NORTH SOUTH UNIVERSITY

CSE331 SECTION 8

Microprocessor Interfacing & Embedded System

PROJECT REPORT

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Title: Ultrasonic Object Detection (UOD)

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Introduction:

Generally, the distance can be 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 LCD.

Objective:

The objective of this experiment is to build an Ultrasonic rangefinder using 8051 Microcontroller and Ultrasonic Sensor which measures the distance up to 4 meters.

Components:

- 8051 Microcontroller
- 16x2 LCD Unit
- HC-SR04 Ultrasonic Sensor
- Jumper Wires
- Buzzer
- Breadboard

Software Requirements:

- Keil Uvision
- Programming language: C Language

Methodology:

1. Initially burn the program to the microcontroller.
2. Now give the connections as per the circuit diagram.
3. The HC-SR04 module has ultrasonic transmitter, receiver and control circuit on a single board. The module has only 4 pins, VCC, GND, Trig and Echo.
4. When a pulse of 10sec or more is given to the Trig pin, 8 pulses of 40 kHz are generated. After this, the Echo pin is made high by the control circuit in the module.
5. Echo pin remains high till it gets echo signal of the transmitted pulses back.
6. The time for which the echo pin remains high, i.e., the width of the Echo pin gives the time taken for generated ultrasonic sound to travel towards the object and return.
7. Using this time and the speed of sound in air, we can find the distance of the object using a simple formula for distance using speed and time.
8. While giving the connections make sure that VCC of ultrasonic module is connected to 5V DC.
9. Switch on the board supply.
10. Place the obstacle in front the ultrasonic module, now you can observe the distance on LCD.
11. Switch off the board supply.
12. Used to measure the obstacle distance.
13. This system used in automotive parking sensors and obstacle warning systems.
14. Used in terrain monitoring robots.

Circuit Diagram:

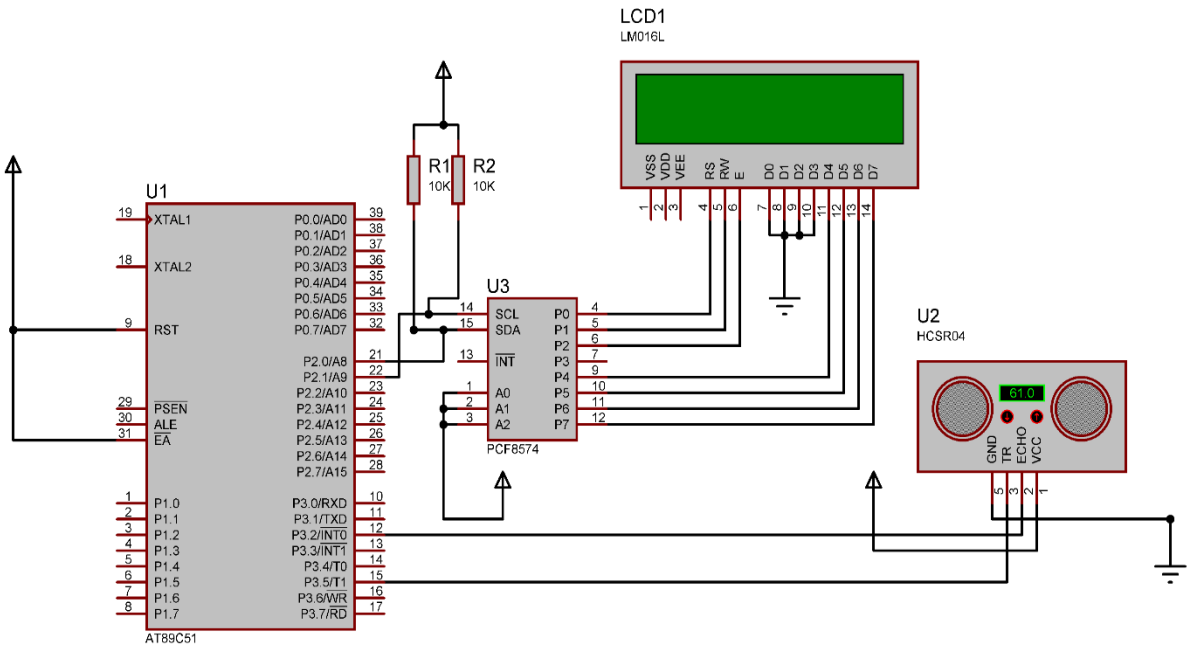

Figure: Circuit Diagram

In this circuit, only P2 and P3 are used as output and input respectively. Port 1 is connected to the 16x2 LCD display to show the output of distance covered, and Port 3 is used with HC-SR04 Ultrasonic Sensor to take the distance measurement data of an object, far or close to the sensor. Additionally, Port 2 is linked with 16x2 LCD display's Register select pin, Read/Write pin and Enable pin to configure the unit.

Simulation:

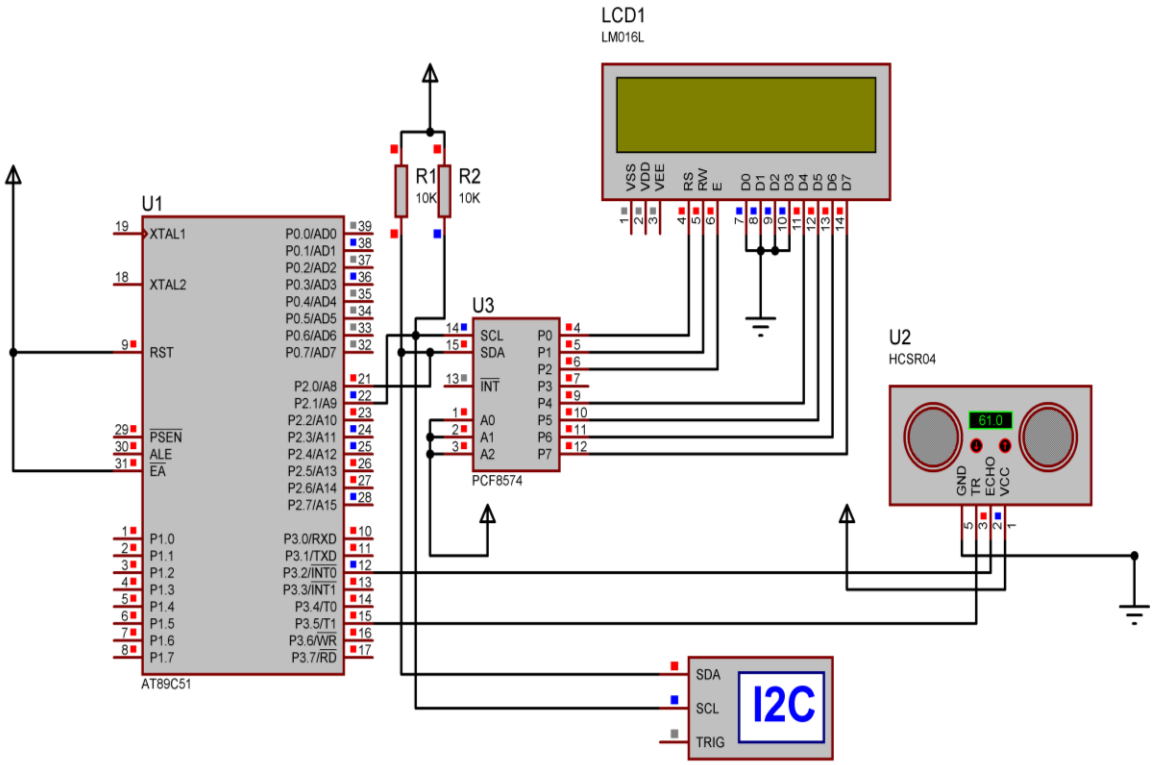

Figure: Simulation Diagram

In this circuit, only P2 and P3 are used as output and input respectively. Port P2.0 and P2.1 is connected to the SCL and SDA of the I2C display adapter to show the output of distance covered in the 16x2 LCD, and Port 3 is used with HC-SR04 Ultrasonic Sensor to take the distance measurement data of an object, far or close to the sensor. Additionally, Port 0,1,2,3,4,5,6,7 of the I2C is linked with 16x2 LCD display's Register select pin, Read/Write pin and Enable pin to configure the unit.

Algorithm:

The algorithm for finding the distance uses the following algorithm

1. Main Function:
   (a) Initialize the LCD.
      i. Turn on the display
      ii. Turn off the cursor
      iii. Clear the screen iv. Shift cursor to right
   (b) Initialize the timer registers
      i. Set TMOD to 1 ii. Set TR0 to 00H iii. Set TH0 to 00H iv. Set TL0 to 00H
      (c) Call get range subroutine.
2. Delay:
   (a) Produce a delay of n*10mS. Where n is the given argument.
3. Command:
   (a) Strobe the enable pin
4. Put the data value on the
5. Display LCD:
   (a) Call the command subroutine
   (b) Add 10mS delay
   (c) For each character in the display string
      i. Strobe the register select pin
      ii. Strobe the enable pin
      iii. Put the data value on the pin iv. Add delay of 10 mS
6. Get range:
   (a) Set TH0 to 00H
   (b) Set TL0 to 00H
   (c) Pull trigger pin HIGH
   (d) provide 10uS Delay using nop
   (e) Waiting until echo pulse is detected
   (f) Waiting until echo pulse change its state
   (g) Read timer register for time count

(h) Set TH0 to FFH

(i) Set TL0 to FFH

(j) Calculate the timer value (maximum of 35000 us)

(k) Convert the number passed from get range() subroutine to string in the form ”0000 CM”.

(l) Call display lcd subroutine.

Code:

```
#include<reg51.h>
#include<intrins.h>
void i2c_start(void); void i2c_stop(void); void i2c_ACK(void); void i2c_write(unsigned char); void i2c_DevWrite(unsigned char);
void lcd_send_cmd(unsigned char); void lcd_send_data(unsigned char); void lcd_send_str(unsigned char *);
void lcd_slave(unsigned char ); void delay_ms(unsigned int);
unsigned char slave1=0x4E; unsigned char slave_add; unsigned char dis; unsigned int range=0;
sfr16 DPTR=0x82; sbit scl=P0^6; sbit sda=P0^7; sbit trig=P3^5; sbit echo=P3^2;
void send_pulse(){     TH0=0x00; TL0=0x00; trig = 1;  _nop_(); _nop_();_nop_();_nop_();_nop_();
  _nop_();_nop_();_nop_();_nop_();_nop_(); trig = 0; }
unsigned char ultrasonic(){ unsigned char dataD; send_pulse();
            while (INT0 == 0); //waiting until echo pulse is detected
            while (INT0 == 1); //waiting until echo change its state
            DPH=TH0;
            DPL=TL0;
            TH0=0xff; TL0=0xff;
            if(DPTR<38000)
                        dataD=DPTR/59;
            else
                        dataD=0;
            return dataD; }
void i2c_start(void) { sda=1;_nop_();_nop_(); scl=1;_nop_();_nop_(); sda=0;_nop_();_nop_(); }
void i2c_stop(void) { scl=0; sda=0; scl=1; sda=1; }
void lcd_slave(unsigned char slave) { slave_add=slave; }
void i2c_ACK(void){ scl=0; sda=1; scl=1;
while(sda); }
void i2c_write(unsigned char dat) { unsigned char i;
for(i=0;i<8;i++) { scl=0; sda=(dat&(0x80)>>i)?1:0; scl=1; } }
```

```
void lcd_send_cmd(unsigned char cmd) { unsigned char cmd_l,cmd_u;
cmd_l=(cmd<<4)&0xf0; cmd_u=(cmd &0xf0);
i2c_start();
i2c_write(slave_add); i2c_ACK(); i2c_write(cmd_u|0x0C); i2c_ACK();
delay_ms(1); i2c_write(cmd_u|0x08); i2c_ACK();
delay_ms(10); i2c_write(cmd_l|0x0C); i2c_ACK();
delay_ms(1); i2c_write(cmd_l|0x08); i2c_ACK();
delay_ms(10); i2c_stop(); }
void lcd_send_data(unsigned char dataw) { unsigned char dataw_l,dataw_u;
dataw_l=(dataw<<4)&0xf0;
dataw_u=(dataw &0xf0);
i2c_start();
i2c_write(slave_add); i2c_ACK(); i2c_write(dataw_u|0x0D); i2c_ACK();
delay_ms(1); i2c_write(dataw_u|0x09); i2c_ACK();
delay_ms(10); i2c_write(dataw_l|0x0D); i2c_ACK();
delay_ms(1); i2c_write(dataw_l|0x09); i2c_ACK();
delay_ms(10); i2c_stop(); }
void lcd_send_str(unsigned char *p) { while(*p != '\0')
lcd_send_data(*p++); }
void delay_ms(unsigned int n) { unsigned int m;
for(n;n>0;n--){  for(m=121;m>0;m--);
                _nop_();  _nop_();   _nop_();   _nop_();   _nop_();   _nop_();}}
void lcd_init(){
lcd_send_cmd(0x02);// Return home
lcd_send_cmd(0x28);// 4 bit mode
lcd_send_cmd(0x0C);                // Display On , cursor off
lcd_send_cmd(0x06);// Increment Cursor (shift cursor to right)
lcd_send_cmd(0x01); // clear display
}
void main(void) {
            TMOD=0x09; TH0 = 0x00; TL0 = 0x00; TR0 = 1;
            lcd_slave(slave1); lcd_init();
            lcd_send_cmd(0x80); lcd_send_str("**UOP PROJECT**");
while(1){   range=ultrasonic(); range=range/2;
            lcd_send_cmd(0xC0); lcd_send_str("Distance:");
            lcd_send_data((range/100)+48);lcd_send_data(((range/10)%10)+48); lcd_send_data((range%10)+48);
            lcd_send_str("cm"); delay_ms(500);}}
```

Conclusion:

In this project, Interfacing of Ultrasonic module HC-SR04 with 8051 Microcontroller using Keil C software was performed successfully. 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. Using the mechanism of the ultrasonic sensor the object distance up to 4 meters was measured and this system (HC SR04 ultrasonic sensor) was not able to measure longer distances. In order to measure the distance, Object Distance(in cm) = (Sound Velocity * Time)/2,Where, Sound Velocity = 34300 (in cm per second), oscillator frequency of AT89S52 (8051) is 11.0592 MHz, then timer frequency of8051 will be 921.6 kHz. So, Time required to execute 1 instruction is 1.085 us. So, timer gets incremented after 1.085 us time elapse. Hence, for more range, we can try replacing the sensor module.

References:

- https://nevonprojects.com/ultrasonic-object-detection-project/
- https://youtu.be/uTXIlk86afI
- https://www.electronicshub.org/ultrasonic-rangefinder-using-8051/
- https://www.instructables.com/Ultrasonic-Range-Finder-Using-8051/