# Smart Shoes: Assistive Shoes for the Visually Impaired People

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*Abstract*— the advancement in technology is increasing day by day and still requires new inventions to make life of people much easier and as engineers it's our prime duty to develop new technology to enhance the living standard. Every day, we hear about the smart technologies such as smart TV, a smart car etc., so why not smart shoe? Many people suffer from serious visual disability which is preventing them from working independently. Accordingly they require a tool of wide range which helps to make them independent. Smart shoe is simple and better option to help the blind in their orientation and train them to move on their own independently and safely depending on the other remaining senses. This project presents a prototype model and a system concept to provide smart electronic aid for blind people. This system consists of Ultrasonic sensor, microcontroller and a wireless headphone. The project aims to develop an electronic kit to help blind people obstacle free path. If an obstacle comes in the path, an indication would be relayed by one ultrasonic sensor placed inside the shoe; this unit would take the instruction through the microcontroller, which will generate a sound in wireless headphone. A 9V dc battery is also installed in the shoe which gives supply to the circuit.

***Key words:*** Ultrasonic Sensor, 8051 Microcontroller, SD Card, Headphone

## I. INTRODUCTION

Blindness is a state of lacking the visual perception due to physiological or neurological factors. The partial blindness represents the lack of integration in the growth of the optic nerve or visual centre of the eye, and total blindness is the full absence of the visual light perception. Imagine walking into an unfamiliar place. One has to ask for guidance in order to reach to the destination. But what if the person is visually impaired and person has to completely depend on other people to reach destination. Generally we observe that white cane is the best friend of visually impaired person. But many a times this cane is not useful. In an unfamiliar surrounding visually impaired person might get confused. So this restricts their mobility. This makes them dependent on others. Regardless of the tool used, the factor that most determines a person's mobility is the use of essential personal skills.

Total blindness is the complete lack of form and visual light perception and is clinically recorded as NLP, an abbreviation as "no light perception". Blindness is frequently used to describe severe visual impairment with residual vision. Those described as having only light perception have no more sight than the ability to tell light from dark and the general direction of a light Source.

Many people suffer from serious visual impairments preventing them from travelling independently. Accordingly, they need to use a wide range of tools and techniques to help them in their mobility. One of these techniques is orientation and mobility specialist who helps the visually impaired and blind people and trains them to move on their own independently and safely depending on their other remaining senses. Another method is the guide dogs which are trained specially to help the blind people on their movement by navigating around the obstacles to alert the person to change his/her way. However, this method has some limitations such as difficulty to understand the complex direction by these dogs, and they are only suitable for about five years. The cost of these trained dogs is very expensive, also it is difficult for many of blind and visually impaired persons to provide the necessary care for another living being. There is an international symbol tool of blind and visually impaired people just like the white cane with a red tip which is used to enhance the blind movement. The walking cane is a simple and purely mechanical device dedicated to detect static obstacles on the ground, uneven surfaces, holes and steps via simple tactile-force feedback. This device is light, portable, but range limited to its own size and it is not usable for dynamic obstacles detection neither than obstacles not located on the floor. Recently, many techniques have been developed to enhance the mobility of blind people that rely on signal processing and sensor technology. These called electronic travel aid (ETA) devices help the blind to move freely in an environment regardless of its dynamic changes. According to the literature, ETAs are mainly classified into two major aspects: sonar input (laser signal, infrared signals, or ultrasonic signals) and camera input systems (consists mainly of a mini CCD camera).The way these devices operate just like the radar system that uses ultrasonic fascicle or laser to identify height, the direction, and speed of fixed and moving objects. The distance between the person and the obstacles is measured by the time of the wave travel. However, all existing systems inform the blind of the presence of an object at a specific distance in front of or near to him. These details permit the user to change his or her way. Information about the object characteristics can create additional knowledge to enhance space manifestation and memory of the blind [1], [2].

To overcome the above-mentioned limitations, this work offers a simple, efficient, configurable virtual for the blind. The originality of the proposed system is that it utilizes an embedded vision system of five simple ultrasonic sensors and brings together all reflective signals in order to codify an obstacle through 8051 microcontroller. Furthermore, the user of the system does not need to carry a cane or other marked tool. He/she can just wear a hat, a hand mini stick (size of a pen) and foot shoes just like others. It is very suitable for real-time applications.

## II. LITERATURE REVIEW

Over the years of human nature development and behaviour pattern development shows that he sees, realizes, he understood. In case of blind person, it is painful that he cannot see but he tries to ask and get realization of locality and put it into memories when he moves around by sensing

 

the noises and some pick point he understood the situation/ locality. If by mistake he removes the kept memorized tag from his mind he cannot realize the locality and he got confused and has to ask his fellow or other moving persons for assistance. Similar case is about direction finding for moving towards desired destiny. It clearly shows that any persons/whether impaired or not person keep memorizing the locality information and sense tags in to memory and recover it when they wants to moves around. Literature analysis shows that there are mainly four technologies and combinations are used to work in context with similar objective for blind personals.

They are mainly as below:

- GPS
- RFID information grid
- Ultrasonic sensor based

Let us discuss about above one by one.

### *A. GPS*

Global positioning system uses longitude and latitude calculations for find out the position of object. Since it uses geospatial satellites signals, to calculate the positional difference from satellite; the accuracy is quite in the range of 100m to 300m.For the person who is walking on the road can receive these signals, but for indoor it is very hard to receive the same. Also the accuracy required is not achievable; hence it is a void solution for blind person to use for navigating device [2].

### *B. RFID Information Grid*

RFID is radio frequency identification device. It holds unique information such as number or symbol or text etc. It is passive device which is energized by interrogators emf field. To form an information grid the RFID tags are arranged in such a way that it could describe the longitudinal and latitudinal position. The searching device enquires about the positional information and sends it to server by SMS. The server holds database with relational description of local position for reference send by SMS. It search in database for same and broadcast it on FM which could be heard by the enquirer's device. The big issue To Design RFID Based Cognition Device for Assistance to Blind and Visually Challenged Personal for Indoor Use in system is that the SMS sending and delivering time. Again the air calls traffic congestions. The personal device may work properly but server failure detection case cannot be solved. Hence addressed solution is more of problems than the solution [1].

The two three device on different location should work in tune with single fetched query make more dependable which is not viable. The same about remaining technological solutions more or less they are combinations of two or more type of technical mix hybrid device. The RFID grid system with an RFID reader integrated into the user's shoe and walking cane with Bluetooth connection to the user's cell phone [1].

### *C. Ultrasonic Sensor based*

Mobility is one of the main problems encountered by the blind in their life. Overtime, blind and visually impaired people have used some methods and devices such as the long white cane and guide dog, to aid in mobility and to increase safe and independent travel. Due to the development of modern technologies, many different types of devices are now known as electronic travel aids. Among these aids are sonic pathfinder, Mowat –Sensor and Guide cane which are called clear path indicators or obstacle detectors since the blind can only know whether there is an obstacle in the path ahead. These devices are used to search for obstacle in front of the blind person, and they operate in a manner similar to a flashlight, which has very narrow directivity. Sonic-sensor since it has wide directivity enabling it to search for several obstacles at the same time [3], [4].

Portability, low cost, and above all simplicity of controls are most important factors which govern the practicality and user acceptance of such devices. The electronic travel aid (ETA) is a kind of portable device. Hence it should be a small sized and lightweight device to be proper for portability. The blind is not able to see the display panel, control buttons, or labels. Hence the device should be easy to control. No complex, control buttons, switches and display panel should be present. Moreover, the ETA device should be low –price to be used by more blind persons [3].

## III. DESIGN AND IMPLEMENTATION

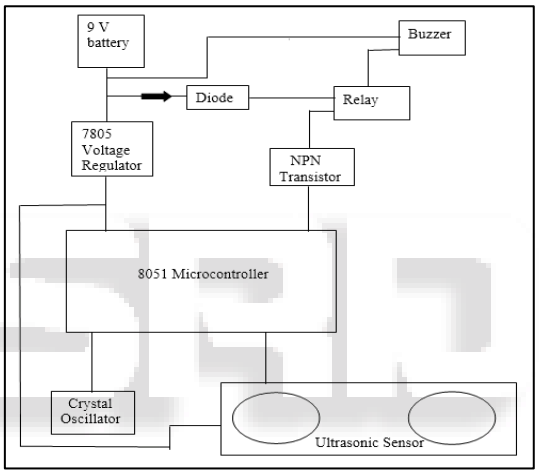


Fig. 1 Block Diagram of Virtual Eye

In order to overcome the difficulties in the existing method and to provide the cost effective and user friendly system for blind navigation, the following design is proposed. Fig. 1 shows that this project mainly consist on five parts namely Ultrasonic sensors, Microcontroller, SD Card, Headphone, Power supply.

### *A. Hardware Description*

#### *1) Ultrasonic Sensor*

In order to provide the obstacle avoidance, Ultrasonic sensor is used. Ultrasonic ranging provides 2cm- 100cm non-contact measurement function, the ranging accuracy can reach to 3mm.it includes ultrasonic transmitters, receiver and control circuit. Ultrasonic use I/O trigger for at least 10us high level signals. Sensor 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 I/O duration is the time from sending ultrasonic to returning.

 


Fig. 2: Ultrasonic Sensor

The ultrasonic sensor determines the distance to a reflective surface by emitting high-frequency sound waves and measuring the time it takes for the echo to be picked up by the detector. The ultrasonic sensor can determine the distance to an object between 3cmand 3m away; closer than 3cm will result in the sound waves echoing back to the sensor before the detector is ready to receive. The ultrasonic sensor actually consists of two parts: an emitter, which produces a 40 kHz sound wave; and a detector, which detects 40 kHz sound waves and sends an electrical signal back to the microcontroller. In order to determine the distance to an object, it is necessary to implement a timing loop in your microcontroller code to measure the length of time required for the sound wave generated by the emitter to traverse the distance to the object.

*2) 8051 Microcontroller*

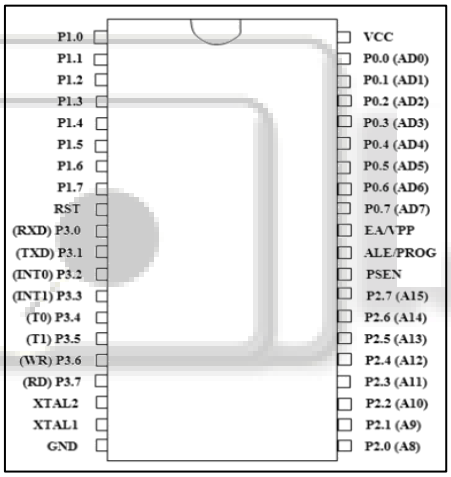


Fig. 3: Pin Diagram of 89c51 microcontroller

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 [5].

The AT89C51 provides the following standard features: 4K bytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, and on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power-down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset [5].

*3) SD Card*

The Secure Digital (SD) Card is a non-volatile memory card format developed by the SD Card Association for use in portable devices. It is based on flash memory technology and widely used in digital cameras, cell phones, e-book readers, tablet computers, notebook computers, media players, GPS receivers, and video game consoles. Ever since its adoption in the year 2000, the format has been proved very popular and it is considered as the de-facto industry standard.

*4) Headphone*

The headphone is used in this project for guiding the visually impaired persons to navigate independently by amplifying the predefined voice signals.

*5) Power Supply*

Since all electronic circuit work only with low dc voltage, we need a power supply unit to provide the appropriate voltage supply. This unit consists of battery, rectifier, filter and regulation.

*B. Hardware Implementation*

*1) Working*

To implement the ultrasonic sensors, 8051 microcontroller and SD card are used. Based on signals, decision is made in 8051 Microcontroller to manage and give timely signals. The input string is from the ultrasonic sensors which 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. It can detect obstacle from 2cm to 1 meter, with a precision of 3 cm. The input string is received by the 8051 microcontroller. The microcontroller will carry out the issued commands and then communicate the status of a given appliance or device back to the Headphones using SD Card Technology. SD Cards are a small and cheap method of storing data [6].

*2) Ultrasonic Sensor Module*

The Prototype Hardware consists of one ultrasonic sensor that is placed on a shoe to scan a front area up to a distance of 100cm. It includes a wearable equipment consists of a pair of Shoes.

*3) 8051 Microcontroller Module*

8051 microcontroller based control module receives instruction and command from a remote guidance system using ultrasonic sensor. The 8051 microcontroller processes it. Carry out the issued commands and then communicate the status of a given appliance or device back to the Headphones using SD Card module. It provides the necessary interface between the sensor signals and audio system.

Now you are going to learn the basics of writing to and reading from an SD Card. SD Cards are a small and cheap method of storing data, and an 8051 Microcontroller can communicate relatively easily with one using its SPI interface. You will learn enough to be able to create a new file append to an existing file, timestamp a file, and write data to that file [7], [8].

This will allow you to use an SD Card and an 8051 microcontroller as a data-logging device to store whatever data you wish.

 

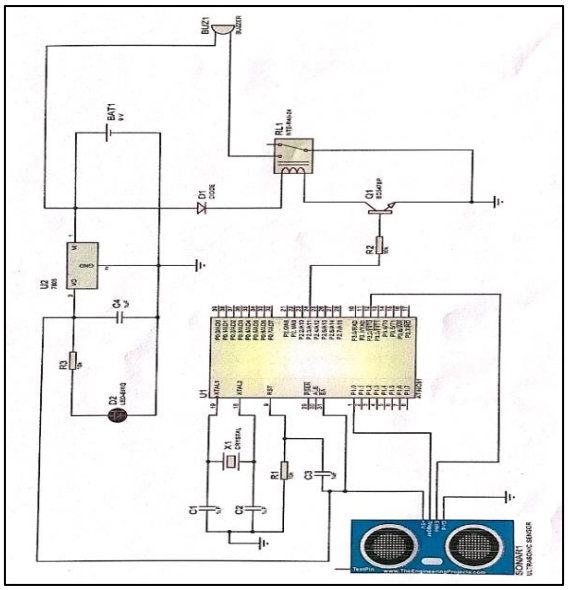

Fig. 4: Circuit diagram of prototype hardware

*4) SD Card Module*

The present application note deals with the implementation of the SPI-based access mode to read data from / write data to a SDSC (standard SD) card using an 8051 microcontroller. Fig. 5 shows the SD card pin out [11].

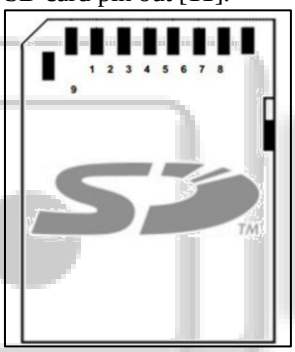


Fig. 5: SD card pin out

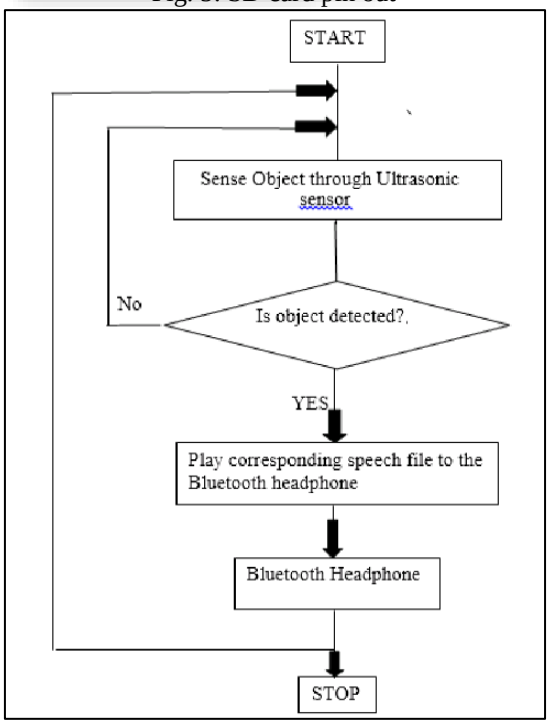


Fig. 6: Flow chart of virtual eye

## IV. SIMULATION AND RESULTS

The presented system is designed and configured for practical use. The system is able to handle seven states that may face the blind people. The system will respond to each state according to a specific program which is coded and installed in the 8051 microcontroller.

The portability is an important parameter of the system. The system which can be worn and used by the subject for prolonged time is considered as a portable system; otherwise it is regarded as non-portable. The easiness of the system usage is considered as another parameter. An easy to use device is actually easy to get to and an easy to function.

Finally the non-invasive utilization of the system is considered as a property of the system [9], [10], [11].

| Distance (From the shoes in cm) | Type of signal |
|---|---|
| 100 to 90 cm | Very slow signal |
| 90 to 70 cm | Slow signal |
| 70 to 50 cm | Normal signal |
| 50 to 20 cm | Fast signal |

Table 1: Result of Ultrasonic Sensor

### *A. Advantages*

- Low design time.
- Low production cost.
- This system is applicable for both the indoor and outdoor environment.
- Setting the destination is very easy.
- It is dynamic system.
- Less space.
- Low power consumption.

## V. CONCLUSION AND FUTURE SCOPE

A simple, cheap, configurable, easy to handle electronic guidance system is proposed to provide constructive assistant and support for blind and visually impaired persons. The system is designed, implemented, tested, and verified. The real-time results of the system are encouraging; it revealed an accuracy of 93% in detecting distances. The results indicate that the system is efficient and unique in its capability in specifying the source and distance of the objects that may encounter the blind. It is able to scan area in front of the blind person regardless of its height or depth. Therefore, it was favoured by those who participated in the test. The ultrasonic sensor has been fully utilized in order to advance the mobility of the blind and visual impaired people in safe and independent way. This system does not require a huge device to be hold for a long distance, and it also does not require any special training. This system also resolves limitations that are related to the most of the movement problems that may influence the blind people in their environment.

Future work will be focused on enhancing the performance of the system. It can also detect the material and shape of the object. Matching percentage has to be nearly all the time correct as there no chance for correction for a blind person if it is to be trusted and reliable one. The principles of mono pulse radar can be utilized for determining long range target objects. The other scope may include a new concept of optimum and safe path detection based on neural networks for a blind person. New sensor should be developed to sense the obstacle efficiently and to measure the height of the obstacle and to find distance between the sensor and obstacle.

 

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