Project Report

Autonomous Water Pump

Submitted for the Degree of

Bachelor of Technology (B-Tech) in Electrical and Electronics Engineering

By

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Introduction

The main objective of this Project is to develop an autonomous Water Pump for Houses. Implementation of this Project ensures users with ease of water availability. The Project employs a sensor to monitor the level of water in the overhead tank, and accordingly signals the microcontroller to take necessary action. Based on the input from the sensor the microcontroller turns on/off the water pump through a relay. The relay which acts as a switch closes/opens to complete/break the motor circuit resulting in controlled action of motor. Additionally the relay also provides electrical isolation for low power electronic devices against high power rated motor. Alarms and Displays are also incorporated to acknowledge the user about the actions.

Apparatus Requirements

Electronics Section:

1. **Arduino Uno**

The Arduino Uno R3 is a microcontroller of Arduino series boards, is employed in the project for logic control. The board has 14 digital I/O pins, 6 analog I/O pins, and is programmable with the Arduino IDE, via a USB cable. Operating voltage of the board is 5 volts dc. It can be powered by the USB cable or by an external battery. Out of 14 digital I/O pins, 10 pins are utilized in this project for various I/O devices. None of the analog I/O pins are used. The figure below shows a glimpse of the board.

Fig-1

2. Ultrasonic sensor

HC-SR04 is an ultrasonic sensor is used to measure the empty level of water in the overhead tank. The sensor works on the principle of reflection of sound wave. It emits a sound wave at a frequency too high for humans to hear, and then waits for the sound wave to be reflected back from an object. It counts the total time required by the wave to return back and calculates the distance travelled by the sound wave using the formula,

Speed = Distance/Time

Since, it calculates the total distance which includes forward path and return path, the actual distance between the sensor and the object is half of the total distance travelled by the wave. This actual distance is the empty level in the overhead tank. The sensor used has minimum and maximum range of 5cm and 400cm respectively. The figure below shows a glimpse of the sensor and its working principle.

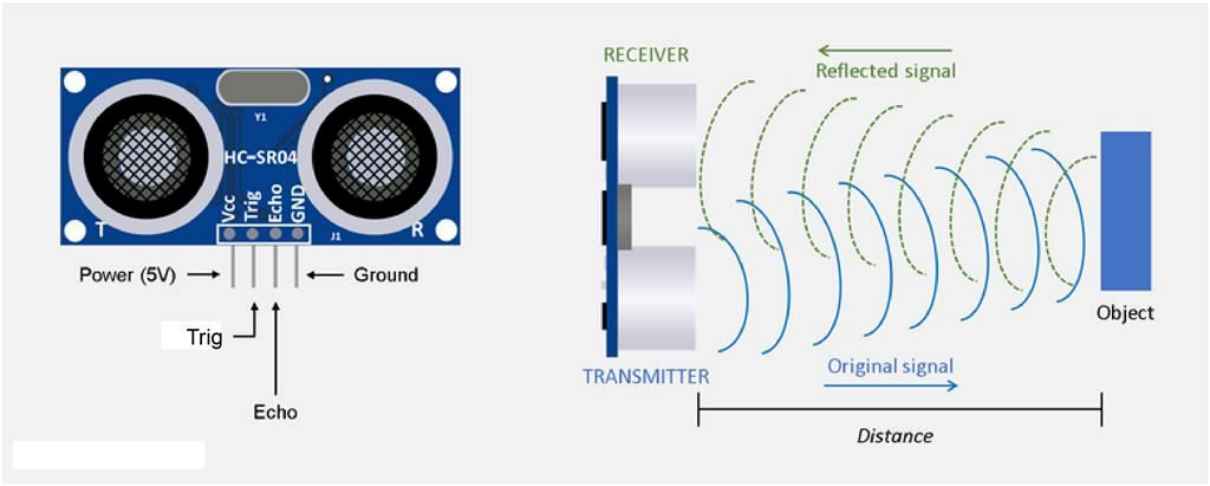


Fig-2

3. Buzzer

A buzzer or beeper is an audio signaling device. The project employs an active buzzer, which has an internal oscillating source, and the buzzer will sound as soon as it is energized. The buzzing sound is used as an alarm to alert the user, indicating that motor is turned on/off. The figure below depicts a buzzer.

Fig-3

4. LCD

LCD, short for Liquid Crystal Display is flat-panel display that uses light-modulating properties of liquid crystals combined with polarizer. LCDs works on the principle of blocking the light. A backlight is required as they do not emit light themselves. The project employs a 16 x 2 LCD, which means that it can display 16 characters per line and there are 2 such lines. The figure below shows a typical LCD display.

Fig-4

5. Relay Module

The Relay Module is used as an electrical switch which is operated by an electromagnet. It works on the principle that, when a current flows through a solenoid, a magnetic field is produced which can attract ferrous metal components in its vicinity. These relay modules may be of low activated or high activated. Here, low activated Relay module is used; meaning that the solenoid is energized or attracts a metal when low level signal is applied resulting in the completion of the external motor circuit. Either Normally Open (NO) or Normally Closed (NC) contacts of the Relay module can be used for switching action. In addition to this, the Relay module also provides electrical isolation between the high and low power devices. The figure below depicts a typical Relay Module.

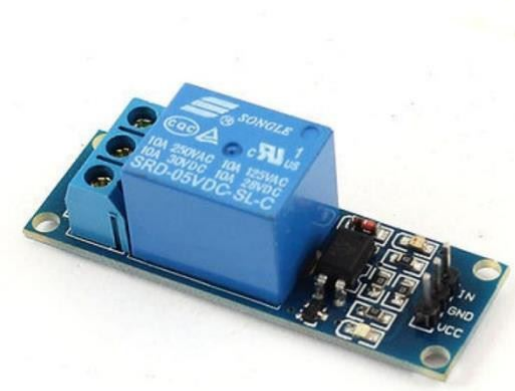


Fig-5

Electrical Section

1. ac Motor

The project uses a single phase, 230v, ac motor as the Water Pump. The figure below shows a visual of the motor.

Fig-6

Supplementary Requirements

1. Jumper Wires

They are essential for interconnection of various equipments.

Fig-7

2. Potentiometer

A Potentiometer (or simply Pot) is a variable resistance. It is required to adjust the resolution of the LCD display. A 10K ohm pot is used in the Project.

Fig-8

3. Bread Board

It is just used to aid proper connection so as to avoid detachments of wires or errors.

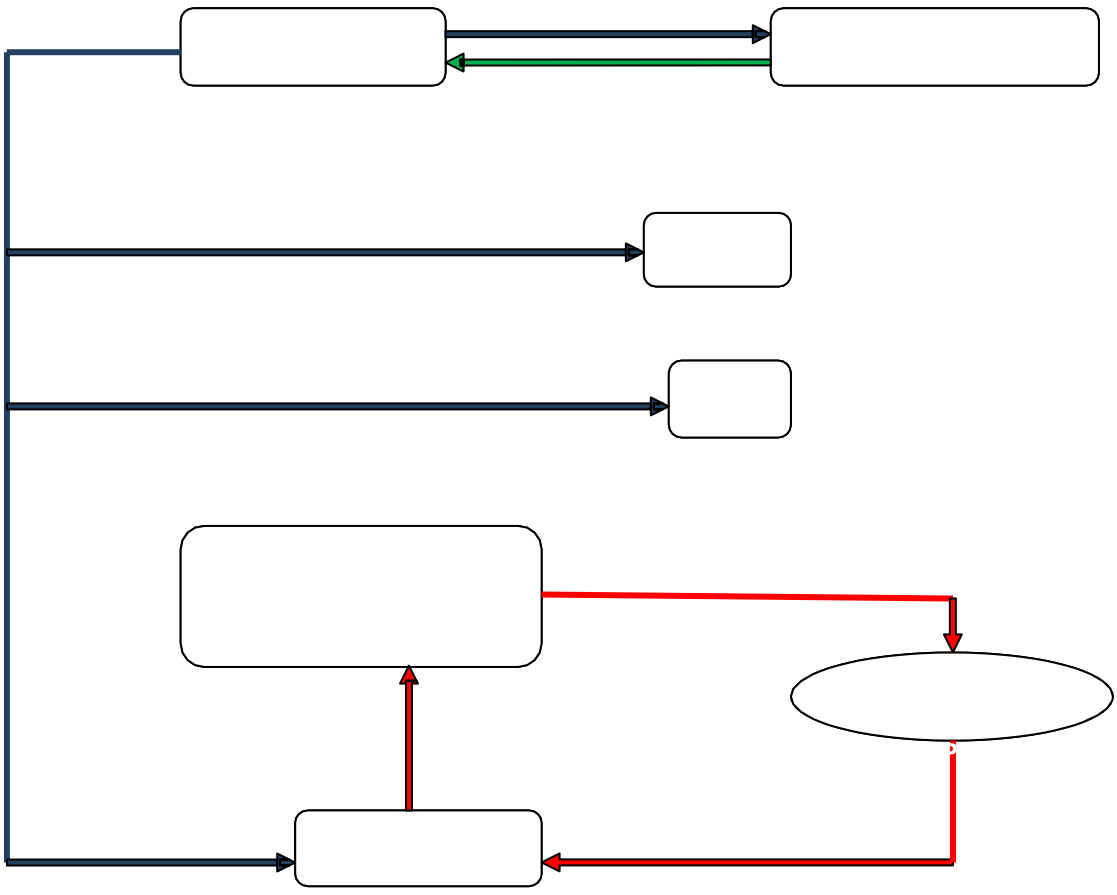
Fig-9

System Design and Development

Component Connections

Fig-10 shows connections between each component involved in this Project. The system is mainly controlled by Arduino UNO. In detail, the connections can be divided into three sections: control of input device, control of display device, and control of output machine. In the input section, the Ultrasonic sensor is directly controlled by Arduino Uno. In the display section, buzzer and LCD are also directly controlled by the Arduino.

In the output section, a Relay Module is directly controlled by the Arduino. A Relay Module is used to provide external power supply to the water pump. This is because high current is required to drive the water pump which is much higher than the ability of Arduino Uno's provision. Thus, the Arduino controls the water pump indirectly through a relay.



ControlSign

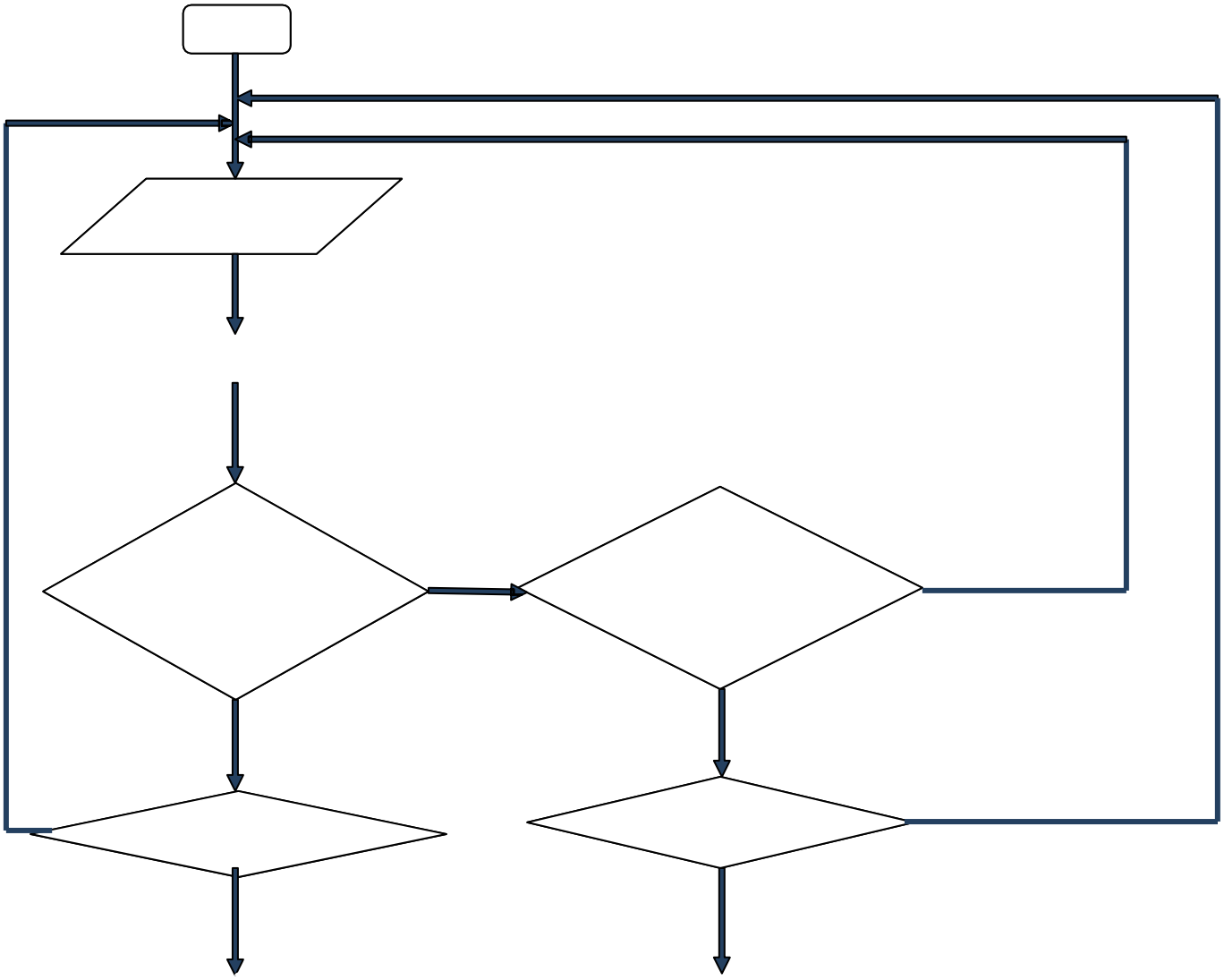
alInputSign

al

Fig-10: Components connection diagram

Programming algorithm

For Arduino Uno, C language is used to build the logic code. The flowchart of the entire system function is shown in fig-11.



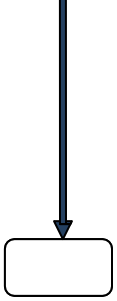


Fig-11: Flowchart of the system process

Once the system is activated, the Arduino triggers the Ultrasonic Sensor to get the input. The microcontroller then determines the empty level and accordingly executes one of the several pre-defined instructions to control the action of water pump.

Experiment

Experiment Plans:

Firstly, the determination of empty level should be tested. Then the entire system should be tested. Later, synchronization of display units with the system process should be tested. All experiment results should be recorded for later analysis and improvements.

Experiment Results:

The determination of the empty level in the overhead tank using the ultrasonic sensor is successful and has 1% accuracy with the physical measurement using a ruler. Synchronization of the display with the system processes is successfully verified. However, the control of motor through a relay module did work only a few times out of several attempts.

Conclusion

Application of this project is recommended at the residential or household level. However, it can be employed at the industrial level by using a properly designed Relay module, which is the takeaway of this project. Another takeaway is that measurement of the level is affected by the ambient temperature conditions, as speed of sound waves varies with the temperature of the medium in which it is travelling. So, a temperature sensor can be interfaced along with the ultrasonic sensor to get a precise measurement of the level.

Appendix: Arduino Code for the System

```
#include<LiquidCrystal.h>              //loads LCD library

LiquidCrystal screen(10,9,5,4,3,2);    //an LCD object named screen has been created and it uses
                                       //the pin numbers of the arduino that are specified in braces



float emptylevel;             //variable for distance between ultrasonic sensor and water
float upperlimit=5.0;         // max level of water in the tank
float lowerlimit=25.0;        //min level of water in the tank
int relaypin=7;               //relay pin is connected to pin 7
int trigpin=12;               // transmitter pin of ultrasonic sensor is connected to pin 12
int echopin=8;                // receiving pin of ultrasonic sensor is connected to pin 8
int buzzer=6;                 //buzzer is connected to pin 6
int LCDdelay=1000;            //delay time for LCD display (screen) in milliseconds
int buzzdelay=250;            //delay time for buzzer in milliseconds



void setup()
{
  Serial.begin(9600);                 //starts serial communication
  screen.begin(16,2);                 //starts LCD(16 columns,2 rows)
  pinMode(relaypin,OUTPUT);           //initializes as output pin
  pinMode(trigpin,OUTPUT);            //initializes as output pin
  pinMode(echopin,INPUT);             //initializes as input pin
  pinMode(buzzer,OUTPUT);             // initializes as output pin
  screen.print("WELCOME");            //prints to LCD
 }


//user defined function 1          To measure the empty level


float determine()
{
  float timetaken;                    // variable for total time taken by sound signal
  float speedofsound=343.0;           //speed of sound in m/s
  float distance;                     //variable for total distance travelled by the sound signal
  digitalWrite(trigpin,LOW);          //outputs 0v to the trigpin
  delayMicroseconds(2000);            //delay time of 2000 microseconds (2 milliseconds)
  digitalWrite(trigpin,HIGH);         //outputs 5v to the trigpin
  delayMicroseconds(10);              //5v output is maintained for 10 microseconds
  digitalWrite(trigpin,LOW);          //outputs 0v to the trigpin

  timetaken=pulseIn(echopin,HIGH);       //receives and estimates the time in microseconds taken
                                         //by high pulse to reach echopin

  timetaken=timetaken/1000000.0;         //converts time from microseconds to seconds
```

```
 Serial.print("total travel time is ");          //prints to serial monitor
 Serial.print(timetaken);                       //
 Serial.println(" seconds");                    //
 delay(500);

 distance=speedofsound*timetaken;          //determines total distance travelled in meters
 distance=distance/2.0;                    //actual distance between sensor and water is half of

                                                        //the total distance travelled


 distance=distance*100.0;                                 //converts from m into cm
 Serial.print("distance of water from sensor is ");      //prints to serial monitor
 Serial.print(distance);                                  //
 Serial.println(" cm");                                   //
 delay(500);

 return(distance);
}



//user defined function 2          To clear the LCD display


void wipe()
 {
  screen.setCursor(0,1);                    //places cursor at column 0 and row 1
  screen.print("             ");            //prints 16 blanks to LCD
  screen.setCursor(0,0);                    //places cursor at column 0 and row 0
  screen.print("             ");            //prints 16 blanks to LCD
  screen.setCursor(0,0);                   //again places cursor at column 0 and row 0
 }




void loop()
{
 emptylevel=determine();                   //calls determine() function

 // first if statement.....
 if(emptylevel<upperlimit)
 {
  wipe();                                  //calls wipe() function
  screen.print("EMPTY LEVEL IS ");        //prints to the LCD
  screen.setCursor(0,1);                   //
  screen.print(emptylevel);                //
  screen.print(" cm");                     //
  delay(LCDdelay);                         //delay of 1000 ms

  if(relaypin==LOW)                        //if relay is on or motor is on
   {
    wipe();
    screen.print("TANK IS FULL");          //prints to the LCD
    screen.setCursor(0,1);                 //cursor moves
```

```
   screen.print("MOTOR WILL OFF");          //prints to LCD
   delay(LCDdelay);                          //delay of 1000 ms
   digitalWrite(relaypin,HIGH);              //turns off the motor
   digitalWrite(buzzer,HIGH);                //buzzer sounds
   delay(buzzdelay);                                 //for 250 ms
   digitalWrite(buzzer,LOW);                 //buzzer turns off
  }
 else
  {                                  //if relay is off or motor is off
   wipe();
   screen.print("TANK IS FULL");             //prints to the LCD
   screen.setCursor(0,1);                    //
   screen.print("MOTOR IS OFF");            //
   delay(LCDdelay);                          //delay of 1000 ms
  }
}


  //second if statement starts.....
if(emptylevel>lowerlimit)
 {
 wipe();
 screen.print("EMPTY LEVEL IS ");             //prints to the LCD
 screen.setCursor(0,1);                      //
 screen.print(emptylevel);                   //
 screen.print(" cm");                        //
 delay(LCDdelay);                            //delay of 1000 ms


 if(relaypin==HIGH)                          //if relay is off or motor is off
  {
   wipe();
   screen.print("WATER IS LESS");              //prints to LCD
   screen.setCursor(0,1);                     //
   screen.print("MOTOR WILL ON ");            //
   delay(LCDdelay);                           //delay of 1000 ms
   digitalWrite(relaypin,LOW);                //turns on the motor
   digitalWrite(buzzer,HIGH);                 //buzzer sounds
   delay(buzzdelay);                                 //for 250 ms
   digitalWrite(buzzer,LOW);                  //buzzer turns off
  }
 else
  {                                          //if relay is on or motor is on
   wipe();
   screen.print("WATER IS RAISING");           //prints to LCD
   screen.setCursor(0,1);                     //
   screen.print("MOTOR IS ON");               //
   delay(LCDdelay);                           //delay of 1000 ms
  }
}


    //third if statement starts.....
if(emptylevel>upperlimit && emptylevel<lowerlimit)
 {
```

```
  if(relaypin==LOW)                    // if relay is on or motor is on
   {
    wipe();
    screen.print("WATER IS RAISING");        //prints to LCD
    screen.setCursor(0,1);                   //
    screen.print("MOTOR IS ON");             //
    delay(LCDdelay);                         //delay of 1000 ms
   }
  else
   {
    wipe();
    screen.print("WATER IS ");               //prints to LCD
    screen.setCursor(0,1);                   //
    screen.print("SUFFICIENT");              //
    delay(LCDdelay);                         //delay of 1000 ms
   }
  }
}
```