Guidance for Blind and Visually Impaired People Using Modern Technology

[1]Spoorthi Chandranna, [2]Tejaswini M L

[1]UG Scholar, [2]Assistant Professor
[1,2]Electronics and Communication,
Don Bosco Institute of Technology, Bangalore, India

***Abstract*: Abnormalities in visual function are a devitalizing condition that has affected millions of people globally. Outwardly disabled individuals discover troubles recognizing obstacles ahead of them which makes it unsafe to navigate without a guidance of sighted person. There are plethora of challenges which are faced by a visually impaired person, but we figured out the dominant problems and tried to simplify their lives by implementing a smart cane using modernized technologies. We designed a stick that basically contains two parts. The upper part is dedicated to detect the obstacles in all the three directions using an ultrasonic sensor and provides navigation instructions via voice message. A unique feature of our project is that the language to give commands can be chosen in the favor of user. However, we opted English as the medium of communication. The second part which is mounted at the lower end helps to locate the user during emergency calls by sending a google map link along with the parameters of latitude and longitude in the form of text with the help of GPS and GSM module. This part also consist of water sensor that alerts the presence of two levels of water via buzzer. Moreover, the levels are differentiated by two various frequency values. It is an effective device and will ease the lives of blind.**

***Index Terms*: Smart cane, Blind, Visually impaired, GPS, GSM, Obstacle**

I. INTRODUCTION

Human eye is one of the most essential part that reacts to light and allows vision. Damage to this vision create complications in one's life. In a survey it is concluded that about 4% of the world population suffer from visual impairment or blindness[2]. Many experiments has been going on by the researchers in the field of electronics to enhance the life of the visually impaired [2]. Normal people are easily utilizing the trend of advanced technology. However, its usage by the blind community is very low. Many blinds navigate through their way with the aid of a simple white cane which is not effective enough and provides less safety. There are plethora of reasons for a person to be blind or visual impaired. Few of them are by birth, an accident or by diseases. They may not be reversible in spite of using lenses, or going through an extreme surgery. It predominantly occurs due to glaucoma, diabetes, macular degeneration infection and traumatic injuries. There are even more causes including complication of eye surgery, complications of premature birth, stroke and tumors, blocked blood vessels. Discomfort and weary eyes, foreign body sensation, and pain are some of the symptoms of blindness.

Based on the survey conducted by the World Health Organization (WHO), about 285 million people are blind and visually impaired across the globe [3]. There are around 39 million blind people out of 285 million people and unfortunately over 15 million are from India. The number varies in each country and is rapidly increasing every single year by up to 2 million globally. Its occurrence is usually seen in the aged people. Around 65% of the visually impaired are 50 years of age or older, with about 20% of the world's population in this age group.

The mobility of a blind person is hard and insecure without a proper guidance. Therefore, people tend to use a normal white stick in order to detect the obstacle. But, their usage and facilities are limited that fails to provide proper navigation. It probably identifies the objects at a very lower level. Blind people have to face some severe issues during the travel to their destination and there are high possibilities of accidents especially in unknown locations. Though many blinds are capable of a particular work, they face difficulties to maintain their daily routine and constant employment. A smart cane should be designed to overcome the challenges they face during the navigation along with few extra features.

II. SCOPE OF THE PROJECT

A basic rule to be followed before designing a product is to know the prerequisites. In the case of smart cane we conducted a survey to understand the challenges which blind people undergo and design the cane accordingly. The main aim of this project is to develop a cane which is portable, light in weight, user-friendly, reliable, cost effective and can also provide decent navigation. There are numerous conditions to be taken under considerations in the real life scenario but, it is impossible to implement each of them. So, we have taken only the major problems into the consideration and designed an effective cane.

The device is of high standards that is capable of finding the distance of the object that may come across the user in three different directions namely right, left and front nonetheless of height and depth of the obstacle. It does not require any special skills in order to operate the device and also include a switch button to turn on the device which leads to the less consumption of power. This device is portable and also gives quite good accuracy in detecting the object distance.

III. PROPOSED METHODOLOGY

There are various proposed prototypes in the market which helps in mobility. Designing such prototypes requires step by step process. Firstly, we studied each models and listed all the features along with the requirements. Followed by prioritizing the main essential necessities and deciding the components that attain the functionality. Our module is outlined to provide three different features. The main function is to detect the obstacle and provide instructions via earphone or speaker. It also alerts the presence of water via buzzer in two verity of sounds to differentiate between two levels of water. The user can make use of a panic button which is designed to locate the current place and send it to the care taker in form of text during the emergency situations.

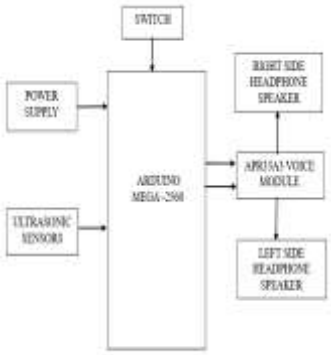

Fig.1 Upper part block diagram

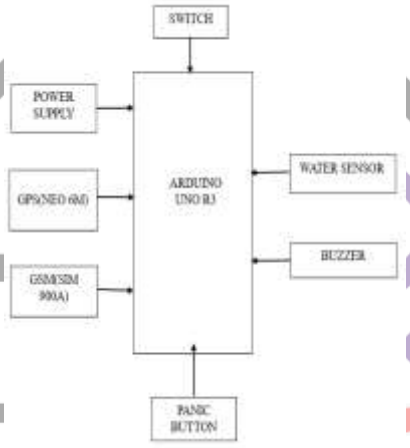

Fig .2 Lower part block diagram

Various components are included in our model which performs particular function namely:

A Arduino (UNO R3 and MEGA 2560):

Arduino is single-board microcontroller used to build digital devices that can sense and control all the activities and is programmable with the Arduino IDE. Here we have make use of two Arduino. Arduino UNO R3 for water sensor and GPS/GSM modules. The board includes 20 digital/analog pins which accepts voltage between 7 and 20V [5]. Arduino MEGA 2560 is handed-down to detect the obstacles encountered near the user. The board consists of 54 I/O pins which can be interfaced with expansion boards or other circuits.

Fig.3 Arduino UNO R3

Fig .4 Arduino MEGA 2560

B Ultrasonic sensor HC-SR04

Ultrasonic sensors are designed to measure distance with the aid of ultrasonic waves. It includes both transmitter and receiver, along with VCC and ground pins. We have used HC-SR04 sensor which determines distance of the obstacles in the range from 2cm to 400cm. They generate 8 cycle burst of ultrasound at 40 kHz via trig pin which travels in the air that takes a reflected path when an object is encountered and is received via echo pin.

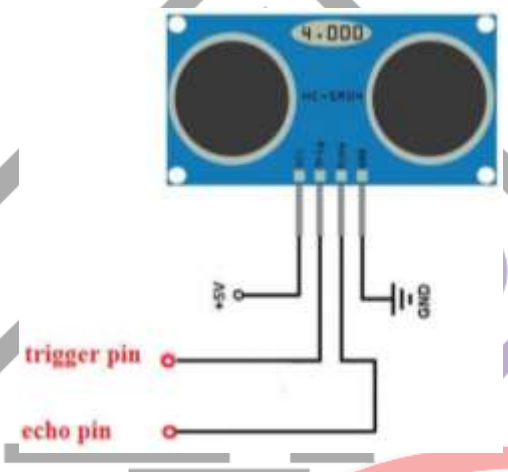

Fig.5 Ultrasonic sensor HC-SR04

C Voice module APR33A3

This device is a voice recording and playback module that includes in-built microphone. It will facilitate with high quality recording and playback with 8 channels where each channel can be recorded up to 1.3 minutes each. On whole we can record up to 11 minute audio at 8 KHz sampling rate with 16 bit resolution. It has a non-volatile flash memory technology so there is no need of battery back-up.

Fig.6 Voice module APR33A3

D GSM module

We are using SIM900A in our model to send the message in the form of text. In this modern world GSM is used in applications like embedded systems and IoT. It helps in UART interface and includes a single SIM card slot. It supports a supply voltage from 3.4V to 4.5V [1].
This module is operated with the aid of AT commands and few examples are listed below.

TABLE 1 List of AT Commands

AT command	Function
+CMGS	Send a message
+CMSS	Send a message from storage
+CMGW	Write a message to memory
+CMGD	Delete message
+CMGC	Send command
+CMMS	More message to send

These commands are used to initialize SIM900A when interfaced with the Arduino. It helps in sending and receiving appropriate message in form of texts.

Fig.7 GSM module SIM900A

E GPS module

We have opted NEO-6M module which has a unique feature of saving the data when the main power is turned off by a mere chance. It includes built-in antenna which has a capability of gaining strong satellite signals. The status of the signal can be known by a LED indicator which informs about the connectivity with the satellite. It basically contains transmitting and receiving pins for communication purpose i.e., it calculates the current location that is sent to the care taker via GSM module.

Fig .8 GSM module NEO-6M

F Water sensor

Water sensor is a device which detects the presence of water and helps in alerting via buzzer, vibrator and so on. The sensor has two parts namely circuit module and sensing module. It includes a series of exposed traces connected to ground and sensor traces are present in between the ground. These sensor traces have a weak pull-up resistor of 1 MΩ. They have many more applications like rainfall detection, water leakage detection, water level detection [6].

Fig .9 Water Sensor

G Buzzer and Speaker

Buzzer and Speaker are the two components used for alerting the presence of obstacles and water respectively. They are interfaced with the Arduino and function accordingly based on the conditions given via code.

IV. DESIGN FLOW

The flow charts given below represent the step by step procedure or the work flow of:

1. Ultrasonic sensor: According to the code, first all the pins, outputs, inputs, Vcc and ground are initialized. After this the ultrasonic sensor will start calculating the distance according to the formula if any kind of obstacle is found. Based on the given condition of distance the appropriate voice message will be played to alert the presence of obstacle. If there is no obstacle detected no voice will be played.

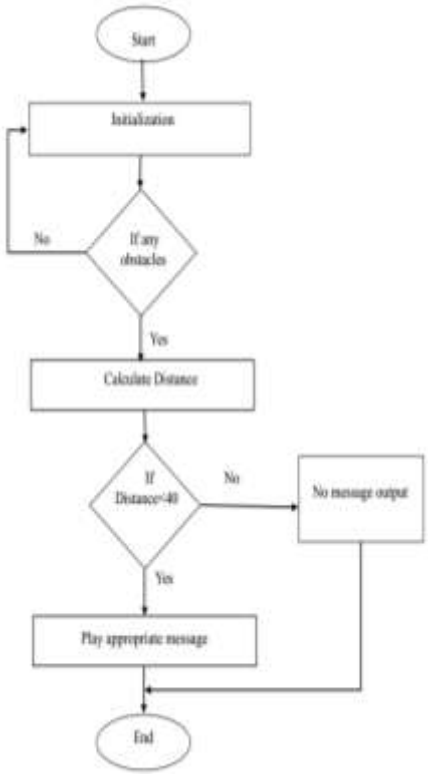

Fig .10 Flow chart of ultrasonic sensor working

2. Water sensor : For any component, initialization is the first and formost step to be followed. When initialization is done the analog value of water level is calculated if the water is present.Based on this value two different beep sound is made by differing the frequencies (low level : 100 Hz, high level 2KHz). Two different frequencies are given to differentiate between the water level.

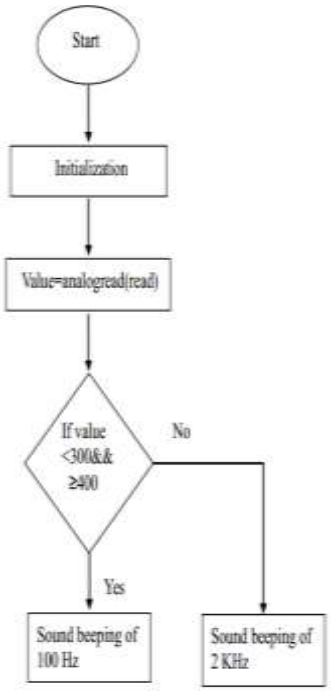

Fig .11 Flow chart of water sensor working

3. *GPS and GSM*: The main aim of using these two models is to send the current location through SMS in emergency situations. For this a small panic button is utilized and switched on to send the message. When the PIN(panic button is on) is high GPS will calculate current location's latitude and longitude. To send this calculated values GSM is checked for good signal, if signal is available SMS is sent to the care taker in the form of link (Google Maps). If GPS is unable to calculate the latitude and longitude values or if GSM does not have signal, message will not be received by the care taker.

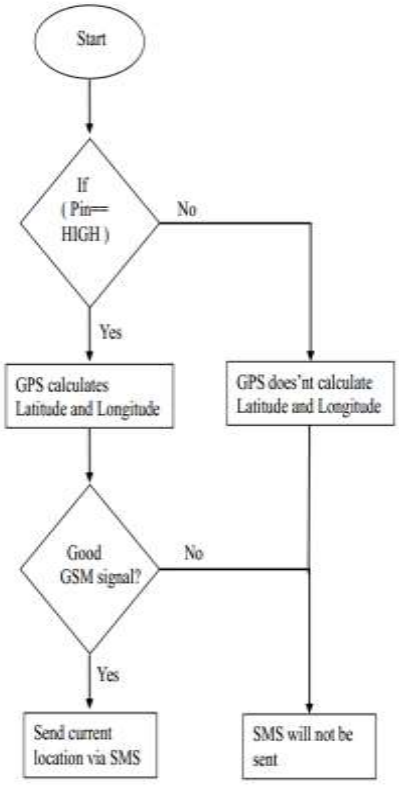

Fig .12 Flow chart of GSM and GPS working

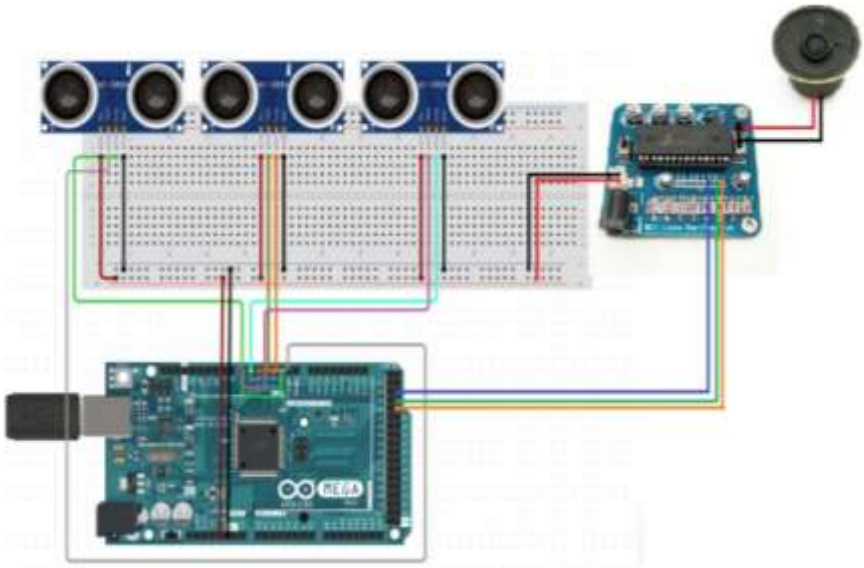

Fig .13 Circuit diagram of sensing part

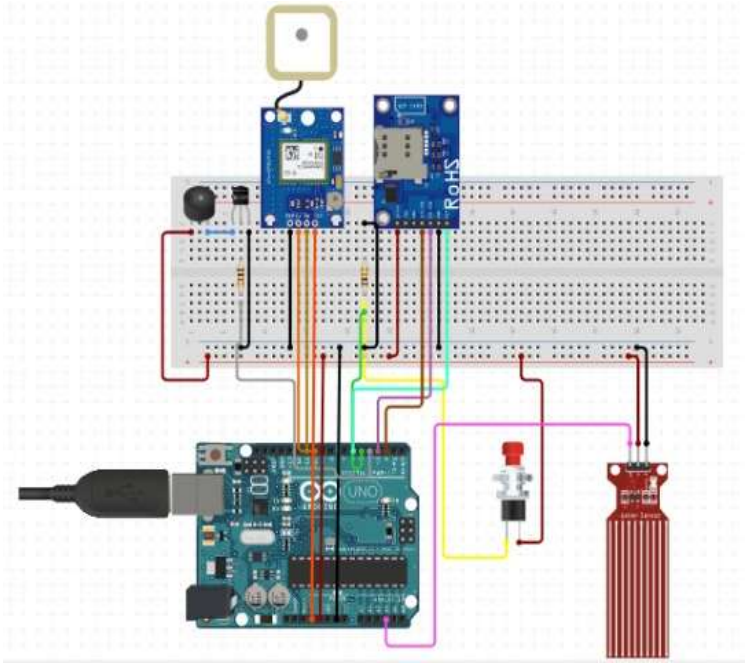

Fig .14 Circuit diagram of navigation part

V. PRACTICAL IMPLEMENTATION

Ultrasonic Sensor and Voice module APR33A3 is Interfaced with Arduino Mega2560, which is implemented on the stick. When obstacle is detected it will alert the user through audio output when the condition is satisfied which is given through a code. With aid of earphone the speech warning message kit is able to speak aloud warning message to the blind instead of incomprehensible sound and public embarrassment.

GSM (SIM900A), GPS (NEO 6M), Water Sensor and buzzer are interfaced with Arduino UNO R3 which is implemented on the stick. A Water Sensor can detect the presence of water which is indicated by beep sound of buzzer. The sound of the buzzer varies for low and high level of water by setting two frequencies 100Hz and 2 KHz respectively. With the use of GPS and GSM modules in the smart cane the user will be able to send the present location by pressing the panic button in emergency conditions.

TABLE 2 Distance Conditions

Sl no	Distance	Sensor position	Warning Message
1	>40 cm	Left	"Obstacle is in the left"
2	>40 cm	Right	"Obstacle is in the right"
3	> 40 cm	Front	"Obstacle is in the front"

Fig .15 Implemented model

VI. CONCLUTION

Smart cane is one of the guidance that provides safety to many blind and visually impaired people and make their lives simple with less challenges. It is a productive and portable device. Each individual can operate the device without the knowledge of special skills and is user-friendly. It has a good accuracy in detecting the obstacles lying ahead of the user. This module offers reliability, low power consumption, portability and a robust solution for navigation in short time response. Though many modules and sensors are implemented on the stick it is light in weight and easy to carry. The modern technology has taken a wide leap in making the lives simpler and easy.

VI. ACKNOWLEDGEMENT

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