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Ultrasonic Range Finder using 8051

Charu Pramod Kumar[1], Rajinder Kaur Ghumman[2], Cheryl D'souza[3], Pushpa U S[4]
[1, 2, 3, 4]*Department of Electronics and Telecommunication Engineering, University of Mumbai*

Abstract: ***This project presents a rangefinder using 8051 controller. Generally, the distance can be measured using pulse echo and phase measurement method. Here, the distance is measured using pulse echo method. The ultrasonic module transmits a signal to the object, then receives echo signal from the object and produces output signal whose time period is proportional to the distance of the object. The mechanism of the ultra sonic sensor is similar to the RADAR (Radio Detection and Ranging). This circuit calculates the distance of the object based on the speed of the sound wave at normal temperature and displays the distance on SSD. The project aims at designing a system, which is user friendly, easy to setup, eco-friendly, effective and very useful.***
Keywords: SSD (Seven Segment Display), RADAR, SONAR, ultrasonic transducer module, pulse echo

I. INTRODUCTION

Ultrasonic rangefinder can find the distance between an object from itself using ultrasonic sensor. HC – SR04 Ultrasonic Module works on the principle of SONAR and is designed to measure the range of the object in small embedded projects. It offers excellent range detection with high accuracy and stable readings. The operation of the module is not affected by the sunlight or black material. The ultrasonic rangefinder can measure distances up to 2.5 meters at accuracy of 1 cm. AT89S51 microcontroller and the ultrasonic transducer module HC-SR04 forms the basis of this circuit. The ultrasonic module sends a signal to the object, then picks up its echo and outputs a wave form whose time period is proportional to the distance. The microcontroller accepts this signal, performs necessary processing and displays the corresponding distance on the 3 digit seven segment display. The objective of this research work is to measure the obstacle distance from reference. This system used in automotive parking sensors and obstacle warning systems and can be used in terrain monitoring robots. This circuit finds a lot of application in projects like automotive parking sensors, obstacle warning systems, terrain monitoring robots, industrial distance measurements etc. Ultrasonic sensor HCSR04 has stable performance and high ranging accuracy that makes it a popular module in electronic market .Compared to the Sharp IR ranging module, HC-SR04 is more inexpensive than it. But it has the same ranging accuracy and longer ranging distance.

II. WORKING

A. Working of Ultrasonic Sensor

An Ultrasonic sensor has the following specifications, Power supply: 5V Dc, Quiescent current: <2mA, Effectual angle: <15°, Ranging distance: 2cm – 500 cm, Resolution: 1 cm, Ultrasonic Frequency: 40k Hz. A short ultrasonic pulse is transmitted at the time 0, reflected by an object. The senor receives this signal and converts it to an electric signal. The next pulse can be transmitted when the echo is faded away. This time period is called cycle period. The recommend cycle period should be no less than 50ms. If a 10μs width trigger pulse is sent to the signal pin, the Ultrasonic module will output eight 40kHz ultrasonic signal and detect the echo back. The measured distance is proportional to the echo pulse width and can be calculated by the formula above. If no obstacle is detected, the output pin will give a 38ms high level signal.

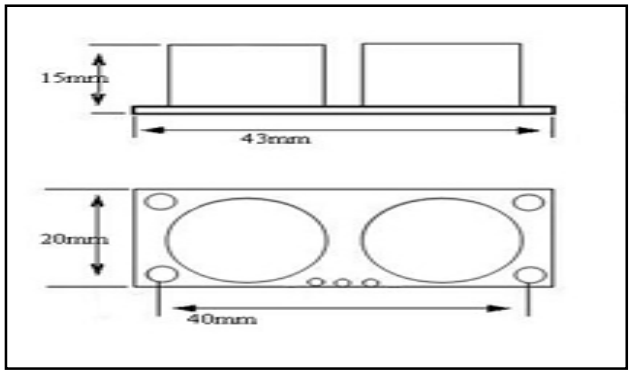


Fig.1 Ultrasonic sensor

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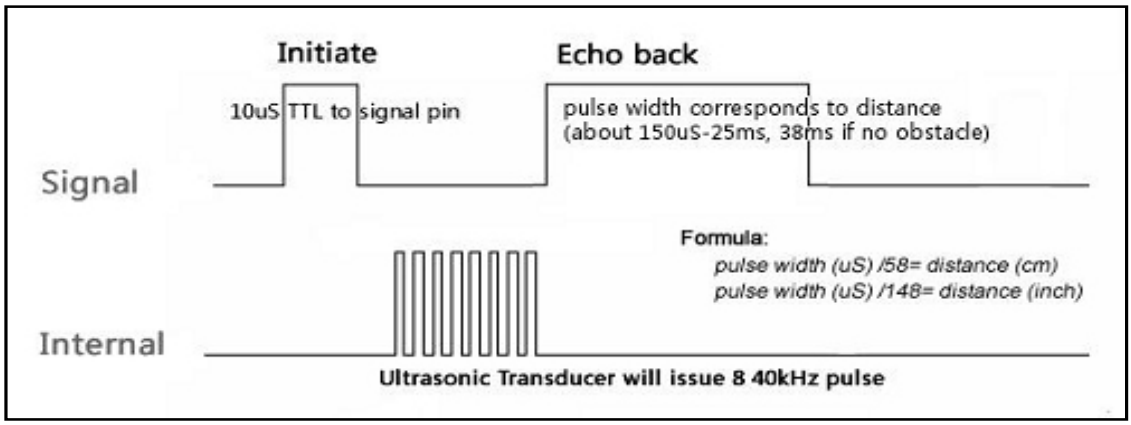


Fig.2 Ultrasonic pulses being transmitted

Vcc : 5V DC supply voltage is connected to this pin. Trigger: The trigger signal for starting the transmission is given to this pin. The trigger signal must be a pulse with 10uS high time. When the module receives a valid trigger signal it issues 8 pulses of 40KHz ultrasonic sound from the transmitter. The echo of this sound is picked by the receiver. Echo**:** At this pin, the module outputs a waveform with high time proportional to the distance.GND: Ground is connected to this pin.

B. Working of Ultrasonic Range Finder

The main components required are AT89C51 Microcontroller- 8051 Programming board, Programming cable, HC – SR04 Ultrasonic Module, 10µF / 16V Electrolytic Capacitor, 2 x 10KΩ Resistor (1/4 Watt), 11.0592 MHz Crystal, 2 x 33pF Capacitors, Connecting wires, Power Supply. The software required is-Keil µVision Software, Proteus, Willar Software.The major components in this project are AT89C51 Microcontroller, Ultrasonic Sensor and SSD Display. The TRIGGER and ECHO pins of the Ultrasonic Sensor are connected to the P3.0 and P3.1 pins respectively. SSD data pins are connected to the PORT0 of the microcontroller. Here, the SSD is used to display distance of the object. Power supply pins of the microcontroller, SSD and Ultrasonic Sensor are connected to the 5V DC.Initially burn the program to the microcontroller and give the connections as per the circuit diagram. While giving the connections make sure that Vcc of ultrasonic module is connected to 5V DC. Switch on the board supply. Place the obstacle in front the ultrasonic module, now you can observe the distance on SSD. Switch off the board supply.

C. Algorithm

1) Send HIGH pulse for 10 micro seconds on TRIG pin

Initially P3.0 = 0;
P3.0 = 1;
Delay ms (10);
P3.0 = 0;

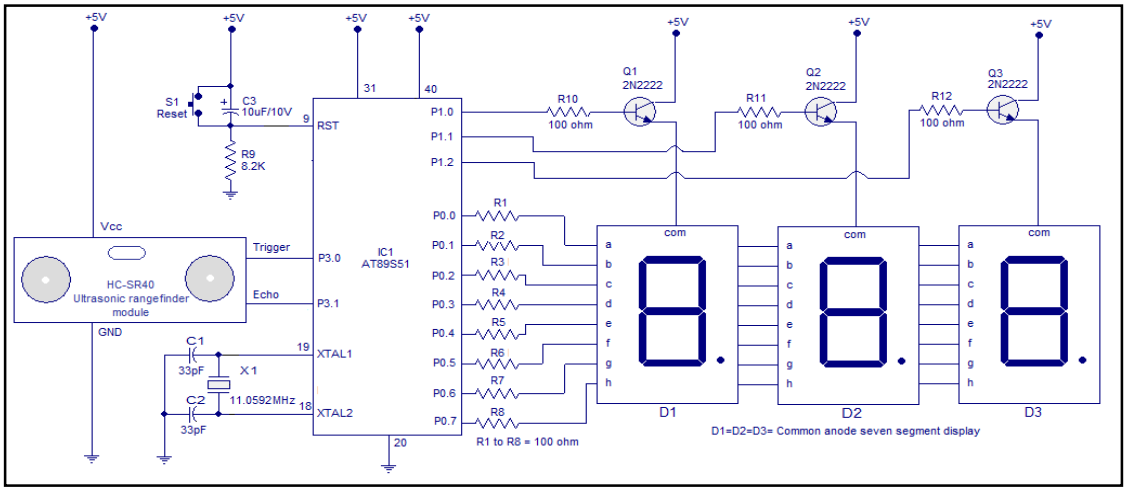


Fig.3 Block Diagram

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2) Wait until the module transmits 40 KHz pulses. When 8thpulse is transmitted echo pin becomes HIGH TIMER1 starts counting.
3) TIMER1 value is equal to the time taken by the signal to go forward and comeback so we need to take only half time.
4) Distance Measured:
a) The speed of the ultrasonic pulse is nothing but the speed of sound which is 340.29 m/s or 34029 cm/s
b) Here the timer starts counting from 207D because from datasheet we know that count 58 corresponds to one cm.
c) So here we take count as 48 and this is done to in order to compensate for the time lags caused by the branching instructions used for checking the status of P3.0 and P3.1 Pins.
d) At 11.0592 MHz, TIMER0 gets incremented for 1µs.

III. ADVANTAGES AND APPLICATIONS

A. *Advantages*

1) The ultrasonic sensor has high frequency, high sensitivity and high penetrating power therefore it can easily detect the external or deep objects.
2) The use of ultrasonic sensor makes this range finder more accurate than other methods.
3) This range finder is easy to use, not dangerous during operation for nearby objects, person, equipment or material.

B. *Applications*

It is used in machines like Automotive parking sensor, obstacle warning systems, Terrain monitoring robots, industrial distance measurements.

IV. RESULT

This ultrasonic rangefinder can measure distances up to 2.5 meters with an accuracy of 1 centimeter.

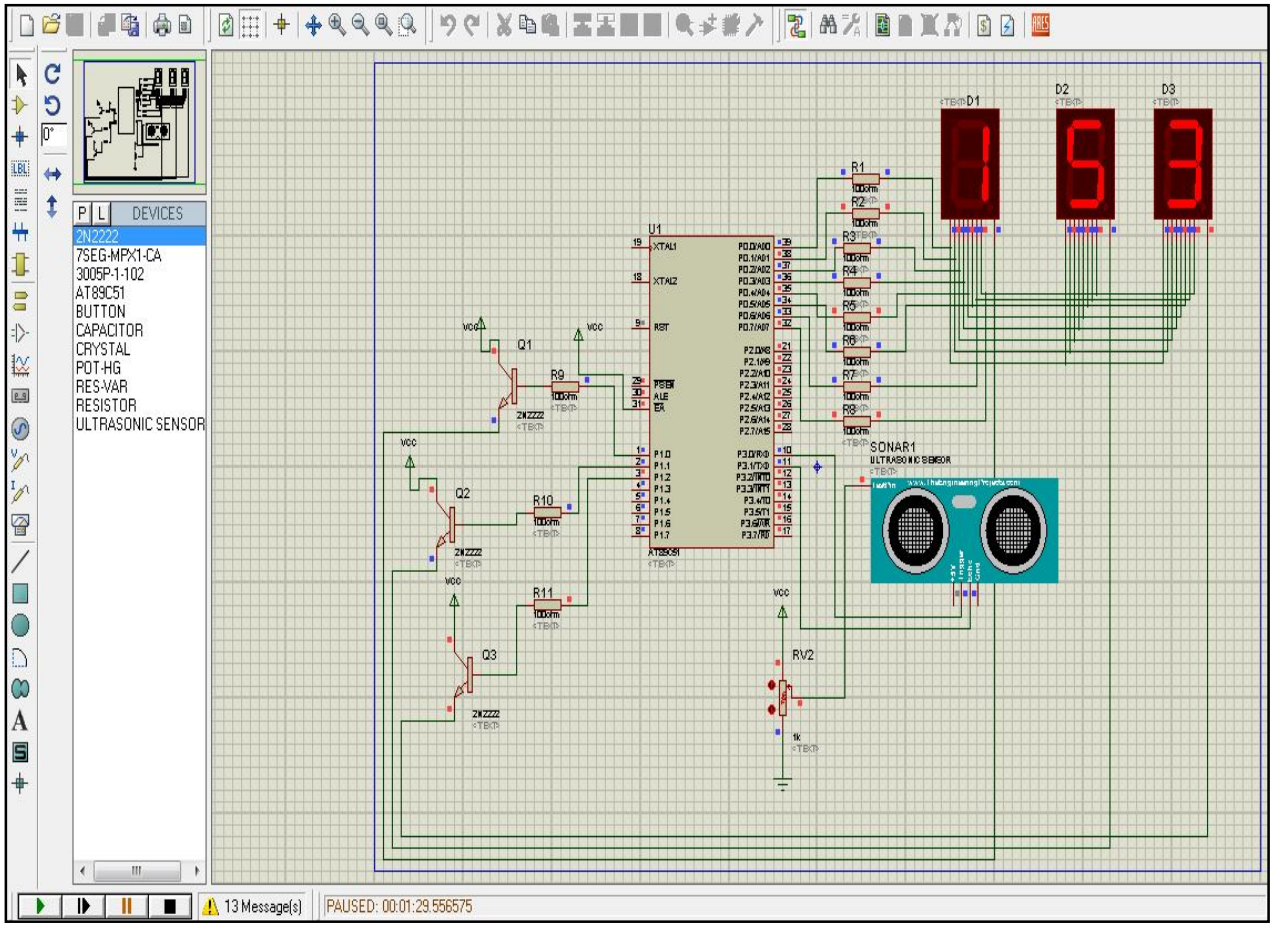


Fig.4 Proteus output

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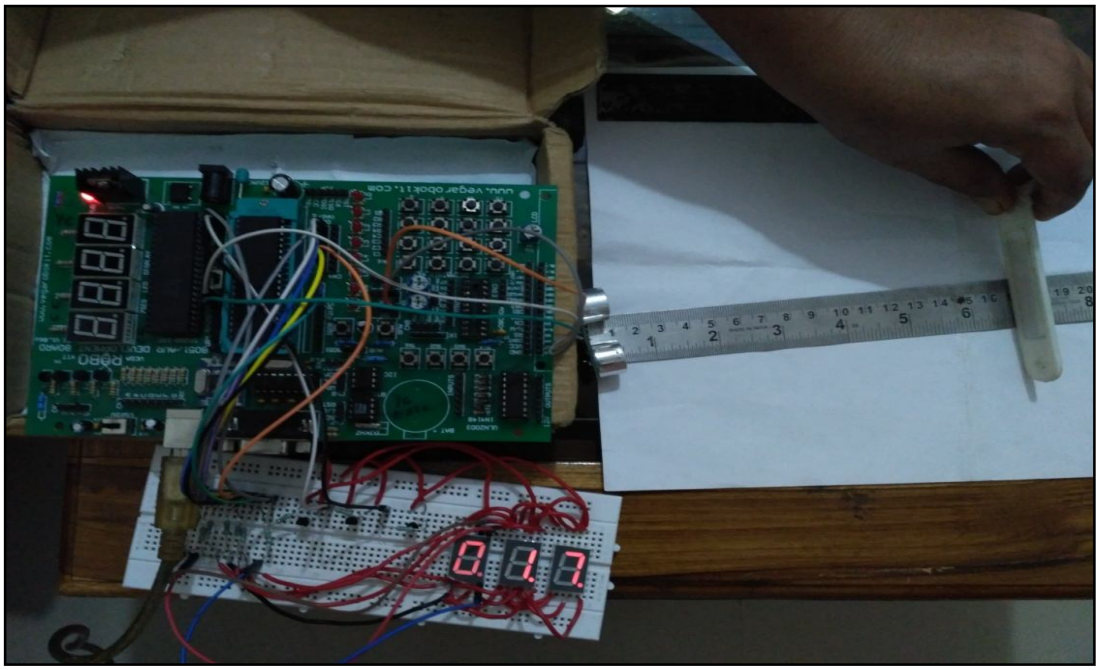


Fig.5 Hardware output

V.CONCLUSION

This project can be used to measure a distance of 2.5 meters with an accuracy of 1cm. So it can be very well used in detecting various obstacles which are at that distance apart. The best use of this can be made to find the distance between the car and the wall for parking purpose.

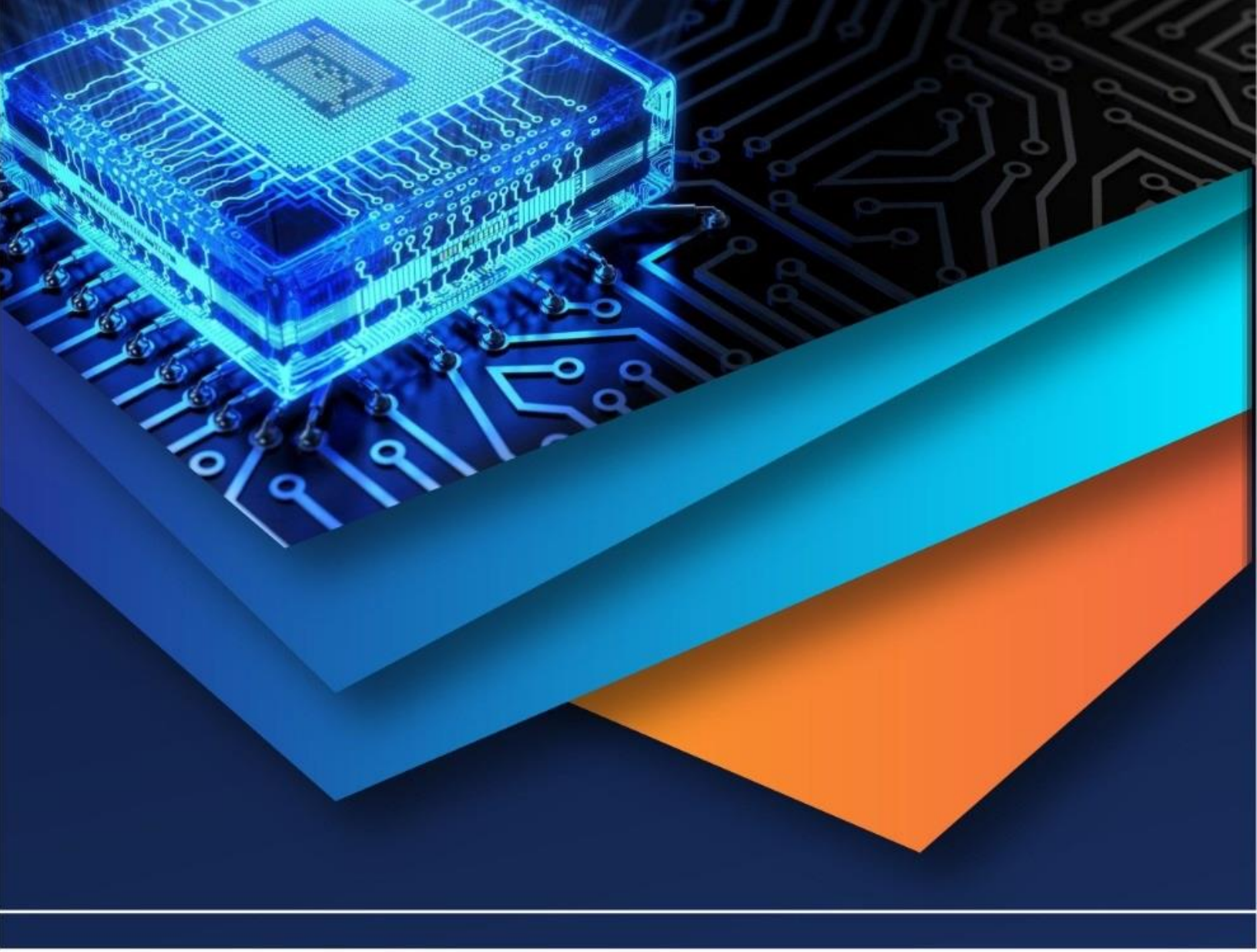
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