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Small Sized Vision Based System for Blinds

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Abstract:
Blindness is frequently used to describe severe visual impairments with or without residual vision. The challenges faced by the blind people in their everyday lives are not well understood, obstacle avoidance problem is an essential part of navigation for the blind. Visually challenged people generally have difficulty while walking alone. Today, the visually challenged people use sticks while walking which is quite cumbersome to use. The main issue that must be tackled is to help blind people walk avoiding the obstacles present in their path. Thus a system is proposed that would replace these sticks with small and wearable devices. The main aim of building this project is to help the society with technology.

Keywords: Blindness, Ultrasonic Transceiver, Microcontroller, Vision Aid, and Small Size Locket Based System.

I. INTRODUCTION

Mobility for the visually impaired can be characterized as the ability to move effortlessly, speed and securely through his surroundings. With the advances in modern technologies, such type of devices can be designed which help a blind person to avoid obstacles in his path and support the mobility of blind which is generally known as electronic travel aid which aims at conveying information about the environment to visually impaired individuals, so that they can exploit part of the information that sighted people normally use to experience the world and navigate it. To build a prototype we focused on user's compatibility and ease of use, this work aims to build a system to assist people with disabilities. Vision based system for blinds intend to help them in providing the information in the form of distance. This system will detect an obstacle using ultrasonic (U/S) module. Obstacle detection sensor acts as the heart of the system. The system is small sized locket based so blind can wear it. Different techniques are available in the market, may be a stick or a device which may be bulky and blind cannot move freely. The importance is to design small size, light weight device. Small sized locket based system is easy to wear and carry for a blind person. Due to accurate distance and buzzer system person will know the position of obstacle that is near or far. This designed system further can be implemented as face detection and navigation system operated on smart phones for blinds with recognizable voice output. Same principle can be used automatic vehicle speed detection and for height detection of BCA system developed at BARC.

II. SYSTEM CONFIGURATION

In order to generate the ultrasound signal, need to set the Trig on a High State for 10 µs. That will send out an 8 cycle sonic burst which will travel at the speed sound and it will be received in the Echo pin. The Echo pin will output the time in microseconds the sound wave travelled, explained in Figure1. Figure 2 shows designed system configuration and describes as follows:

Voltage distribution: The system consists of a rechargeable battery and a low voltage drop out regulator IC which supplies +5V DC supply. The whole system requires ±5V supply, the +5V output of the regulator is given to the complete system. Further, the output of +5V is converted to +3.3 V for microcontroller operation.

Ultrasonic Module (HC-SR-04):

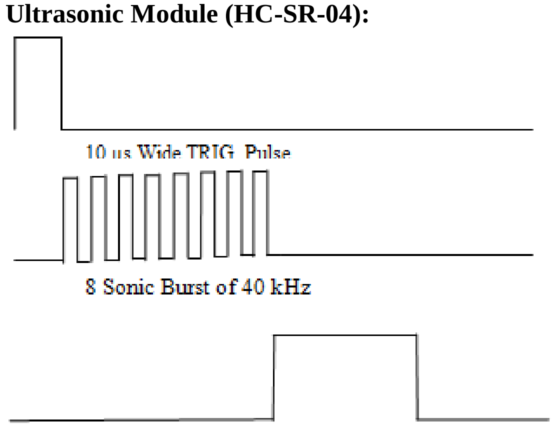

Figure.1. Hcsr-04 Timing Diagram [9]

The Ultrasonic (U/S)Module need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distant object that is pulse width and the range in proportion. The range can be calculated by means time interval between received echo signal and sent trigger signal.

Driver IC (MAX232): Driver IC is used to match the voltage level between microcontroller and U/S module as micro controller requires 3.3V signal level whereas U/S module needs a 5V signal level to work.

Microcontroller (MSP430FG4618): To Generate TTL input waveform for U/S module of 10µS wide timer A0 is configured and connected to trigger pin of U/S module. In response to a trigger, a sensor will send echo signal which is in proportional to the distance between the obstacle and the sensor. This distance is calculated as a count and send over BT to display distance on Graphical User Interface (GUI) of PC.

Bluetooth Module (HC-05): Bluetooth (BT) Module is a wireless device transmits data i.e. distance count to pc as it gets the command from PC. When connected to serial port red led blinks 1time/2s in an interval, while disconnected only blue led blinks 2times/s.

PC based system: The PC based system is to display the accurate distance between obstacle and U/S module. To display distance the system is used LabWindows CVI software which will display the distance.

Buzzer: If the system gives output distance less than 40cm then U/S buzzer will ring.

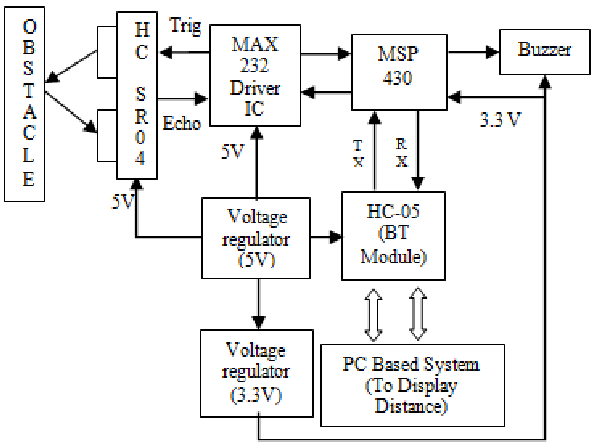

Figure. 2.System Configuration

III. CIRCUIT DESCRIPTION

3.1 Voltage Distribution

The system consists of a two Lithium ion rechargeable battery of 4.2 V, 1400 mAh or we can use complete 9V DC battery. A low voltage drops out regulator IC which supplies +5V DC supply. The whole system requires ±5V supply, given by regulator IC. Further, the output of battery is converted to +3.3 V for microcontroller operation. Figure 3 shows the voltage distribution circuit

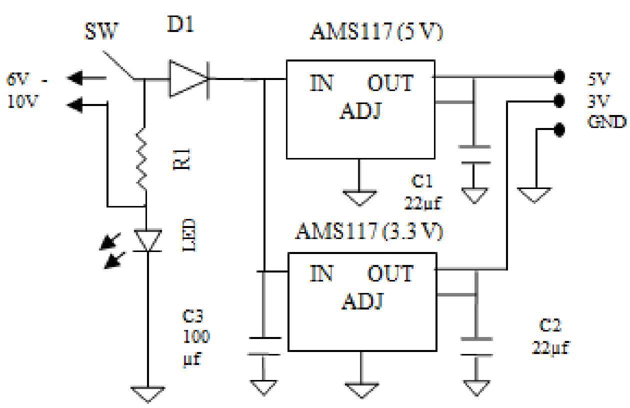

Figure .3. Voltage Distribution Circuit [10]

3.2 Ultrasonic module:

HC-SR-04 is U/S module having 4 pin configurations: two pins are assigned for power supply and other pins for a trigger and echo respectively. The trigger is an input taken from micro controller i.e. 10μs wide pulse for boosting U/S module. After receiving trigger of 10 μs wide U/S module generates echo signal. The width of the echo signal is proportional to the distance between a sensor and the obstacle. The distance may calculate by one of the following formulae:

Centimeters = μs / 58

OR

Inch = μs / 148

OR

The Range = High Level Time * Velocity (340M/S) / 2 .... (1)

Where μs=positive interval time in μsec of echo signal

Figure 4 shows ultrasonic module connections with microcontroller

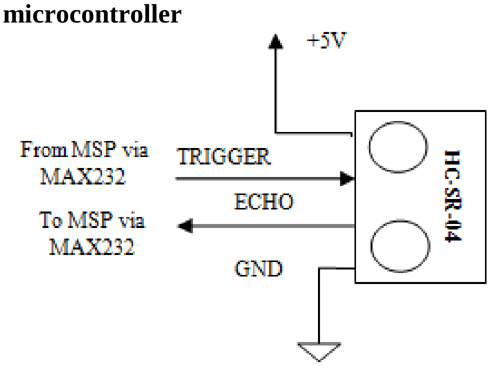

Figure .4. U/S Module Connectons

3.3 Driver IC (MAX232): Max 232 is an IC that converts TTL logic level signal (5V) into its equivalent RS-232c level signal (3.3V) and Rs-232c level (3.3V) to its equivalent TTL level signal (5V). This IC plays a vital role in VBVS because we need to make the connection and transfer data between MSP (3.3V level) and U/S module (5V level) which works on different signal level wave forms. Max232 can operate up to 120 Kbits/s. It has two driver channels and two receiver channels. Max232 will give inverted waveform so we have to consider this point in the computation of distance_cm parameter. Figure 5 shows the circuit of max232 which is intermediate between MSP and U/S module.

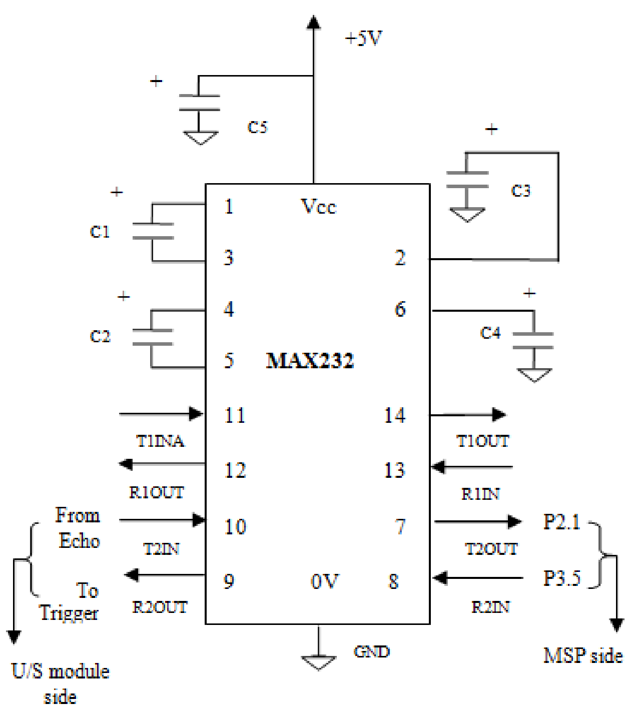

Figure. 5. Driver Ic

Five capacitors are connected to work properly C1 to C5 of same value i.e. 1uf. IC requires 5V supply voltage to work. First MSP will send trigger signal so Pin 8(R2IN) is receiver input connected to the port pin (P3.5) of MSP whereas the output of the receiver is pin 9(R2OUT) connected to trigger pin of U/S module, this connection will convert 3.3V signal level to 5V signal level. In response to trigger module will send echo signal so echo pin of U/S module is connected to driver input pin 10(T2IN). The output of this driver pin7 (T2OUT) is connected to a port pin of MSP (P2.1) this connection will convert a 5V signal to 3.3V.

3.4 Bluetooth module (HC-05)

BT module is required to make a wireless connection between MSP and PC (GUI) to display the accurate distance between the obstacle and the system. The BT module works on baud rate of 9600, with no parity, 8databits, and one stop bit. BT Module is working in slave mode so that connected to any of PC. Figure 6 shows the Bluetooth module connections with microcontroller. RX and TX pin requires3.3V voltage level signal, as MSP works on 3.3V it is compatible to make a connection with BT module. RX of BT module is connected to a port pin of MSP (P2.4) which functions as TX will transmit the data to BT module. Similarly, TX pin of BT module is connected to MSP port pin (P2.5) which functions as RX data from BT module. Further data are sent to PC by a secure connection.

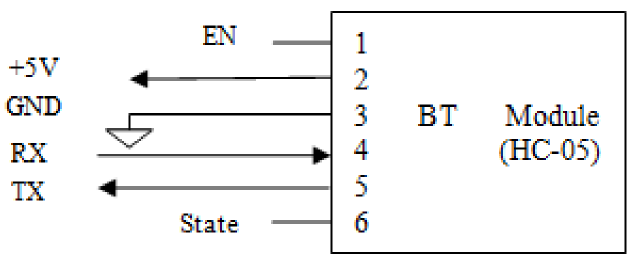

Figure. 6. Bluetooth Module

IV. SOFTWARE FLOW

Firstly the Microcontroller is initialized and configures the I/O Pins, Timer and UART. The Watchdog timer is set. By default the clock frequency is 1 MHz, which is boosted to the 8MHz.Microcontroller has two timers - Timer A and Timer B. Figure 7 shows the flowchart of microcontroller program. When the Acquire_Char is read from port, first MSP will recognize whether it is Start_char ('A') or Stop_char ('S'). If start char is recognized, then timer A0 register TACCRO is loaded with a value such that the timer will generate 10 µs wide negative going pulse because it will be inverted via driver IC and fed up to U/S module. To avoid uninterrupted operation and proper distance measurement cycle is maintained to 60 ms after 500µs U/S module will send echo signal back to port pin of MSP via MAX232, but this signal is inverted so we have to count the time of negative time interval. As the edge of port pin changes to high to low timer B0 will start counting time of negative interval to max level and the timer will turn off as low to high edge detected. Here we get the Distance_count; the next task is to send this Distance_count parameter to PC for distance calculation and further displayed on PC on user interface. Obtained Distance_count is to send to port. Distance calculation is done by using Equation (1).If distance_cm is less than 40cm then the buzzer will ring. If stop char is recognized then hardware will not send any of data and continue the loop.

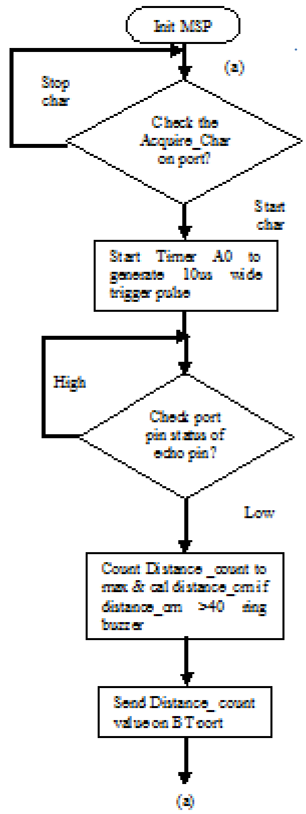

Figure.7. Flowchart of Microcontroller Program

4.1 User Interface:

The user interface was developed using LabWindows/CVI (CVI is short for C for Virtual Instrumentation) tool. Lab Windows/ CVI is an ANSI C programming environment for test and measurement developed by National Instruments. Figure 8 shows designed user interface.

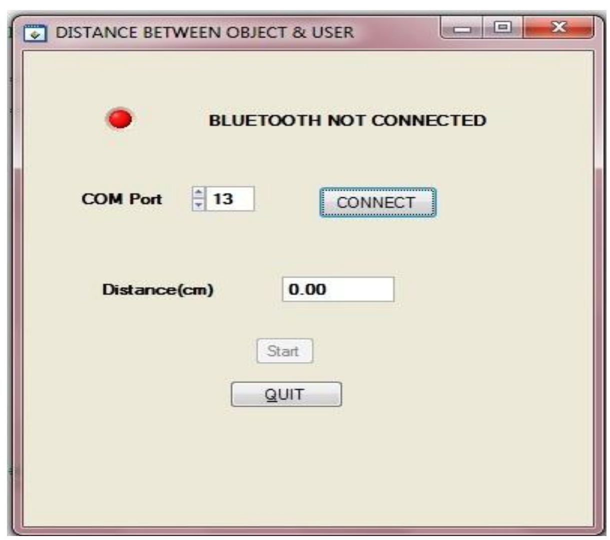

Figure. 8. User Interface Panel for Displaying Voice Based Vision System Developed At Barc [Image Courtesy- Barc]

First of all, COM port number is set and button 'CONNECT' is pressed to connect to Vision based system's hardware. After proper connection, aquire_char sent. One can select either "START" or "STOP" button. When "START" button pressed, here aqn_on flag set to high and start char is write on port i.e.

‘A’ so that controller can send the data. After that it will check on port is 4 bytes are received or not if not then program will run in loop. After receiving 4 bytes that will converted to long integer data format so that it can be readable, these small packets of size ten averaged and at last distance computation done using Equation (1).After this distance (cm) will be displayed on GUI. If aqn_on is low then Stop_char is written on port. Further LED indicator, COM port number is other options provided for flexibility and QUIT button stops the program. Figure 9 demonstrates the flow chart of the complete process.

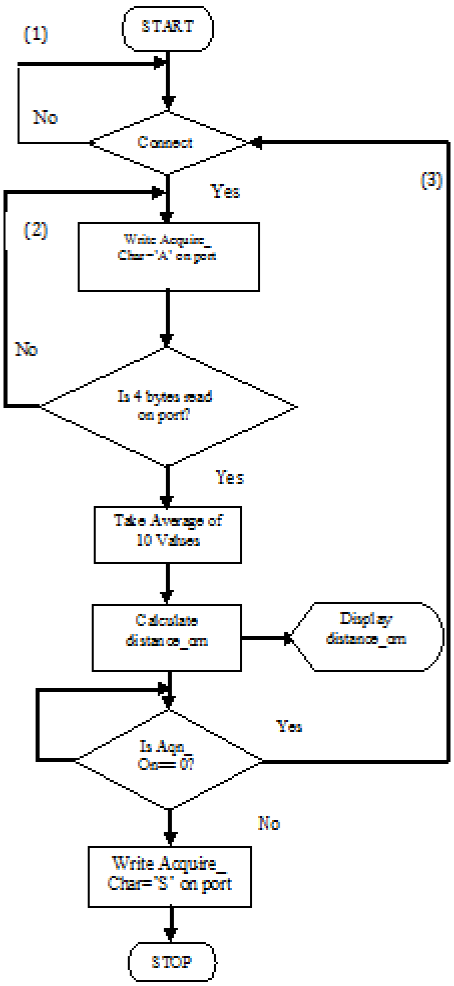

Figure .9. Flowchart of Gui Program

Figure 10 Shows working model of vision based system, this small sized system can be wearable to visually impaired person

Figure.10. Working Model Of Vision Based System

V. RESULT AND DISCUSSION

Distance measurement was performed with 10 different readings, to check whether VBVS is accurate or not. Percent error (%Error) can be used to measure accuracy and it may be positive or negative.

Given as formula:

%Error = [(Measured Distance –Accepted Distance) / Accepted Distance] × 100 … (2)

Table 1 is formed by using Equation (2) to check accuracy of designed system.

After calculating %Error to check accuracy following 3 conditions are useful

1.If %Error < |5%|, then the system has high accuracy.

2.If |5%| ≤ %Error ≤ |10%|, then the system has moderate accuracy.

3.If %Error > |10%|, then system has low accuracy.

Figure 11 and 12 Shows working of vision based system when not connected and connected to Bluetooth.

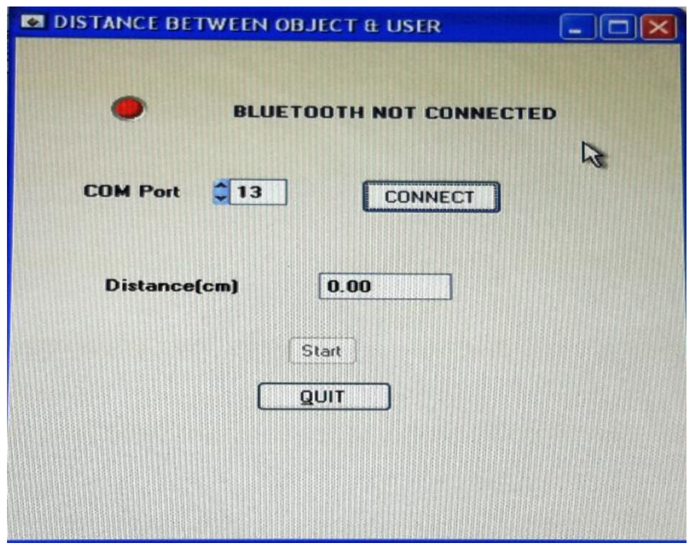

Figure.11. vbvs gui is not connected to hardware. [Image courtesy-barc]

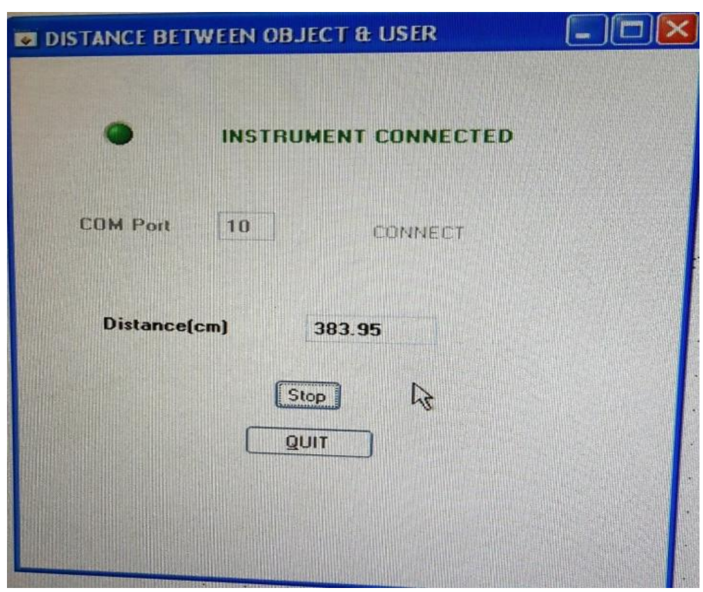

Figure .12. vbvs gui connected to hardware showing distance 383.95 cm. [image courtesy-barc]

Table .1. comparison of 25 different readings taken on vbvs system showing percent error to measure accuracy.

Sr no.	Accepted Distance [AD]	Measured Distance [MD]	%Error = (MD-AD)/AD×100
1.	45	45.47	1.04
2.	35	35.28	0.80
3.	10	10.15	1.50
4.	20	20.01	0.00
5.	15	15.56	3.73
6.	05	05.06	1.20
7.	26	26.86	3.30
8.	33	33.60	1.81
9.	17	17.02	0.11
10.	52	52.70	1.34
11.	02	2.02	1.00
12.	253	253.30	0.12
13.	08	8.50	6.25
14.	80	80.31	0.38
15.	348	348.22	0.057
16.	100	100.53	0.53
17.	06	5.70	5.00
18.	225	225.79	0.35
19.	03	3.17	5.67
20	85	85.51	0.60
21.	04	4.12	3.00
22.	157	157.89	0.56
23.	285	285.61	0.21
24.	384	383.90	0.01
25.	300	300.96	0.32

VI. CONCLUSION

This paper represents a hardware system specially designed for visually impaired people helps in avoiding obstacle by wearing locket based system. Software is designed for validation of approximate distance output. From Table 1 we conclude that system is highly accurate and can be used for blind peoples for free and safe outdoor navigation. Further this system can be used along with smart phone and enhanced advanced features.

VII. ACKNOWLEDGEMENT

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