**Deliverable F: Prototype I and Customer Feedback**

November 4th, 2021

Group 18: Calum Avon, Poula Rezkalla, and Ashley Larocque

*Abstract*

*The purpose of this deliverable is to document the first stage of prototyping, to allow for the planning and testing of future prototypes. This includes detailed images of the prototype, documenting the prototyping test plan, analyzing the results obtained from testing the prototype, and identifying stopping criteria. Customer feedback will be gathered and considered to update the detailed design and target specifications for future prototypes.*

[**Objectives**](#_8rwrc6ouf1) **4**

[**Prototype I: Detailed Images**](#_gsixz2cevl1) **4**

[**Prototype I - Testing**](#_2z1gm5wcwja0) **7**

[Temperature Sensor Testing](#_3n7cmclklhx3) 7

[Accelerometer Testing](#_onal5ckx4ih0) 9

[Motion Sensor Testing](#_vy8ax2mhi4rr) 11

[Carbon Monoxide Sensor Testing](#_oxnso56wkge9) 13

[Speaker Testing](#_pywfm3tgn9y9) 14

[**Customer Feedback**](#_grbpeuwkfkm9) **15**

[Connectivity Testing](#_ntci0t19y99b) 15

[Carbon Monoxide sensor testing](#_w09k0n65j2a4) 15

[Installation Testing](#_ssp3k8br11ta) 15

[Sensors in Union](#_i4fpqp3xrvru) 15

[**Updated Bills of Materials**](#_87916h4o6458) **16**

[**Prototype II - Test Plan**](#_rsl4ncyw2x3m) **16**

[Objective:](#_wielw6ri7yq6) 16

[Procedure:](#_w71mjf2ykk10) 17

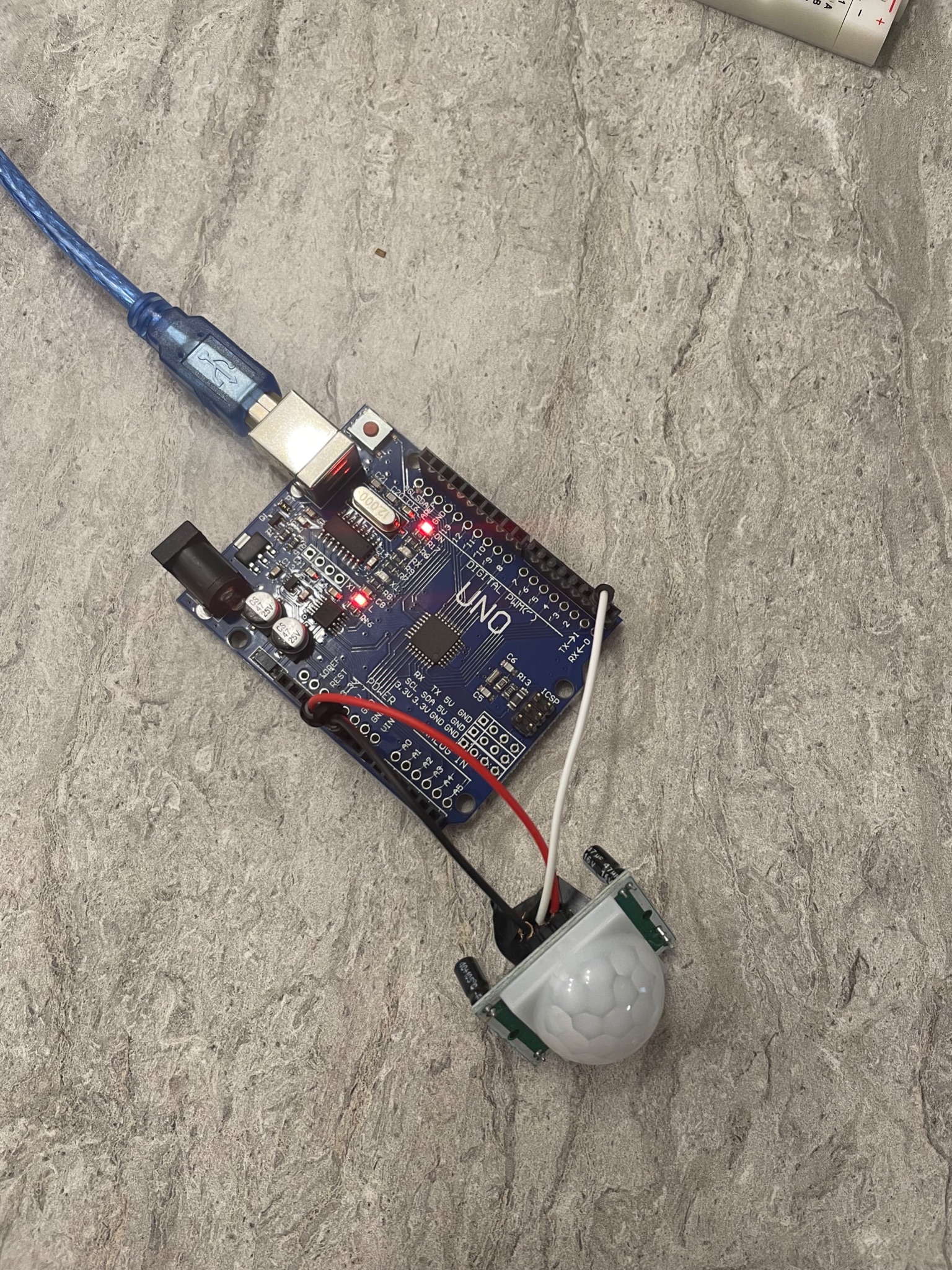
[Stopping Criteria:](#_z7bz0nj7z4ru) 17

[**Conclusion**](#_d1wdnl173vab) **17**

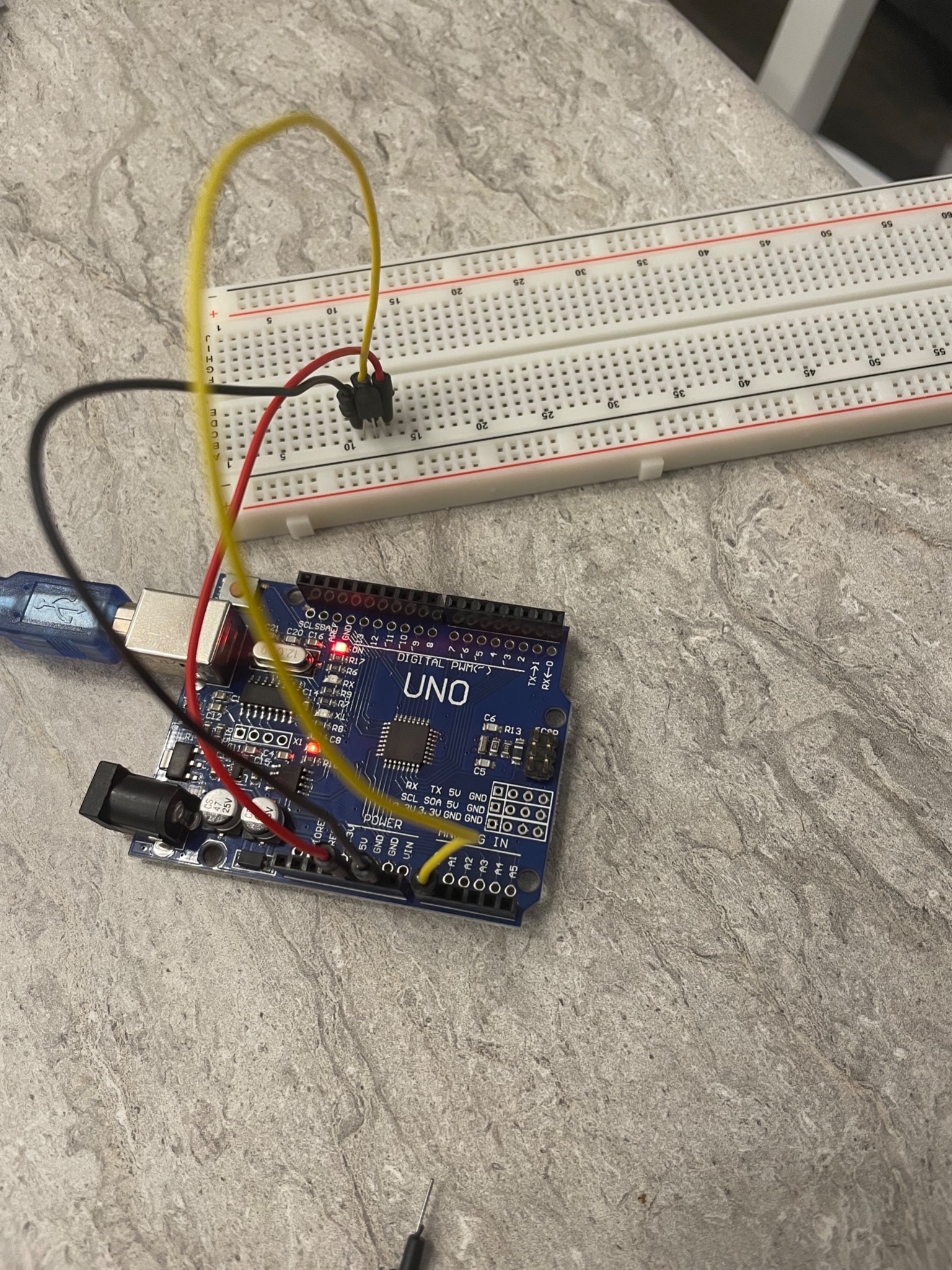
# Objectives

For today’s test, we will be conducting some simulations and analyses to see how our product will respond to the amount of CO gas present in a room of 21.5 degrees celsius and outside in a temperature of 7 degrees celsius. Also, we will be testing the efficacy of our motion sensor.

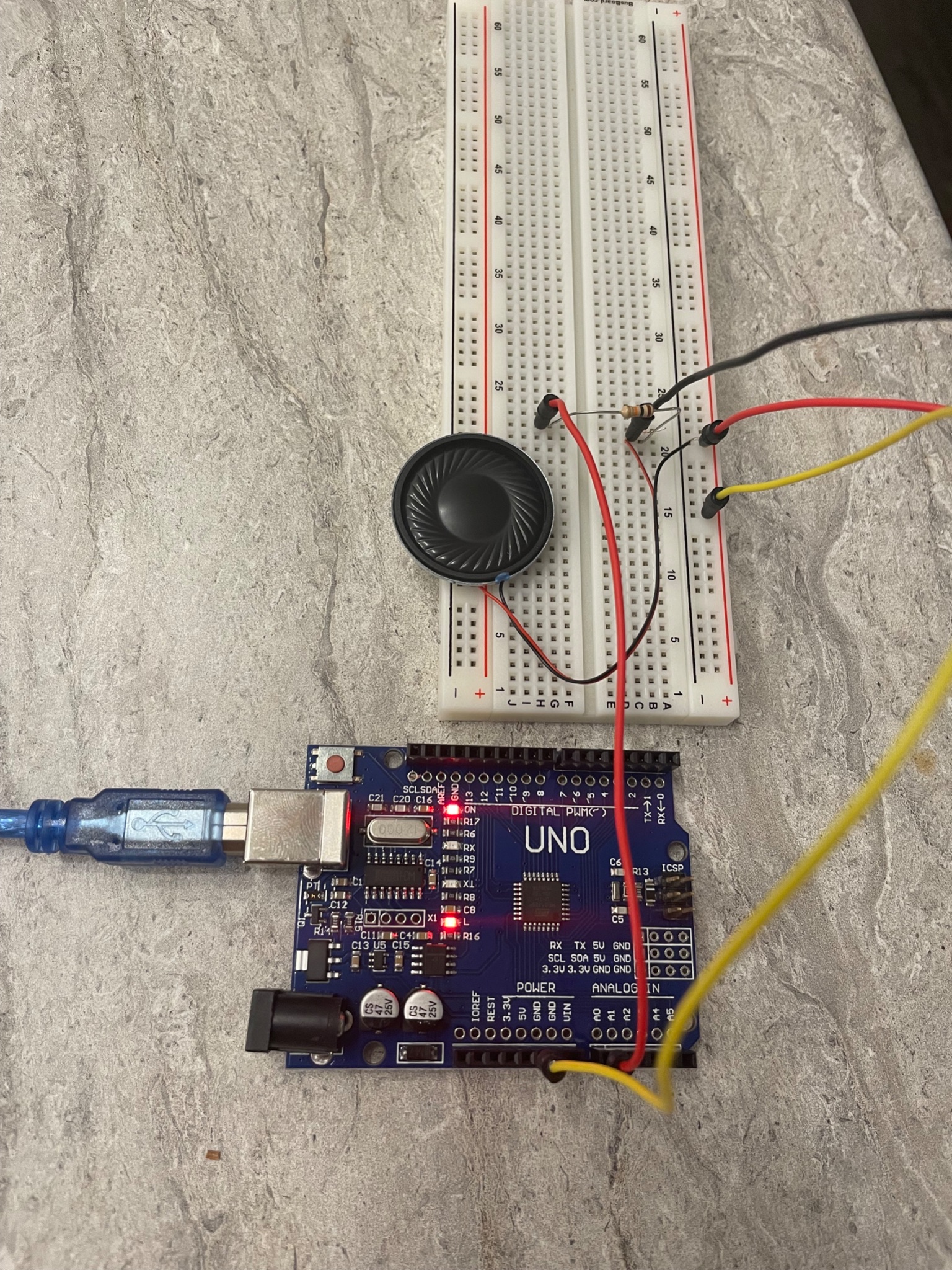
# Prototype I: Detailed Images



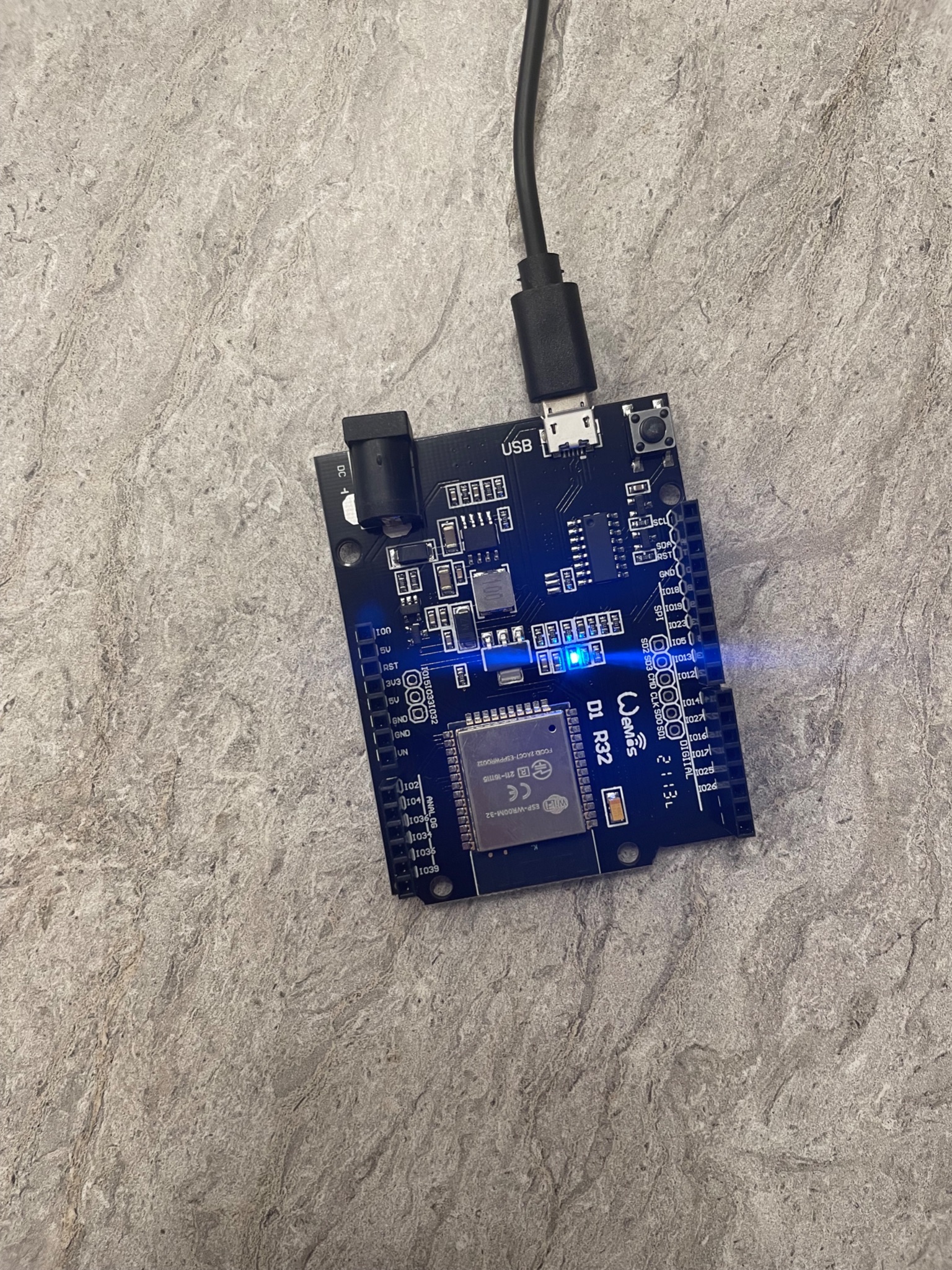
*Figure 1: PIR motion sensor and the Arduino*



*Figure 2: Temperature sensor and the Arduino circuit*

**

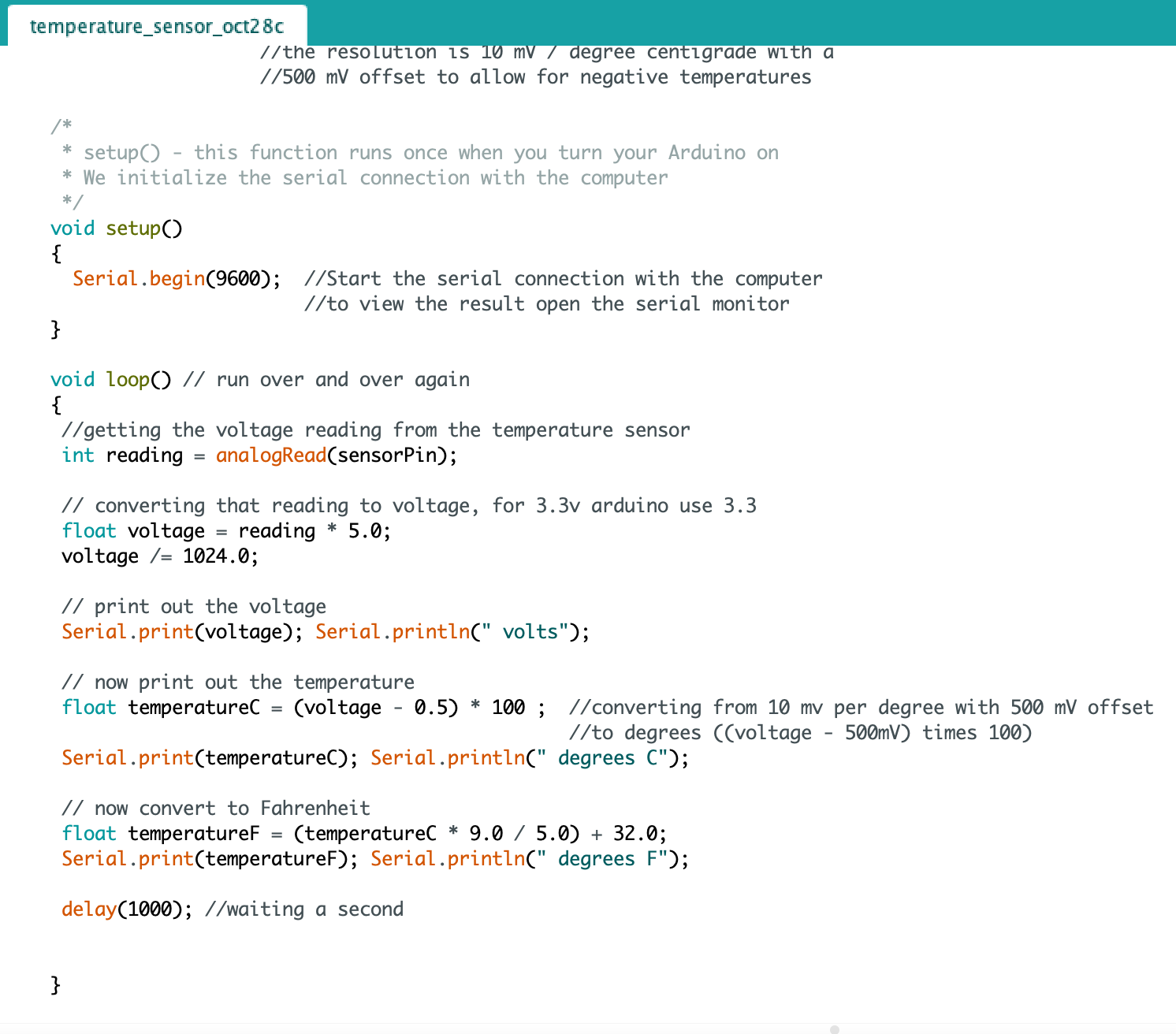
*Figure 3: Speakers and the Arduino circuit*

**

*Figure 4: ESP32 BLE*

# Prototype I - Testing

## Temperature Sensor Testing



*Figure 5: Temperature sensor code in the Arduino IDE*



*Figure 6: Temperature sensor readings inside an apartment at 21.5 degrees celsius*

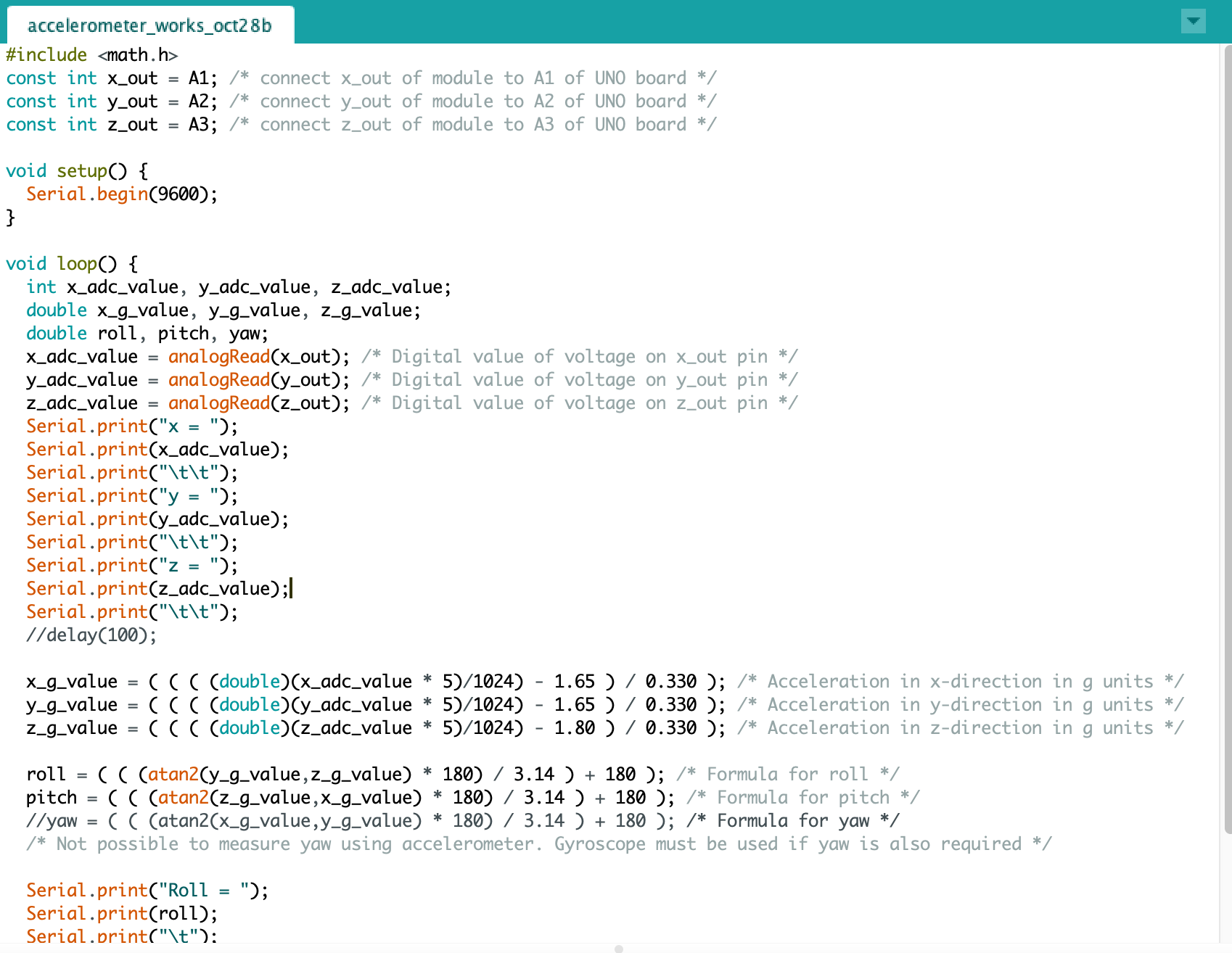
**

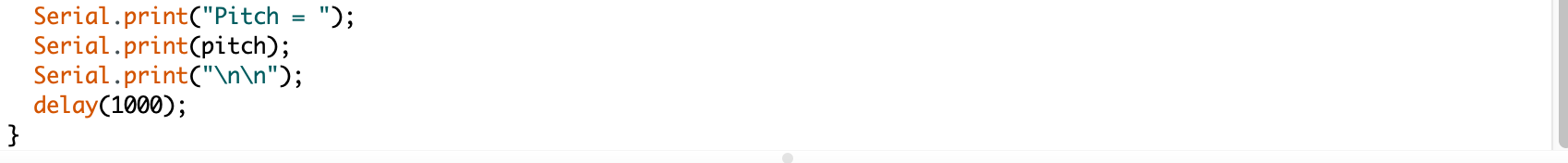
*Figure 7: Temperature sensor readings outside in 7 degrees celsius weather*

The results obtained in the initial testing of the temperature sensor resulted in much higher readings than what was expected. The tests were conducted in a room that was 21.5 degrees celsius, and the sensor was reading values of 137.01 degrees celsius. Next, testing was conducted outside where it was approximately 7 degrees celsius, and the sensor was reading values of -29.00 degrees celsius. These values are very far outside the margin of acceptable error thus further testing must be conducted.

## 

## Accelerometer Testing

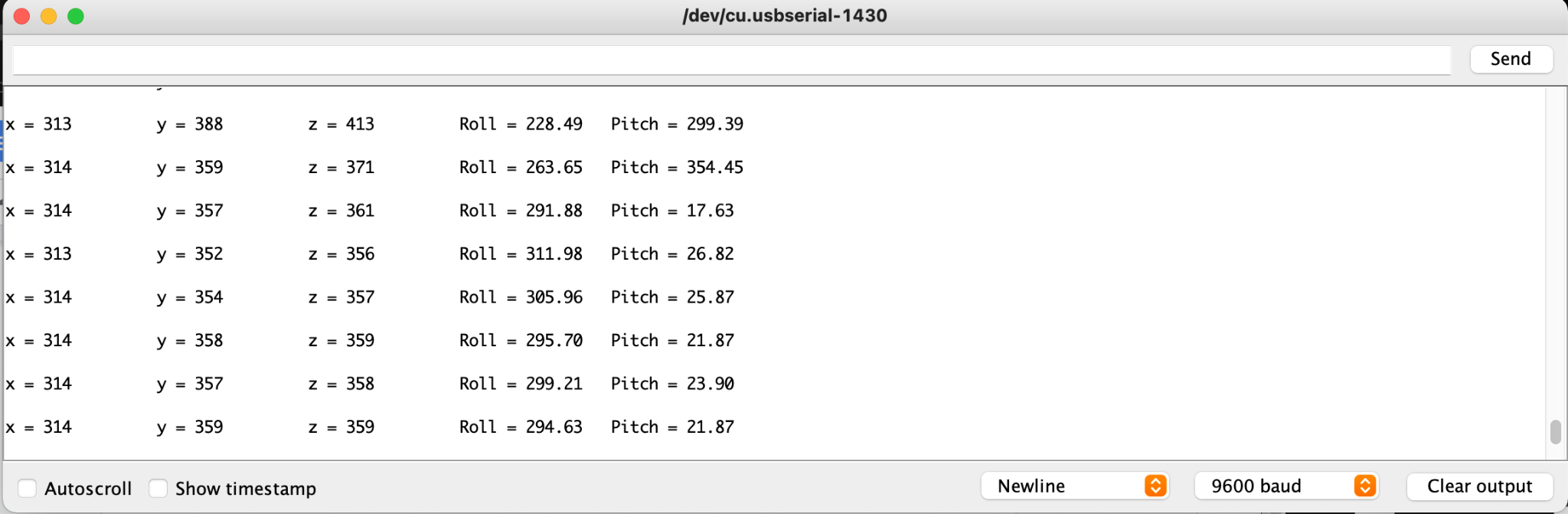




*Figure 8: Accelerometer code in the Arduino IDE*



*Figure 9: Accelerometer readings when the system is in motion*

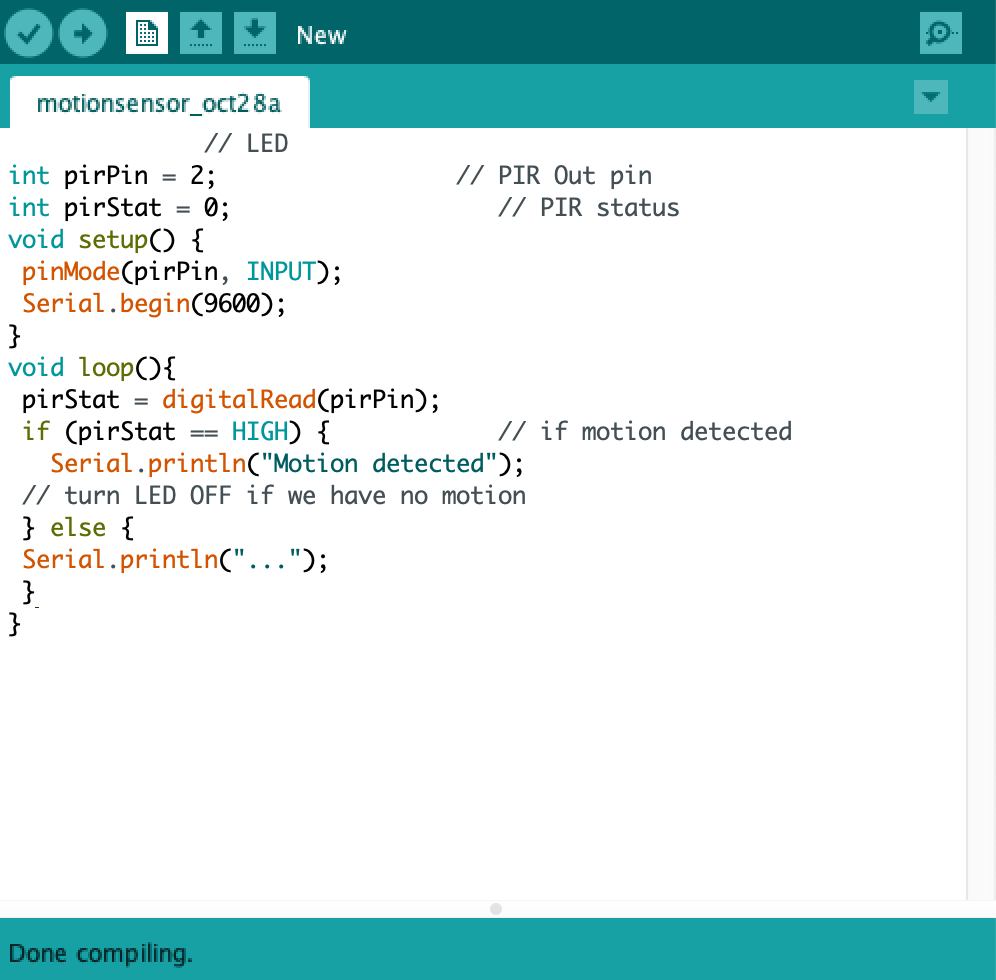
**

*Figure 10: Accelerometer readings when the system is at rest*

The initial testing conducted with the accelerometer consisted of testing while the system was at rest and while the system was in motion. The results of this test were successful, the values were consistent when the system was at rest and they varied when the system was in motion, as expected.

## 

## Motion Sensor Testing



*Figure 11: Motion sensor code in the Arduino IDE*



*Figure 12: Serial Monitor when the sensor was unobstructed*

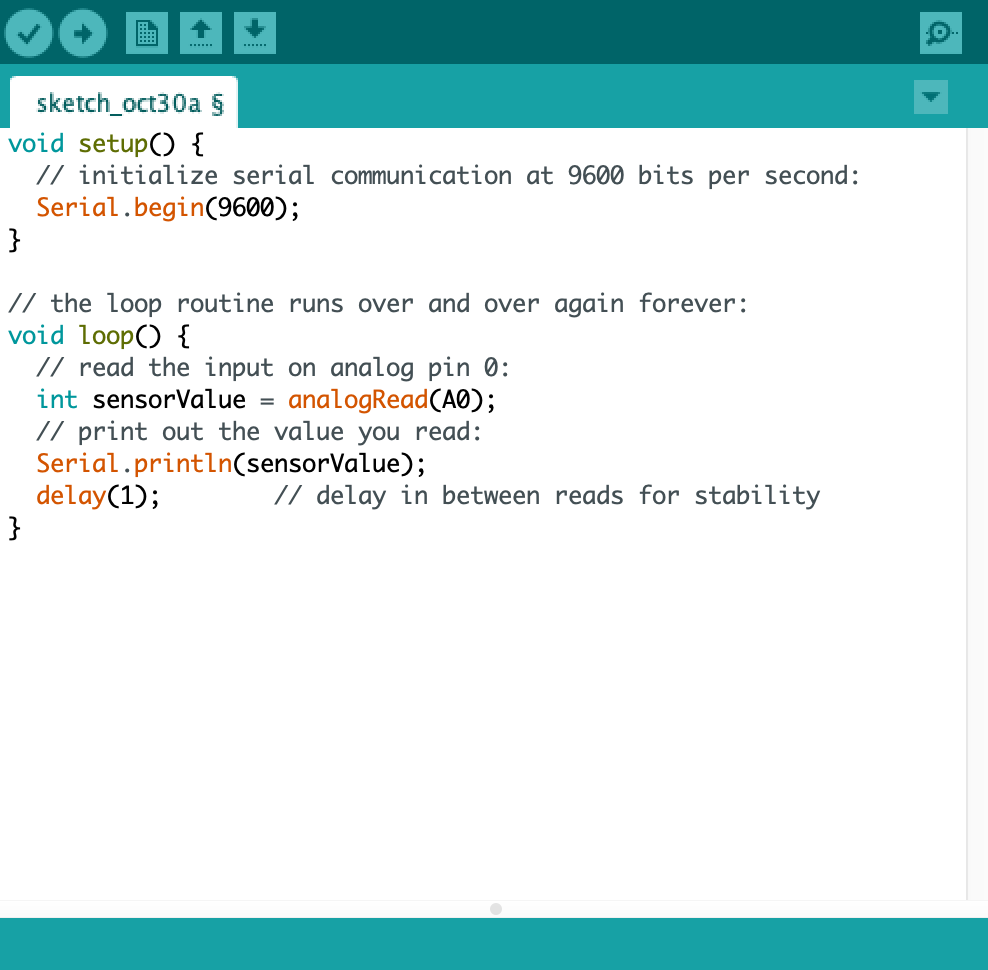


*Figure 13: Serial monitor when the sensor view was obstructed*

The initial testing of the motion sensors was successful. *Figure 12* shows the serial monitor when the sensor was uncovered and there was movement in the room. We also tested to make sure the sensor is unresponsive when there is no movement in the surroundings or the sensor is covered (*Figure 13).*

## Carbon Monoxide Sensor Testing

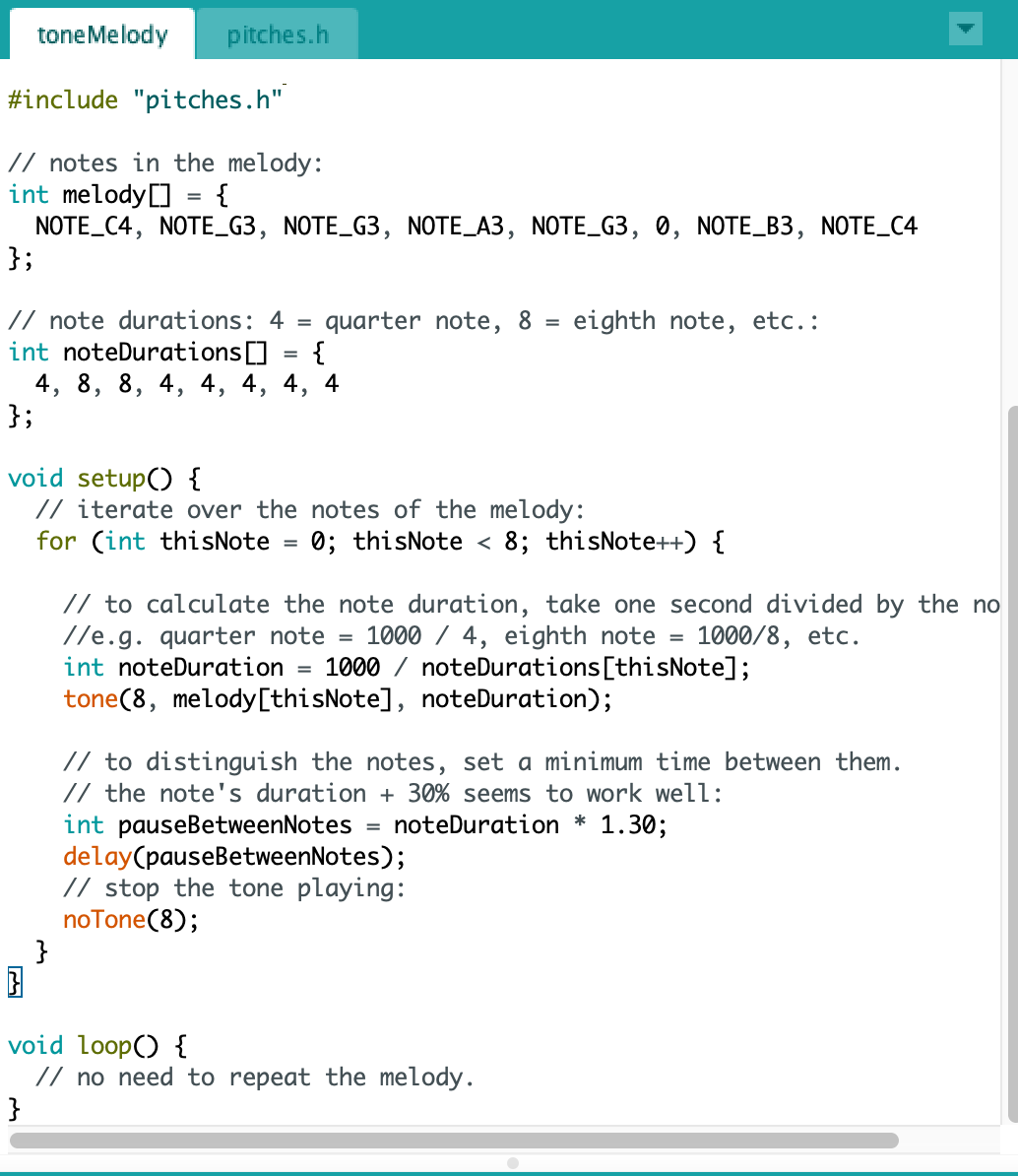
Testing on the carbon monoxide gas sensor has not yet been conducted, due to a mistake when ordering the materials. However, the part has been ordered and everything is prepared for testing to begin upon its arrival.



*Figure 14: Carbon monoxide gas sensor code in the Arduino IDE*

## 

## Speaker Testing



*Figure 15: Speaker testing code in the Arduino IDE*

# 

# Customer Feedback

Potential clients and users were identified and were shown the initial testing and prototyping, some of their comments, questions, and ideas are shown below.

## Connectivity Testing

Many potential clients expressed concern that the WiFi/Bluetooth and notification system had now been tested initially. This is valid as it is an instrumental part of the system. The reason that they were not tested was due to a lack of software and hardware that made it impossible on the initial prototype day. The mentioned software and hardware has since been or is in the process of being obtained. The missing hardware included a 12V barrel connector for the GSM module and missing software for the Bluetooth and WiFi board.

## Carbon Monoxide sensor testing

Concern was presented for the lack of Carbon monoxide testing as well. This is also very valid as this sensor will determine if the vehicle is becoming a life-threatening environment for the occupants and if the authorities are to be contacted. In order for the testing to be conducted, a missing part had to be ordered. It is expected to arrive sometime next week and testing will resume once it has.

## Installation Testing

Questions were made on the final design and the installation method. As it wasn't planned to test these aspects there was no progress made. Testing of this aspect and making of a case for the system will be conducted in the near future, this testing will include mounting in different locations inside of a car to ensure that it is feasible and easy, and ensuring that measurements remain accurate and that sensors are placed in appropriate locations.

## Sensors in Union

As the sensors were tested individually, and not in union, there were questions on when testing would feature all sensors working together and if they would be capable of detecting the desired parameters accurately. All of this testing will occur next over the next couple of sessions, as it is a large task. But now that it is known that all sensors function individually, the combination of them should be fairly simple and is just a question of integration.

# 

# Updated Bills of Materials

| Item | Quantity | Cost | Taxes | Shipping | Total | Link |
| --- | --- | --- | --- | --- | --- | --- |
| Arduino Uno | 1 | 17.00 | N/A | N/A | 17.00 | [[1]](https://makerstore.ca/shop/ols/products/arduino-uno-r3) |
| Motion Sensor (HC-SR501) | 1 | 11.99 | N/A | N/A | N/A | [[2]](https://www.amazon.ca/gp/product/B086XCTTP6/ref=ppx_yo_dt_b_asin_title_o02_s00?ie=UTF8&psc=1) |
| ESP32-BLE | 1 | 16.90 | N/A | N/A | N/A | [[3]](https://www.amazon.ca/gp/product/B07P1L7839/ref=ppx_yo_dt_b_asin_title_o02_s00?ie=UTF8&psc=1) |
| Various Capacitors | 1 | 11.68 | N/A | N/A | 54.36 | [[4]](https://www.amazon.ca/gp/product/B00W1COWV8/ref=ppx_yo_dt_b_asin_title_o02_s00?ie=UTF8&psc=1) |
| Carbon monoxide gas sensor (MQ-7) | 1 | 8.76 | 2.69 | 9.21 | 20.66 | [[5]](https://www.robotshop.com/ca/en/carbon-monoxide-sensor-mq7.html) |
| Accelerometer (Cytron ADXL335) | 1 | 11.86 | N/A | N/A | N/A | [[6]](https://www.robotshop.com/ca/en/cytron-adxl335-3-axis-accelerometer.html) |
| Temperature Sensor (TMP-36 | 1 | 1.92 | 3.44 | N/A | 26.43 | [[7]](https://www.robotshop.com/ca/en/temperature-sensor-tmp36.html) |
| Transistor 2N2222 | 1 | 9.66 | N/A | N/A | N/A | [[8]](https://www.amazon.ca/gp/product/B008UFY08K/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&psc=1) |
| 8Ohm speakers | 1 | 9.26 | N/A | N/A | 20.90 | [[9]](https://www.amazon.ca/gp/product/B07BFTYY6L/ref=ppx_yo_dt_b_asin_title_o01_s01?ie=UTF8&psc=1) |
| Resistors (10k,15k,27k,470k)Ohm | 4 | 0.65 | 3.29 | 13.85 | 25.27 | [[10]](https://www.pcboard.ca/index.php?route=account/order/info&order_id=2798) |
| GPRS/GSM development board | 1 | 26.19 | 0.94 | N/A | 27.13 | [[11]](https://www.amazon.ca/gp/product/B084HCPDVV/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&psc=1) |
| Pololu carrier for MQ Gas sensors | 1 | 1.95 | 0.30 | 7.69 | 9.93 | [[12]](https://www.pishop.ca/product/pololu-carrier-for-mq-gas-sensors-bare-pcb-only/) |

(Taxes and shipping costs are grouped by order)

**Total Estimated Cost with taxes and shipping = 201.68 $**

# 

# Prototype II - Test Plan

## Objective:

The objective of the second prototype is to integrate the different sensors together into one system, to enable further testing and analysis of the critical subsystems.

## Procedure:

1. Develop the required codes in the Arduino IDE to integrate the sensors.
2. Build the circuits for each subsystem.
3. Test that the accelerometer properly activates the system when the vehicle is at rest.
4. Test to verify that the temperature sensor and carbon monoxide sensors are activated when the vehicle is at rest.
5. Develop the application through which notifications will be sent.
6. Combine the physical prototype with the application and test the notification system.

## Stopping Criteria:

Testing will end once it has been confirmed that the sensors are properly integrated and are collecting reliable data. Adjustments will be made accordingly until the prototype has a high degree of fidelity.

# Conclusion

In conclusion, we have completed and documented the first stage of prototyping, once this was done we presented the test results to potential clients for feedback and have since developed a second test plan that will be completed for the next deliverable. The next set of testing will include developing the codes required to run the system on the microcontroller, we will build all required circuits, and test the systems that could not be tested initially. Once this testing is done it will be documented once again in the next deliverable.

## 