21AIE114

PRINCIPLES OF MEASUREMENTS AND SENSORS

S2 B. TECH CSE AIE

AUTOMATIC WATER LEVEL CONTROLLER

PROJECT REPORT

Submitted by

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ABSTRACT

Water is extremely valuable to all living beings and the way we are wasting water shows that the day is not far behind when there will be very little water left on the planet. This is a problem that affects the majority of the country's and world's cities. This is one of the driving forces behind our project and the deployment of strategies to conserve water while also benefiting the environment. In many houses there exists unnecessary wastage of water due to overflow from overhead tanks. Automatic Water Level Controller can provide a solution to this problem as well as saves electricity.

The system works on dual control process. It senses level at both the source tank and the overhead tank to process commands. While a digital sensor (flow sensor) monitors the sump or the source tank, an ultrasonic sensor detects the water level in the overhead tank. The power supply is rectified and regulated and is given to the Arduino. The Arduino checks if the water in the overhead tank falls below a certain prefixed level, the power is correctly maintained and if the water in the sump is above a certain level. Only if all the conditions are satisfied a command is sent to relay which sets the motor into operation. Once the water level in the overhead tank reaches the prefixed upper level or the water in the sump goes below a certain level, a command is sent to turn off the motor. Hence an automatic functioning of the motor and a regulated water level in the overhead tank is maintained.

TABLE OF CONTENTS

INTRODUCTION

Here, we present a completely automated water level control system that keeps track of the water level and activates or deactivates the motor as needed. What distinguishes our project from other water level management systems is that it monitors the water levels not only in the overhead tank, but also in the source tank. By monitoring the supply voltage, it further safeguards against overvoltage.

The system makes use of dual controls. It gauges the level in both the source and overhead tanks to process orders. A flow sensor measures the water level in the sump or source tank, while an ultrasonic sensor measures the water level in the overhead tank. A rectified and regulated power source is provided to the Arduino. The Arduino keeps track of three different things: if the power is kept on, whether the water in the sump is over a certain level, and whether the water in the overhead tank falls below a certain level. The relay receives a command only when all of the prerequisites are satisfied, where at this point the motor is turned on.

In order to avoid adding unnecessary complexity and making it uncomfortable overall, the design was kept simple and straightforward. We can conserve power by utilizing our project. It can be applied in locations where load shedding is an issue. It limits the quantity of power used since it is automatically managed. Utilizing one of these devices is beneficial because energy conservation is in utmost need.

This automated water level controller may be produced at a minimal cost, making it accessible to individuals from all socioeconomic backgrounds. This is applicable to both big enterprises and the ordinary homes we live in. This has the potential to simplify life and conserve a significant amount of water and power.

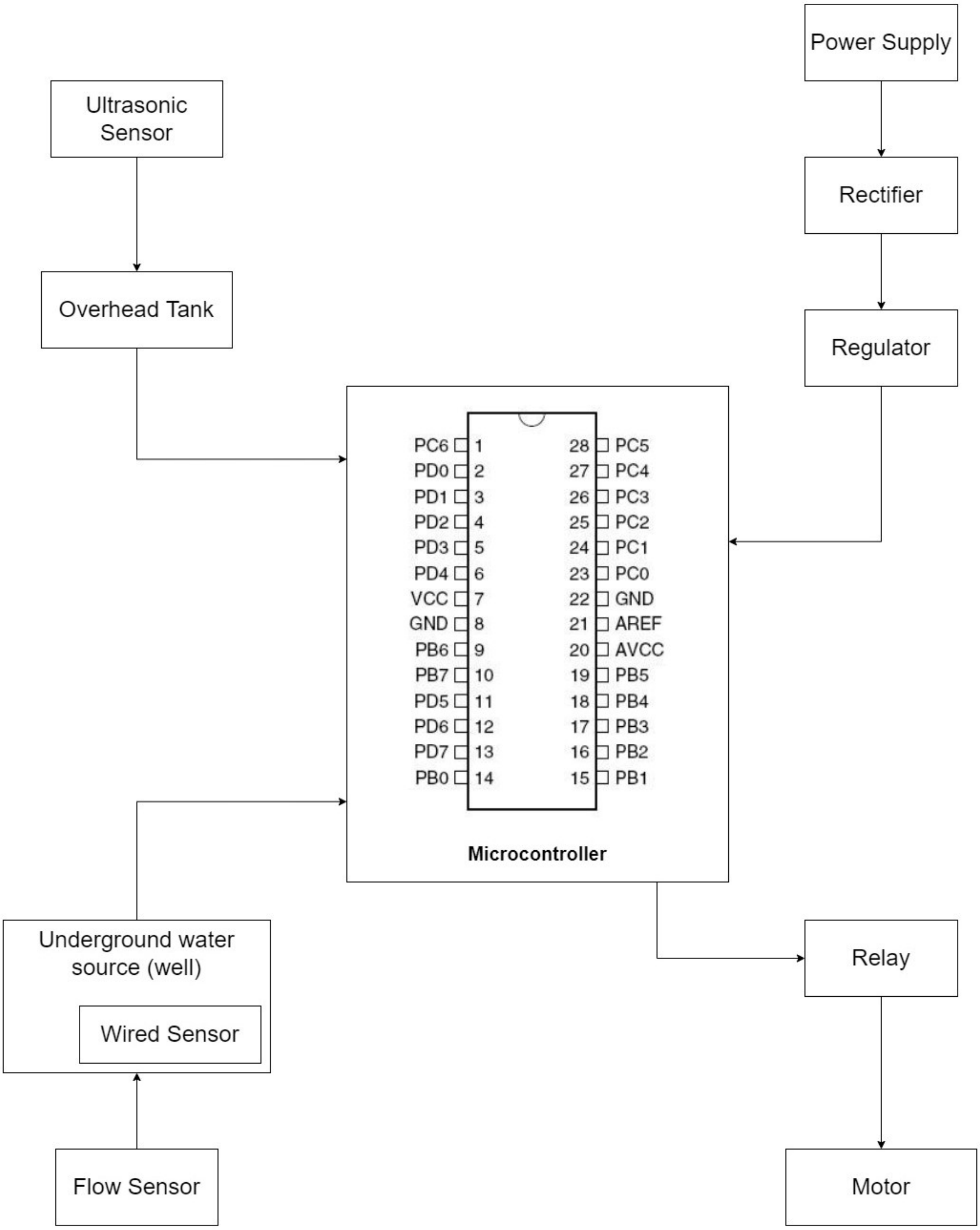
SCOPE:

Future applications for automatic water level monitoring systems are promising, particularly in the agricultural industry. Water level controllers are necessary in many different places. This project may be made wireless by use an NRF transmitter and receiver. We may also install Ethernet shield so that we can access all the information utilizing mobile phones and regulate it properly.

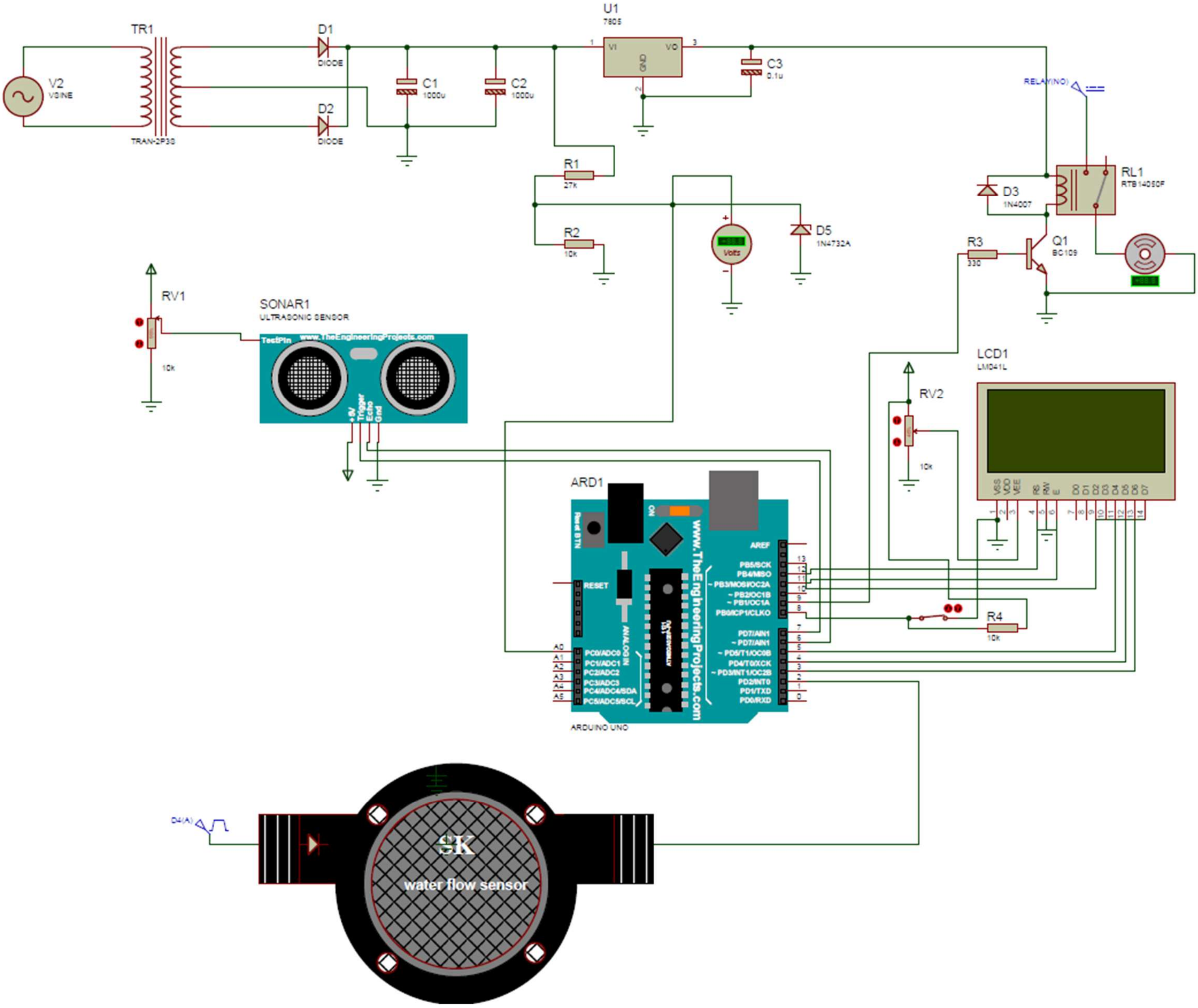
COMPONENTS REQUIRED

1. Arduino Uno
2. Ultrasonic Sensor
3. Flow Sensor
4. 16 x 2 LCD
5. DC Motor
6. Center Tapped Transformer
7. 7805 Regulator
8. Sine Wave AC Voltage Source
9. Relay
10. Transistor
11. Zener Diode
12. Resistors- 330 Ω, 10 k Ω, 27 k Ω
13. Capacitors- 1000uF, 0.1uF
14. Diodes
15. Potentiometer
16. Voltmeter
17. DC generator
18. Switch

BLOCK DIAGRAM

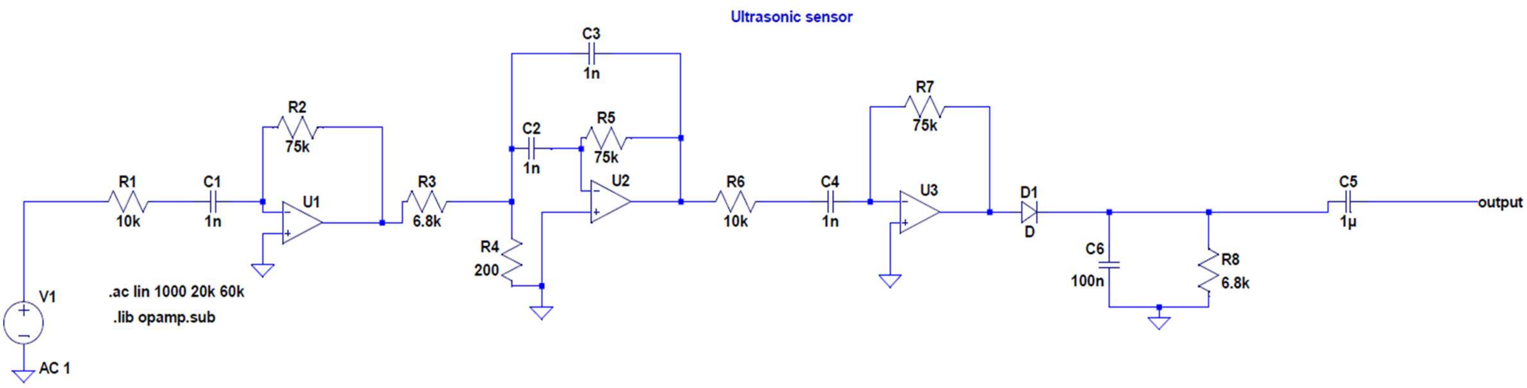


CIRCUIT DIAGRAM

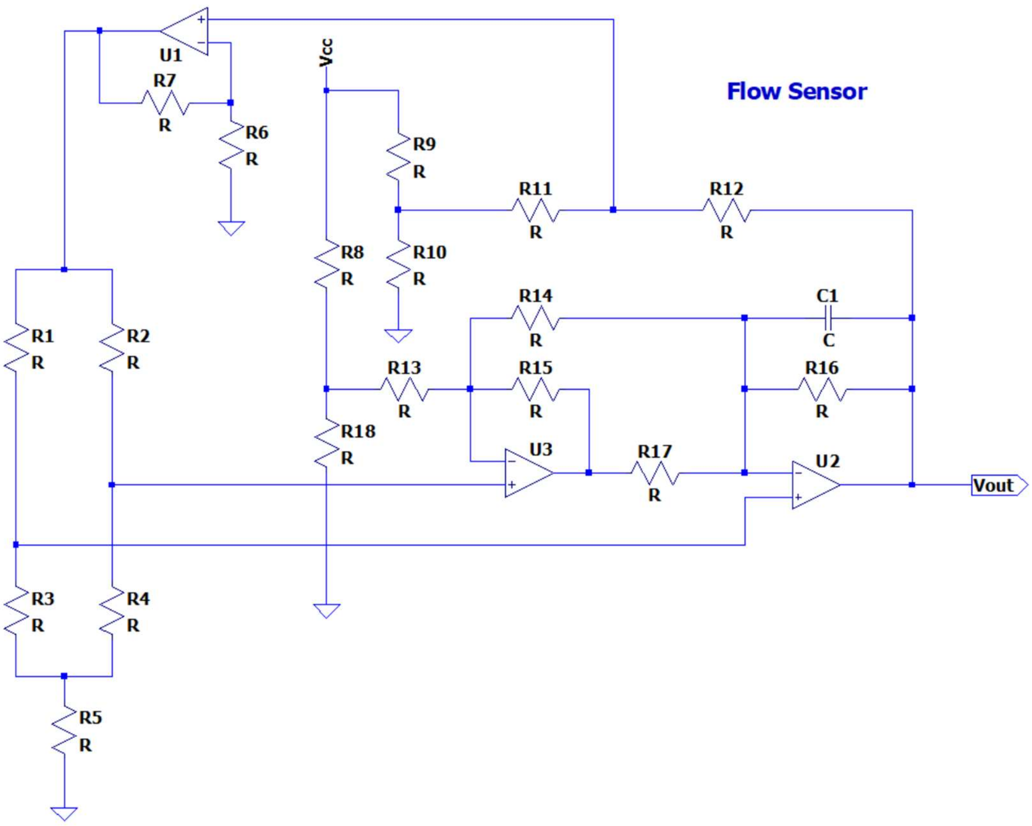


Internal Circuit Diagram of the Sensors:

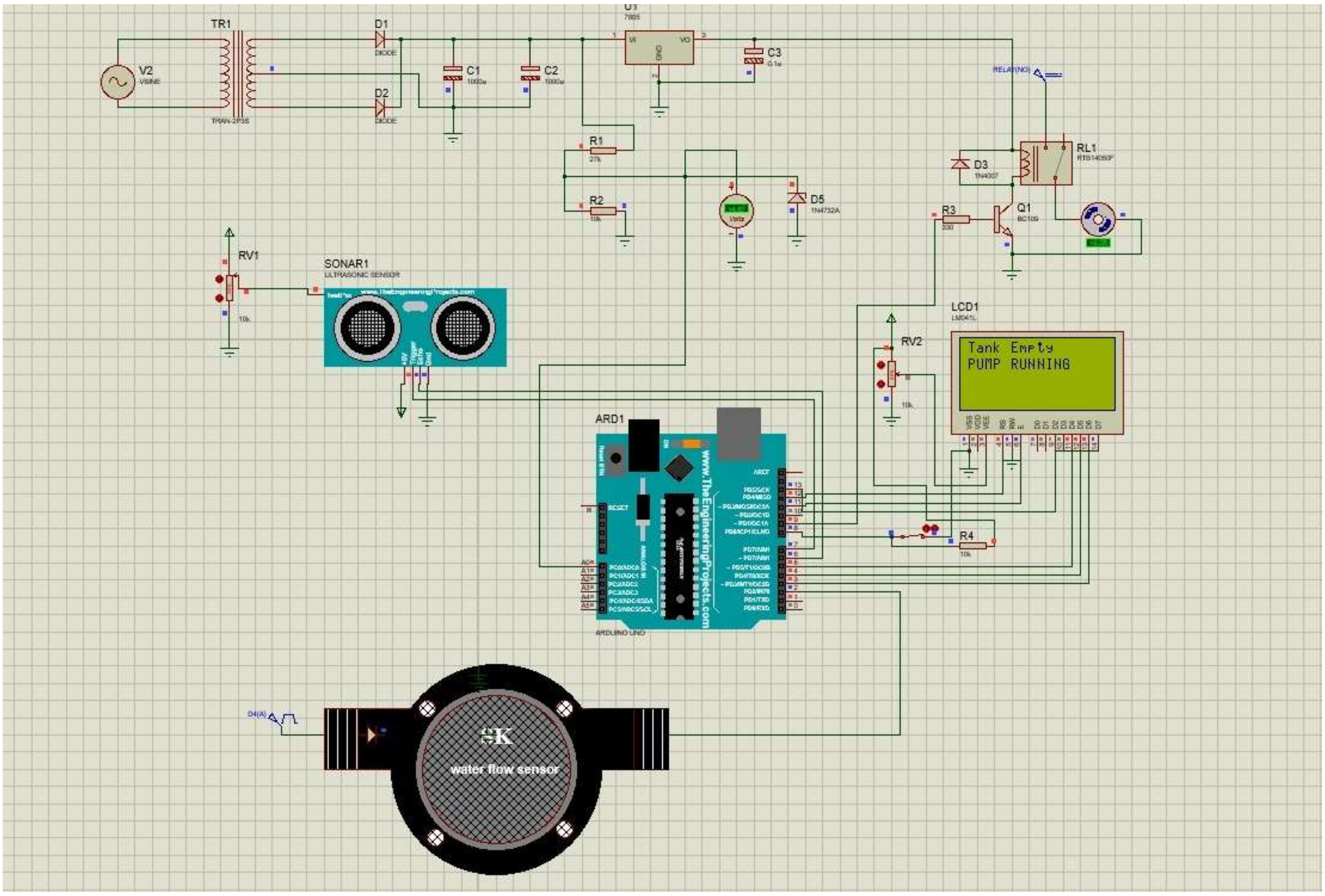
Ultrasonic Sensor:



Flow sensor:



SIMULATION DIAGRAM



APPENDIX

```
#include<LiquidCrystal.h>

LiquidCrystal lcd(12, 11, 5, 4, 3, 13);

const int pingPin = 7;
const int echoPin = 6;
const int relayPin = 9;
const int sumpPin = 8;
const int voltagePin = A0;
long int Htime;
long int Ltime;
float Ttime;
float frequency;
int sumppin =0;


void setup() {
  pinMode(relayPin, OUTPUT);
  pinMode(pingPin, OUTPUT);
  pinMode(sumpPin, INPUT);
  pinMode(voltagePin, INPUT);
  pinMode(echoPin, INPUT);
  pinMode(2,INPUT);
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.setCursor(3,0);
  lcd.print("AUTOMATIC");
  delay(500);
  lcd.setCursor(2,1);
```

```
  lcd.print("WATER LEVEL");
  delay(500);
  lcd.clear();
  lcd.setCursor(3,0);
  lcd.print("CONTROLLER");
  delay(1000);
  lcd.clear();
}

void loop() {
  long duration, inches, cm;
  int tanklevel = 0;
  float inputvoltage;
    lcd.clear();

  lcd.setCursor(0,0);
  lcd.print("sump level");
  Htime=pulseIn(2,HIGH);
  Ltime=pulseIn(2,LOW);
  Ttime = Htime+Ltime;
  frequency=1000000/Ttime;
  lcd.setCursor(0,1);
  if(frequency<50)
  {
        sumppin=0;
  }
  else
  {
        sumppin=1;
  }
```

```
lcd.print(frequency);

delay(1000);
lcd.clear();
digitalWrite(pingPin, LOW);
delayMicroseconds(2);
digitalWrite(pingPin, HIGH);
delayMicroseconds(10);
digitalWrite(pingPin, LOW);
duration = pulseIn(echoPin, HIGH);
cm = microsecondsToCentimeters(duration);
lcd.setCursor(0,0);
lcd.print("Tank Empty");

if(cm > 1000) {
  lcd.clear();
  lcd.setCursor(0,0);
  lcd.print("Tank Empty");
  if(sumppin== 1)
  {
     inputvoltage = ReadVoltage();
     if(inputvoltage < 3.75)
     {
       digitalWrite(relayPin, LOW);
       lcd.setCursor(0,1);
       lcd.print("V < 200 PUMP OFF");
     }
     else if(inputvoltage > 4.75)
     {
       digitalWrite(relayPin, LOW);
       lcd.setCursor(0,1);
```

```
          lcd.print("V > 250 PUMP OFF");
        }
        else {
          digitalWrite(relayPin, HIGH);
          lcd.setCursor(0,1);
          lcd.print("PUMP RUNNING");
        }
    }
    else {
          lcd.setCursor(0,1);
          lcd.print("SUMP TANK EMPTY");
    }
}
else if(cm < 10) {
    digitalWrite(relayPin, LOW);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("Tank Full");
    lcd.setCursor(0,1);
    lcd.print("PUMP OFF");
}
else {
    tanklevel = 100-(cm*100/990);
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print("Tank Level");
    lcd.setCursor(2,1);
    lcd.print(tanklevel);
    lcd.print(" %");
}
```

```
 delay(1000);
}

long microsecondsToInches(long microseconds) {
   return microseconds / 74 / 2;
}

long microsecondsToCentimeters(long microseconds) {
   return microseconds / 29 / 2;
}

float ReadVoltage() {
  int adcval;
  float voltage;
  adcval = analogRead(voltagePin);
  voltage =  adcval * (5.0 / 1023.0);
  return voltage;
}
```

WORKING OF THE SYSTEM

Major building blocks of the Automatic Water Level Controller system are the following:

- Arduino Uno board
- Overhead tank sensor (Ultrasonic sensor)
- Sump tank sensor (Flow sensor)
- Water Pump
- Relay circuit for pump control
- Overvoltage/Undervoltage detector
- LCD screen for displaying the status
- Power supply

THE POWER SUPPLY BLOCK

The Arduino board, sensors, and relay require +5V to operate, which is produced by the power supply block. A 230/12V center-tapped step-down transformer that produces 12V AC output is connected to the mains supply. This is rectified by diodes D1 and D2 and the DC output produced by the diodes are smoothened by the capacitors C1 and C2. The 7805 regulator IC receives it and generates a controlled DC output of +5V. Capacitor C3 is used to filter high frequency noise from the DC output.

OVERVOLTAGE/ UNDERVOLTAGE DETECTOR

To provide the sense voltage needed to identify an overvoltage or undervoltage condition, a resistive divider made up of R1 and R2 is utilized. The recommended operating range for the pump is 200V to 250V AC. The Arduino's A0 analog input pin reads a voltage from the sense circuit that ranges from 3.75V to 4.75V. A0 pin on an Arduino can only receive a maximum input voltage of 5V. However, a voltage in the mains above 280V can yield more than 5V in the A0 pin. A Zener Diode with a 4.7V rating is connected in parallel to R3 to prevent this situation. The voltage will be clamped at 4.7V, which is a safer level.

ULTRASONIC SENSOR

Ultrasonic sensor is mounted on top of the overhead tank to detect the water level in the tank. This sensor has 2 pins, the Trigger Pin and the Echo Pin. They are connected to the Arduino digital pins 7 and 6 respectively. Pin 7 is configured as an output and Pin 6 as an input. Arduino applies a short LOW-HIGH-LOW pulse to the trigger pin. When this pulse is applied, ultrasonic sensor transmits an ultrasonic wave pulse into the tank. This pulse gets reflected by the water in the tank and the reflection creates a LOW-HIGH-LOW pulse in the Echo pin. Arduino reads this Echo pulse through the input pin 6. Time delay between sensing out a pulse on the output and reading a pulse in the input is an indication of water level. When there is more water in the tank, the delay will be less since the distance travelled by the ultrasonic wave is less. On the other hand when the tank is nearly empty, the ultrasound wave will have to travel more distance and the delay read by Arduino will be more. Arduino program calculates the water level based on this.

FLOW SENSOR

The Sump tank sensor is a flow sensor which is connected to the digital pin 2 of the Arduino. The water level in the sump tank is determined by the input frequency of the sensor. If the input frequency is greater than 50Hz then the sumppin is turned 1, which indicates that there is enough water in the sump tank. When the frequency is less than 50Hz, the pin reads a LOW(0), indicating there is insufficient water in the sump tank.

RELAY

Water pump is activated through a relay. Relay's input and output voltage ratings are 12V and 250V, respectively. The relay coil cannot be driven by the Arduino's output due to its limited capacity to source current. Therefore, transistor Q1, which also serves as a switch, is used to operate the relay. The transistor is biased to function between the saturation and cutoff areas using a 330 Ohm resistor that is linked between the base of Q1 and Arduino pin 9. When a HIGH is applied to the pin, transistor switches to the saturation region and current flows through the relay coil. This will latch the relay output coil and the pump will start running. When a DC current is suddenly applied to the relay coil, back emf gets induced in the coil which can damage the transistor. Diode D1 shunts off this back emf and hence protects the transistor.

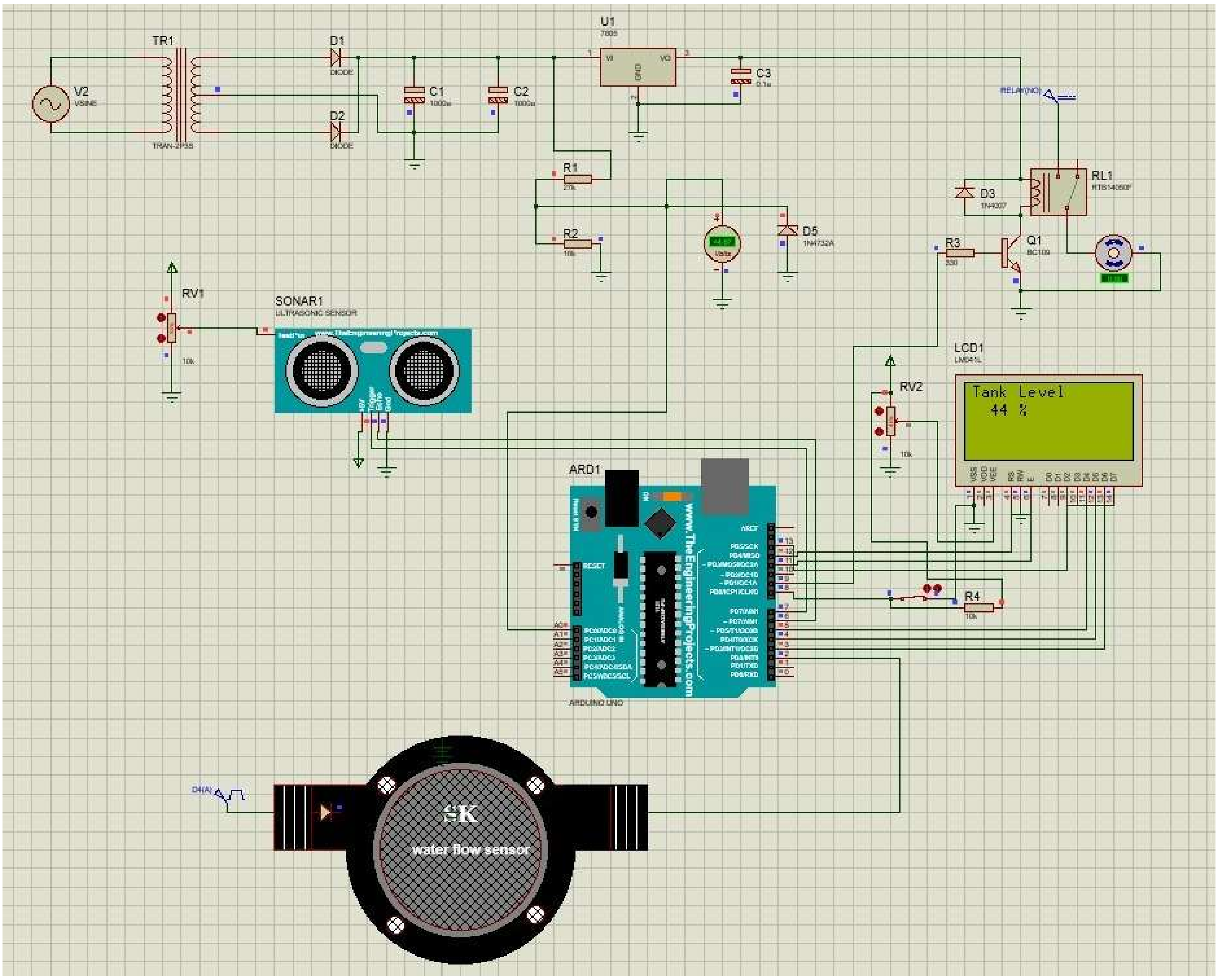
LCD FOR STATUS DISPLAY

To show the status, an Arduino board is attached to a 16X2 character LCD module. The Arduino pins 5, 4, 3, and 13 are linked to the D4, D5, D6, and D7 lines, respectively, and it is set up to use 4 data bits. Pins 12 and 11 are linked to the RS and E control inputs of the LCD, respectively.

The Arduino program continuously measures the tank level and displays it in the LCD. When it detects that the tank level is below a certain threshold value, it checks the sump tank sensor. If it detects that there is enough water in the sump tank, it then reads the voltage through the analog input. If the voltage is in a safe range, it switches on the Pump. When the tank level becomes full, it automatically switches off the Pump. The status is displayed in the LCD screen.

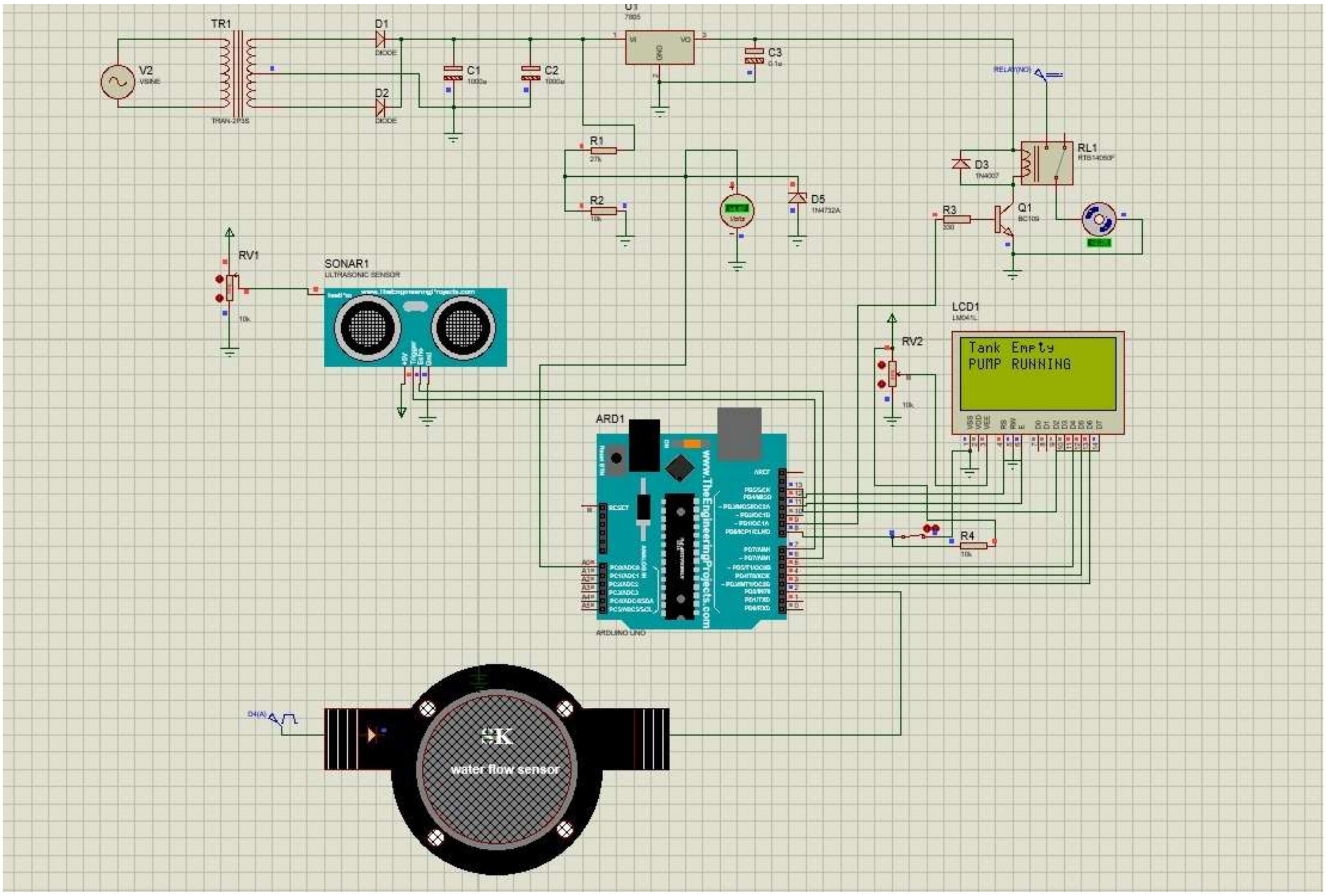
RESULT

The ultrasonic sensor reads the water level in the overhead tank.



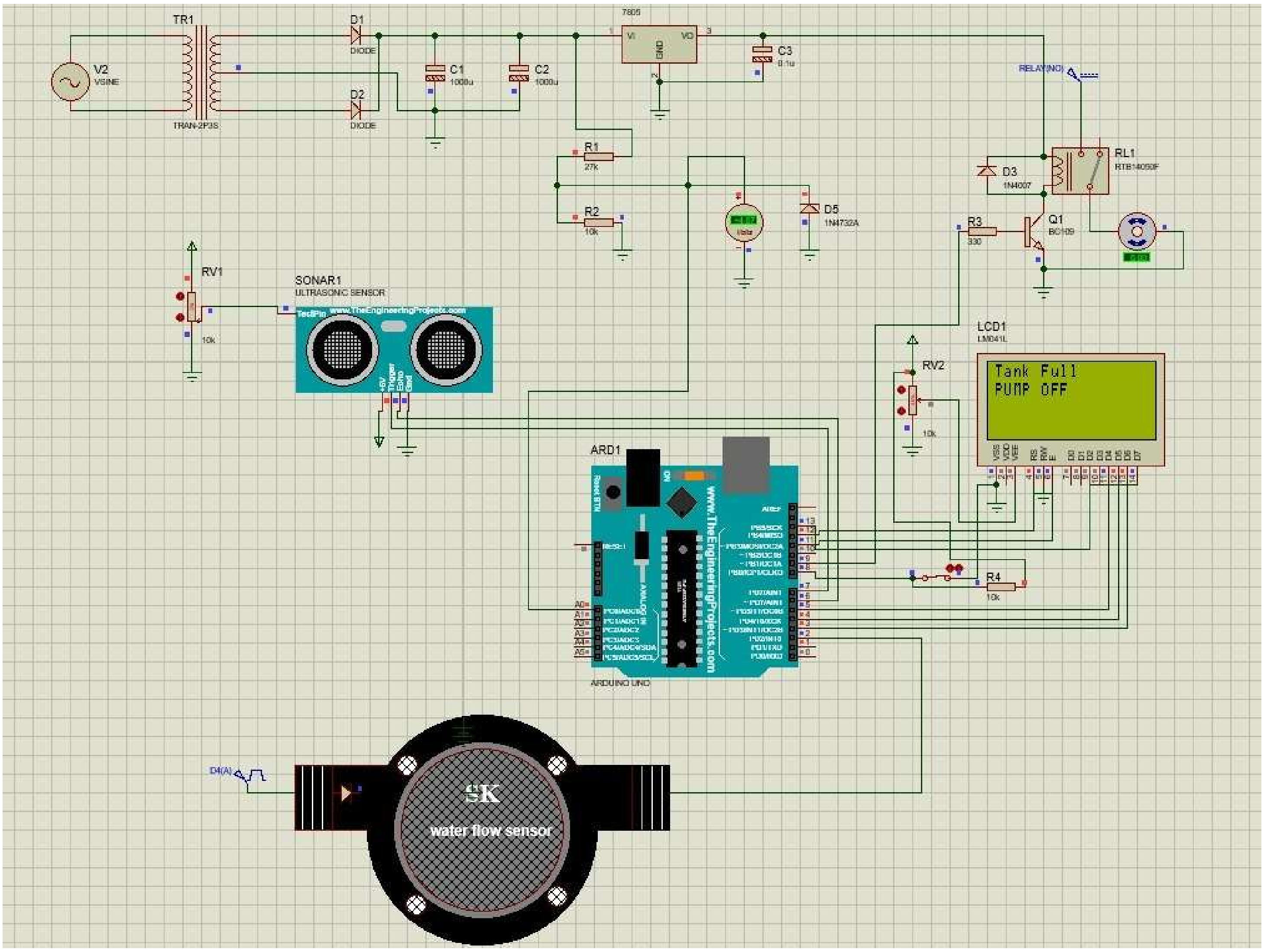
CASE 1:

If the tank is empty, a sufficient amount of water is present in the sump tank and receives a healthy voltage, the motor starts running.



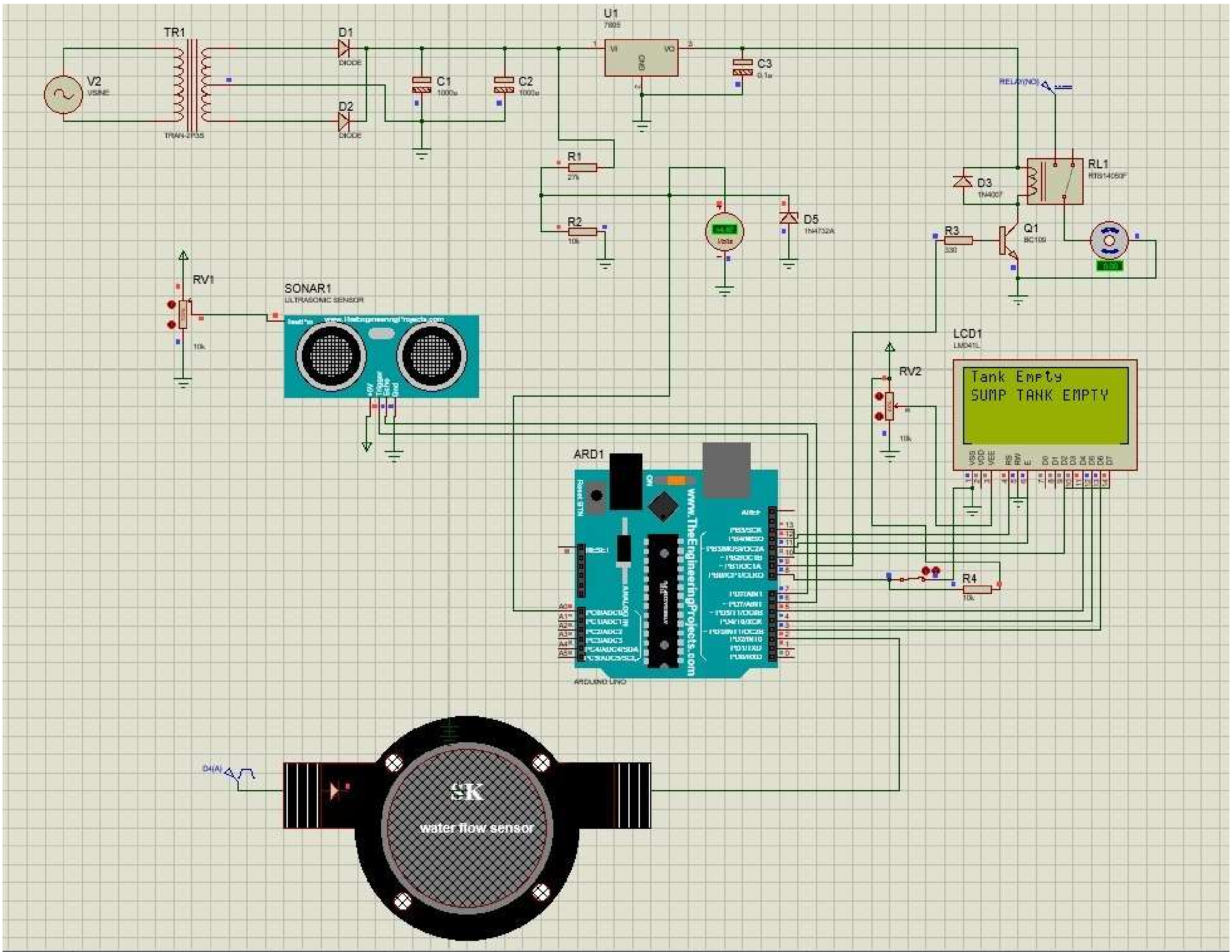
CASE 2:

If the overhead tank is full, the motor stops running.



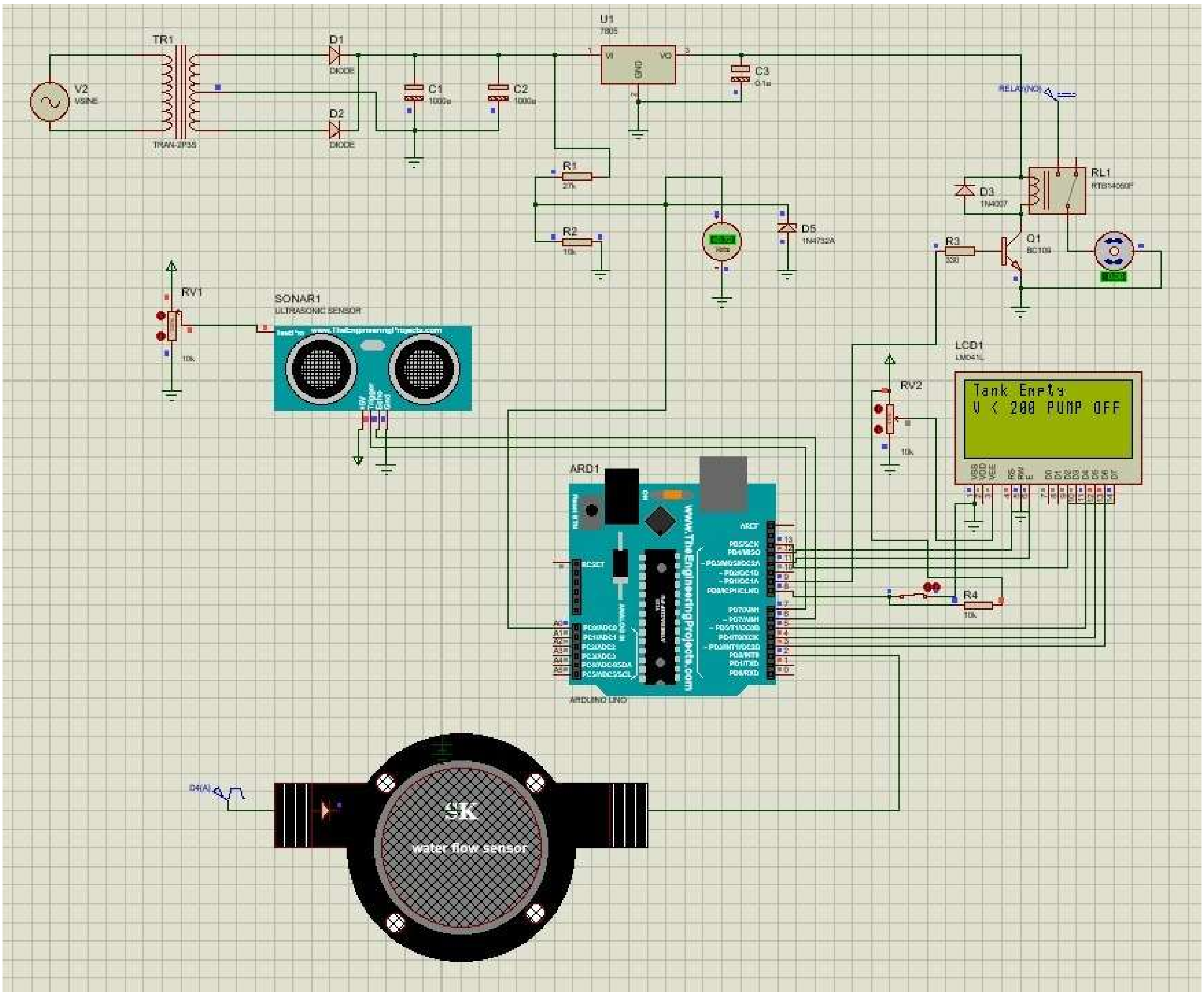
CASE 3:

If the tank is empty and receives a healthy voltage, but sump tank is empty.



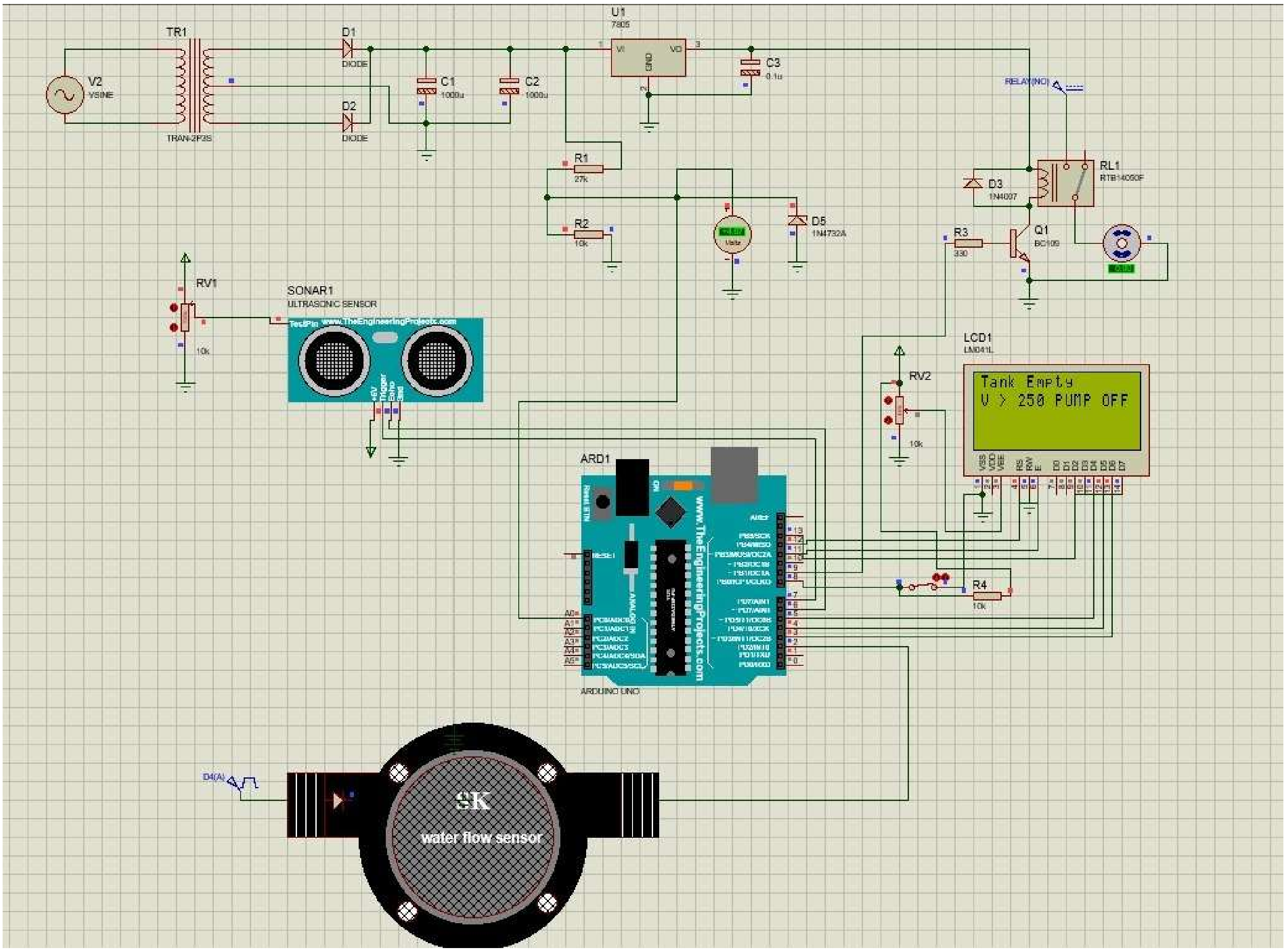
CASE 4:

If the tank is empty, a sufficient amount of water is present in the sump tank but receives a low voltage (under voltage).



CASE 5:

If the tank is empty, a sufficient amount of water is present in the sump tank but receives a very high voltage (over voltage).



CONCLUSION

The primary goals of this project have been met. In cases of undervoltage, overvoltage, or insufficient water in the sump tank, the motor is not activated. Only when the overhead tank is empty, enough water is present in the sump tank, and the motor obtains a safe voltage does it begin to run. Water and electricity can be conserved by controlling the motor's power usage and water loss from unintended overflow. The motor tends to have a longer lifespan and less chances of being damaged because there isn't an excess of voltage supply or consumption.

REFERENCES

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