PROJECT REPORT for TA 212 - Workshop Practice

Academic Year- 2018-19

ON
'WALKING STICK FOR THE BLIND'

by

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Mar 2019

ABSTRACT

Blindness is a more severe problem among other disabilities of human beings. Since a blind person cannot precisely feel their surroundings like a normal person, they might often require some sort of aid to perform various tasks, travelling being one of them. Researchers and developers invented several devices to achieve independent navigation for the blind. But most of these inventions are for a specific task or are usually not cost effective. To facilitate independent navigation, a device with more features is required. For this purpose, “Walking stick for the blind” has been designed to fulfill the goal. The device eliminates the requirement of human assistance for blind while traveling outdoors. It is made from reliable parts and features a relatively low cost compared to industrial bots. Every part of the device is simulated and tested. The device can be operated by any operator and requires low power. Arduino Mega (ATMega2560) has been used as the processor, ultrasonic sensors have been used to detect obstacles (at a distance both horizontally and depth wise), IR sensors have been used to detect lines. Two dc motors are joined using a full bridge motor driver L98 module to navigate. A buzzer and a vibration motor is used to give notification to the user.

1. INTRODUCTION

Eyesight is one of your most important senses. 80% of what we sense or perceive comes through our sense of sight. The way sight works is why it is among the five senses. The eyes are the physical portal through which data from the environment is collected and sent to our brain for processing. The brain does its job by converting this light into usable information like – how distant, how bright, what color. Our eyes aren't just performing a task, they are the portal through which our brain can tell us about our world, learn new things, and make wonderful memories. All of which are reasons why vision is such a crucial thing to be required to take care of.

However it is unfortunate that some people are deprived of the ability of vision which could be due to a number of reasons. Blindness or visual defect is a state barren of the visual notion due to physiological or potentially neurological factors. The partial blindness implies the shortage of integration within the growth of the nervus opticus or visual core of the attention, and complete blindness would be the total deficiency of the visible light perception [1]. Visual impairment or losing of vision can happen in several ways resulting from either disease, injury, or congenital or degenerative conditions which cannot be corrected by traditional means, such as refractive modification, medication, or surgery [2].

New emerging advanced technologies have become hope for them in recent times. The concept of assistive technology for the blind is not so ancient [11]. Among all these technologies; a few are: Smart Walking Stick [4] that performs a fresh dimension of useful assistance and also provides a little bit of artificial vision. The Guide Cane [5], which is a fancy device designed to reduce hazards faced by a blind pedestrian. The Nav Belt [6] is a wearable device that gives acoustic feedback in two distinct modes of operation: the guidance mode and the image mode. But the limitation of these devices is that they are designed to only perform specific tasks. 'The walking stick for the Blind' proposed in this paper aims to overcome this limitation.

2. LITERATURE REVIEW

A navigation system for the blind people assisted by voice has been introduced in [8] by Ananth Noorithaya, Kishore Kumar M. and Dr. Sreedevi A. which is also designed based on ultrasonic sensors. The signals obtained from the sensors are analyzed by the microcontroller in a way so that it can detect any chance on the ground if it happened. This cane based navigation system can detect obstacles as close as 4 centimeters.

A paper on the navigation system for the visually impaired person using ultrasonic sensors has been presented in [7] by Anika Nawer, Farhana Hossain, Md. Galib Anwar. This microcontroller based project has the potential to avoid the obstacles ahead of the blind person fully automatically and reach the knowledge about obstacles by audible notification to the required person.

A wearable Zigbee-based guidance system [9] has been implemented by Minseok Song, Wanhyung Ryu, Aaron Yang, Jaewoo Kim and Byeong-Seok Shin. In this system, Global Positioning System (GPS) has also been incorporated to detect obstacles along with the conventional ultrasound sensors. A new scheduling scheme has been proposed in the system which interleaves the signals obtained from ultrasound sensors and GPS modules to avoid the collision between these two signals.

A stick based walking aid device for blind people using ultrasound has been proposed in [2] by Olakanmi O. Oladayo. The detection range of the sensors being used in this device is 0 meter to 1 meter at the front of the stick as well as right side and left side. The microcontroller i.e. the control unit provides a light alert along with voice guidance through a headphone to the user.

A paper on designing a virtual eye for the visually impaired person has been presented in [1] by Pooja Sharma and Mrs. Shimi S. L which is an Arduino based project utilizing the ultrasonic sensors. The Arduino carries out the granted instructions and then communicates the situation of a provided appliance or device returning to the earphones employing SD Card Technology.

An intelligent path guidance robot (iPath) has been designed in [10] by Siti Fauziah Toha, Hazlina Md Yusof, Mohd Fakhruddin Razali and Abdul Hadi Abdul Halim for assisting the visually challenged people to move through the environment comfortably without helping of another person. The robot is controlled by the user and the user can control the speed of the robot according to his need. The advantage of the robot is that it is lightweight and can sense the movement of the user, also because the cane is often easily detached from the body of the robot.

A blind assistive robot similar to what has been discussed in this paper has been designed in [21] by Abu Tayab Noman, M A Mahmud Chowdhury, Humayun Rashid, Humayun Rashid, S. M. Saifur Rahman Faisal, Iftekhar Uddin Ahmed, S M Taslim Reza. This robot also aims to provide a range of functionalities and is claimed to be cost effective too.

3. METHODOLOGY

3.1 Overview

The aim of this project is to assist blind people to navigate without needing help from others. Ultrasonic Sensors are employed to detect front obstacles, the wall on both sides as well as obstacles like stairs or slopes and to detect holes in front. An IR sensor is used to locate the path. In order to keep the stick along a definitive path, the project testing was carried out on a predefined path which was detected by the IR sensor. As designed, the stick will trigger an alarm notification via buzzer and vibration to its user on encountering any obstacle. Arduino IDE (V1.6.3) has been used as the programming software in this project.

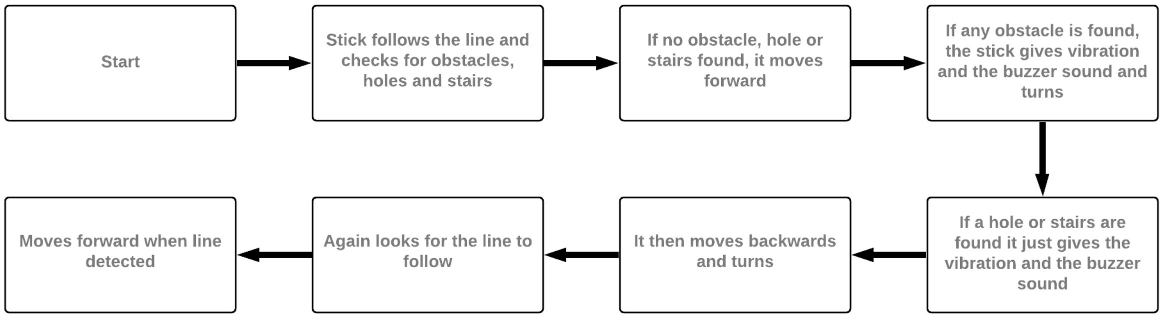

Fig 3.1 Functional block diagram

The above figure demonstrates the complete block diagram of the project.
The stick becomes functional as soon as power is activated. Then the stick goes along with the person's movement and checks for obstacles like walls and even for stairs and holes. In case any obstacle, hole or stair is not found, the stick shows no response.
If the stick detects obstacles, then it will turn providing vibration and one beeping sound. If any hole or stair is found, then the stick will stop instantly with a vibration as well as two beeping sounds. Then it moves backward and turns left or right. If the stick turns right then it beeps three times and if it turns left, it beeps for four times. The stick now stops motion and the user can make a decision for which direction to move in.

3.2 Hardware Requirements

List of major Components used and their brief description are given below.

1. Arduino Mega (ATmega2560)
2. Ultrasonic Sensors
3. Line Tracking IR Sensor Array
4. Full Bridge DC motor Driver: L298
5. Vibration Motor
6. DC Motors
7. Buzzer

3.2.1 ARDUINO Mega (ATmega2560)

Arduino Mega (ATmega2560) is the most advanced microcontroller board of Arduino based on the ATmega2560 processor [12]. Figure 3.2 shows an Arduino Mega (ATMega2560). It has 54 digital input/output pins and 16 analog inputs. 14 out of 54 digital input/output pins can be used as PWM (Pulse Width Modulation) output. It has also 4 UARTs (hardware serial port, a 16 MHz Crystal Oscillator and a USB connector, a power jack, an ICSP header, and a reset button, simply connecting it to a computer with a USB cable or power it with a AC to DC adapter or battery to get started. The Arduino Mega is compatible with most of the shields designed for the Arduino Duemilanove or Diecimila. Table 3.1 shows the features of the Arduino Mega (ATmeg2560).

Parameter	Characteristics
Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (Limits)	6-20V
Input Voltage (Recommended)	7-12V
Digital Input/Output Pins	54 (of which 14 used as PWM output)
Analog Input Pins	16
DC Current per Input/Output Pins	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8KB
EEPROM	4KB
Clock Speed	16MHz

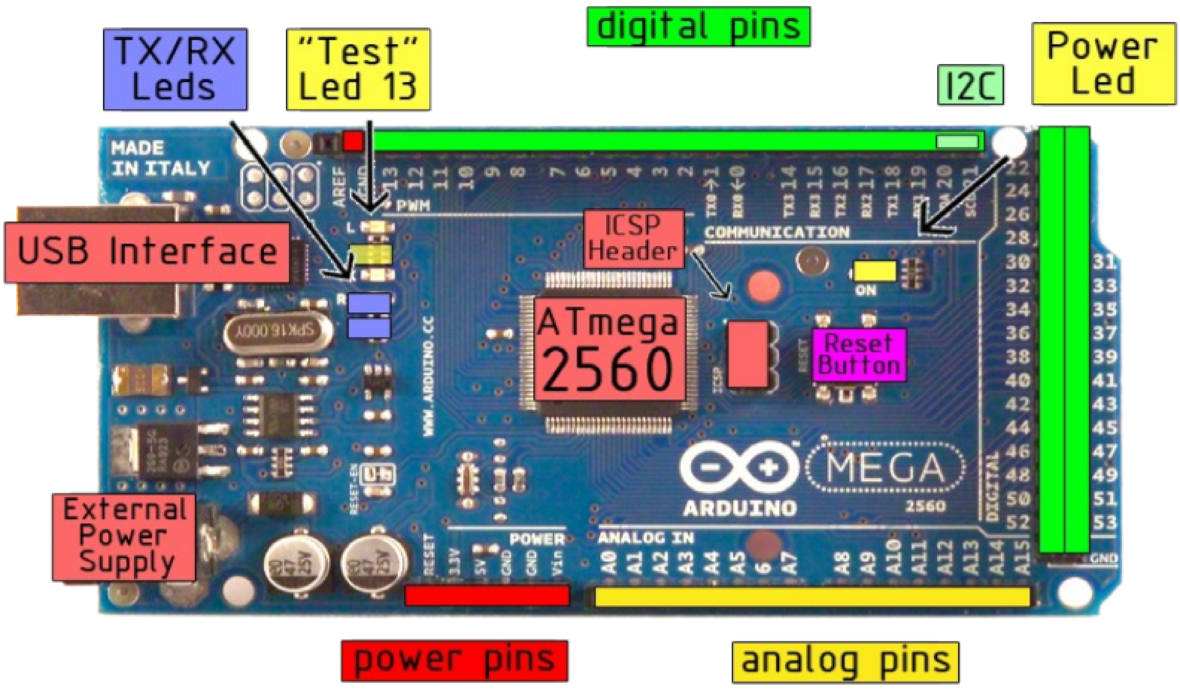

Figure 3.2 Arduino Mega (ATmega2560) [12]

3.2.2 Line Tracking IR Sensor Array

Line Tracking Sensor Array consists of 4 pairs of IR Transmitter-Receiver shown in Figure 3.3. A POT is used to control intensity of the infrared wave for every pair. IR Sensors work by using a specific light sensor to detect light wavelengths in the Infra-Red (IR) spectrum. By using a LED which produces light at the same wavelength as what the sensor is looking for, can be looked at the intensity of the received light [13]

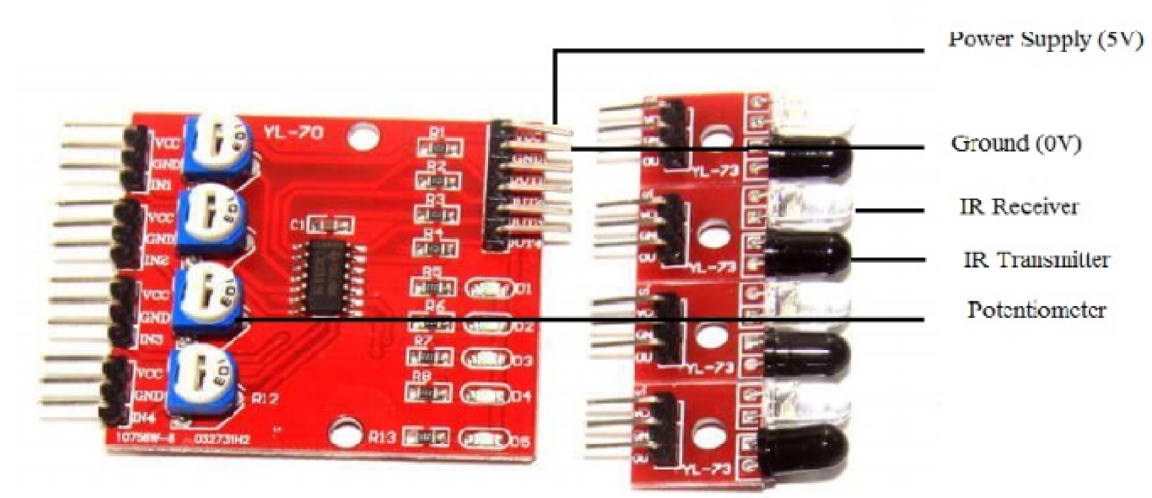

Fig 3.3 Line Tracker IR Array Module [13]

Working Principle

When Infrared rays are transmitted from the transmitter and hit on a white surface [Figure 3.4 (a)], it reflects to the receiver. So the output pin of the receiver gets high due to the light intensity of the infrared ray. When Infrared rays are transmitted from the transmitter and hit on a black surface [Figure 3.4 (b)], it absorbs IR. So the output pin of the receiver remains low.

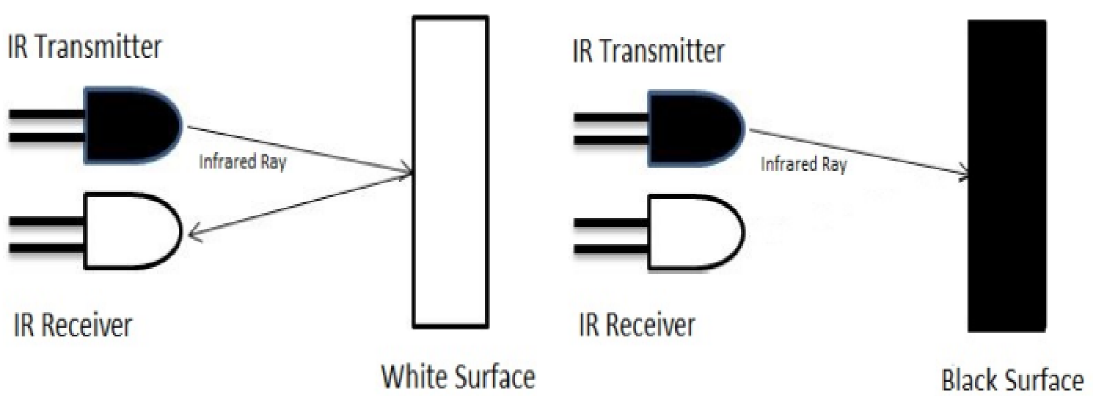

Fig 3.4 IR Operation (a) IR reflection on white surface
(b) IR absorption on dark surface

3.2.3 Full Bridge DC Motor Controller: L298D

The motor driver module is based on the L298 dual dc motor driver IC. It can control a maximum of 2 DC motors at a time in the desired direction. To use this module, simply connect the two leads of the motor to the blue terminal block connector and give proper signal to the all enable and input pins. The module has an on board voltage regulator for supplying 5V to L298 IC. There are also three separate power rails for Input voltage, Ground and 5V supply so the module can be used as a small power distribution board. The enable switch performs the activation and deactivation of the L298 IC. Figure 3.5 shows the pin diagram of L298 IC. It has 15 pins where four input, four output, two enable, one Vcc, one Vs, one ground and two current sensing pins. Figure 3.6 shows the complete overview of Full Bridge Motor Driver L298.

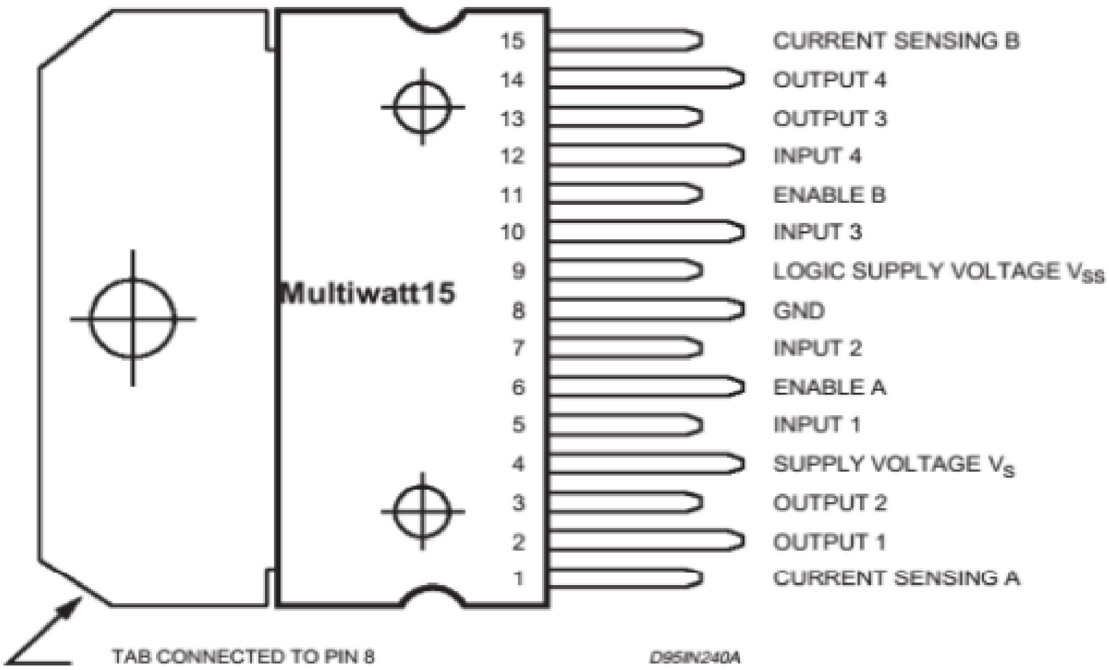

Fig 3.5 Pin diagram of L298 [14]

Symbol	Parameter	Value
Vs	Power Supply	50V
Vss	Logic Supply Voltage	7V
Vi, Ven	Input and Enable Voltage	-0.3V to 7V
Io	Peak Output Current	2A
Vsens	Sensing Voltage	-1V to 2.3V
Ptot	Total Power Dissipation	25W

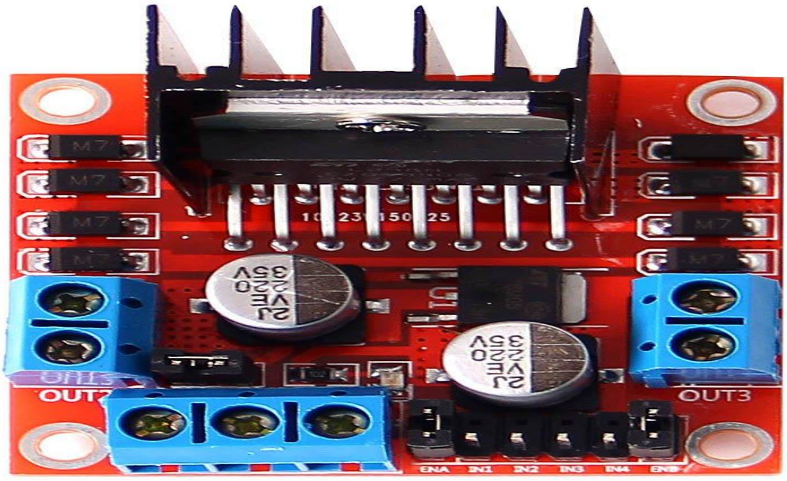

Fig 3.6 DC Motor Driver module: L298 [15]

3.2.4 Ultrasonic Sensor: HC –SR04

An Ultrasonic sensor is a device that can measure distance or detect obstacles ahead of it by using sound waves. It measures distance by sending out an ultrasonic sound wave at a selected frequency and listening for that sound to revert back. Figure 3.7 shows an Ultrasonic Sensor. The module consists of a transmitter, a receiver and a control circuit including a crystal oscillator. The four pins of the ultrasonic sensors are: Supply Pin Vcc (5V) Trigger Pin (Input) Echo Pin (Output) Ground Pin (0V).

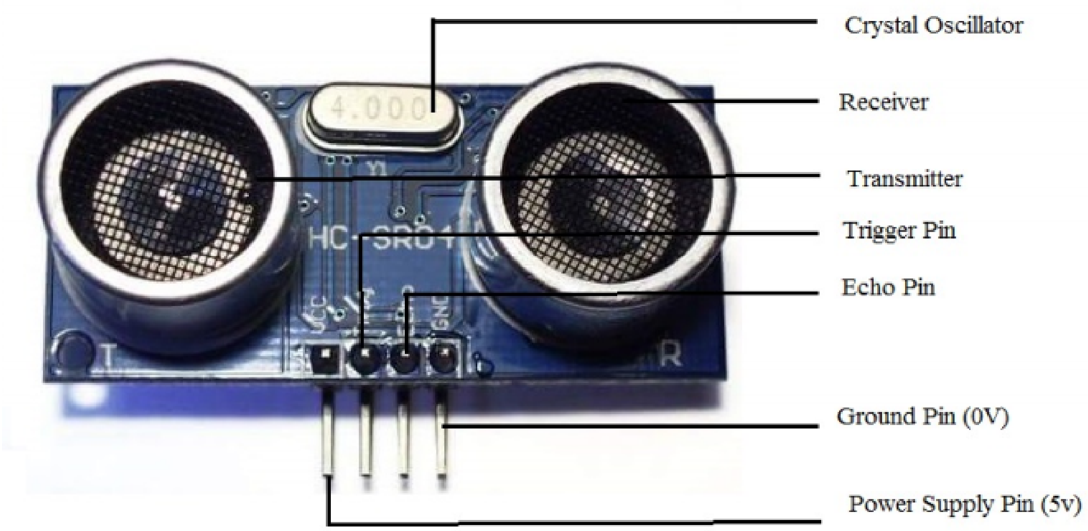

Fig 3.7 Ultrasonic sensor [16]

The working principle of the device is similar to the radar and sonar system. Active ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. By measuring the time interval between sending and receiving the echo, the distance between the sensor to the object can be measured. Ultrasonic ranging module: HC-SR04 is used in this project. The range of the sensor is 2cm to 400cm and the ranging accuracy can reach to 3mm [17].

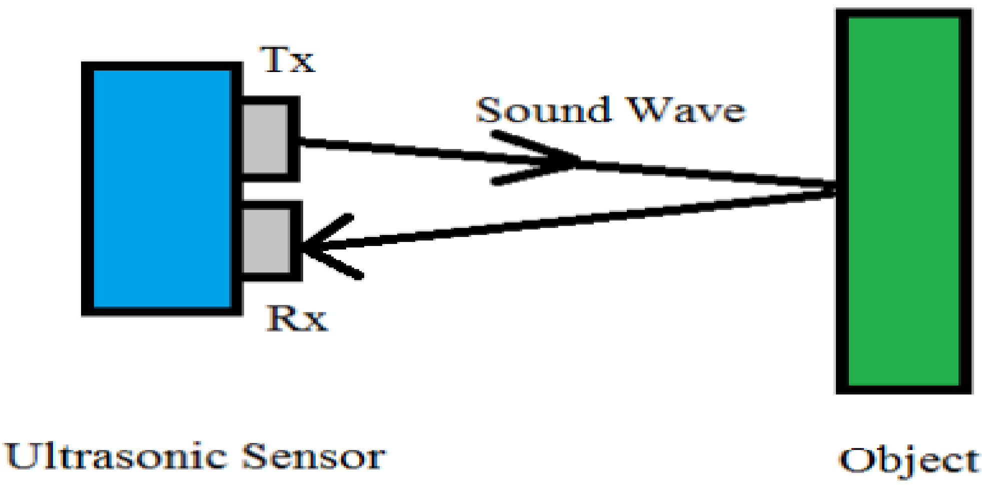

Fig 3.8 Basic working principle of an ultrasonic sensor

The basic working principle of the sensor is:

- Using I/O trigger for at least 10us high level signal.17
- When a low to high pulse is applied to the trigger pin, it sends eight 40KHz sound waves or a pulse signal back.
- If the signal goes back through high level, time between sending and receiving signal is measured. And the distance is measured by this equation: Distance = (Velocity of sound x time between sending and returning)/2 [17]

3.2.5 Buzzer

A buzzer is a sound generating device. 5v continuous tone buzzer used in this project shown in Figure 3.9. It is a magnetic type transducer. Sound pressure level is 82dB and frequency is 203KHz. It can generate continuous beep tones. Operating voltage of this is 5VDC and rated voltage is 3VDC. Current rating is 30mA [18].

Fig 3.9 Buzzer [18]

3.2.6 DC Motors

The DC gear motor is used for the purpose of navigation of the stick. Two DC motors are used in this project. Figure 3.10 shows the DC Motor. Wheel can be mounted on either side of the motor. The motor operates from 3 to 6 volt DC where at 5 volt, it rotates smoothly. Maximum torque of the motor is 800g.cm. speed without load 90 rpm (app.). no load current is 190mA and operates upto 250mA. Stall current rating is 1A [19].

Fig 3.10 DC motors [19]

3.2.7 Vibration Motor

Coin type vibration motor is used in this project. Figure 3.11(a) shows the physical shape of the Coin type vibration motor. This small device consists of rotor, stator, armature, windings, brushes etc. The need for smaller, thinner designs led to the adaptation of brush motor technology into the coin-type vibration motor. Figure 3.11(b) is an internal construction diagram of the brush coin-type motor. Similar to the bar-type vibration motor, coin-type vibration motor consists of a weight, a ring magnet, rotor with commutation points attached in the front and coils assembled on the back, and power supplied brushes attached to the ring magnet. The commutation points, which are the yellow part on the bottom pic, are in contact with the end of the brushes. It will energize the electrical coils in the rotor. Energizing the coils produces a magnetic field and it is strong enough to interact with the ring magnet integrated into the stator, causing rotation. A force is generated due to the magnetic field. This force causes the weight to displace. The repeated displacement of the weight produces a varying force which is felt as vibration. The commutation points are used in changing the polarity pairs, so that as the rotator moves, the coils are constantly reversing the polarity.

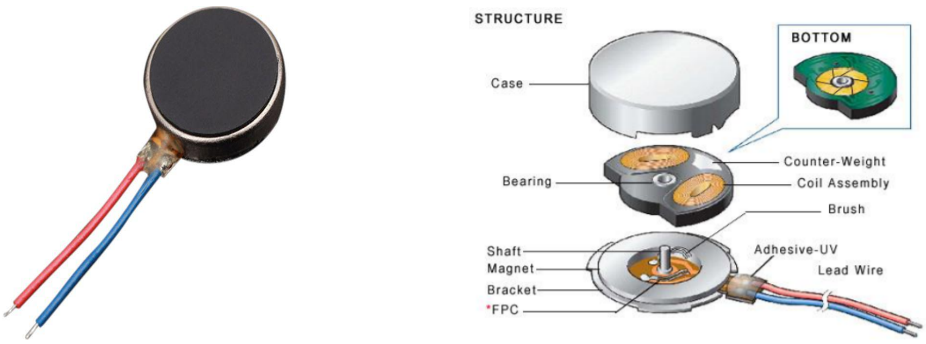

Fig 3.11 Vibration motor (a) outer (b) inner structure [20]

4. CIRCUIT DEVELOPMENT

Figure 2 illustrates the circuit diagram for the walking stick consisting of an Arduino Mega (ATMega2560), five Ultrasonic sensors, four onboard line tracking IR sensor pairs, two DC motors, a buzzer and a vibration motor. An On-Off switch is used to signify line following or obstacle averting mode. Ultrasonic sensors are used for left, right, front obstacle or wall detection, along with hole detection stairs as well. The Trigger Pin and Echo pin of the Left ultrasonic sensor are connected respectively to 52 and 53 number pins of Arduino Mega. Similarly, Middle ultrasonic sensor is attached to 50 and 51 number pins whereas Right ultrasonic sensor is connected to 58 and 49 number pins, hole detecting ultrasonic sensor is connected to 42 and 43 number pins and finally stair sensing ultrasonic sensor is connected to 40 and 41 number pin of Arduino Mega. Line Tracking IR sensor's pins are connected to 46,47,45,44 number pins of Arduino Mega. The vibration Motor is connected to the 6 number pin and the Buzzer is connected in parallel with the vibration motor. Left motor is engaged with the 2 and 3 number pins of Arduino Mega. The positive lead of the left motor is connected to pin 2 whereas Negative lead is connected to pin 3. 4 and 5 number pins are employed for the right motor of the stick. The positive lead is connected to pin 4 and Negative lead is connected to pin 5.

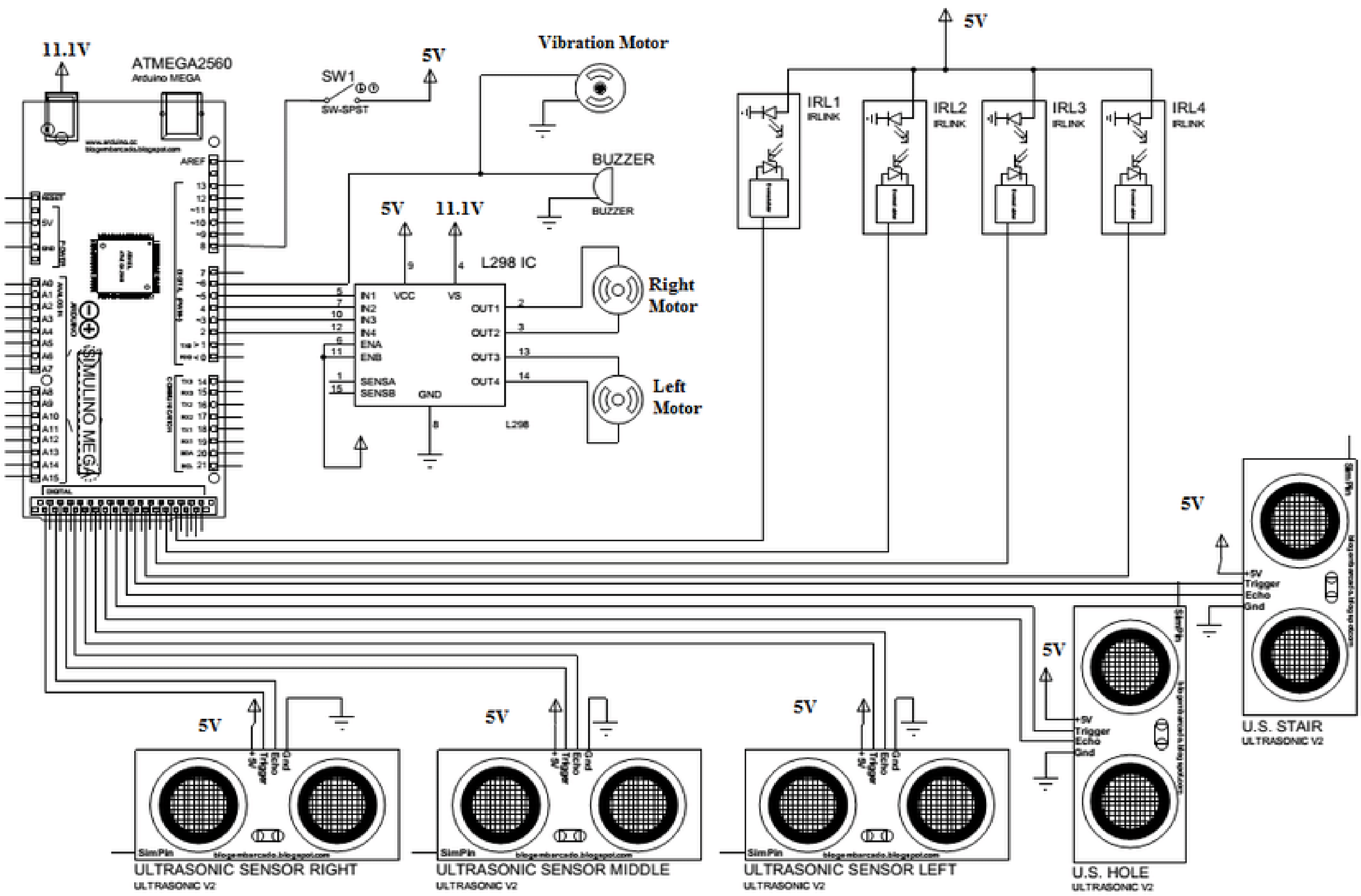

Fig2. circuit diagram for the "walking stick for the blind"

5. OPERATING PRINCIPLE

If switch status is ON, the line following mode will be activated automatically. If IR2 and IR3 sensor output pins get high, at the same time IR1 and IR4 sensor output pins are low then both motors will rotate in the forward direction. If the IR1 output is high then the right motor will rotate forward. And when IR4 gets high, the left motor will rotate forward. If switch status is OFF and if any obstacles are detected by the middle ultrasonic sensor, the right motor will rotate forward (4 number pin = 1& 5 number pin =0) and the left one will remain stopped. It will also be giving a beeping sound continuously. Left and right ultrasonic sensors follow the wall. If the left and right ultrasonic sensor reading is more than 30 cm, both motors will rotate forward (2 number & 4 number pin = 1, 3 number pin & 5 number pin =0); consequently, the stick will move forward. If the left ultrasonic sensor reading is less than 30cm and the right ultrasonic sensor reading is more than 30cm, the left motor will rotate forward, and the right motor will stop. The stick will turn right and beep twice. If the left ultrasonic sensor reading is more than 30 and right ultrasonic sensor reading is less than 30cm, the right motor will rotate forward as a result the stick will turn left and beep once. If both left and right ultrasonic sensor readings are less than 30cm, both motors will rotate reverse. As for the downward facing ultrasonic sensor, if reading is more than 20cm, then both motors will stop because this indicates the presence of hole or downward stairs. The stick will detect upward stairs if the top ultrasonic sensor reading is greater than the middle ultrasonic sensor reading.

6. ALGORITHM

Figure 3 and figure 4 show the complete flowchart of the programming sequence of this stick, where “Y” represents “Yes” statement and “N” represents “No” statement. At first, the program will check whether the switch status is ‘ON’ or ‘OFF’. If it is ‘ON’, it will take a reading of every sensor, IR1, IR2, IR3, IR4 will sense the line. Then it goes for comparison with logic operations.

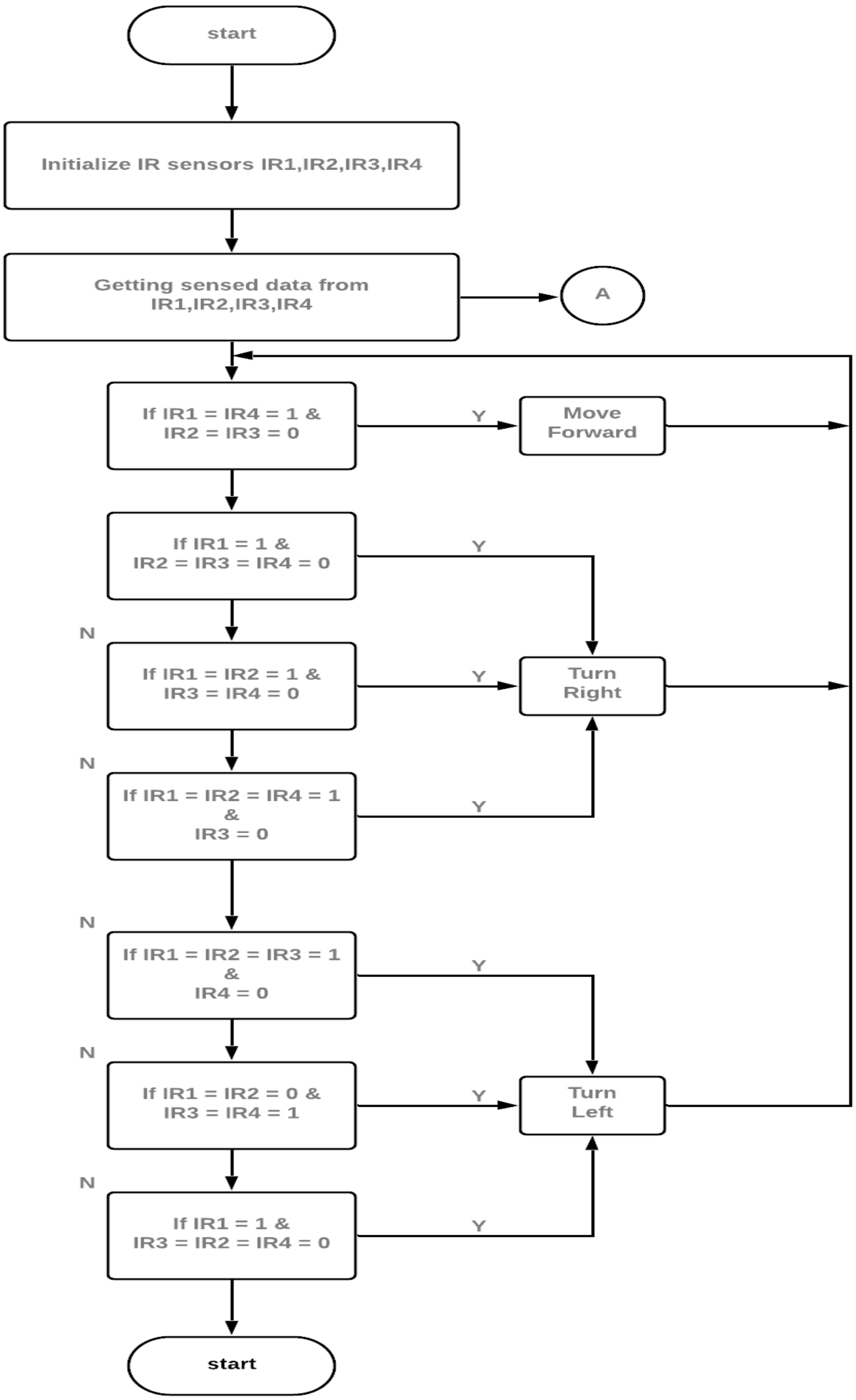

Fig3. control-flow diagram for ‘OFF’ switch status

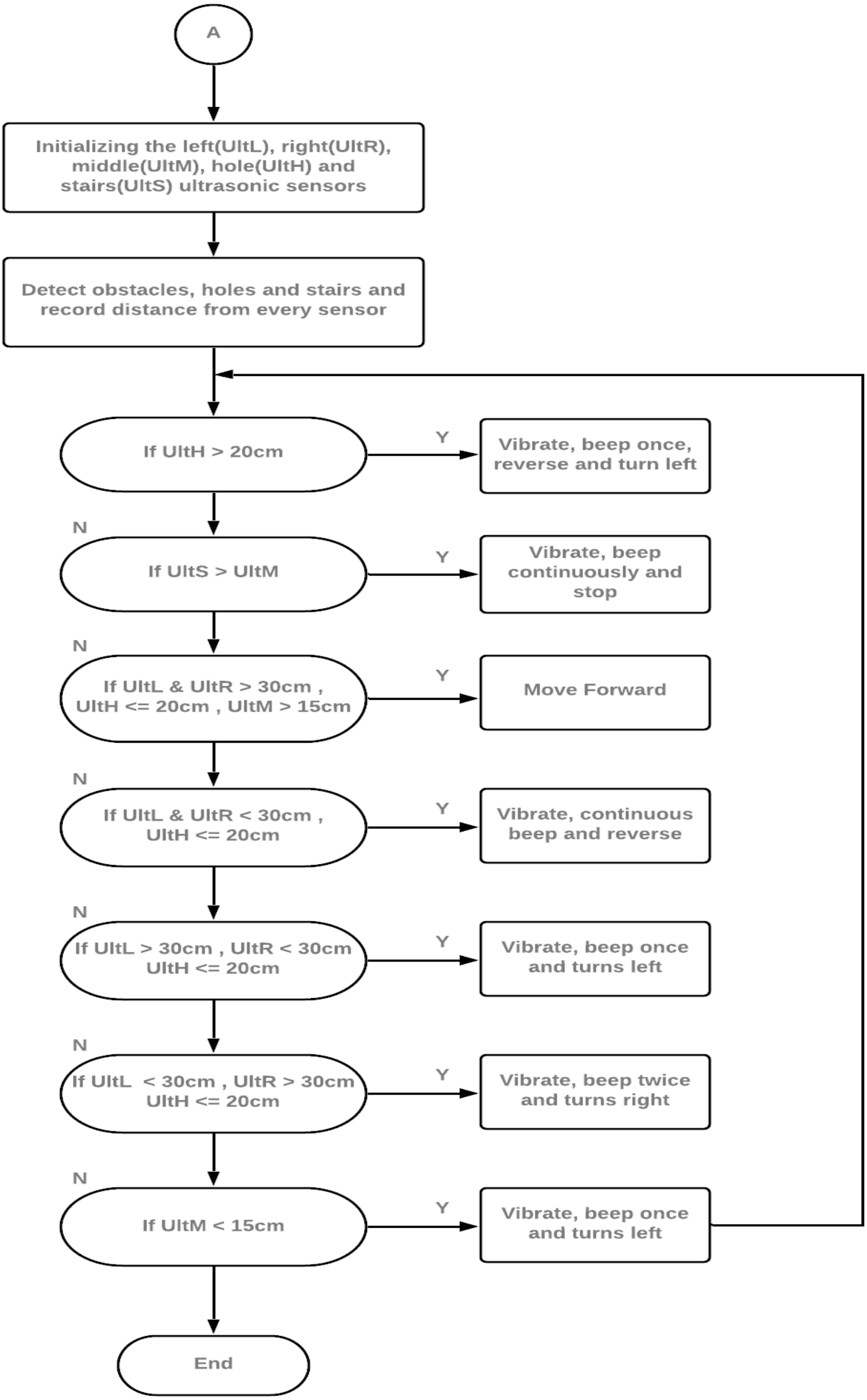

Fig 4. Control-flow diagram for ‘ON’ switch status

Line tracking will be initialized if any line is detected. Then the stick moves forward. If IR2 and IR3 condition is TRUE and IR1 and IR4 condition is FALSE, the stick will keep moving forward. By turning left and right this principle is gained. The ultrasonic sensor operates if switch status is off. If the hole Ultrasonic sensor > 20cm, then it indicates hole or downward stairs. If the stair Ultrasonic sensor > UltM, then it indicates upward stair or upward slope. If UltL>30cm & UltR>30cm & UltM >15cm then it provides a signal of no obstacles ahead and the root will move forward. In order to follow this logic, the stick will turn left or right.

7. RESULT AND ANALYSIS

The walking stick for the blind is divided into two parts. The main body of the Stick and the handle . In the main body, Arduino 2560 has been used as a processor for processing data from the sensor and for taking decisions for the navigation of the stick. IR sensors have been used for detecting lines. Ultrasonic sensors are used to detect an obstacle, holes and stairs. The vibration motor which is attached with the handle is used as an indicator to grab the attention of the user. The buzzer is used to indicate any movement or object. Motor driver controller with L298 IC has been used for driving 6-volt DC gear motors. For powering the complete unit, an 11.1-volt rechargeable lithium-polymer battery has been used.

If Switch status is ON, line following mode will be activated. If both the middle IR sensors are on the line and the other two IR sensors are out of the line, then the stick will move forward through the line. Otherwise, it will turn left or right to remain in this condition of 4 IR sensors.
If Switch status is OFF, Obstacle avoiding mode will be activated.

Line following and obstacle avoiding capability are handled separately by using a switch. Because all the IR sensor and Ultrasonic sensor send and receive data at a time, hence it is difficult to maintain the specific task of every sensor. When line following and obstacle avoiding mode are combined, the stick falls in a loop.

8. CONCLUSION

This walking assistive stick can be a helping hand for visually impaired persons without engaging any other people at an affordable cost. A major goal of the project was to mitigate difficulties of blind people while navigating or traveling. The device promises relatively smoother navigation both indoor and outdoor for the blind. This project covers a lot of sectors of blind assistive technology. However, the future scopes available for this project are:

• Voice notification and navigation features could be added in future.
• The device can be attached to a wheelchair with autonomous navigation for crippled blind person.

• Using Solar panels with rechargeable batteries, the issue about charging could be removed.

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10. SOURCE CODE

https://github.com/SvayamGopal/Blindman_Walking_Stick