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ARTIFICIAL INTELLIGENCE BASED SMART WALKING STICK

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ABSTRACT

This paper shows the Smart Walking Stick based on Ultrasonic sensors and Arduino for Visually Impaired. There are roughly 37 million individuals over the globe who are visually impaired as indicated by the World Health Organization. Individuals with visual inabilities are regularly subjected to outer help which can be given by people, trained dogs or electronic gadgets for basic assistance. We proposed least effort and light weight structured with microcontroller that processes signal and alerts the visually impaired person over any obstacle, water through beeping sounds or vibrations. The system comprises of ultrasonic and infrared sensors for process of receiving, processing and sending signals to the alarm system which finally alerts the user for action. The system will revolutionize the lives of the blind people. The main objective is to provide more mobility and independency to blind people.

Keywords: Arduino, Artificial Intelligence, GPS Tracking, Pothole Detection, Ultrasonic Proximity Sensors.

INTRODUCTION

Independence is the important method in achieving objectives, dreams and goals in life. Visually impaired person has little or no opportunity to execute daily task and also limits their interaction with the surrounding world consequently affecting quality of life. Visually impaired individuals are the general population who thinks that it's hard to identify the finest detail with solid eyes. The individuals who have the visual intensity of 6/60 or the flat scope of the visual field with the two eyes open have not exactly or equivalent to 20 degrees. These individuals are viewed as visually impaired. An overview by WHO (World Health Organization) in 2011 reviewed that on the planet, around 1% of the human population is outwardly disabled (around 70 million individuals) and among them, around 10% are completely visually impaired (around 7 million individuals) and 90% (around 63 million individuals) with low vision as per [1]. Recently, much research effort has been focused on the design of Electronic Travel Aids (ETA) to aid successful and free navigation of the blind. Our methodology changed this stick with some hardware segments and sensors, the electronic helping gadgets are intended to explain such issues. The ultrasonic sensors, water sensor, signal, and RF transmitter/Receiver are utilized to record data about the nearness of obstacle. Ultrasonic sensor has the ability to recognize any obstacle inside the range of 2cm-400cm. Along the path at any point if there is an obstruction in this range it will caution the user. Water sensor is utilized to distinguish if there is water in way of the user. Most visually impaired direction framework utilizes ultrasound of the fact that of its insusceptibility to the ecological clamor. Moreover, ultrasound emitters and detectors are portable components that can be carried without the need for complex circuit.

This Smart Stick consists of Ultrasonic Sensors that can sense both the distant and nearer objects or obstacles and a RF remote to locate this smart stick and this complete setup is controlled by Arduino UNO. Visually impaired persons will receive all this feedbacks with the help of a playback device and buzzer that will automatically get activated and start producing sound and vibrating motor will vibrate when the user reaches near to the obstacle. Apart from the obstacle detection this smart stick using integrated GPS technology that is recorded with preprogrammed locations to determine the optimal route to be taken to reach their destination and can also locate the position of the person to their loving ones and communicate with them.

The smart stick facilitates the blind person to make calls at times of emergency via the GSM/GPRS module. The GPS module also helps to trace the blind person through the data collected by it. The use of a rechargeable battery in the system also ensures longer time usage. The drawback of this proposed stick is that it can be difficult to keep because it was not designed to be foldable. Modification to the proposed system would be: A Braille input device to give the blind person an uncomplicated method to provide the destination address for navigation, Programmable wheels to steer the stick away from the obstacles and also lead the blind person towards his/her destination and Employing IoT to give the benefits of inter-communication between smart sticks (or mobile, PCs) nearby to utilize the functionality of the other stick when one stick's functionality breaks down.

Their device is made up of components such as ATMega328PU Microcontroller, 4 HC-SR04 Ultrasonic Sensor Modules, 1 Infrared Sensor, Vibration Motor, Battery and Audio feedback. Their method alerts users by pre-recorded sound messages and a haptic feedback in form of vibrations. The stick can detect pits, potholes, downfalls, staircase (up and down), low lying and knee level obstacles and even those above the waist. Their system is a moderate budget navigational aid for the visually impaired. The entire circuitry along with the battery is hidden within the stick thereby decreasing the risk of damage to the circuit and making the device less bulky. The system provides ON/OFF switch. The idea behind the design of the stick was to keep it structurally similar i.e., thin, lightweight and easy to handle, yet give an active feedback to the user regarding obstacles in his walking path. In this work, section one is the introduction while section two is literature survey and section three is Methodology. Section four has the simulation and discussion with section five been the conclusion.

LITERATURE SURVEY

The main aim of this system is to permit blind persons to explore alone in the outside environment. Ordinary route navigational systems in the outdoor environment are expensive and its manufacturing is time consuming. Blind people are at extensive drawback as they regularly do not have the data which is required, while passing obstacles and dangers. They generally have little information about data such as land marks information that is crucial for them to explore them through new environment.[1]

Smart stick is intended and executed to aid blind persons so that they can walk independently without much difficulty knee above obstacle detection and avoidance system is implemented by using and extra ultrasonic sensor on the highest of the stick with turn an alarm and vibration ON when there's a person, obstacle or wall at a distance of fifty cm ahead to avoid an accident and thus helping the person to maneuver independently. This proposed system apparatus a new technique for supporting blind people by means of the ultrasonic sensors and a global positioning system modem. The system will make available the obstacles hindrance feature and avoiding vehicle dash to the blind people.[2]

Smart walking Stick helps blind people in moving and allowing them to perform their work easily and comfortably. The blind person cannot recognize what is the size of that object and how far is he from the object. So, it is difficult for blind person to move here and there. The smart walking stick supports Object recognition and output comes mainly in the form of Voice output. In Smart Walking Stick, we detect the object with the help of a camera. The stick measures the distance between objects and Smart Walking Stick by Ultrasonic sensor. When the objects or obstacles come in range of the ultrasonic sensor, the speaker tells name of obstacle in front of the stick. Images will be captured using a camera and the camera is connected to the Raspberry Pi. If any obstacle comes in front of blind person, he can know about the obstacle by hearing the sound generated by the head phone. The smart walking stick is very useful for the visually impaired persons for their safety and freedom from the other persons at all the time. The developed system gives good results in detecting obstacles in front of the user [3].

METHODOLOGY

The main components that will be used in constructing the Intelligent Walking Stick are:

1. The Arduino UNO Microcontroller Board.
2. HC-SR04 Ultrasonic Module&IR Sensor.
3. Piezo Buzzer and Vibrating Motor.
4. APR9600 Single-Chip Voice Recording&Playback Device.
5. LM386 Amplifier Module.
6. 7805 Voltage Regulator.
7. GPS Tracking Unit&GSM/GPRS Module.

The Arduino UNO is a micro-controller board dependent on the AT-mega328 developed by Atmel. It has 14 digital Input/output pins (of which 6 can be used as PMW outputs), 6 analog inputs, a USB association, a 16MHz quartz crystal, an ICSP header, a reset button and a power jack to power it with an AC-to-DC adapter or battery to get started. The Atmel 8-bit AVR RISC-based microcontroller incorporates 32kB read-while-write ISP flash memory, 1kB EEPROM, 23 general purpose I/O lines,32 general purpose working registers, serial programmable USART,6- channel 10-bit A/D convertor. The Uno is the latest in a series of USB Arduino boards.

Ultrasonic transducers are transducers that convert ultrasound waves to electrical signals or vice versa. Those that both transmit and receive may also be called ultrasound transceivers; many ultrasound sensors besides being sensors are indeed transceivers because they can both sense and transmit. These devices work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. The Ultrasonic range module HC-SR04 is used for obstacle detection using ultrasonic waves. These sensors require a power supply of 3.3V and offers non-contact measurement feature from 2cm to 400cm, with a range accuracy of up to 3mm and each can detect obstacles within an average angle of 25degrees in the sphere. Ultrasonic transmitters, receivers and control circuits are included in these modules. Using I/O, the trigger for a high-level signal of at least 10us, the module automatically sends 840 kHz pulses and detects if there is a reflected pulse signal. The time measured from sending the ultrasonic pulse to the time the echo returns is high-level time. The basic principle of work: (1) Using IO trigger for at least 10us high level signal, (2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back. (3) If the signal back, through high level, time of high output I/O duration is the time from sending ultrasonic to returning. Test distance = (high level time × velocity of sound (340m/s))

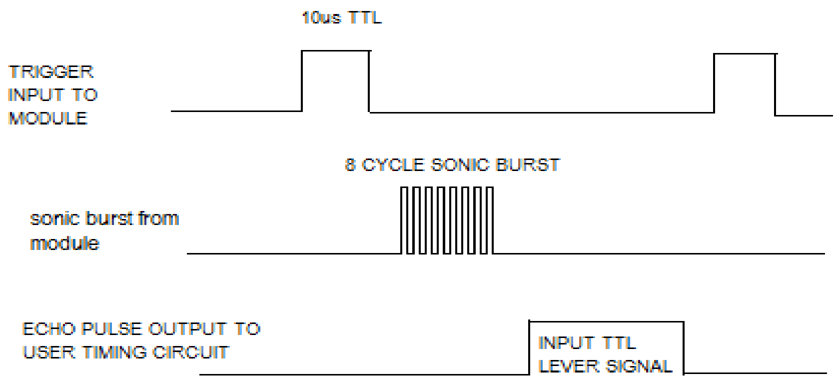

Figure 1: Timing Diagram

Here, Duration (Time)=Echo Output; and since we need only one-way distance, hence we divide this duration by 2.

Test distance=(High level time*Velocity of sound(340m/s))/2;

- The speed of sound is 343.5m/s or 0.0345cm/µseconds.
- 1/0.0345cm/µseconds is 29.1µseconds/cm.

Distance= ((Duration/2)/29.1);

Toggle switch is used to save the power when the device is not in use or when the impaired person has support of others to guide.

The basic concept of an Infrared Sensor which is used as obstacle detector is to transmit an infrared signal, this infrared signal bounces from the surface of an object and the signal is received at the infrared receiver. There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius Temperature. The LM35 does not require any external calibration to provide accuracy.

A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a person, object, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base using a Cellular network. This allows the user location to be displayed against a map backdrop either in real time or when analyzing the track later, using GPS tracking software.

The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. Sample rates are user-selectable, allowing designers to customize their design for unique quality and storage time needs. APLUS integrated achieves these high levels of storage capability by using its proprietary analog/multilevel storage technology implemented in an advanced flash non-volatile memory process, where each memory cell can store 256 voltage levels. This technology enables the APR9600 device to reproduce voice signals in their natural form. It eliminates the need for encoding and compression, which often introduce distortion.[4]

Arduino plays the role of micro-controller. The Arduino gets initialized by switching ON. Ultrasonic sensors are being used for distance measurement and additionally for obstacle detection. For the same, majorly 3 ultrasonic sensors and one IR sensor are being used. These 3 ultrasonic sensors cover all 3sides (left, centre, right) of the individual and infrared sensor is used to detect the sudden potholes.

The separation between stick to street side (right half of the street) will be estimated by ultrasonic sensor 1, distance between stick to centre street will be estimated by ultrasonic sensor 2 and the distance between stick to street side (left half of the street) will be estimated by ultrasonic sensor 3. Water sensor will identify the water or liquid substance. The obstacle is identified with the ultrasonic sensor and at the point when the obstacle is detected then vibrator will vibrate and with the assistance of speaker the obstacle position is informed to the user as an audio. Later the distance is calculated by the distance formula.

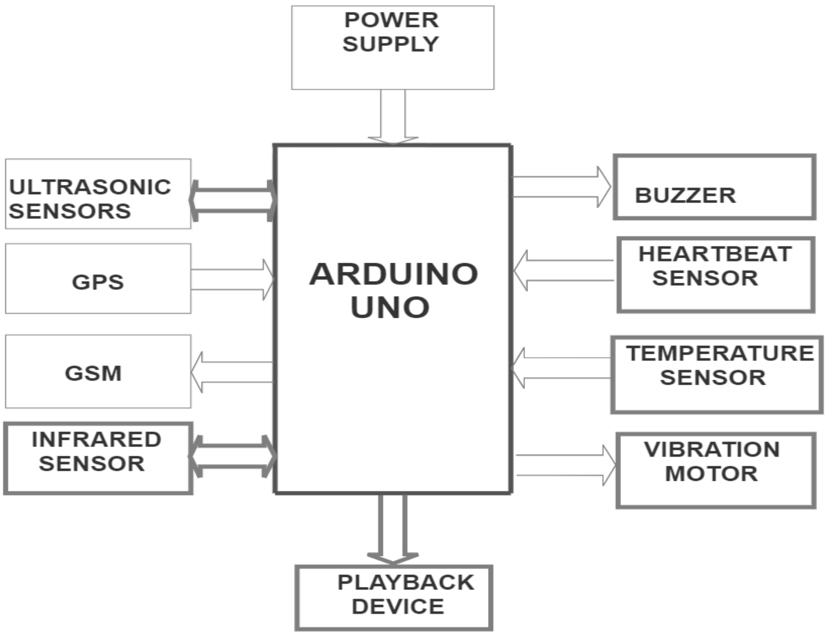

Figure 2: Block Diagram of the Intelligent Walking Stick

This system basically performs two tasks i.e., distance measurement from stick to obstacle and obstacle detection. Obstacle detection identifies potholes, bumps, objects on the ground in the user's route, guiding the user to avoid it.

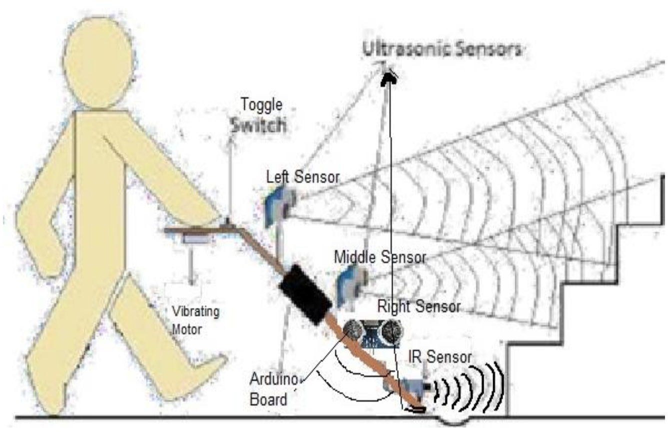

Figure 3: Schematic of proposed system

Ultrasonic sensors-The ultrasonic sensor creates high frequency sound waves and evaluates the echoes got back by the sensors. For the task of obstacle detection, the ultrasonic sensors mounted on the three sides of the stick sends ultrasonic waves and begins the clock. The clock is stopped when the waves reflected are received. Utilizing the time required by the waves to return back to the sensor, the distance value between the stick and the ground is calculated in the Arduino board.
Distance measurement-Distance from stick to obstacle will calculated by distance formula and then after comparing distances the longest distance will choose for walk.

Distance Formula:

$$d=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$$

The heartbeat sensor and temperature sensor are also interfaced to check the health conditions.

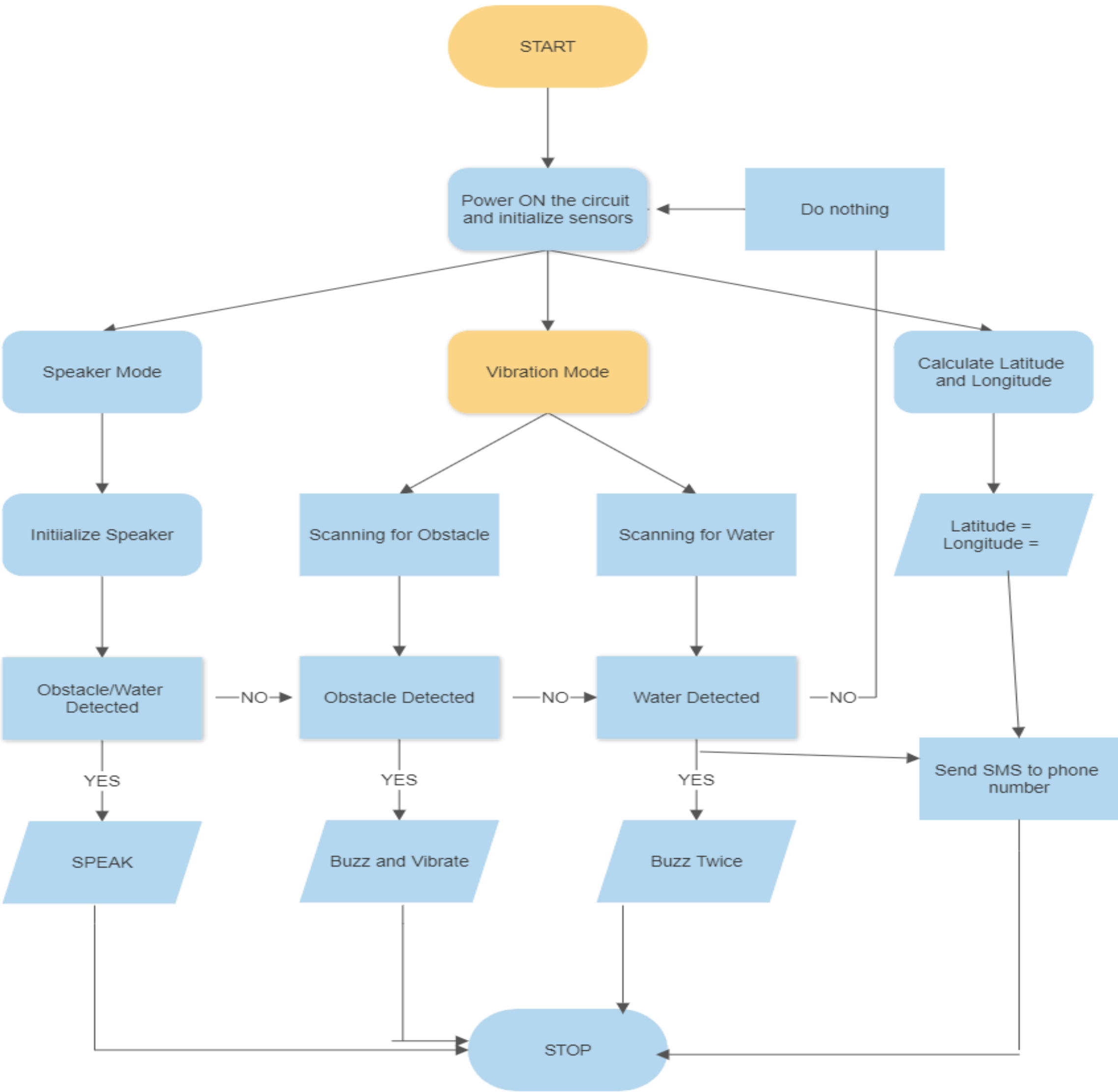

Figure 4: Proposed system flowchart

SIMULATION AND DISCUSSION

In this simulation, Arduino board, GSM, WIFI, Heartbeat sensor,Temperature sensor,Water sensor,Ultrasonic sensors,IR sensor,Water sensor are present.The water sensor is connected to the Arduino pin and this sensor is used to sense the water.The sensor resistance is inversely proportional to the water level.When the sensor is fully immersed it shows the low resistance,thus indicating the more height of the water.If there is water present then water sensor will give the input signal to the Arduino controller and through Arduino board we can get the output via buzzer and vibration motor.GSM have both transmitter and receiver.Transmitter pin is connected to the Arduino pin and the receiver pin is connected to another Arduino pin.Through GSM the guardian will get the message through mobile phone.The message through is the location of the blind person. Ultrasonic sensor's pins (Trigger, Echo) are connected to the Arduino pins and this sensor is used to find the obstacles. If there are any obstacles in front of that blind people, the sensor will sense and send signals to the Arduino controller and the output through buzzer or vibration motor the person can find the obstacles. The output results show that the system can provide the required output notification (warning) to the user as sound or vibration while detecting the obstacles. The simulation shows that the interfacing of the GPS modem, GSM modem, Heartbeat sensor, ultrasonic sensor and temperature sensor is successfully done.

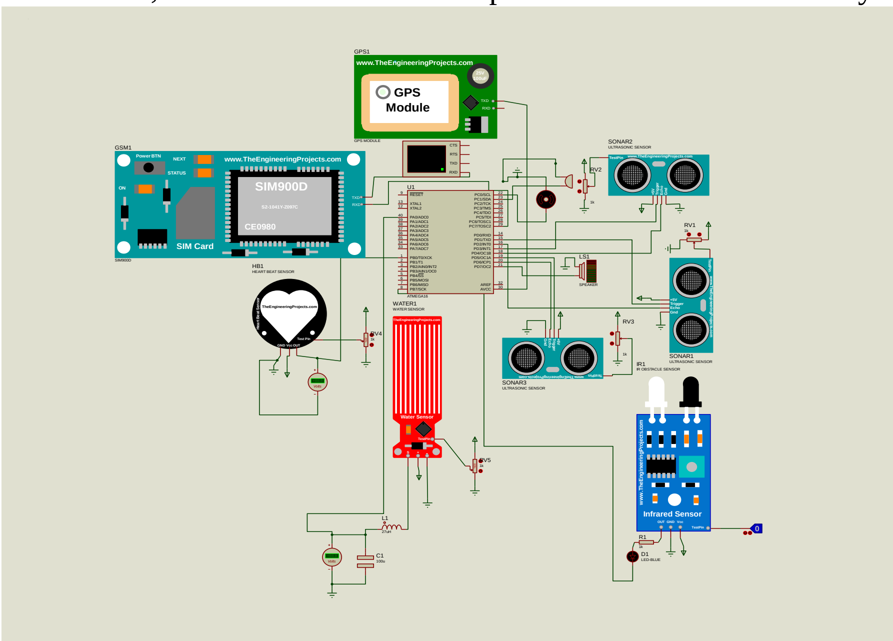

Figure 5: Simulation of Model in Proteus

The microcontroller will be the main component of the controller section and also for the entire system.This is because the other sections are included and the events that occur on the system are guided by the microcontroller.Two processes will be involved in the implementation of the controller section one is hardware/physical connection of the pins to the programmed inputs and outputs and the other is microcontroller software programming.The pins will be listed by in the programe as input or output.
The ATMega328 microcontroller programming is achieved using the Arduino development kit. The programming language used in the microcontroller's programming is embedded C language. The microcontroller will be configured on the basis of the functions presented in the block
diagram.

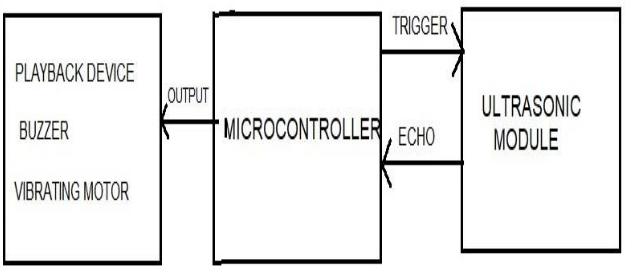

Figure 6: Block Diagram of functioning of Model

The simulation is done in Thinkercad (an online simulation tool) and working of the model is tested. The three ultrasonic sensors, piezo buzzer, vibrating motor are there the LEDs are included for the sake of convenience that the buzzer is producing sound and motor are vibrating. The safe range limits are included in the program and if any obstacle comes within the range of the ultrasonic sensors then they start vibrating.

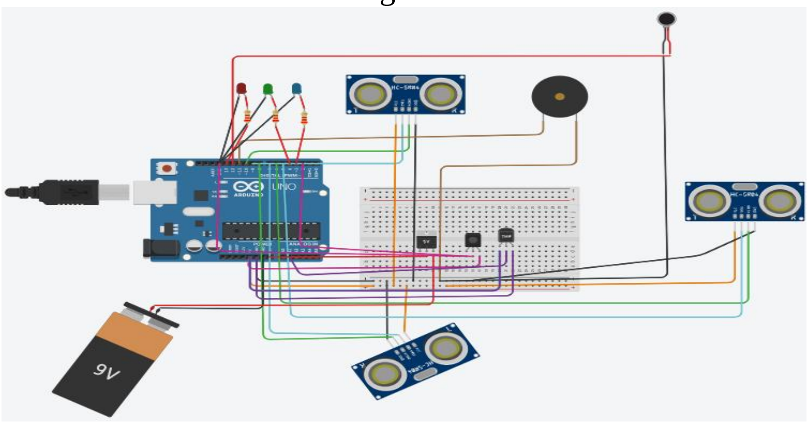

Figure 7: Simulation Circuit of the Model in Thinkercad

Initially, the obstacles are out of range to all three ultrasonic sensors. The serial monitor displays the distance of obstacle from the stick and gives the information about whether they are in range or not.

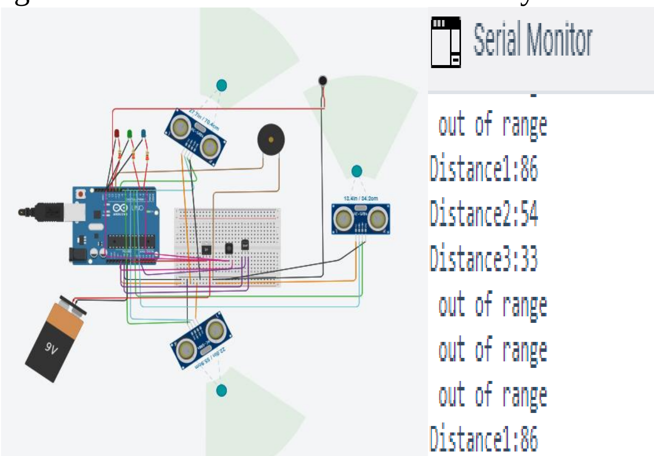

Figure 8: When the obstacles are out of range

When the obstacle comes in range of front sensor then the buzzer and vibrating motor produces output high i.e., they start vibrating and buzzer start producing sound, which is indicated by Blue LED.

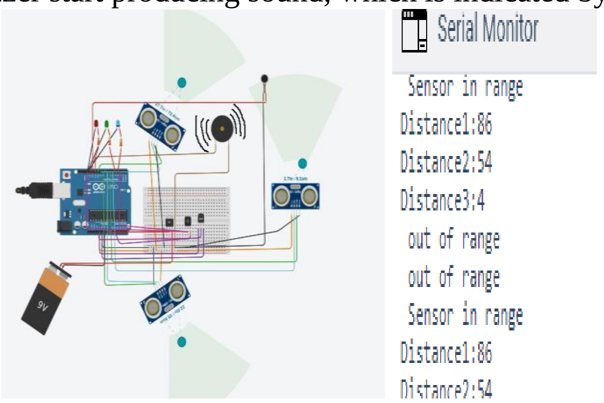

Figure 9: When the obstacle in range of front sensor

When the obstacle comes in range of left sensor then the buzzer and vibrating motor produces output high i.e., they start vibrating and buzzer start producing sound, which is indicated by Red LED.

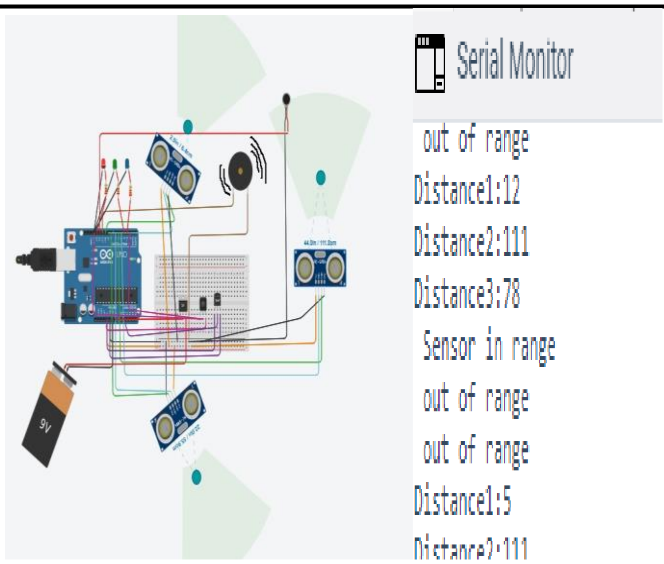

Figure 10: When obstacle in range of left sensor

CONCLUSION

The design of an intelligent walking stick system was simulated by using Thinkercad and Proteus software. The program code was written by using Arduino IDE. However, this system having the delay while detecting the obstacles between 2 to 4 second. The delay for the GPS to get the location for the stick is around 30 seconds to one minute. The Smart Stick acts as a basic platform that's helpful for the visually impaired to navigate securely both indoor and outdoor. It is efficient and affordable. In addition to that, GPS system cannot be used for indoor because of the GPS signal will be too week. The Ultrasonic sensors when tested correctly send the signal to the vibrating motor as soon as an obstacle is detected, and which in turn triggers the audio section to respond appropriately. The audio feedback then alerts the user of the presence of the obstacle, the vibrating motor also vibrates with various strengths according to the distance of the obstacle. It is effective and reasonable. It prompts great outcomes in recognizing the obstacles on the way of the user in the range of three meters. The ultimate aim of the project is to develop a low cost and convenient embedded personal guidance system dedicated to visually impaired user.

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