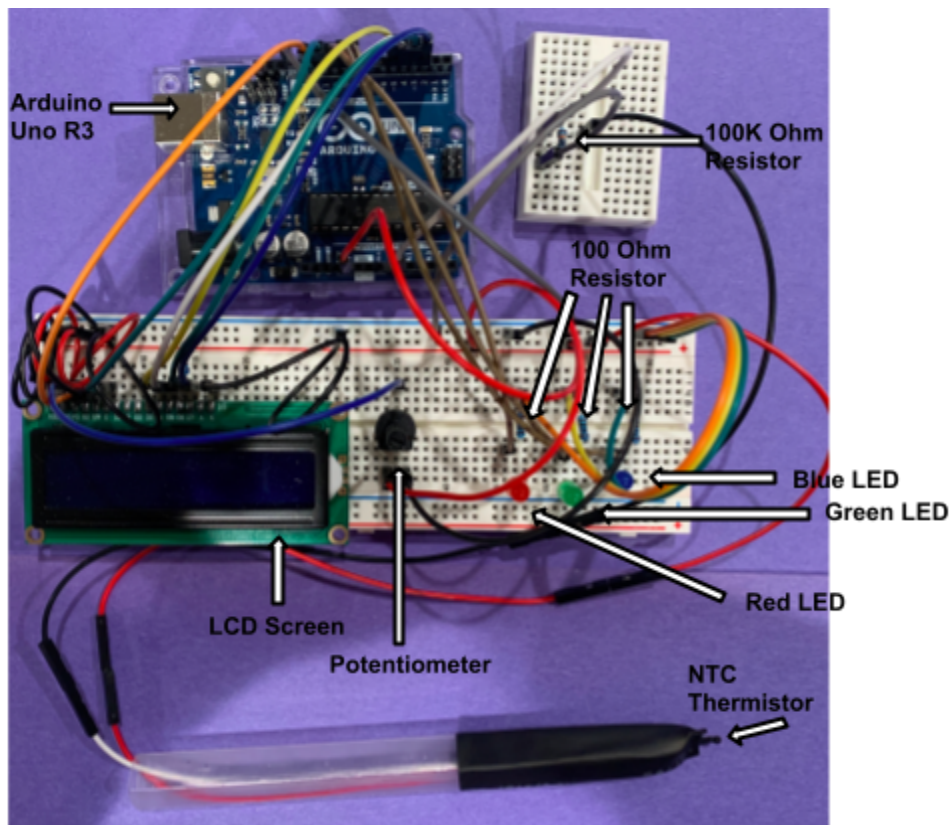


Detector Building Design Log



Device Construction

This device was constructed using an Arduino Uno R3 (an open-source microcontroller board), a LCD screen to display the desired values, a potentiometer which is a variable resistor needed to regulate the power distributed to the LCD screen, a 100K Ohm resistor, three 100 Ohm resistors, three LEDs, and a NTC thermistor. The wiring of the LCD screen was first completed which included the potentiometer. Following such, the three LEDs (green, blue, and red) were each wired to a 100 Ohm resistor, that of which was then connected to the ground, and an analog pin on the Arduino board. Lastly, we wired the NTC thermistor into a voltage divider in which case the NTC was connected to the power supply, an analog pin, and a 100K ohm resistor.

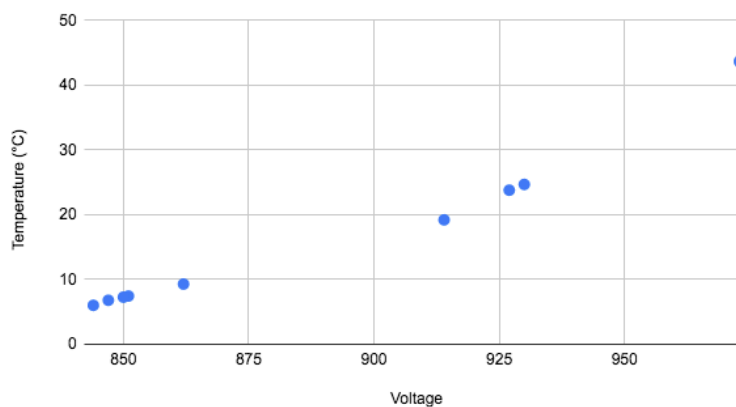
To ensure the device would be capable of detecting the voltage and, therefore, temperature of the water, the wires to the NTC thermistor were extended with additional wires and fed through a long, plastic tube that tapered at the end. Following such, heat shrink was applied to the end of the plastic tube on the side of the thermistor to ensure no water would damage the electrical components.

Device Trials

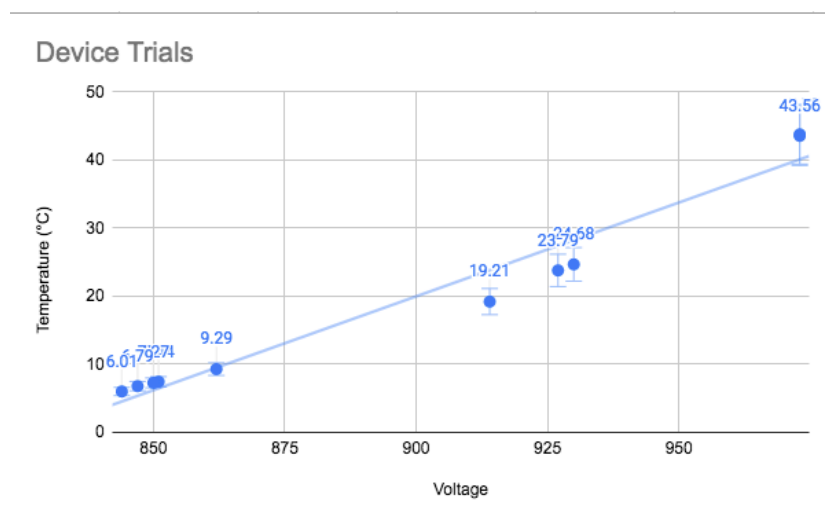
Scatter Graph of Device Trials

Trial	Voltage	Temperature (°C)
1	862	9.29
2	851	7.44
3	850	7.27
4	847	6.79
5	844	6.01
6	973	43.78
7	973	43.56
8	914	19.21
9	930	24.68
10	927	23.79

Device Trials



Function Graph



Equation

$$\text{Temperature (}^{\circ}\text{C)} = (1 / (A + B \log R2 + C*\log R2^3)) - 273$$

$$A = 1.009249522e-03$$

$$B = 2.378405444e-04$$

$$C = 2.0192026973e-07$$

$$R2 = 100000 * (1023.0 / \text{voltage} - 1)$$

Program

```
#include <LiquidCrystal.h>
```

```

int ThermistorPin = A0;
int Vo;
float R1 = 100000; // variable resistor value
float logR2, R2, T;
float A = 1.009249522e-03, B = 2.378405444e-04, C = 2.019202697e-07; // Steinhart-hart coefficients

int Red = 10;
int Green = 9;
int Blue = 8;

LiquidCrystal lcd(12, 11, 5, 4, 3, 2); //pins of LCD

void setup() {
  Serial.begin(9600); // set data rate as 9600 bps
}

void loop() {
  Vo = analogRead(ThermistorPin);
  R2 = R1 * (1023.0 / (float)Vo - 1.0);
  logR2 = log(R2);
  T = (1.0 / (A + B*logR2 + C*logR2*logR2*logR2)); // Steinhart-hart Equation -> T= 1/{A + B[ln(R)] + C[ln(R)^3]}
  T = T - 273; // K to C
  // T = (T * 9.0)/ 5.0 + 32.0; // conversion equation from C to F

  // lcd.setCursor (0,0);
  lcd.print("Temp = "); // display word : Temp
  lcd.print(T); // display value of T
  lcd.print(" C"); // display C for celcius
  // lcd.setCursor(0,1);
  // lcd.print("R = ");
  // lcd.print(R2);

  delay(2000);
  lcd.clear();

  lcd.print ("Volt = ");
  lcd.print (Vo);

  delay (2000);
  lcd.clear();

  if ( T < 0) {
    digitalWrite (Red, HIGH); // if Temp below zero -> Red LED lighted
  } else if ( 0 < T < 20) {
    digitalWrite (Green, HIGH); // if Temp above zero but below 20 C -> Green LED lighted
  } else if ( T > 20) {
    digitalWrite (Blue, HIGH); // if Temp above 20 C -> Blue LED lighted
  }
}

```

}

}