# Discrete Distance and Water Pit Indicator using AVR ATmega8 in Electronic Travel Aid for Blind

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***Abstract***

*The present electronic travel aid device consist usually available ultrasonic sensor to detect obstacles on the way within a distance of two to three meters. It transmits ultrasound beams at a regular time interval. If any object is present on the way, the emitted ultrasound will be reflected back to the sensor. The discrete distance of the object is then measured according to discrete levels of 1, 2 and 3 meter and sensed by tactile vibrators. In addition to this, device is to give information about water pits in the traveling path which is sensed by audio signal.*

***Keywords:*** *Blind mobility; electronics travel aid (ETA); discrete distance; obstacle detection; ultrasonic range finder.*

## 1. Introduction

Mobility for the blind can be defined as the ability to move with ease, speed and safety through his environment independently. It is estimated that there are 180 million people in the world currently who are affected by problems with their vision. Within this number, approximately 40 – 45 million are blind, by definition not able to walk unaided. With an estimated 7 million people going blind each year, the number of people visually impaired is expectedly to double by the year 2020[1]. Looking at this locally, we see that within Australia, it is estimated that there are 380 thousand people who have low vision or are classed as legally blind. A person who cannot see at 6 meter nor has a field vision of 10° or less is considered legally blind. 95% of people classed as legally blind have some vision. To be classed as blind, there is a total loss of vision. Low vision cannot be corrected by visual aids such as glasses and contacts [2]. With the general population living longer due to advances in medical technology, more people are being affected by age-related macular degeneration (AMD). This is a leading cause of blindness on the developed countries with an estimated 25 – 30 million people affected worldwide. This number is expected to triple in the coming 25 years. AMD causes the degeneration of central vision, leaving only peripheral view. This is caused by damage to the damage to the retina and hence cannot be corrected. While it rarely causes blindness, it can deteriorate into severe cases causing large disruption to normal life.

Mobility aids like walking stick and guide dogs are commonly used by the blind even today [3]. With the advances of modern technologies many different types of devices are available to support the mobility of blind. These mobility aids are generally known as electronic travel aid [4]. This devices aim at conveying information (typically via the haptic and auditory channels) about the environment to visually impaired individuals, so that they can exploit part of the information that sighted people normally use to experience the world and navigate it. In this technical report we focus on the objective and architecture of discrete distance indication in electronic travel aid. The electronic travel aid like laser cane uses laser beam [5]. But most of the commonly used electronic travel aids use ultrasound [6, 7]. These devices, along with many others, are all based on producing beams of ultrasonic sound or laser light. The device receives any reflected waves, and produces either an audio or tactile stimulus in response to any nearby object. The intensity of the sound or tactile vibration is proportional to the proximity of the detected object.

## 2. Related Works

In the past three decades several electronic travel aids (ETAs) were introduced that aimed at improving their blind users' mobility in terms of safety and speed these devices are:

### 2.1. Sonic Torch

A battery operated hand held device basically operates by transmitting the ultrasound in the forward direction and receiving the reflected sound beam from the nearest object (s).

### 2.2. Mowat Sensor

It is a light weight, hand held, pocket size device [8]. Like a sonic torch a Mowat sensor also detects nearby object by sending high frequency ultrasound and receiving the reflected beam. The user can identify the distance of the object by the rate of vibration that is produced by the device.

### 2.3. Sonic Pathfinder

Like a Mowat sensor and sonic torch, a sonic pathfinder also detects an object by receiving the reflected ultrasound that is transmitted by the device [9]. But unlike Mowat sensor which is a hand held device, a sonic pathfinder is fitted on the user's head. The sonic pathfinder produces audio signal of different notes which produce a familiar tonal progression as the user approaches an object and is fed to the user through earphones.

## 3. Disadvantages of the Present Devices

Sonic pathfinder a head mounted device, on the other hand produces audio signal of different frequencies but not designed to detect any hanging object. Moreover a blind person having hearing acuity may be unable to use it properly due to the absence of any tactile sensor. Distance information between blind person and object is missing in these devices because intensity of audio signal or tactile vibration is uniform as blind person is approaching towards object. Accepts this there is no provision for finding dig and water pits information in these devices.

## 4. Suggested Device

The suggested device uses ultrasonic sensor SRF04 and can detect any object that lies on the ground or hanging from top, situated a distance of 3 meters from the user. The minimum size of the object that can be detected should not be less than 3 cm width (or diameter). In operation a beam of ultrasound of 40 KHz frequency is transmitted at a regular interval in the forward direction. The ultrasound will be reflected from a nearby object, if any. The sensor will then detect the presence of any object that lies within 3 meters by detecting the reflected sound beam. The time intervals at which the transmitter will transmit ultrasound depend on the walking speed of the user. For water pit indication electrodes are fitted at the bottom of the stick these electrodes are sensing water and conveying information to blind people. Information's are defined at two levels the first level is small water pit (spread water), and second level is water pit about 0.5 to 1fit.

## 5. Block Diagram

Figure 1, shows the complete block diagram of the suggested device. Once triggered the sensor will generate and transmit ultrasound in the forward direction. This ultrasound will be reflected back to the sensor if any object is present within 3 meter range. The time taken by the ultrasound to travel to and back from the obstacle is measured by a counter using specific clock frequency. Again for continuous distance measurement the ultrasonic sensor should be triggered at a regular time Interval and the counter inside microcontroller should also be reset accordingly. The counter output of microcontroller is then decoded and interfaced appropriately with output devices. This produces one of the two audio signal either for water pit or for low battery indication and to activate tactile vibrator to indicate discrete distance of 1 or 2 or 3 meter. The detail description of each block is given below:

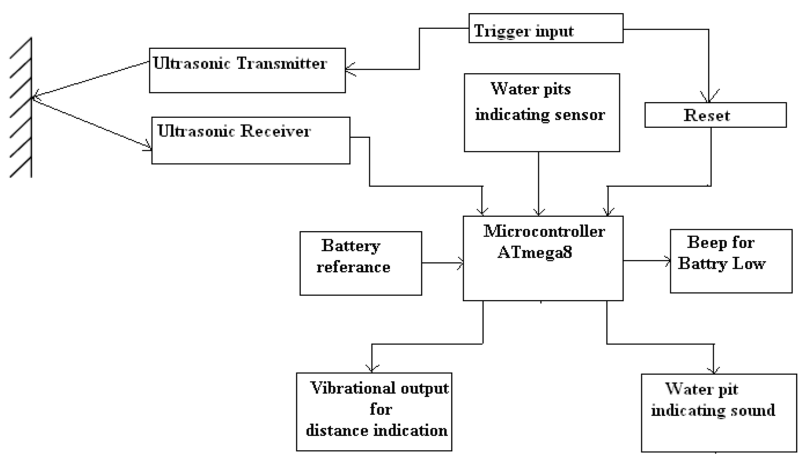


**Figure 1. Block Diagram**

### 5.1. Ultrasonic Sensors

It is the heart of the suggested device. We have used ultrasonic sensor type SRF04, known as ultrasonic range finder [10]. The SRF04 is a light weight ( of 0.4 Oz), small size ( 4 cm wide, 2 cm height and 1.5 cm depth) sensor and produces ultrasound of 40 KHz frequency and has built-in transmitter and receiver. It operates from 5 V DC and consumes 30 mA to 50 mA current. The maximum range of this sensor is 3 meters. This sensor can detect a stick having diameter of 3 cm from a distance of 2 meters or more.

This SRF04 uses a microcontroller and requires an input trigger pulse of minimum 10 micro second widths. In operation the processor of SRF04 waits for a trigger pulse. After receiving a proper trigger pulse the processor will generate eight cycles of sonic burst of 40 kHz. This sonic burst will be reflected back to the sensor by any obstacle that is situated within the range 3 meters. Accordingly an echo pulse whose width is proportional to obstacle distance will be generated by the microcontroller. The width of the echo pulse can be anywhere between 100 microsecond to 18 m sec, if there is any obstacle present within the specified range. The minimum pulse width is 100 microseconds corresponds to a distance of 1.67 meter and the maximum pulse width of 18 m sec corresponds to a distance of 3 meters. However if there is no obstacle within the range of 3 meters then width of the echo pulse will be 36 m sec.

### 5.2. Input Trigger

The ultrasonic sensor SRF04 should be triggered regularly at a specified time interval for continuous distance measurement. Considering the walking speed of a blind person in an unknown place as 1.5 km/hour, the time taken to travel 1 meter is 2.4 second. The sensor needs to be triggered at the time interval of 2.4 second which corresponds to a clock frequency of 0.417Hz. The timer IC 555 in a stable configuration is used to generate trigger pulses of 0.417Hz frequency [11].

### 5.3. Reset Circuit

This circuit will generate pulse automatically to reset all the counters so that a new set of data may enter into the counter. The reset pulse should be synchronized with the input trigger pulse that is used to trigger the ultrasonic sensor. Every time a trigger pulse appears there should be a corresponding reset pulse. Once again 555 timer has been used as a monostable multivibrator that is triggered by the input trigger pulse to generate the required reset pulse.

### 5.4. Battery Level Indicator

Each and every time after decoding to the distance controller is checking for battery status, if status is below some specified value then it is generating a signal to produce a beep which is indication of low battery.

### 5.5. Wire Probes for Water Pit Indication

Two wire probes are provided in circuit, which are fitted at the bottom of stick for sensing water pits in the travelling path. Information about water pits are indicated at two levels, at first level there is small water pit or spread water and at second level there is water pit around 0.5 to 1fit. Indication to the blind people is conveyed through different sound intensities. These wire probes are shown in figure 2.

**Figure 2. Wire Probe**

### 5.6. Output Devices

Two different types of output devices namely tactile vibrator and audio sound generator are used. The vibrator is increasing its intensity of vibration as it is approaching to obstacle, this intensity is indicated at three levels, first level is 2 meter distance at this distance vibration is minimum so the information to the blind person is watch out ,second level is 1meter distance at this distance vibration is more than first level so information to the user is beware, third level is 0.5meter distance at this distance vibration is maximum or continuous vibration so information to the user is dangerous. For audio two piezo-buzzer having different notes also been fitted in the device. These audio tones are giving information about water pits in the travelling path and can hear through head phone. Figure 3 shows prototype of the stick.

**Figure 4. Measurement Error Relative to the Obstacle Distance**

## 6. Design Parameters

The proposed ETA is designed according to the following parameters:

| | |
|---|---|
| Detectable range in meter | 0.2 to 2.5 |
| Weight in gram | 300 to 350 |
| Operating Voltage | 9V |
| Allowable input frequency | 40 kHz |
| Sensitivity in db | -63±3 |
| Operating temp. Range ($^oC$) | -30 to +85 |

## 7. Results and Discussion

This design is focused on low power consumption, small size, lightweight, and easy manipulation.

### 7.1. Experimental Results

Error measurement of different shape Obstacles:

In this system, new pulses are transmitted as soon as the echo from the previous pulse is detected. After transmitted, previous pulses are processed before interrupted by the new pulses. Therefore, scan interval is 50ms which emitted energy can be reached at round-trip distance 10m four representative objects were chosen to verify the accuracy of the distance measurement.

The objects included flat panel of 80 by 60cm, coal-tar cylinder of 13cm diameter, steel pole of 3cm diameter, and sweater. As can be seen from fig.4, the distance measurement data for the flat panel have shown a low relative error of around 2%. Relative error of cylinder is around 3% and that of the steel pole can is around 4%. Maximum relative error of the sweater has shown a high relative error of around 5%.

### 7.2. Real-Time Testing

During this evaluation, the complete ETA system was tested and evaluated by blindfolded and visually impaired person. Three different routes have been chosen to test the performance and reliability of the system.

**Route 1:** The route was on the second floor of Laboratory building where there were more corners of the wall than obstacles. The blind was unfamiliar with the place. A comparative performance with white cane is shown in Table 1,The total length of the route was 69.6m and was covered at an speed of 0.773 m/s with white cane, whereas, with ETA the speed is 0.516m/s. The result might show that white cane has outperformed the ETA, however, familiarity with ETA would certainly improve the situation.

**Table 1. Comparative Performance of ETA with White Cane in Route 1**

| Path | Length (m) | With ETA | | With white Cane | |
|---|---|---|---|---|---|
| | | Time (sec) | Speed (m/s) | Time (sec) | Speed(m/s) |
| A | 28.8 | 77 | 0.37 | 42 | 0.69 |
| B | 13.8 | 21 | 0.66 | 16 | 0.86 |
| C | 27.0 | 52 | 0.52 | 35 | 0.77 |

**Route 2:** Putting several different obstacles randomly on the way of the blind created the route 2. The obstacles include chairs, rod, polystyrene and tables. The test was carried out for five times changing the orientation and number of obstacles for both ETA and walking cane. Results are summarized in Table 2, from the testing results it can be inferred that the ETA can be effectively used as a traveling aid for the visually impaired.

**Table 2. Comparative performance of ETA with white cane in route 2**

| Total Obstacles | With White Cane | | With ETA | |
|---|---|---|---|---|
| | No. of Collisions | % | No. of Collisions | % |
| 13 | 6 | 38.56 | 5 | 38.46 |
| 10 | 6 | 60 | 4 | 40 |
| 15 | 7 | 46.67 | 6 | 40 |
| 7 | 4 | 57.14 | 2 | 28.57 |
| 12 | 5 | 41.56 | 4 | 33.33 |

## 8. Conclusion

This designed Electronic Travel Aid uses ultrasonic sensors. These sensors are capable of detecting obstacle maximum at 2-3 fit; this is light weight device and includes ultrasonic sensors and few electronic components with long life battery. The broad beam angle ultrasonic sensors enable wide range environment recognition. The main functions of this system are the clear path indication and the environment recognition.

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