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Temperature Compensated Ultrasonic Ranging and Location finder for Blind Person

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Abstract— This paper is intended to provide a theoretical model of object detection and real time assistance via Global Positioning System(GPS).This paper aims at the development of an Electronic Travelling Aid (ETA) kit to help the blind people to find obstacle free path. This ETA is fixed to the stick of the blind people. When the object is detected near to the blinds' stick it alerts them with the help of vibratory circuit. Ultrasonic sensors are used to evaluate distance of the objects around the blind person to guide the user towards the secure and available path. Output is in the form of vibrations which the blind person can easily recognize. The hardware of entire system contains ARM7 (LPC2138), temperature sensor, ultrasonic sensors and mobile vibrator, Global positioning system (GPS) module and Global System for Mobile (GSM) module. It contains temperature compensation method to reduce the error in measurement of distance using ultrasonic sensors.

Index Terms— *ARM7, temperature sensor, ultrasonic sensors, GPS, GSM.*

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I. Introduction

Different ways are available to measure the distance of obstacle from blind person. One of the methods is by means of ultrasonic sensor. Different applications are available in the field robotics and self -propelling vehicles. Self propelling vehicles are very much used in industries which are totally dependent on automatic machines.

15 million blind people are from India Out of the 37 million across the globe. We should have a system which can make life of blind persons very much easier. The main objective of this project is to provide artificial guidance to the visually impaired people and also gives location of blind person for his parent.. With the help of an Ultrasonic Sensors, Temperature sensor, and mobile vibrator physically mounted on a stick. As ultrasonic sensors is sensitive to factors like temperature, humidity, pressure etc. In this paper we considered only one important parameter as temperature. so to compensate this sensitivity temperature sensor is incorporated with ultrasonic sensors to reduce error in calculated distance.[1]

II. LITERATURE REVIEW

There are three main categories of these systems:

2.1.1 Electronic travel devices (ETDs): devices that transform information about the environment that would normally be seen through vision into a form that can be conveyed through another sensory part.

2.1.2 Electronic orientation devices (EODs): devices that provide orientation prior to, or during the travel. They can be external to the user or can be carried by the user (e.g., infrared light transmitters and handheld receivers).

2.1.3 Position locator devices (PLDs): which include technologies like Global Positioning Systems, European Geostationary Navigation Overlay Service (EGNOS), etc.

Electronic travel device can also be categorized depending on how the information is gathered from the environment and depending on how this information is given to the user. Information can be gathered with sonar, ultrasonic sensor, infrared, laser scanners, or cameras and the user can be informed through the auditory and/or vibration sense. Sounds or synthetic voice are the options for the first case and electro tactile or vibrator for the second. Vibrator feedback has some great advantage because it does not block the auditory sense (free-ears), which is the most important perceptual input source (the others are touch, wind, odors, and temperature) for a visually impaired user.

The National Research Council's guidelines for ETDs are listed below:

1) Detection obstacles in the front of the blind people from ground level to head height for the full body width.

2) Give surface information including textures, color and discontinuities.

3) Detection of objects bordering the travel path for projection.

4) Distant object and direction information for projection of a straight line.

5) Landmark positions and identification information.

6) Information enabling self-familiarization and mental mapping of the surrounding.

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7) In addition: ergonomic, operate with minimal interface with natural sensory channels, single unit, reliable, user choice of auditory or tactile modalities, durable, easily repairable, robust, low power and cost.[2]

III. METHODOLOGY

This paper contains a method to implement a mobility device for blind person. Model contains signal processing unit with ARM7 (LPC2138) microcontroller which receives distance from ultrasonic sensor and temperature from temperature sensor & gives alert to the blind person using vibrator. It will have different vibrations for different distances. Temperature compensation method is used to reduce the error in measurement of distance. Global Positioning System module is used to find the location of blind person and after pressing a switch message is transmitted through SMS to parent of blind person..

IV. SYSTEM ARCHITECTURE

The system contains ultrasonic sensor and temperature sensor as the input units. Different types of ultrasonic sensor and temperature sensors are available in the market and in a given system HC-SR04 and LM35 are used respectively due to their low cost and great features over other sensors. Ultrasonic sensor measures the round trip delay which is directly proportional to output pulse width. The distance measured by sensor varies with environment temperature, humidity, pressure and obstacle surface. But temperature compensation is necessary as it have more impact on measured distance. Temperature compensation method is implemented by microcontroller unit. The microcontroller unit provides an interface between sensors and computer. The power unit provides power to all devices. The block diagram of proposed system is shown in Figure 4.1.

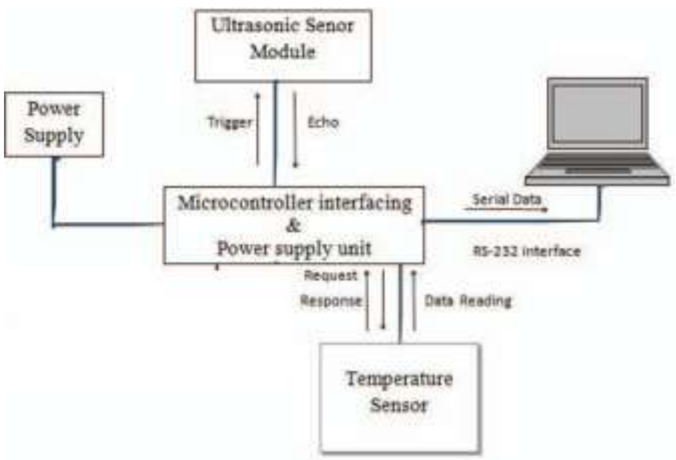

Fig 4.1. Block diagram of system

The microcontroller unit triggers the ultrasonic sensor and receives echo. It also communicates with the temperature sensor. The microcontroller collects distance information from ultrasonic sensor and environment temperature from temperature sensor. It computes the corrected distance with temperature compensation. The microcontroller requires 5v TTL signal and the computer provides RS-232 signals. For TTL to RS-232 and vice versa conversion we require MAX-232 IC. The serial data transmitted from microcontroller to computer are pulse width, temperature and distance with temperature compensation. The serial data is displayed on PC using visual basic software which plays as a human machine interface. The received data is analyzed using Visual Basic.

V. PROPOSED HARDWARE DESIGN

Distance of obstacle depends upon speed of ultrasonic and time required for its traveling. If the time required in traveling the pulse from ultrasonic sensor to obstacle and return back to sensor can be measured, then the measurement of distance can be done very easily. This can be achieved by using an ultrasonic module which can give the time waveform on C.R.O. in terms of pulse width. The output pulse width will vary in proportional to the distance travel by the ultrasonic wave. The sensor transmits an ultrasonic wave and returns an output pulse that is directly proportional to round trip delay. By measuring the pulse width of output wave, the distance to target can easily be calculated. The ultrasonic sensor produces Pulse width in the output. Ultrasonic sensor consists of 4 pins. These are Trigger, OUT, VCC and GND. GND and VCC are ground and supply pins. Trigger input receives 10µs trigger pulse. ARM 7 LPC2138 will make this pin HIGH then delay for about 10 µs and make pin LOW again. OUT pin gives the Output pulse width depending upon distance travel. After the trigger is given to LPC2138, it measures pulse output on OUT pin. Timing diagram of ultrasonic sensor output wave is shown in Figure. 5.1.

The output pulse duration is converted to distance measured and the temperature effect is also considered. The method of temperature compensation is described here [7].

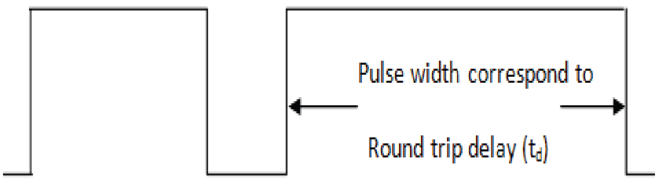

Fig. 5.1 Ultrasonic sensor output wave

Ultrasonic sensor has three pulses first is a short pulse which is transmitted as input pulse. Second pulse is the pulse reflected by an object and third pulse is the signal that the sensor receives and converts it to a pulse of variable duration. The temperature sensor LM35 is used for temperature measurement. There are 4 pins in Temperature sensor out of which 3 pins are VCC, Data and GND and one pin has no connection.

Communication with LPC2138 is divided into three steps. In the first step the LPC2138 makes the data pin low for 18ms and then make the pin high for 40µS so that temperature sensor LM 35 understand that a request receives from LPC2138. In the second step LM35 gives an automatic reply which indicates that temperature sensor LM 35 received LPC2138 request. The response is 54µS low and 80µS high pulse. In the third step Data Reading takes place. The data has total 40 bits which are divided into 5 parts of 8 bits each. These 5 parts are integer Relative humidity, decimal Relative humidity, integer temperature, decimal temperature and Parity bits of 8 bits each. Firstly all the required components are connected on a PCB and LPC2138 burned with the program. LPC2138 has In System Programming. Trouble shooting is important so it consume more time and efforts. Different sensors are used for taking input and then computer is connected to receive output from RS-232 serial adapter. Block diagram of processing unit is shown in Figure 5.2.

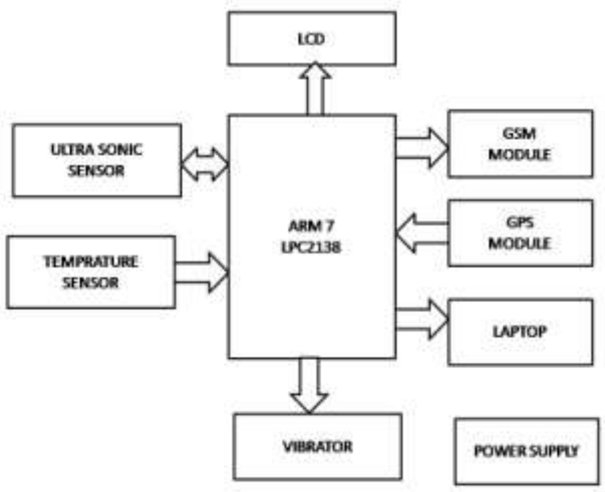

Fig. 5.2 Hardware Block Diagram

PCB manufactured manually has several disadvantages like large size, more power loss etc. Trouble shooting is complex so the circuit diagram and layout preparation is done on the Proteus software. The final layout is manufactured for PCB fabrication. The data required at the output are Pulse Width, Temperature and Distance with Temperature compensation which is calculated by the use of Pulse Width and Temperature. The round trip delay (td) is measured by Pulse Width which is scaled by a factor 16.5 calculated by the use of manual distance measurement. [7]

VI. Results

The serial data are PWM & Temperature and distance (D) is taken manually using scale. These data has been feed into visual basic program and the PWM received are scaled by a factor so that it is comparable to round trip delay and all input PWM is scaled. The output data generated are distance & error with and without temperature compensation as shown in table 1 and table 2.

TABLE I: Output data received after Temperature compensation

Sr. No.	Distance Without T.C. D1(cm)	Distance with T.C. D2(cm)	Error Without T.C. E1 (%)	Error With T.C. E2 (%)
1	11	0044	33.0	011.2
2	17	0067	23.0	017.3
3	23	0092	29.0	024.1
4	27	0110	42.0	028.2
Sr. No.	Distance Without T.C. D1(cm)	Distance with T.C. D2(cm)	Error Without T.C. E1 (%)	Error With T.C. E2 (%)
5	35	0140	27.0	036.8
6	44	0174	25.0	045.4
7	51	0208	36.0	053.5

TABLE II: Error reduced after error compensation

Sr. No.	Error Without T.C. E1(%)	Error With T.C. E2(%))	Error reduction E (%)
1	17.1912	9.8942	7.297
2	13.0245	7.2288	5.7956
3	5.6497	1.3931	4.2566
4	11.4819	1.5404	6.9415
5	10.3214	6.0786	4.2428
6	7.1463	2.4370	4.7093
7	10.4104	3.9400	6.4704

VII. CONCLUSION

Results show that a mobility aid with temperature compensation is manufactured. The average error with temperature compensation is calculated. The error is reduced from 8.6082 of without temperature compensation to 2.8383 with temperature compensation and better results are found in terms of percentage of error. The analysis can be done for different materials so that effect of all material and their errors with temperature compensation can be analyzed. The error is reduced using Temperature compensation method but humidity and pressure are also other factors which can be included and

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more efforts can be done on these factors. As well as location of blind person is also get found easily and send to parent by SMS.

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