iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** IV **Month of publication:** April 2016

DOI:

Volume 4 Issue IV, April 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Assistance for visually impaired people

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Abstract— This paper presents the development of an shoes system for blind and visually impaired people. The shoes system utilizes a arduino uno board with sound output interfaced with ultrasonic sensors. The prototype system is designed to be specifically mounted on/in the shoes to aid navigation in urban routes. The ultrasonic transducers determine the range from an obstacle and then play an audio message to reflect the distance from the target. This system will assist blind and visually impaired people in navigating a path through an unfamiliar environment.
Keywords—Ultrasonic guidance system; ultrasonic sensors; blind, visually impaired; navigation

I. INTRODUCTION

For those who are fortunate enough to have good eyesight, it is hard to comprehend how difficult it is to live without being able to see. Visual impairment and blindness is caused by a number of factors which include; disease, malnutrition, and hereditary factors . Blind or visually impaired people make use of blind cane to aid them in walking by allowing them to sense the obstacles in front of them.There are a number of projects investigating technologies to assist the blind. Calder et al. developed an assistive technology interface especially for the blind. When worn by the visually impaired or blind user, it warns the user of obstacles ahead by using an ultrasonic pulse-echo method to determine the range of the object distance . Noor et al studied a bus detection device for the blind using RFID application. The blind used auditory touched clues like a walking stick or white cane to determine where to move to. This system is limited as it can only help the blind at pedestrian crossing .Our aim is to build an obstacle detection embedded system for a visually impaired or blind person to detect objects in the direction of movement. This system would send warning by sounding an audible message to '*stop*', '*move backward'* or 'turn left' or 'right' to proceed by avoiding the obstacles. In future it will also incorporate a GPS system to allow inputting the direction to the destination and then guiding the blind person to the destination.

The main motivation for carrying out this project is to design and implement a system which will be a much needed aid to the blind or partially sighted person. By designing and implementing such a system, taking into consideration the needs and requirements of a blind person, this project will contribute to solving a major problem faced by blind people, ease their life and make them less dependent on others. As a result of our investigation we have designed and built a working prototype system on a PCB containing two ultrasonic sensors for each shoe to detect obstacles in the path of movement. This is achieved by interfacing the sensors to arduino uno board to calculate the distance detected by the two sensors and to sound messages to take necessary actions. The prototype models, a pair of shoes, are interfaced in a standalone system for testing and validation purposes in real time situations.

II. SHOES SYSTEM DESIGN

The whole system is designed around an ATmega328 microcontroller Board. The ATMEGA328 microcontroller is the core and the most important component of the shoes tracking manager. The main code is stored onto the chip's programme memory. It can collect data from an external memory where different sound tracks are kept, such as audio file for "stop". The block diagram showing the system functionality is shown in figure 1:

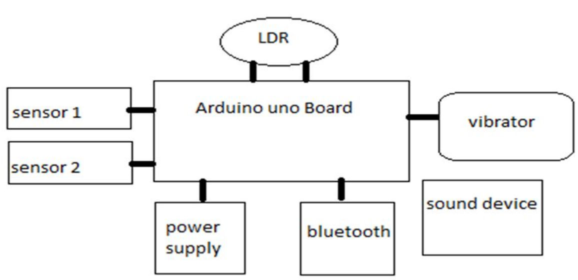

Figure 1: Block diagram of system

www.ijraset.com Volume 4 Issue IV, April 2016
IC Value: 13.98 ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

The most important function of the microcontroller is to receive input information in form of signals from different input components, process the information as instructed in the code, and control the output components as designed. The tracking manager actions are governed by the code embedded in the microcontroller. The chip contains enough memory for current code and future development. Sensors S1 and S2 are utilized to sense obstacles and help generate correct instructions to guide blind to the desired place.

Once the sensors S1 and S2 receive sound from the microcontroller, if an obstacle is present in a line of movement, the sound gets reflected onto a detector. The detector receives ultrasound waves and gives a signal to the microcontroller unit. Here sensor S1 is used to detect the object and sensor S2 is used to detect pit. If an object is closer to sensor S1 send a signal to arduino board and though Bluetooth connectivity blind person get assist via sound. Similarly if pit is there on way of blind person sensor S2 detect it and sends command to person.

III. TECHNICAL DESCRIPTION

The system requires a regulator or power supply of 5Volt. The power supply is directly connected to the Arduino wave shield/component.

The Hardware components used for the system design are briefly described below:

A. Ultrasonic Sensor

Ultrasonic range detection sensor requires 5V DC voltage. Throughout the circuit, maximum current supplied is 15 mill amperes. The frequency is around 40 HZ. The normal output ranges from 0-5 volts and if any obstacle is present then the output is high. The maximum sentry angle used is 15 degrees. The distance between the sentries is 2 cm to 500 cm. The accuracy is high - up to 3 cm. It triggers input signal for 10 micro seconds based on Transistor –Transistor logic impulse form. The echoed signal output is in the form of TTL PWL signal. The size form factor is 45mm * 20mm * 15mm .

Figure 2*:* Pin interface of Ultrasonic sensor

B. Voltage regulator

A 3.3V voltage regulator takes 5V supply from Arduino and converts it to 3.3V supply. Here the understanding of 3.3V voltage regulator is very easy. The conversion of 5V supply to a 3.3V supply is needed because the SD/MMC cards can only work on a 3.3V supply. Otherwise if 5V supply is given to the card it will burn and cause failure of the entire board. MCP1700-330 is the voltage regulator, the current provided by this voltage regulator is 250mA and it consists of 4 capacitors. The capacitors are associated with the voltage regulator. To stabilize the 5V input C1 and C2 capacitors are used; C1 and C2 are the input capacitors. To stabilize the 3.3V output C3 and C4 capacitors are used where C3 and C4 are the output capacitors.

C. ATmega328 Microcontroller

The ATmega328P is a microcontroller with 8-bit and high performance characteristics. The architecture is called RISC architecture. For fully static operation up to 16 MIPS throughout with 16 MHz on chip 2 cycle multiplier is used to execute maximum single clock cycle. It has about 131 powerful commands for 32 X 8 general purpose working registers. The memory segments are high endurance and non-volatile with 32K bytes of flash memory which is In-system self-programmable and 1Kbytes of EEPROM with 2K bytes of internal Static RAM (SRAM). For capturing and compare mode, the ATmega328P microcontroller has the peripheral characteristics of two 8-bit Timer/Counters with detached prescaler which compares the mode, and one 16-bit Timer/Counter with

Volume 4 Issue IV, April 2016
ISSN: 2321-9653

detached prescaler. Other functions of the ATmega328P include ADC noise reduction, Power save, Power down, Standby and extended standby are special features. Is has 23 programmable I/O lines combining both input and output packages and it ranges from operating voltage between 2.7V to 5.5V. The operating temperature range is in between -40 degree Centigrade to +125 degree for the automotive temperature. The ATmega328P block diagram is shown in the Figure 3:

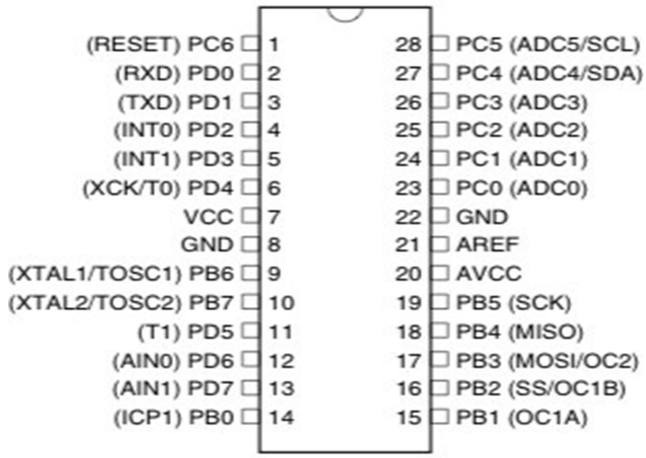

Figure 3*:* Atmega 328P Microcontroller

D. Micro SDHC Card Series

16 GB SDHC (Secure Digital High Capacity) is used for prototype design. This version is used in 2.0 SD SDHC because of its advantage of supporting other devices. The filesystem used in this SDHC cards is FAT32. The operating voltage is from 2.7V to 3.6V and the temperature ranges from -25 to 85˚C respectively. The durability of this card is 10,000 insertion and removal cycles. It supports speed class 6 specifications. This card supports the protection of copy for SD-Audio and Recorded media. The compatibly of this card is seamless with compliant digital audio devices (SDMI). The form factor for this card is 11mm x 15mm x 1mm. By using the mechanical wire protection switch the Micro SD adapter is designed.

E. Bluetooth

The Bluetooth used here to connect android device and kit which is mounted on shoe. Whenever obstacle is detected by a sensor it sends correspondence signal to microcontroller and this microcontroller is get connected to android audio device through Bluetooth device.

IV. SOFTWARE DESCRIPTION

The software for this system is implemented in Arduino Wave Shield using the Arduino Library. The Arduino library is an open resource based library which has useful functions used such as Pinmode(), DigialWrite() and DigitalRead(), to enhance the design of the system involved in this project. The EEPROM library provides varies functions such as read and write. These two functions are used to read and write to or from EEPROM memory of the microcontroller. Rule-based algorithm is design and implemented. The algorithm that represents the system performance is shown in below:

A. Start.
B. Sensor S1 for object and sensor S2 for pit detection.
C. Sensor S1 and S2 start sensing to detect object while sending echo signal as a transmission signal and receiver recives the trigger signal.
D. If the object detect by sensor S1 at a distance closer to 100 cm then interrupt signal is send by sensor S1 to microcontroller.
E. If no then sensor S1 continues to sense object.
F. If sensor S2 detect pit at a distance greater than 100 cm then interrupt signal is send by sensor S2 to microcontroller.
G. If no then sensor S2 continues to sense pit.
H. Collect the data from microcontroller and generate sound output for user.
I. If LDR sensor value is less than or equal to 35 then it should glow else it should off.
J. Stop.

Volume 4 Issue IV, April 2016
ISSN: 2321-9653
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V. TEST RESULTS

The sensor test results indicates that the pulse repetation time of echo signal for the ultrasonic range detection is 3.05 seconds. Both sensor 1 and sensor 2 were tested successfully to detect the obstacle or object in front of a blind person. For example, If object is detected by sensor S1 at a distance closer to 100 cm then the microcontroller generate output signal which is send to android device through Bluetooth and blind person get assist via sound as well as the sense of vibration which is given by vibrator motor fitted in shoe bottom.

If pit is detected by sensor S2 at a distance greater than 100 cm then the microcontroller generate output signal which is send to android device through Bluetooth and blind person get assist via sound as well as the sense of vibration which is given by vibrator motor fitted in shoe bottom.

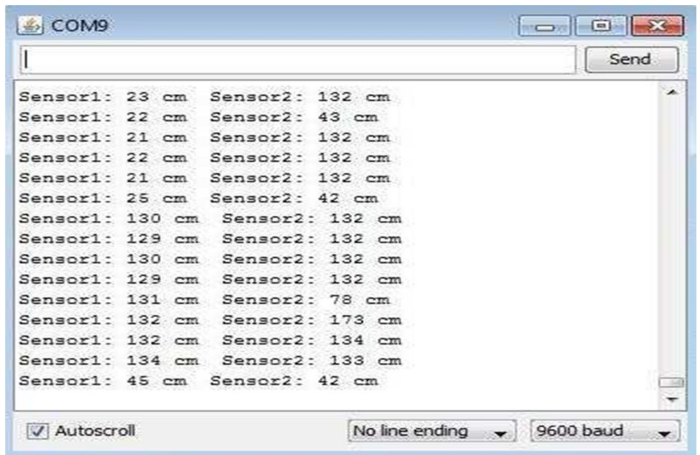

Figure 4: distance measurement for both sensors

It is important to note that the results are saved on the Micro SDHC card and can easily be retrieved when needed. The maximum range of the sensors is 200cm. Various tests performed during the testing confirmed that the system gives instructions to the user only when he or she is too close and do not give signal when they are far from the objects. This aspect of the system is a vital part as it is related to the system reliably detecting an object and giving an accurate instruction, in a timely manner, to a blind person.

VI. CONCLUSION

The aim of this project is to design, build and implement a working prototype system on a PCB containing two ultrasonic sensors to be installed on the shoe of a blind or visually impaired person to detect objects and obstacles. It is designed to send a signal to the microcontroller which will then calculate the distance detected by two sensors and play an audio message, stored in SD card memory. The system gives instructions to a blind person to stop. depending upon where the obstacle is. Based on comprehensive test and analysis, it can be concluded, that the system is able to reliably detect and play audio instructions stored on the SD card. The system does so in real time albeit at a regular intervals of 3.0 seconds. The sensing system design is small and compact enough to mount in/on a person's shoe. It can be concluded that the system, with some additional development, is commercially viable and can be used reliably by a blind person or a visually impaired person.

Although the system has been design to be compact and small enough to be placed on/in a shoe, it is still not rugged enough to withstand the rough environment our shoes are subjected to when we walk on the street, on campus, and shopping malls. It is highly likely that someone could stamp on a shoe in a crowded market place or on a crowded street crossing. Therefore it is recommended that the sensors should be made much smaller and embedded within the shoes to avoid getting damaged.

VII. FUTURE WORK

The shoes system can be improved to detect and play the message instantly within a second rather than approximately 3 seconds taken by the current system. This will further improve the reliability of an already reliable system, giving further boost to the confidence of a blind or visually impaired user to walk on the street without much hindrance. The system could use a Zigbee type wireless system to send the information on distance from the sensors to the Zigbee receiver, and reduce the wiring in the system. Song et al. developed a Zigbee based guidance system for blind based on combined scheduling of ultrasound and GPS signals. The

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ISSN: 2321-9653

sensors are attached to sub-controllers to provide directions for a blind person by collecting ultrasound and GPS signals.

Taking into account the results of a system implemented in a GPS system could be deployed to provide information about the user's immediate surroundings via a designed GPS receiver. Energy harvesting techniques could be used to provide the shoes device with power source for extended battery life and low maintenance cost.

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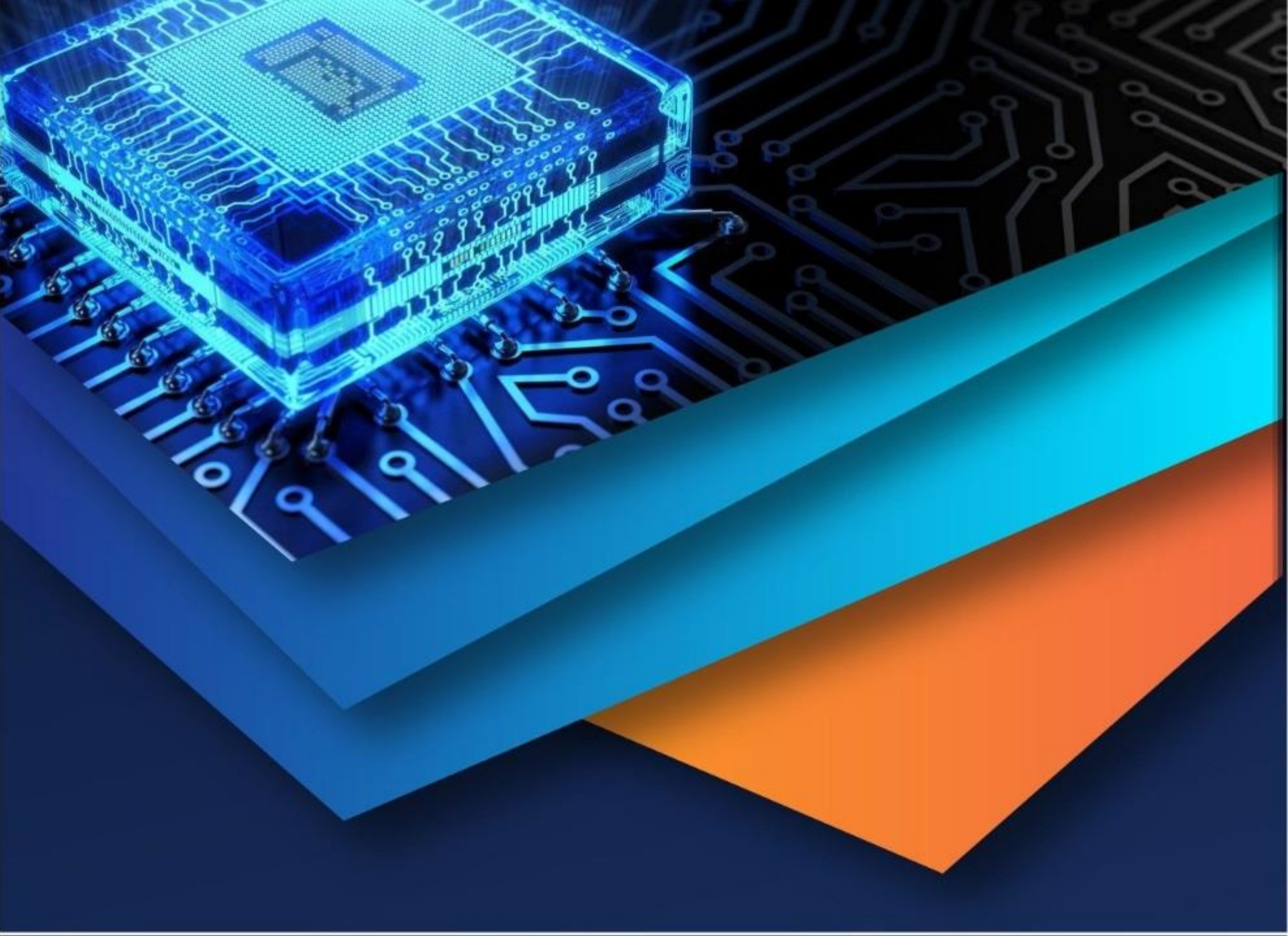

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