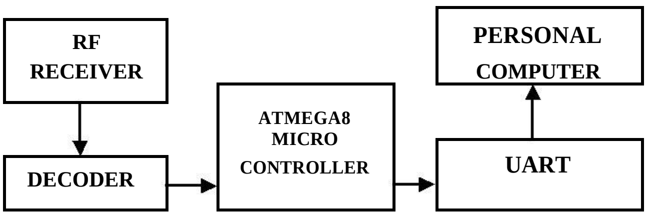

Fig. 2 Block Diagram of Monitoring Unit

The embedded controller controls the vibration motor circuit to warn the people. Correspondingly the controller interfaces the APR9600 voice ChipCorder to alert the people through the recorded voice. So the people know the direction of the obstacles. The various directions can be obtained by three sensors. An algorithm has been developed that allows the microcontroller to work in different conditions required for the navigation system. The System uses a switch for turning on or off the system.

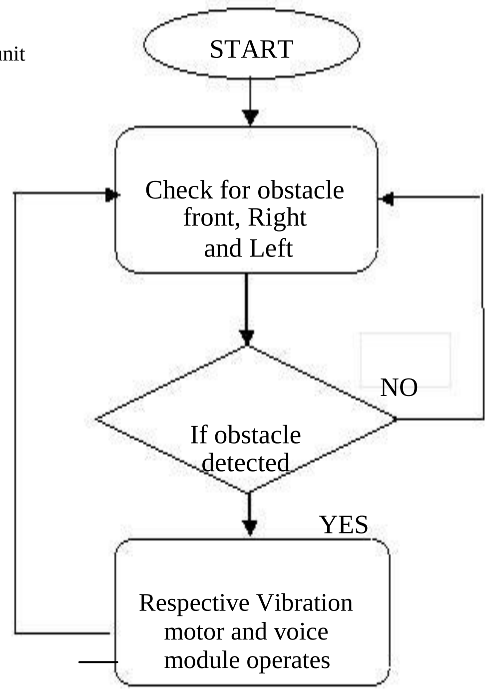

Fig.3 Flow Chart of the Navigation system

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IV. Proposed System

A. *Distance Measurement*:

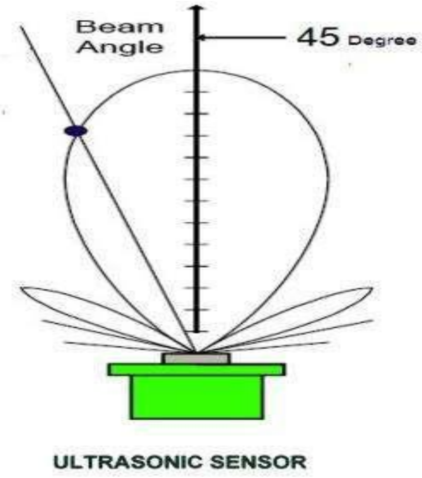

Fig. 4 Angle measurement

Distance measurement is done by a circuit using the ultrasonic sensor, microcontroller ATMEGA16 and an LED display. When there is an object the sensor will send back the signal to the microcontroller. It was found that the smallest time required for the ultrasonic sensor to detect the emitted pulse reflected off the obstacle is 200us. If there is no object the signal descends to low value. The distance calculated by the microcontroller is displayed LED display. The value obtained contained inaccuracies with respect to the actual distance measured. However, the inaccuracies are found to be consistent in every measurement and it was possible to determine the offset. Therefore a correction algorithm is introduced in order to obtain accurate distance between the sensor and the obstacles which can be viewed in the LED display. The experimental range is found to be 10cm~290cm and the signal covers an angle of 45^0 as shown in Fig.4.

B. *Interfacing*

Subsequent to the measurement of the range of the obstacle, the motors were used to generate the vibration. However, the signal generated by the ATMEGA16 does not carry enough power to run vibration motor. Therefore a transistor is introduced to generate the higher flow of current which is required for the vibration motor to run. The transistor is controlled using the ATMEGA16 microcontroller in order to provide the sufficient power to run the vibration motor. The algorithm is developed in a way so that it allows generation of vibration of different motors corresponding to the distance measured. Therefore, the navigation system allows the blind person to assess different distances of the obstacles from vibration of different directions. From the Table-1, for instance, it can be seen that at distance of 30cm the motor will vibrate at various directions belongs to ultrasonic output.

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C. *Voice Feedback*

ASP 9600 IC as shown in Fig.1 has been incorporated in the navigation system to provide speech assistance to the blind person. It is a single chip that allows multiple messages. This chip allows the system to record 60 seconds voice and play it back with very high quality. The ultrasonic sensors are set up to detect the obstacles in the left, right, front, left -right, and right-front and left-front directions. Three sensors are set to detect obstacles in three different directions. The connections of the sonar are adjusted in such a way according to user convenience to detect obstacles of the following left, right and front direction as shown in Fig.5. Upon detection of the signal from the sensors it triggers the recorded messages stored in the different addressing memories of the ASP 9600 to be played. The voice alert is enabled when obstacles are detected. As outlined in Table-2, for obstacles in different directions, different recorded messages are played, such as, “Obstacle upfront”, “Obstacle to the left” and so on.

D. *Figures and Table*

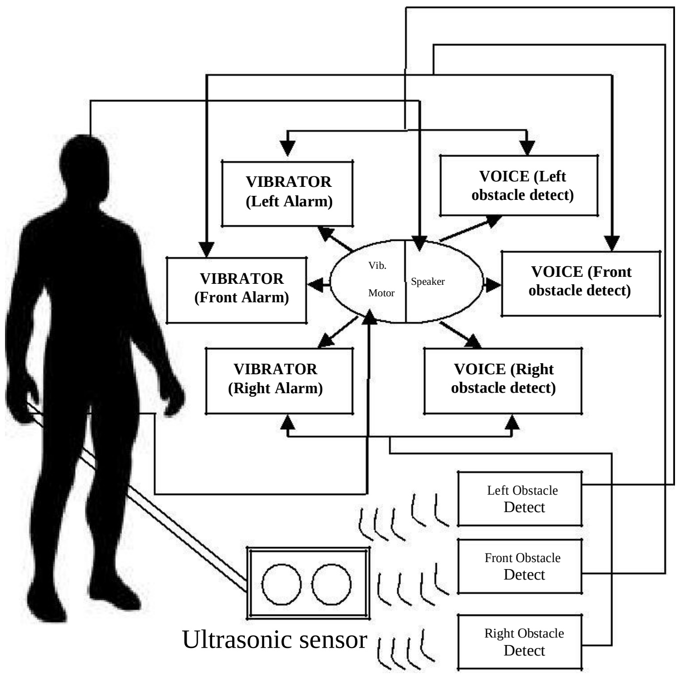

Fig. 5 Navigation aid system processing

In Fig.5 shows that the navigation aid system uses the sonar sensors for detecting waves that bounce off a surface of any object. The strength of the reflected waves activates the vibrator and the voice-alarm accordingly, to inform the users about the obstacles in their surroundings.

Table I. Alarm System Process

Distance between the obstacle and the white Cane	***Response of Vibration motor***
Distance is less then 30cm in front	Front motor vibrates
Distance is less then 30cm in Right	Right motor vibrates
Distance is less then 30cm in Left	Left motor vibrates

Table II. Voice Feedback Process

Direction of obstacle respective to the white cane	***Announcement in the speaker/Headphone***
Front	Obstacle Upfront
Left	Obstacle to the Left
Right	Obstacle to the Right
Front and Right	Obstacle Upfront and to the Right
Left and Right	Obstacle to the Left and Right
Front and Left	Obstacle Upfront and to the Left

V. RESULT

A prototype of the implemented system is shown in Fig 6. A white can is equipped with ultrasonic sensors at the bottom and control circuitry at the top for the feedback.

Fig.7 demonstrates that the ultrasonic sensor position at the front detects strong reflection of waves coming only from the front, meaning that there is an obstacle. The vibrator wrapped around the wrist band vibrate continuously and the recorded voice keep playing "Obstacle on the front" until the user moves away from the obstacle either walking towards left or towards right Similarly if the sonar receives strong ultrasonic waves from the left or right, the system will provide vibration and voice feedback accordingly. Again if the sonar do not receive any reflected wave, then the vibrator and the voice feedback will be inactive, which means the user can walk in any directions (right, left and front) unhindered

Fig. 6 A Prototype of the proposed system

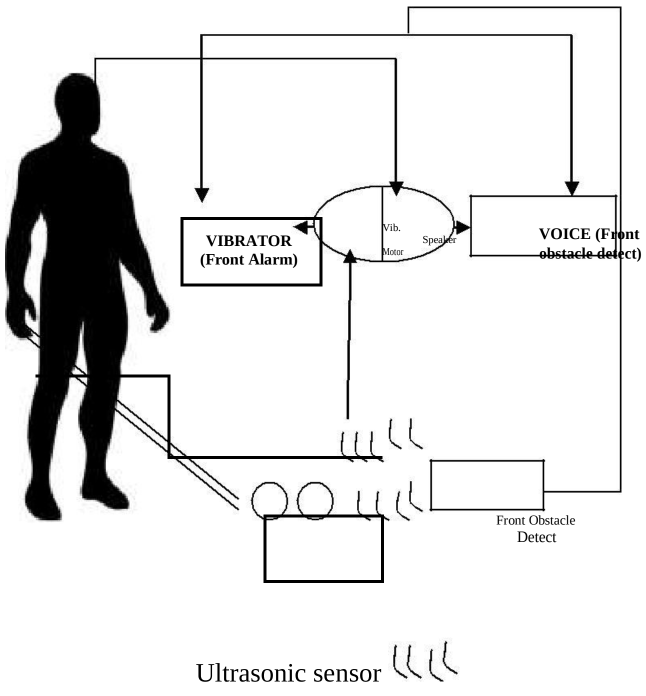

Fig. 7 An obstacle to the front side is detected and the vibrator vibrates

within 70cm range. If the white cane is tilted 45 degree with horizontal axis, then the accuracy of the system will be 95%, with 70 cm as its range. Though the ultrasonic sensor has a 10-200cm range, yet for maximum accuracy, 70 cm range was used. As long as the cane is angled at 45 degree, no matter which way the cane moves, (i.e. left, right or straight) the accuracy will be maximum. Any shift in the angle (30^0-60^0) will reduce accuracy to 70-80%.

CONCLUSION

A novel navigation system is designed and implemented which helps blind people to navigate safely. ATMEGA16 microcontroller was used to develop the smart obstacle detection system which allows the blind person to avoid obstacles using the feedback through vibration and voice. The primary objective of this design was to make the system cost effective and easier to handle for a visually impaired person. In order to make it easier for the person to use, the navigation aid have mounted the sonars for detecting obstacles in particular directions. Therefore the person does not require moving the cane around to detect barriers like they do with the normal cane. They can easily walk with the cane and the sonars will simply detect the obstacles and help the person to maneuver around it. The system has a built in vibration and voice feedback which alerts the user if any obstacle is around and within 70cm. The sonars are adjusted in a way to ensure user convenience in detecting obstacles in three directions. The voice alert and vibration continuously inform user about the obstacle until the user moves away from the obstacle within the range of 70cm. This paper suggested that this aid will be an effective, low-cost and user friendly solution for navigation problems of visually impaired person.

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