3D Ultrasonic Stick for Blind

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Abstract - Today technology is improving daily in different aspects in order to provide flexible and safe movement for the people. In this technology driven world, where people strive to live independently, this paperpropose a low cost 3D ultrasonic stick for blind people to gain personal independence, so that they can move from one place to another easily and safety. A portable stick is design and developed that detects the obstacles in the path of the blind using ultrasonic sensors. It consists of these sensors to scan three different directions, a microcontroller, buzzer and DC vibration motor. The buzzer and vibration motor is activated when any obstacle is detected. In addition, the stick is equipped with GPS and SMS message system. GPS system provide the information regarding the location of the blind person using the stick to his family members. SMS system is used by the blind to send SMS message to the saved numbers in the microcontroller in case of emergency. The programming of GPS modem, GSM modem, buzzer and vibration motor has been successfully done for this system. Computer simulation is done to essence the performance of the system using Proteous software and Easy pic kit.

Keywords – Ultra sonic sensors, GPS-L10 modem, GSM. SIM900D modem

I. INTRODUCTION

According to the world health organization (WHO) statistics, around 39 million blind people are blind on earth. The world health organization expect this number to increase in the coming years. This paper propose the design and develop a portable unit (stick) for the blind people for easy use and navigation in public places. The most widely used stick is the long cane because it can feel the nature of the path and detect obstacles in the path of the blind person. Being an emerging area of research, a review of the most recent literature has been carried out and presented in Section II. The methodological framework and the system design are presented in Section III. Results are given in section IV and conclusion in section V.

II.LITERATURE REVIEW

Voice operated outdoor navigation system for visually impaired persons done by Somnath and Ravi (2012) [1]. Uses a stick equipped with ultra-sonic sensors, GPS and audio output system. The stick contains GPS which will have SD memory card which used to store different locations. The user can set the location by voice and the GPS will guide the person to his/her distention. This system will also provide the speed and the remaining distance to reach the distention. When the ultra-sonic sensors detect any obstacle directly the voice system will activate the caution voice. This system can be classified as a low cost system affordable by the user. In addition to that, it can provides a voice guide for the user with greatest possible accuracy. The system uses the ARM processor which has more memory space, so that the operating speed is high. However, this system cannot operate indoors because there will be no signal for the GPS system. The accuracy of the GPS signal need to be improved because it only can be controlled within 5 meters radios. Finally, the blind person need to be trained on the system so that he or she can use it effectively. Shruit and Prof. A (2011) [2] system done for using smart stick for blind people: obstacles detections, artificial vision and real time assistance via GPS. This system operate by using GPS, artificial vision system, obstacle detection and voice circuit. This system works by fitting a camera on the persons head, the camera will be use an algorithm to identify the highs and obstacles in front the blind person. This system also contains ultra-sonic sensors to detect the obstacles. Furthermore, this system include GPS system is to reach the required destination.

Once any obstacle is detected or the destination is reached the voice circuit will activate providing certain type of voice. All these sub systems are connected to microcontroller which control the entire operation of the system. This system can be classified as a low cost system. The accuracy of the artificial vision unit provide a high accuracy output for the user. In addition to that, the detection distance of the system is 15 meters. However, the designing complexity of the system make it difficult to design and understand. Another study in the same field to help blind people uses the pulse echo technique in order to provide a warning sound when detecting the obstacles. This technique is used by the United States military for locating the submarines. They used pulse of ultrasound range from 21 KHz to 50 KHz which hit the hard surface to generate echo pulses. By calculating the difference between signals transmit time and signal receiving time we can predict the distance between the user and the obstacles. This system is very sensitive interms of detecting the obstacles. It has a detection range up to 3 meters and a detection angle between 0 degree to 45 degree. However, this system require more power to operate because of the transmitter and receiver circuits. So, this system need to be re-designed to operate with less power consumption (Anon., n.d.) [3]. another study done by (Sung, Young, Kim and IN, 2001) [4] for developing an intelligent guide stick for blind people used an intelligent CPU called MELDOG which uses artificial intelligence.It can identify the accurate position of obstacles using ultrasonic sensors and laser sensors. In order to identify the position the "map matching technique" was used by using the ultrasonic sensors. This system includes a DC motor controller which connected to the encoder.When the wheels rotate 18 degree the infrared sensors attached to both wheels will transmit the signal to the CPU in order to provide a location update. This system is an accurate detecting system can provide the user continuous update for detecting the obstacles with detection angle between 0 degree to 18 degree. However, this system is expensive and is complex in designing. It is heavy compared to other similar system. The weight of the system is around 5.5 Kg. The detection distance for the system is very low which is around 87.5 cm to 105 cm. a study done by (Jayant, Pratik and Mita, 2012) [5]proposed a smart cane assisted mobility for the visually impaired. The system is based on normal ultrasonic sensors and ATMEL microcontroller. It operates with two rechargeable battery (7.4v) it can be recharged using USB cable or AC adaptor. The control unit is programed using ATMEL AVR microcontroller ATMEGA328P microcontroller. Once any obstacles are detected vibration and buzzer will start in order to warn the user. This system is a non-complex system to use. It has the ability to cover a distance up to 3 meters and hasthe rechargeable feature of the buttery. Also, this system can be folded in small piece so that the user can carry it easily. However, this system has only one direction detection coverage and it is inaccurate in detecting the obstacles.

All the studies which had been reviewed shows that, there are many types of smart sticks for blind people and all of them uses different techniques to give the required assistance for the blind person. However, the studies shows that, using the ultra-sonic sensors is an efficient solution to detect the obstacles with maximum range of 7 meters and 45 degree coverage. In addition to that, using a noncomplex microcontroller will help the blind person to use the devise (stick) easily and without any problems. Finally, the device should work for a long time with minimum power and it could be recharged. This system propose a stick which uses ultrasonic sensors for detection and a microcontroller that controls the system without complexity. The detection angle is 180 degree. It is use a 12 volt lithium rechargeable battery. It is low cost and light weight system.

III. PROPOSED SYSTEM

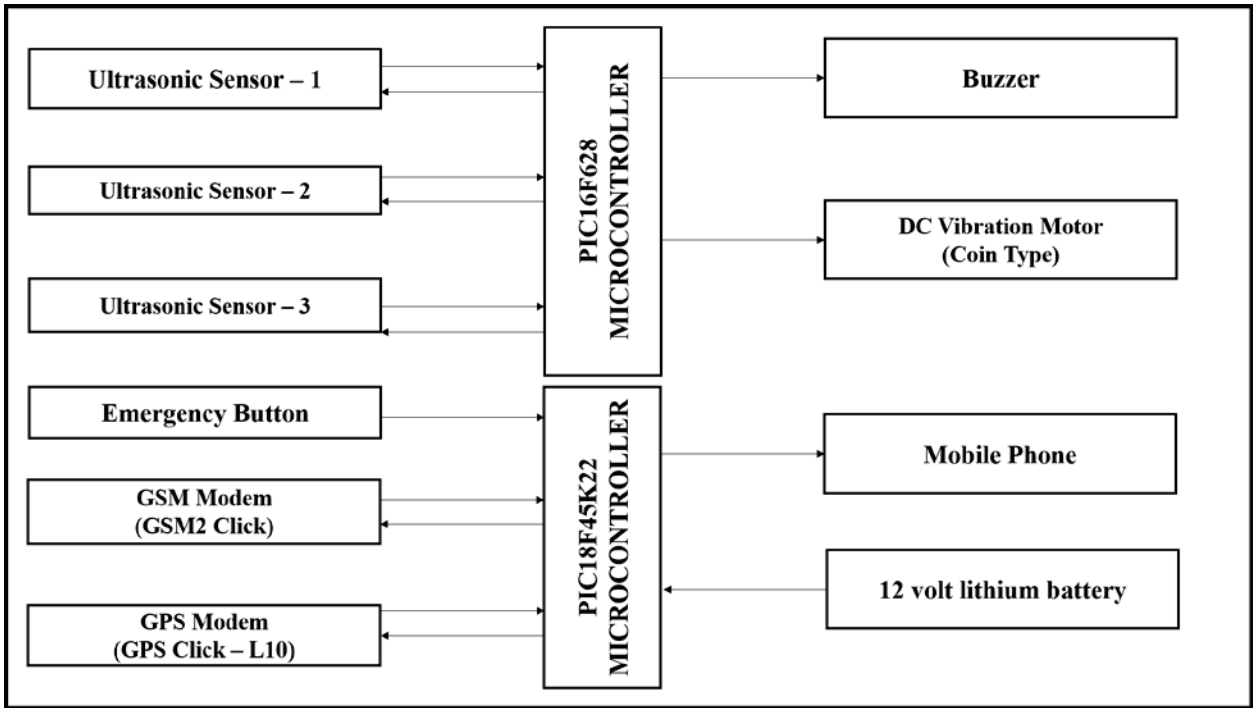

Figure 1. SystemBlock Diagram

A. UTTRASONIC SYSTEM –

The main part in the system is the microcontroller that control the other components of the system. When the ultrasonic sensors detect any objects or obstacles in 180 degree horizontal and 60 degree vertical, it will activate the buzzer and the vibration motorautomatically.

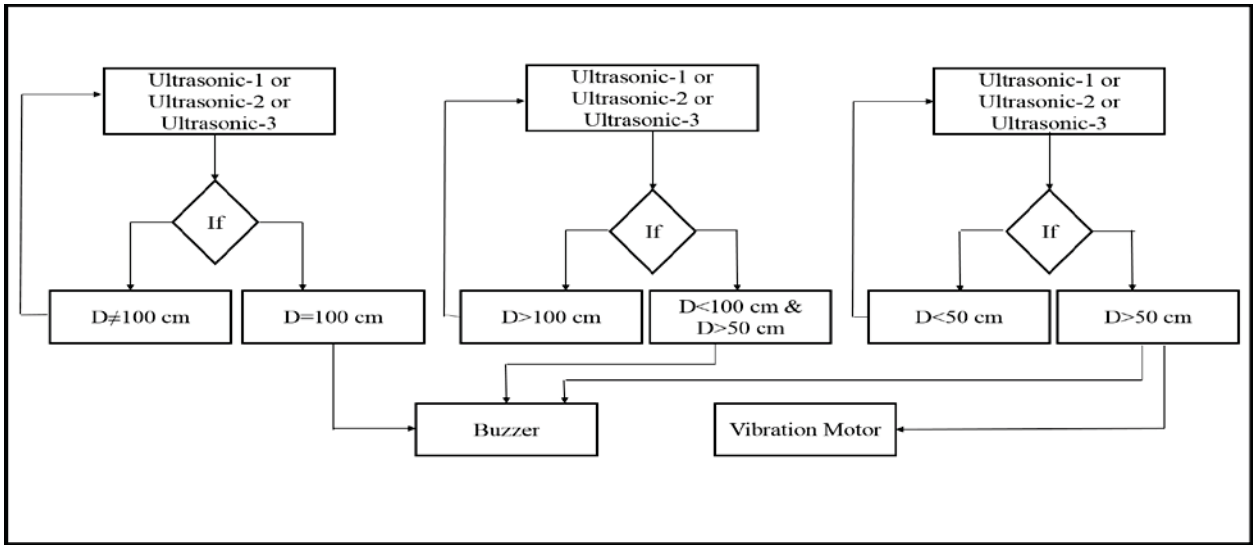

Figure 2. Detection Flow Chart

If any of the three sensors detect any obstacles with in a range of 100 cm the buzzer will be activated with 1000Hz and 2000 ms delay. If the obstacles withinrange of 100 cm and 50 cm the buzzer will activate with 1000Hz and 1000 ms delay. Finally, if the detection is below 50 cm the buzzer will activate with 1000Hz, 500 ms delay and the vibration motor will activate. Figure 3 show the connection of the circuit in Proteous software.

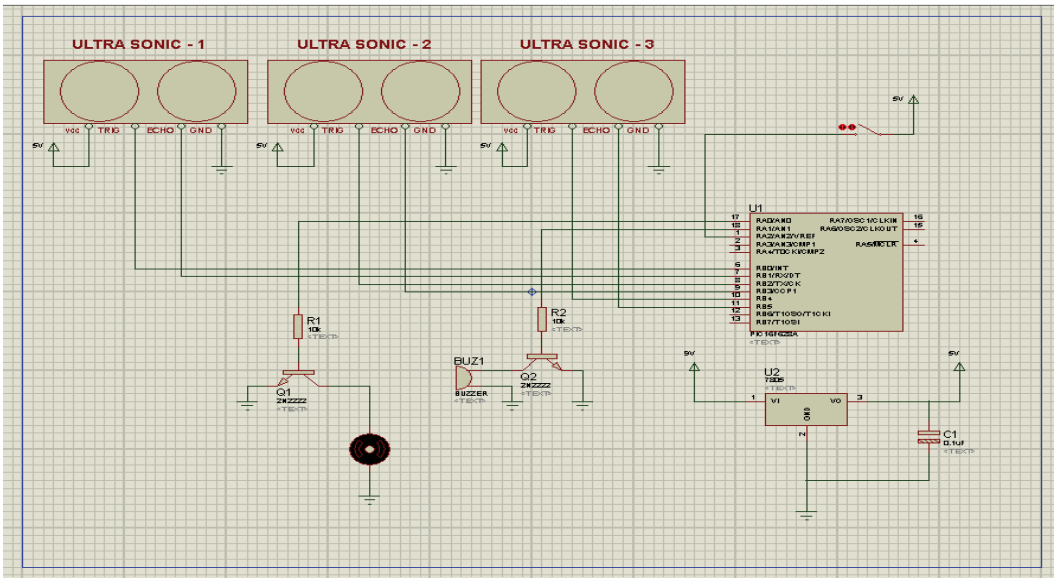

Figure 3. Ultrasonic Sensors circuit

- *Ultrasonic Sensors–*

Ultrasonic sensors or ultra-motion detectors is an electronic kit that contains many sub electronic circuit in it and has many applications. When signals from the sensors of sound circuit, playback circuit or vibrator circuit have been detected, it will be transmitted to an additional circuit connected to it, in order to activate the required output. The ultrasonic sensors contain complete ultrasonic crystal control transmitted 40 KHz and a very sensitive receiver measure 1 to 0.5 by 3 inches. Usually ultrasonic sensors can detect with the range of 3 meters to 7 meters.

- *PIC16F628 Microcontroller–*

It is an 8 bit 18 pins microcontroller that provides 200 nanosecond instruction execution. It has a flash program memory of 3.5 KB and CPU speed up to 5 MPS. Also, it has 4 MHz internal oscillator, 224 Bytes RAM and 128 bytes EEPROM. Addition to that, it has two comparator and operating voltage 2 V to 5.5 V with temperature range -40 C to 125 C.

- *DC Vibration Motor*

This is the type of DC vibration motors used in mobile phones. It requires a voltage supply of 1.3 v to 3 v with current around 125 mA. This type of motors can be programed to control the speed of it by using the PWM (Pulse Width Modulation) method. The speed of the motor is 13500 rpm and the diameters of the motor is 4 mm to 10 mm and the length is 2mm to 15 mm.

B. GPS and GSMSystem:-

When GSM modem receive a message the microcontroller will process the message with the keyword saved in it. Then, it will get the location of the stick from the GPS modem and transmit the location to the GSM modem in order to respond to the sender. In case of an emergency, the user of the stick can press the emergency button the microcontroller access the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the all saved numbers in the microcontroller.

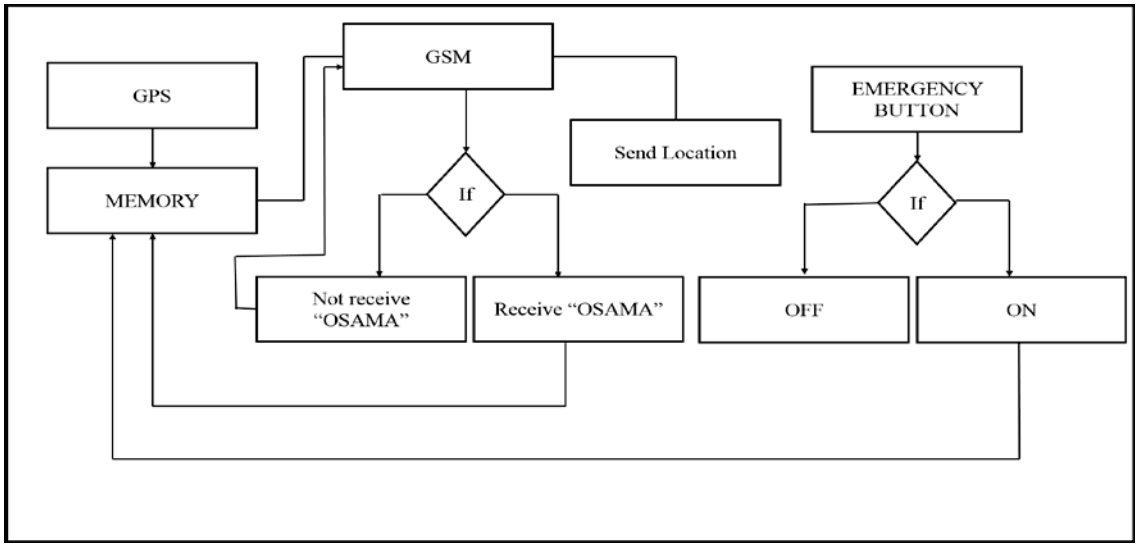

Figure 4. GPS and GSM Modems Flow Chart

The GPS will update the location of the stick and automatically save the location in PIC18F45K22 EEPROM memory. If the microcontroller receive the word "OSAMA" from the GSM modem, the microcontroller will track the last location from the EPROM and transmit it to the GSM modem which will send an SMS message that states the location for the person to the required number. Addition to that, if the emergency button is pressed the directly the microcontroller will transmit the last location saved in the EEPROM to the GSM modem to send it to all saved number in the microcontroller. Figure 6 show the connection of the GPS modem and GSM modem with PIC18F45K22 microcontroller.

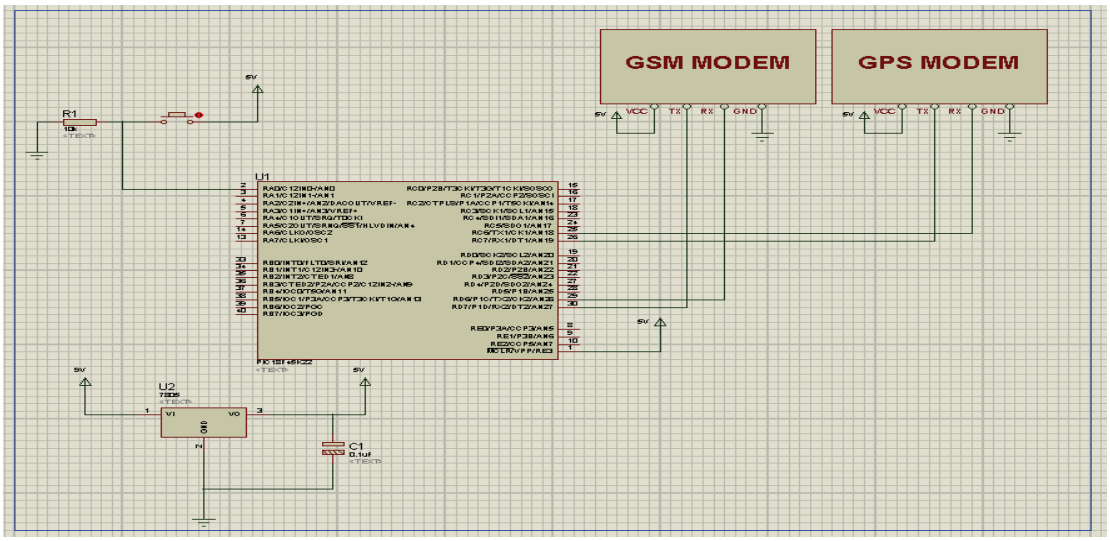

Figure 5. GPS and GSM Circuit

- *GPS Modem L-10:–*

This device can provide GPS function to any systems / devices conneced to it. It is a high performance device and equipped with QUECTEL L10 function, MTK positioning engine, passive and active antenna. It use UART or I2C interface for communication with target board. Transferring data to this device can be done by using USB cable. This device require 3.3 V to operate.

- *GSM Modem SIM900D:-*

SIM 900D can operate on 2G frequency with frequencies of 1800MHz, 1900MHz, 850MHz and 900MHz. it can transfer data at the rate of 85.6kbps. It can be interface of using UART and controlled by using AT commands. It require a voltage of 3 volt to 4 volt to operate.

- *PIC18F45K22 Microcontroller–*

It is a 40 pin microcontroller flash programmable memory with 32KB program memory, CPU speed MISP, RAM 1536 bytes and data EEPROM 256 bytes. It equipped with 2 UART, 2 SPI, 2 I2C2 and 2 comparator. Addition to that, it has 28 channel 10 bit ADC and require 1.8v to 5.5v to operate with temperature range from -40C to 125C.

C. Working Principle–

The main part in the system is the microcontroller that control the other components in the system. When the ultra-sonic sensors detect any objects or obstacle in 180 degree path it will activate the buzzer and the vibration motor. In addition to that, when the GSM modem receive a message it will be sent to the microcontroller which will get the location of the stick from the GPS modem and transmit the location to the GSM modem in response to the sender. In case of an emergency, the user of the stick will press the emergency button and the signal from the button will go to the microcontroller which will get the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the all saved numbers in the system.

IV. RESULTS

The system was simulate successfully. The output results shows that the system can provide the required output notification (warning) to the user as sound and vibration while detecting the obstacleswithin the range of 0 cm to 100 cm. The simulation shows that the interfacing of the GPS and GSM modems is successfully done using UART.

The system was simulated by using Proteous software and Easy PIC kit. The program code was written by using Micro basic language.

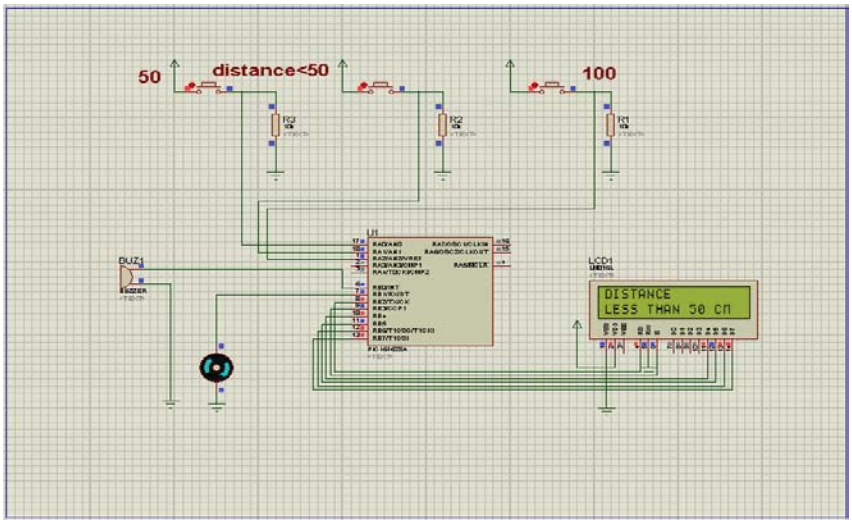

Figure 6. Distance Less Than 50 cm

The implemented system was found to be functioning as per expectations. Ultrasonic sensors was simulated by using push button. The buzzer provided the required output according to the input signal to the microcontroller. The vibration motor only will activate if the distance is less than 50 cm from the obstacles.

V.CONCLUSION

This paper presents a 3D ultrasonic system for blind. The literatures related to this topic were reviewed and analyzed. The simulation results was as expected for the ultrasonic sensors and for integration GPS and the GSM modem in one microcontroller. However, this system have delay while detect the obstacles between 2 to 4 second. The delay for the GPS to get the location for the stick is around 30 second to one minute. In addition to that, GPS system cannot be used indoor because of the GPS signal will be too weak. The proposed system is economical and efficient in comparison with the similar systems developed so far.

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