IOT281

Project – Human Detection Probe

Abstract

This goal of this project was to design and create (simulated on Tinkercad) a human detection probe, that will assist in finding people trapped under rubble during disasters. The project contains diagrams of the layout and wiring for the device, along with the necessary code needed to make the device functional.

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Introduction

It is recorded that over 430 000 casualties have resulted from earthquakes during the 21st century. These result mostly from being trapped under collapsed buildings and other debris. Those who survive the initial building collapse can survive up to 72 hours under the rubble before running out of oxygen. To increase the survival rate of those trapped, survivors should be found and rescued in as little time as possible.

There is usually a protocol for finding trapped survivors. The first step usually involves having dogs search for possible survivors. Thereafter the areas underneath the area rubble are check using video cameras and finally the rescue teams themselves verify if there are survivors in the area. This can be a time-consuming process which can cost many their lives. Furthermore, before the rescue team can start following the protocol they need to determine where to search. This means that they need to evaluate where areas are which could have allowed for survivors to be, such as possible air pockets underneath the rubble. By decreasing the number of areas that rescue teams need to search for survivors, the survival rate can be increased. This is where the use of human (motion) detection probes is being implemented (Zhang et al., 2018).

In the following project, a circuit has been created which will detect human motion and alert by creating a buzzing noise as well as flashing a red LED light.

Design in Tinkercad

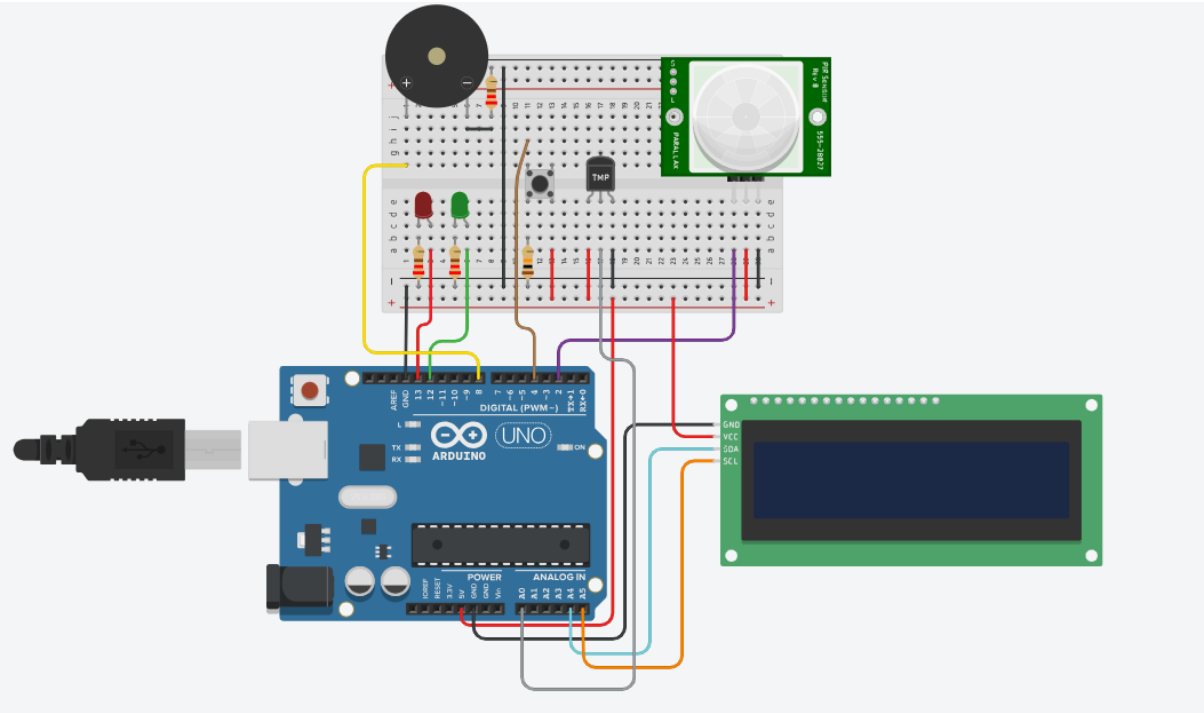

Figure 1 Circuit Design in Tinkercad.

List of Components:

- 1 Piezo Buzzer
- 1 Red LED
- 1 Pushbutton
- 1 Arduino Uno R3 Microcontroller
- 1 PIR Sensor
- 1 32 LCD 16 x 2 (I2C)
- 3 220 Ω Resistors
- 1 Green LED
- 1 10 Ω Resistor
- 1 Temperature Sensor

How the components are connected

The Piezo Buzzer is connected to Digital Pin 8 and then grounded, with a 220 Ohm resistor in the loop.

The two LEDs are connected in the same manner, but in their own independent loop. Both contain a 220 Ohm resistor. The red LED is connected to Digital Pin 13 and the green LED is connected to Digital Pin 12.

The following components receive power from the 5V pin and are also grounded:

- Pushbutton
- Temperature sensor
- PIR sensor
- LCD 16x2 (I2C)

Note that the pushbutton also contains a 10 Ohm resistor.

The pushbutton's terminal "1b" is connected to Digital Pin 4.

The temperature sensors "Vout" terminal is connected to Analogue Pin "A0".

The PIR sensors "signal" terminal is connected to Digital Pin 2.

The LCD screens "SDA" terminal is connected to Analogue Pin "A4" and the "SCL" terminal is connected to Analogue Pin "A5".

Arduino Sketch

```
//Import necessary to use lcd screen

#include <Adafruit_LiquidCrystal.h>

//Initialization of the variable lcd_1 that will

//handle operations of the lcd screen

Adafruit_LiquidCrystal lcd_1(0);


//Initialization of variables that contain

//the “pin” number for each component

const int buzz = 8;

const int pir = 2;

const int redLed = 13;

const int greenLed = 12;

const int button = 4;

int counter = 0;


void setup()

{

 lcd_1.begin(16, 2);

 lcd_1.print("Detecting motion");


 //State whether the component is input or output

 pinMode(buzz, OUTPUT);

 pinMode(pir, INPUT);

 pinMode(redLed, OUTPUT);
```

```
 pinMode(greenLed, OUTPUT);
 pinMode(button, INPUT_PULLUP);
}

void loop()
{
 //Print output in the second line
 lcd_1.setCursor(0, 1);
 //Turn on the green LED and turn of the red LED
 digitalWrite(redLed, LOW);
 digitalWrite(greenLed, HIGH);

 //Convert the voltage reading from the "Temperature sensor"
 //To Celsuis
 int celsius = map(((analogRead(A0) - 20) * 3.04), 0, 1023, -40, 125);

 //Read data from sensor
 int status = digitalRead(pir);

 //Check if the sensor detected any motion
 if(status == HIGH)
 {
  lcd_1.clear(); //Clear screen
        lcd_1.print("Motion Detected!"); //Print out
  tone(buzz, 1000, 1000); //Make bussing sound
```

```
  digitalWrite(redLed, HIGH); //Turn on red LED
  digitalWrite(greenLed, LOW); //Turn off green LED
  delay(3000); //Pause for 3 seconds
  counter += 1; //Count the amount of people found

  lcd_1.clear(); //Clear screen
  lcd_1.print("Detected: "); //Print out
  lcd_1.print(counter); //Print counter
  lcd_1.setCursor(0, 1); //Move cursor to second line
  lcd_1.print("Temp: "); //Print out
  lcd_1.print(celsius); //Print Celsius
  lcd_1.print(" C"); //Print out
  delay(2000); //Pause for 2 seconds
  lcd_1.clear(); //Clear screen
  lcd_1.print("Press button to");//Print out
  lcd_1.setCursor(0, 1); //Move cursor to second line
  lcd_1.print("reset.");//Print out
  delay(2000); //Pause for 2 seconds

  while (digitalRead(button) == LOW)
  {
   //Wait for button to be clicked
   //Nothing will happen until button is pressed
  }
```

```
  digitalWrite(redLed, LOW); //Turn off red LED
  digitalWrite(greenLed, HIGH); //Turn on green LED
  lcd_1.clear(); //Clear screen
  lcd_1.print("Detecting motion"); //Print out
 }
 else
 {
  lcd_1.print("Clear..."); //Print out
 }
}
```

Circuit Schematics

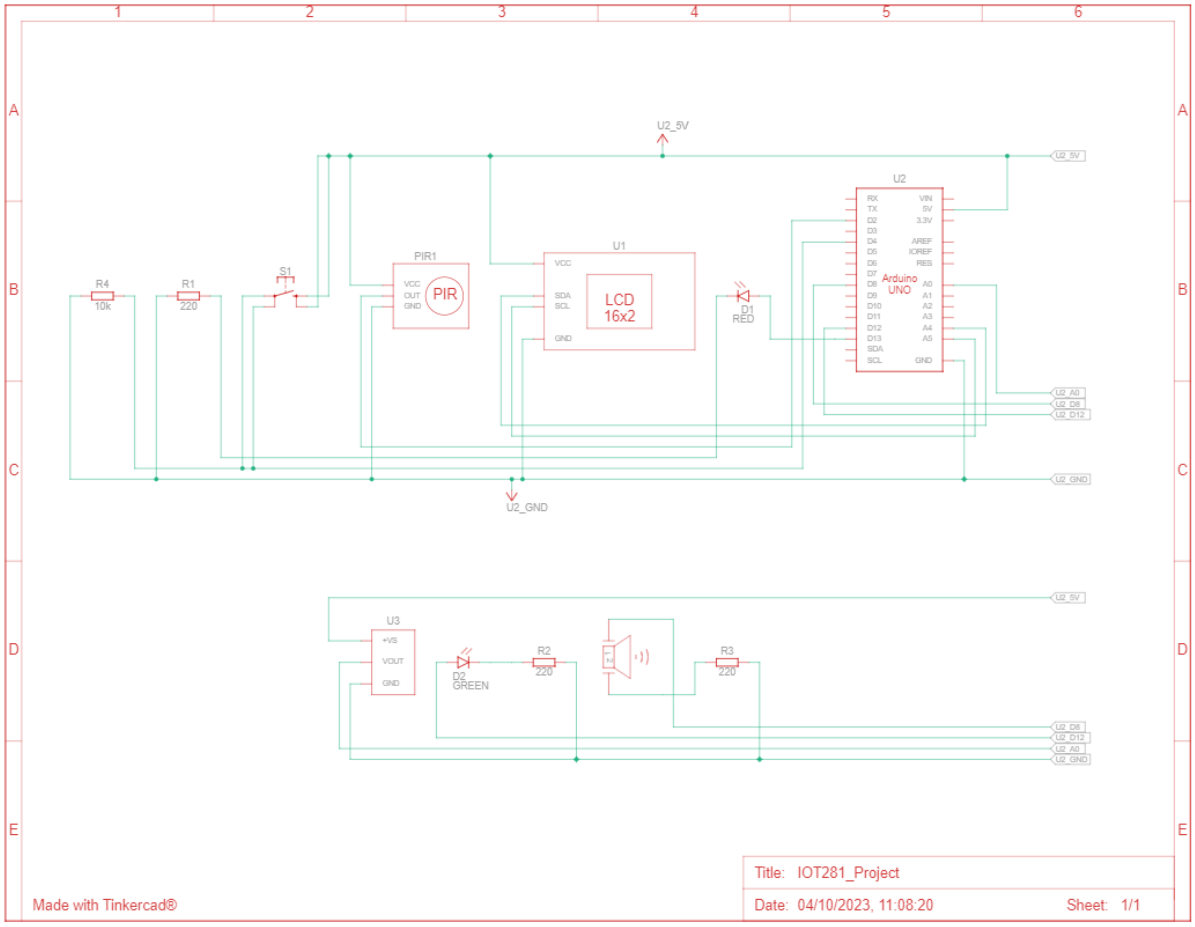

Figure 2 Circuit Schematic for Human Detection Circuit.

How it works

When the circuit is first started, the LCD screen displays that it is busy detecting motion. It also displays that so far; the area is clear. At that time, the green LED will also be lit up. Refer to Figure 3 below:

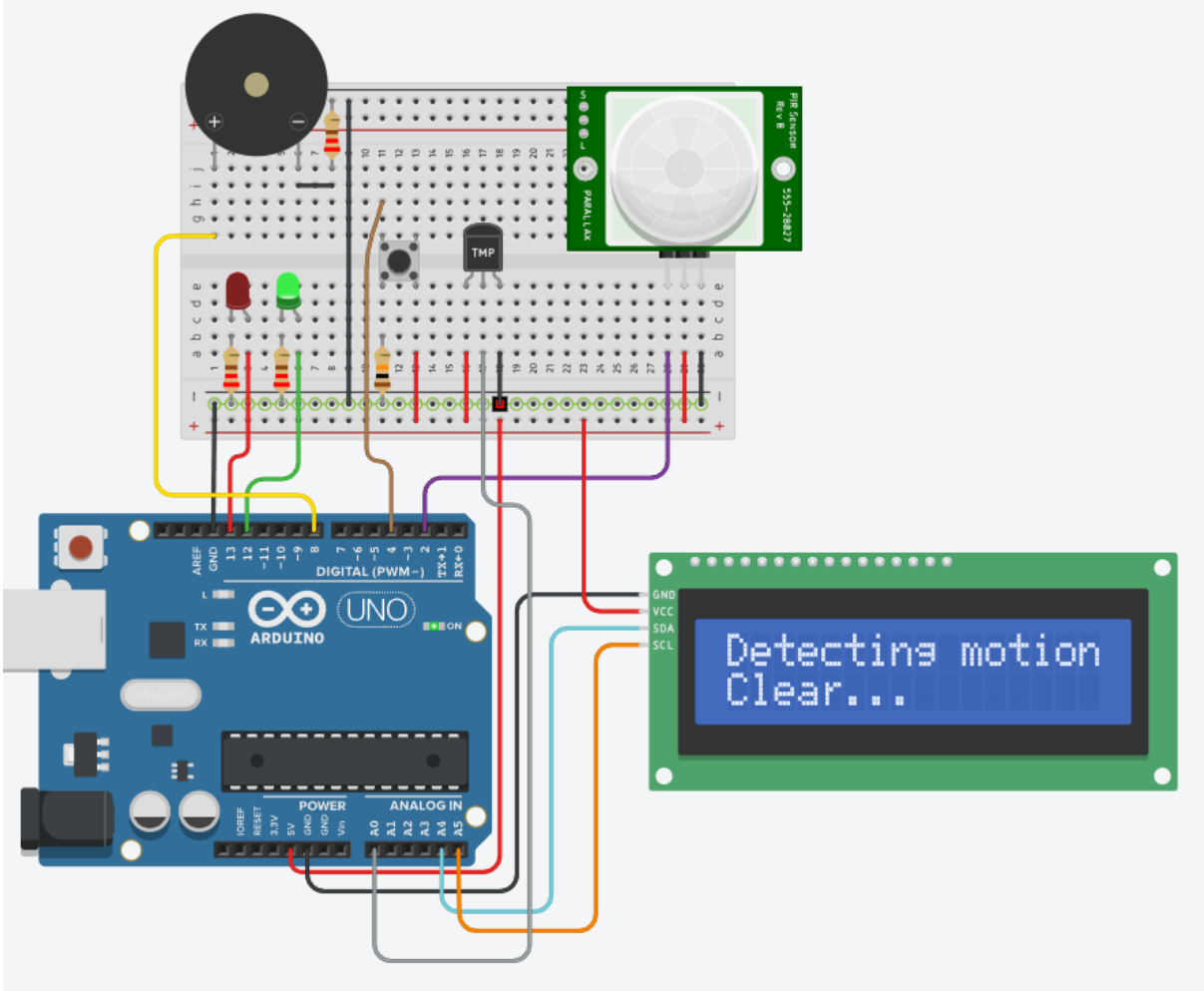

Figure 3 Output while searching for motion.

The PIR Sensor detects the motion made by the trapped survivors. When motion is detected by the PIR sensor, the Piezo buzzer will emit a buzzing sound at 1000hz. Furthermore, the green LED will turn off and the red LED will turn on. The LCD screen will also display that motion has been detected. Refer to Figure 4 below:

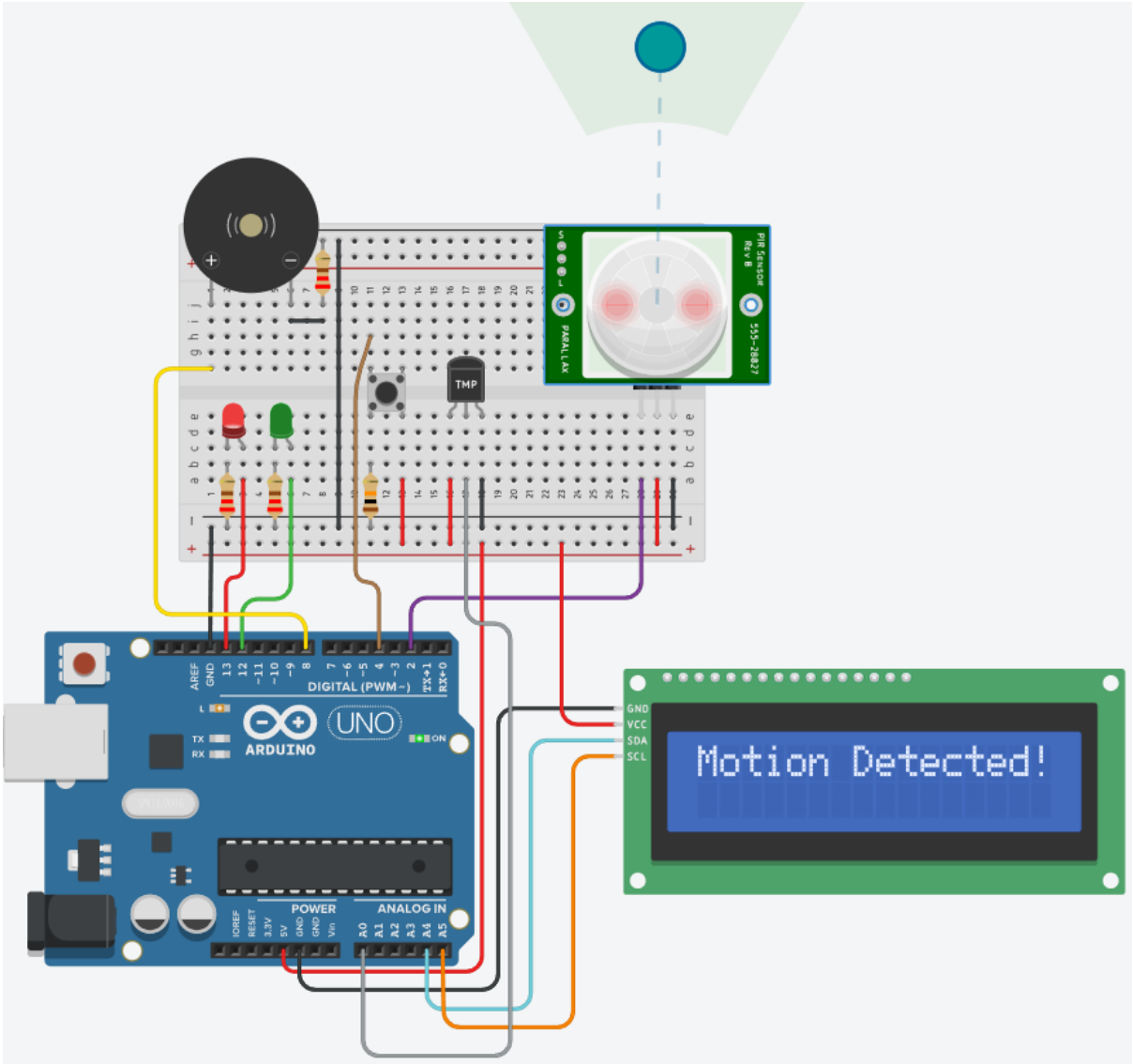

Figure 4 Output changes when motion is detected by the PIR Sensor.

A count will be displayed which will show how many times motion has been detected. Additionally, the temperature sensor will measure the temperature in the area and that temperature will be displayed on the LCD screen as well. Refer to Figure 5 below:

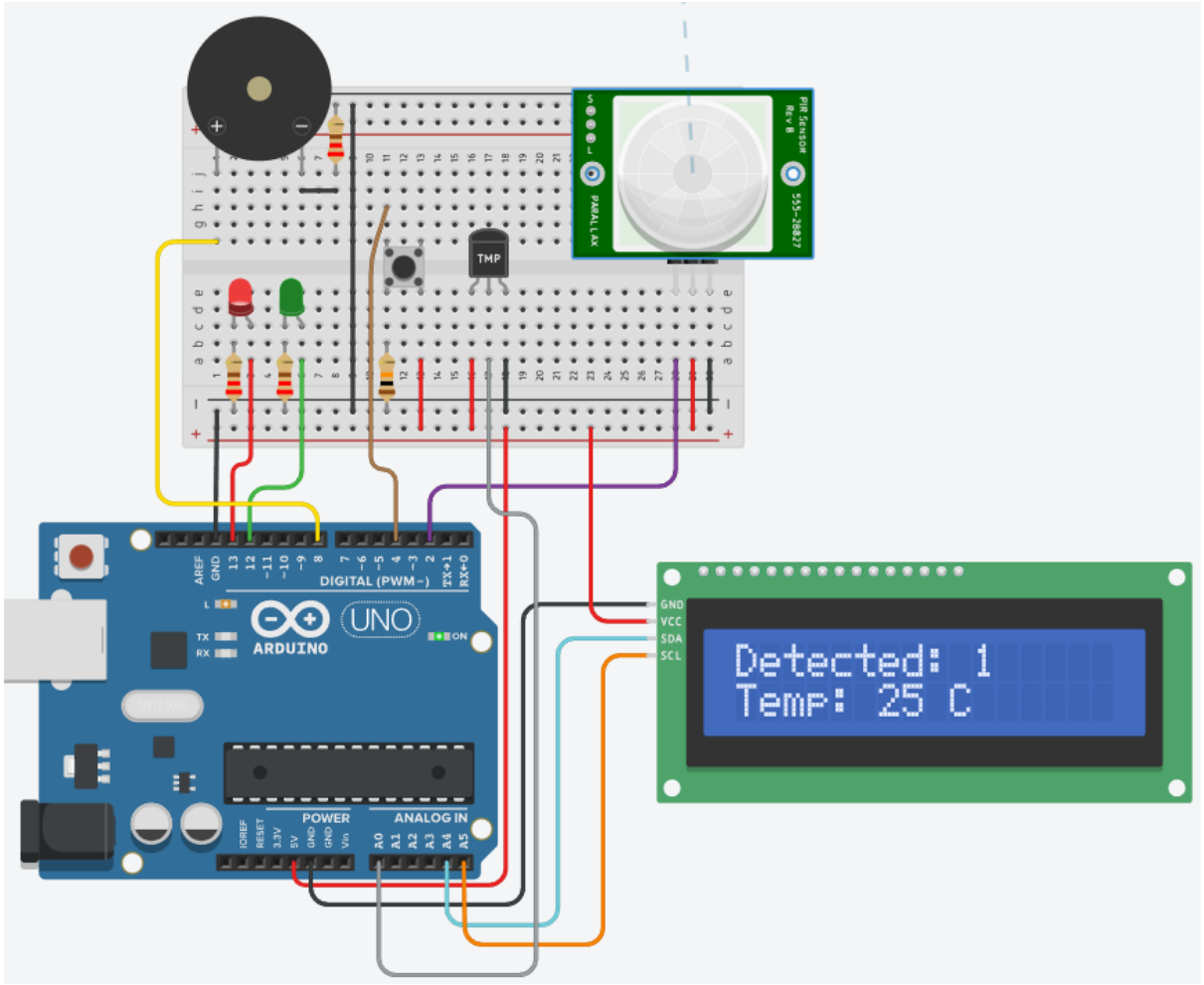

Figure 5 Number of motions detected and Temperature display.

Users will be prompted to press the button to reset the system. Refer to Figure 6 below:

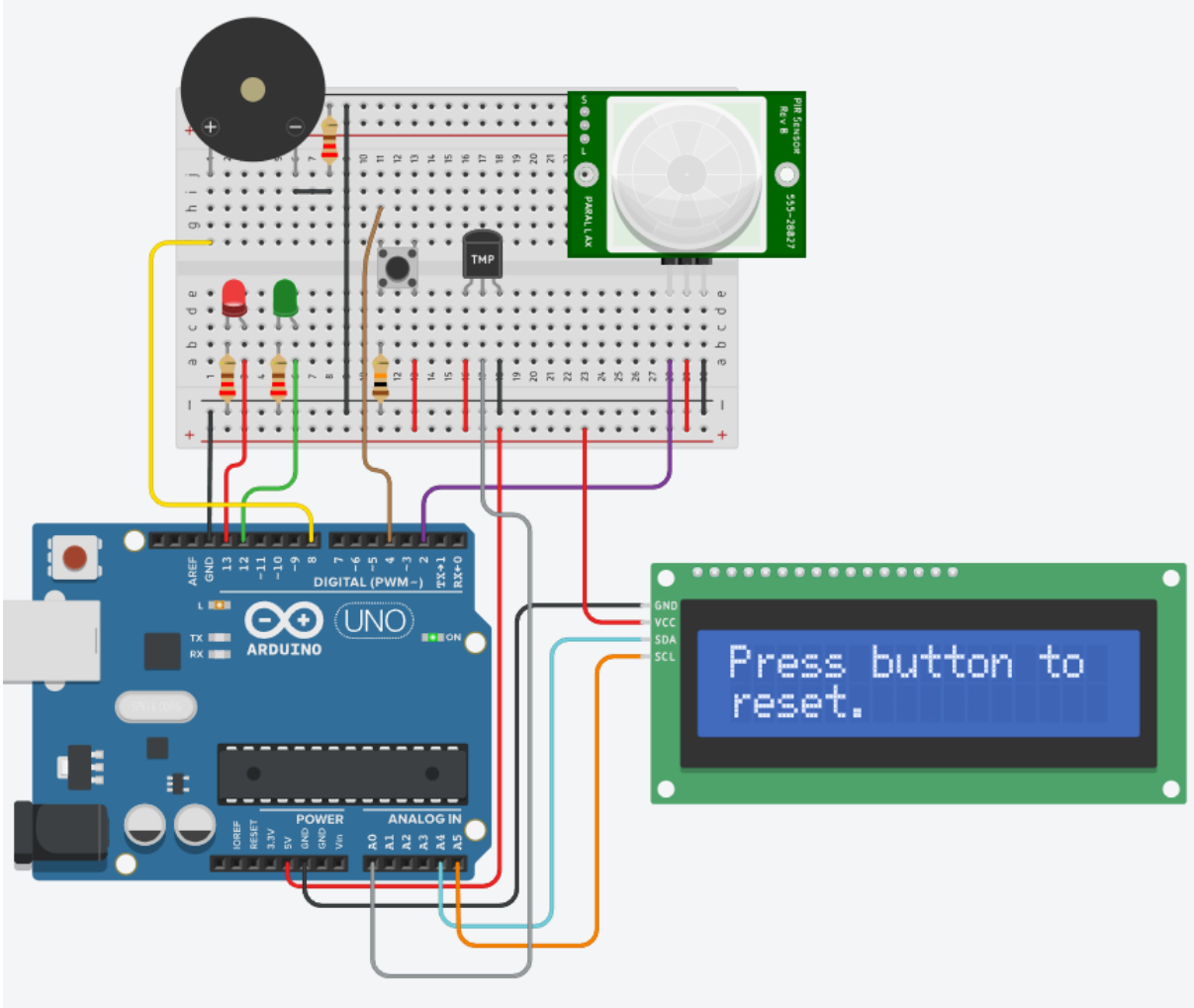

Figure 6 Users prompted to press button.

After pressing the button, the system will return to its original state. The red LED will turn off, the green LED will turn on and LCD screen will clear and output that the motion sensor is searching for motion again.

This process will be repeated with the number of motions detected increasing by 1 each time motion is detected (the system is run).

Link for the Tinkercad project:

https://www.tinkercad.com/things/0q2k0hDbeDg-iot281-project/editel?sharecode=K_uG__tDKLtHxrqvyWlufFtdI2MtvYEnKgj08fCXZLc

Additional capabilities to expand to market.

The first additional capability that was added to the circuit was the temperature sensor. The temperature system will measure the temperature of the area in which it is operating. This temperature will inform rescue teams about the conditions where the sensor is picking up motion. If the sensor picks up extreme temperatures in the areas where movements have been found, it may be a useful tool for determining what areas need to be searched first due to problems such as possible fires breaking out in the areas where survivors are stuck.

Furthermore, the motion sensors cannot function over and under certain temperature thresholds, so the temperature sensor will allow for rescue teams to know which areas to avoid going with the monitors to prevent serious damage to the motion sensors.

Conclusion

In conclusion, the use of human-detection probes can decrease the number of fatalities that occur after earthquakes. In this project, the use of motion sensors and buzzers have been successfully implemented to create a simple version of these human detection probes which can search for survivors trapped under debris. Additional sensors, such as the temperature sensor, were also added to allow for the circuit to be more market ready. Overall, the circuit is easy to use and should be easy to expand if others wish to do so in the future.

Bibliography

Zhang, D., Sessa, S., Kasai, R., Cosentino, S., Giacomo, C., Mochida, Y., Yamada, H., Guarnieri, M. and Takanishi, A. (2018). Evaluation of a Sensor System for Detecting Humans Trapped under Rubble: A Pilot Study. *Sensors (Basel, Switzerland)*, [online] 18(3). doi:https://doi.org/10.3390/s18030852.