Obstacle Detection for Visually Impaired Patients

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***Abstract*— The system is an efficient methodology for aiding the blind and the visually impaired in their navigation. User will be indicated about the nearing obstacle within a closer ambiance. The System detects the nearest Obstacle through a stereoscopic sonar system and sends back vibro-tactile feedback to inform the user about its localization through a beep sound and voice indication for a differentiation between the incorporation of the three sensors. The system also aims at increasing the mobility of visually impaired by offering new sensing abilities. The device is light, portable, but range limited to its own size.**

Keywords—Visually impaired, Obstacle, Sonar System, Sound Buzzer.

I. INTRODUCTION

Eyes play a vital role in our life. All of us have seen the blind people and know the problems that they face in their life. There are about 45 million blind people in the world according to the survey of World Health Organization. In particular, these people are faced with huge difficulties moving in cities, streets, public transportation systems and shopping malls representing a hostile ever-changing environment. As a result, blind people are in danger while moving on their own, and their autonomy is limited. Indeed, if blind people can generally remember their way to some places they cannot know in advance what obstacles they will stumble upon. In consequence, the fear of the unknown often leads the visually impaired to restrict their universe to a small set of known places. Based on these complications many systems are developed to help the visually impaired in their mobility.

Generally guide canes are largely used by the blind people in order to indicate the presence of an obstacle. Incorporation of ultrasonic sensors, infrared sensors and laser telemetry, a cane system was developed to detect the obstacle by having an angle of incidence which covers 20º and the distance with an approximation of 50 cm. The obstacle is indicated through the earphones producing the individual's desired song which is already being recorded [1].The other system developed is a guide cane which detects the presence of an obstacle through mobile robot avoidance sensor and is indicated by a steering effect which has a stepper motor fitted inside to induce the specified effect [2].

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A system is developed to indicate the presence of an obstacle by obtaining an image through a camera being fitted on the corner of the glass and thereby applying a mathematical method consisting of standardized and normalized cross correlation method and binary method to the values being noted from the image obtained, the obstacle is indicated[3].

A wearable system using Ultrasonic sensor for the detection of an obstacle is developed. In this system an overcoat is designed with two ultrasonic sensors using which the presence is detected at a distance which ranges from 3cm to 3m and the field of view is limited to 60º[4]. Once when an obstacle is detected this overcoat produces a whole body vibrating effect in order to indicate obstacles presence [5]. Another system is designed with sun glass incorporated with two cameras that helps in capturing the image of an obstacle. The image captured is sent to a palmtop and a desktop computer [6]. A normal individual is asked to monitor the desktop computer and alerts the visually impaired about the position, depth and the accuracy of an obstacle through earphones [7].

All the above system was developed to help the visually impaired in detection and indication of an obstacle to have a safer navigation, each system have its own disadvantage. In the system using Guide canes the sensors are being incorporated on the bottom which results in the damage of sensors and the obstacle is detected only when it is being touched [8]. The system using mathematical model helps in detecting an obstacle but no indications are given after detecting an obstacle. In wearable system the over coat produces a whole body vibration that leads to heart attack, stroke etc [9].

II. MATERIALS AND METHODS

The various components being incorporated in the system are as follows:

A. Power supply

A power supply of 5volt is produced by connecting four batteries within a case in which each battery has a charge of up to 1.2 volt A charger is provided in case of a low voltage.

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B. Ultrasonic sensor

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. An ultrasonic sensor of model HC-SR04 is being used. It covers a distance of upto 0.3 to 4 meters and an angle of 60^0 .The sensor has four terminals- Vcc, trigger, echo and ground. The working frequency of the sensor is about 40 KHz. The basic principle of work: Using IO trigger for at least 10us high level signal, the Module automatically sends eight 40 kHz and detect whether there is a pulse signal back. 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).

C. Microcontroller

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density non-volatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non-volatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications. This microcontroller has 32 I/O ports, 2 timers, 6 interrupts and a total of 40 pin packaging. Before programming the AT89C51, the address, data and control signals should be set up according to the Flash programming mode. To program the AT89C51, the following points are considered; Input the desired memory location on the address lines, Input the appropriate data byte on the data lines, Activate the correct combination of control signals, Raise EA/VPP to 12V for the high-voltage programming mode[10]. Pulse ALE/PROG once to program a byte in the Flash array or the lock bits. The byte-write cycle is self-timed and typically takes no more than 1.5 ms. Repeat steps 1 through 5, changing the address and data for the entire array or until the end of the object file is reached.

D. Voice IC-APR 9600

The APR9600 device offers true single-chip voice recording, on-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. Integrated output amplifier, microphone amplifier, and AGC circuits greatly simplify system design. The device is ideal for use in portable voice recorders, toys, and many other consumer and industrial applications. APLUS integrated achieves these high levels of storage capability by using its proprietary analog/multilevel storage technology implemented in an advanced Flash non-volatile memory process, where each memory cell can store 256 voltage levels. This technology enables the APR9600 device to reproduce voice signals in their natural form. It eliminates the need for encoding and compression, which often introduce distortion. The features of voice IC includes a Single-chip, high-quality voice recording & playback solution. No external ICs required, Non-volatile Flash memory technology, No battery backup required. User-friendly, easy-to-use and operate. Programming & development systems not required. Level-activated recording & edge-activated play back switches. Low power consumption where the operating current is about 25 mA typical and Standby current is about 1 uA typical [11]

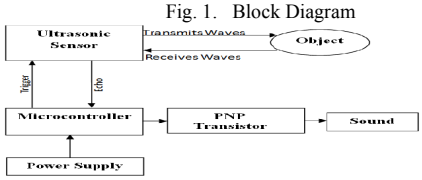
E. Sound Buzzer

In this project two types of sound buzzers are being used. They are continous sound buzzer and intermediate sound buzzer for indicating the presence of the obstacle. A sound buzzer producing minimum sound is being selected which is of low cost. The pitch of the sound buzzer is about 5mm. The low frequency range is about 2Khz and high frequency range is about 4Khz. These two types of buzzers indicate the presence of the obstacle only when the microcontroller is being programmed for detecting the presence of the obstacle.

The working of the system starts when the power supply is being ON. Switch ON the battery supply. Once when a Vcc of 5v power Supply is given the microcontroller ATMEL 89C51 it produces a trigger pulse. This pulse is given to the ultrasonic sensor [12]. Using this trigger pulse the ultrasonic sensor starts detecting the presence of obstacle. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object.

The Ultrasonic Sensor transmits the Ultrasonic waves to check the presence of obstacles so when a obstacle comes into the range of the sensor then the ultrasonic waves hits the obstacle and produces echo signals in reflex. Once this echo Signal is received by the ultrasonic sensor then an echo pulse is given to the micro controller to produce an output. The Microcontroller thus applies a negative voltage to the PNP transistor where it makes the flow of holes higher than the flow of electrons [13]. Once when the negative voltage is applied to the transistor then the high signal is given to the output circuit. In the output circuit when a high signal is given then the sound buzzer starts giving beep sound to indicate the detection of the obstacle. This is the working of single sensor. The power consumption is also minimum and also it can work for a long hour with the merest requirement of the battery supply. Obstacle detection is one of the main problems to solve to ensure safe navigation for blind users. Initially the localization on a horizontal plane is done by a combination of the left and the right side [14]. The proposed system is indicated in (Fig.1)

Fig. 1. Block Diagram



III. Results

Once the components are incorporated on the board, the system is verified in a testing ambience. The working of the sensor is done through the microcontroller (Fig 2) program. Obstacle is indicated through the sound buzzer. Differentiation of direction between left and right is done via intermediate and continuous sound buzzer. (Fig 3) Voice command is given for the indication of an obstacle in the centre direction.

Fig 2: Supply connection to the microcontroller

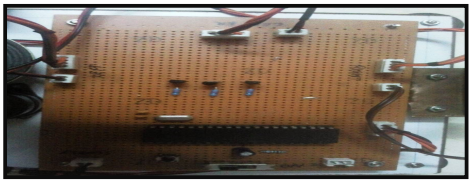


Fig 3: Voice IC Board connection

IV. Discussions

In wearable optical detection system for visually impaired people blind person is being provided with a whole body vibration effect whenever the obstacle is being detected. Obstacle detection is one of the main problems to solve to ensure safe navigation for blind users. The stereoscopic architecture of the system is used to develop new obstacle sensing abilities. Various components like vibrator, microcontroller, sensor and DAC is being used. The sonar system is based on two ultrasonic transducers mounted together. One emits an ultrasonic wave while the other measures the echo. By differentiation of the input and output signals, a microcontroller pic16F87 computes the distance to the nearest obstacle. Then this information is transmitted as a PWM signal to the receiver. The microcontroller gathers the information from the ultrasonic transducers as Pulse Wide Modulation (PWM) signal directly proportional to the distance of the nearest obstacle whole system is depicted in the paper.

In Computerized Obstacle system, gives an overview of existing devices for the guidance of visually impaired pedestrians and discusses the properties of the white cane and of conventional electronic travel aids.Also described are the disadvantages of using a standard mobile robot obstacle avoidance technology. The NavBelt is worn by the user around obstacles. One limitation of the NavBelt is that it is exceedingly difficult for the user to comprehend the guidance signals in time to allow fast walking and in GuideCane system, including the mechanical, electronic and software components, follows a description of the intuitive user-machine interface.The chapter ends with a discussion of the Guide Cane's novel information transfer approach and its advantages and disadvantages in practical term.

From the existing technology, the field of view has been increased to 180º horizontally that covers a cone like projected area by using ultrasonic sensor. With a distance of about 0.3 to 4 meters. The system is portable and does not have any additional huge device to be carried with the individual. The obstacle is being detected without any contact with the sensor unlike the Guide Cane technology.The system does not produce any harm to the health condition of the visually impaired individual unlike the wearable obstacle detection system and also the sensors are placed in the pelvic region such that it can indicate the presence of the smaller and larger obstacles .

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