

TECHIN 514 Final Report
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SteakSense: Steak Doneness Measurement

GitHub: <https://github.com/ruiqingww/514-final-project>



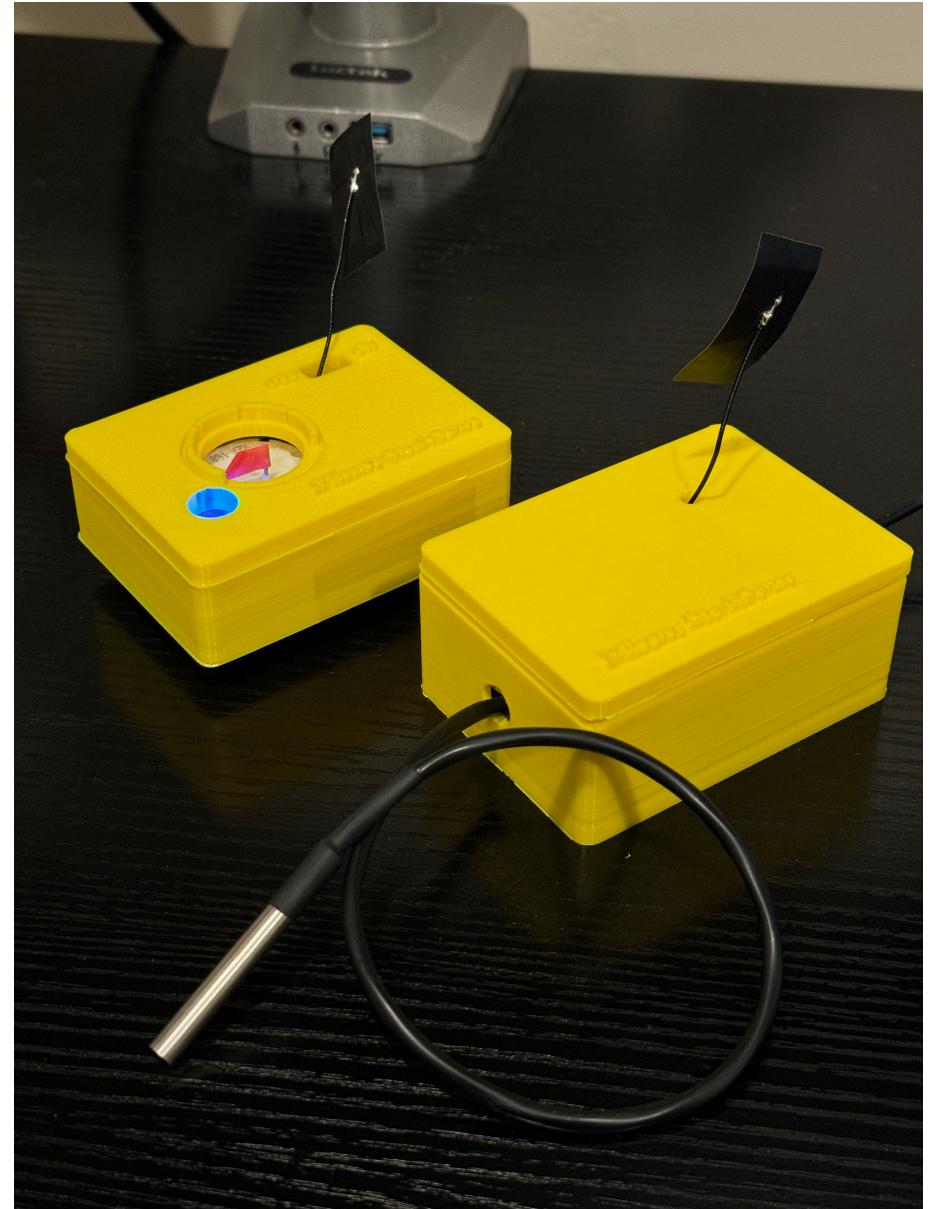
Introduction

- **Problem**

How can temperature tell us how well our steak is done currently, and how long it will take to be done?

- **Solution**

1. Connect the two devices respectively and turn on the switch.
2. When the Bluetooth connection between the two devices is successful, the temperature sensor at the sensing device end starts to collect data and transmits it to the display device end through Bluetooth.
3. The display end changes the pointing area of the pointer according to the temperature range, and the RGB LED lights up in different colors.
4. rare ≤ 40 C; medium rare > 40 C & ≤ 50 C; medium > 50 C & ≤ 60 C; medium well > 60 C & ≤ 70 C; well ≥ 70 C



Sensing Device

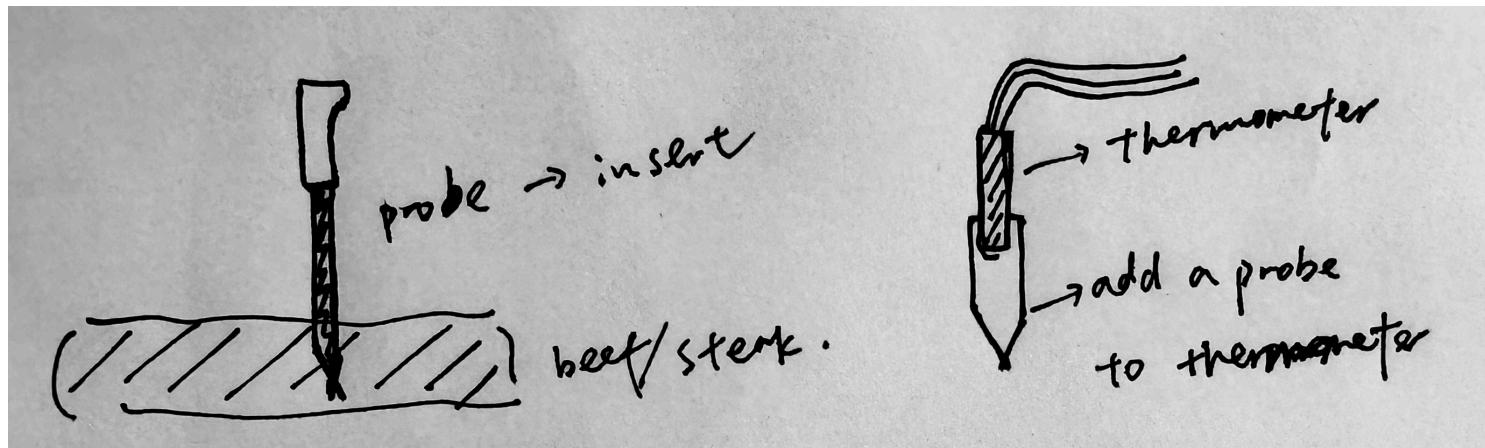
- Seeed Studio XIAO ESP32S3
- DS18B20 Programmable Resolution 1-Wire Digital Thermometer

Wiring: Red(VCC), Yellow(Data), Blue(GND)

Temperature range: -55 C° ~ +125 C°

Power supply: 3.0V ~ 5.5V

(a 4.7K resistor between the Data and VCC)



Steak Degrees of Doneness

RARE

cool red center
125° F – 52° C



MEDIUM RARE

warm red center
135° F – 57° C



MEDIUM

warm pink center
145° F – 63° C



MEDIUM WELL

slightly pink center
150° F – 66° C



WELL

little or no pink
160° F – 71° C



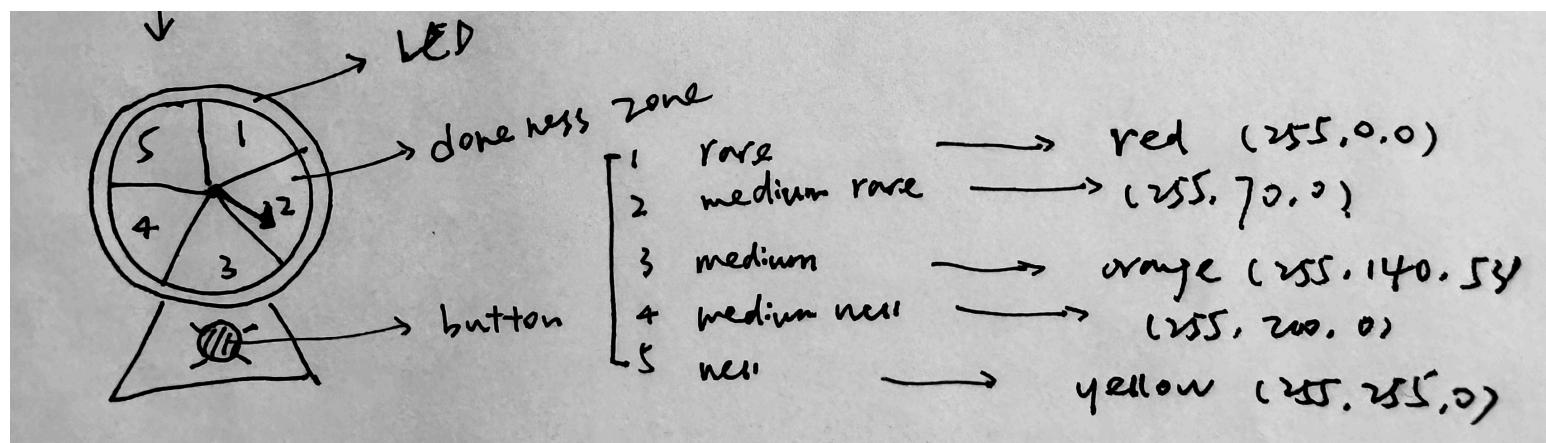
Source: Spicesinc.com

Displaying Device

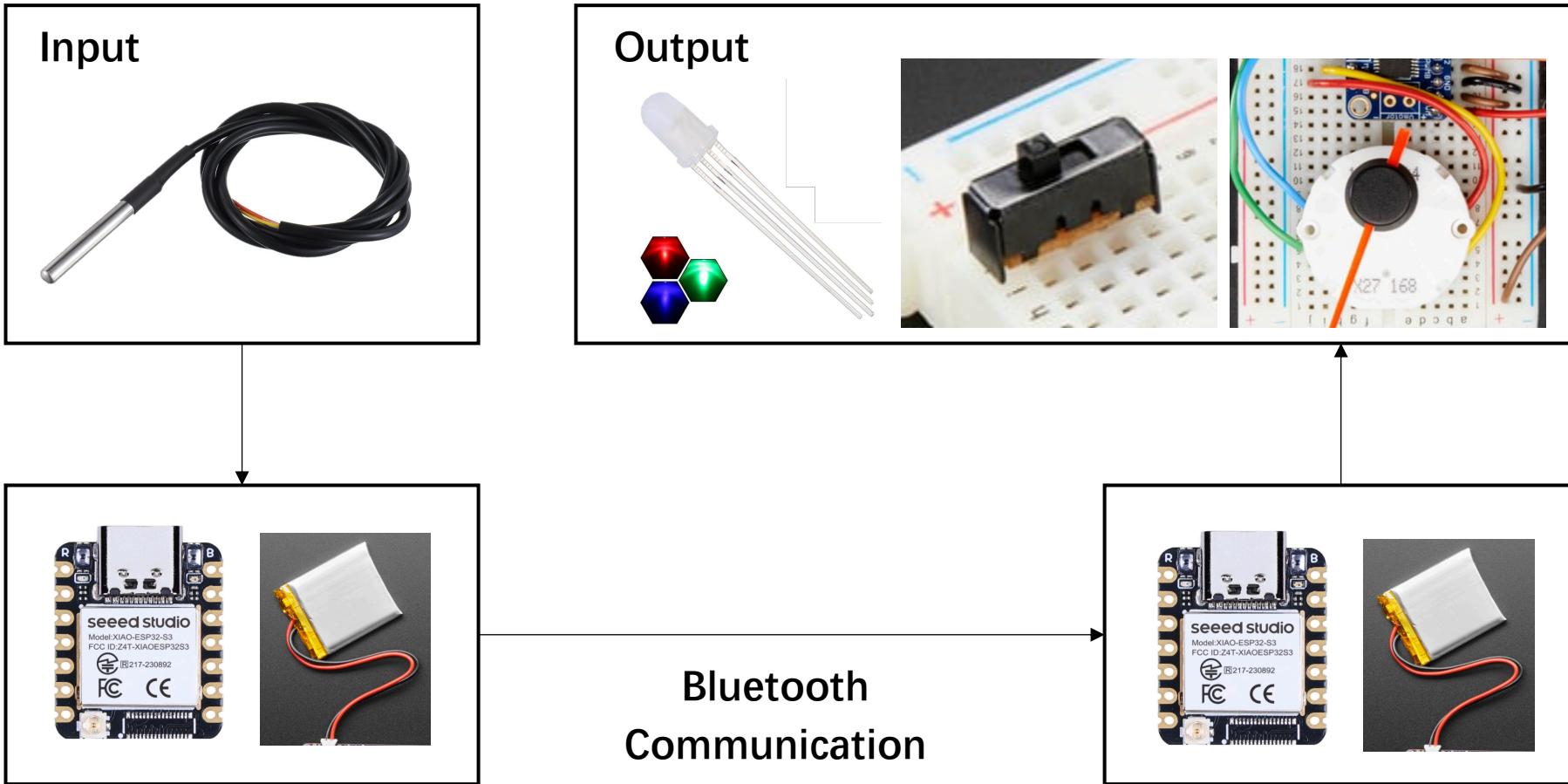
- Seeed Studio XIAO ESP32S3 (<https://www.seeedstudio.com/XIAO-ESP32S3-p-5627.html>)
- 3.7V Lithium battery
- X27.168 Stepper-motor-driven gauge needle

This has extremely fine step precision of about 1/2 a degree per step, 600 steps for single stepping, fast response for quick movements, and a range of ~315° degrees. (<https://www.adafruit.com/product/2424>)

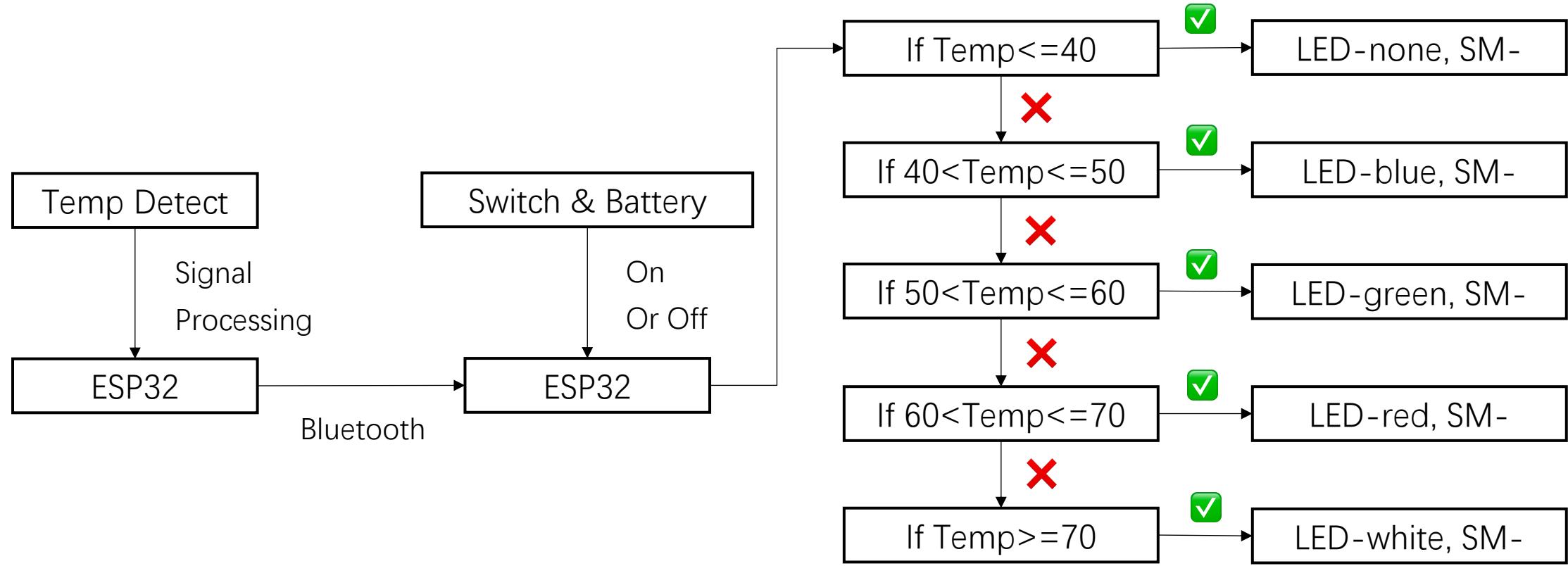
- RGB LED
- SPDT slide switch (<https://www.adafruit.com/product/805>)



System Architecture

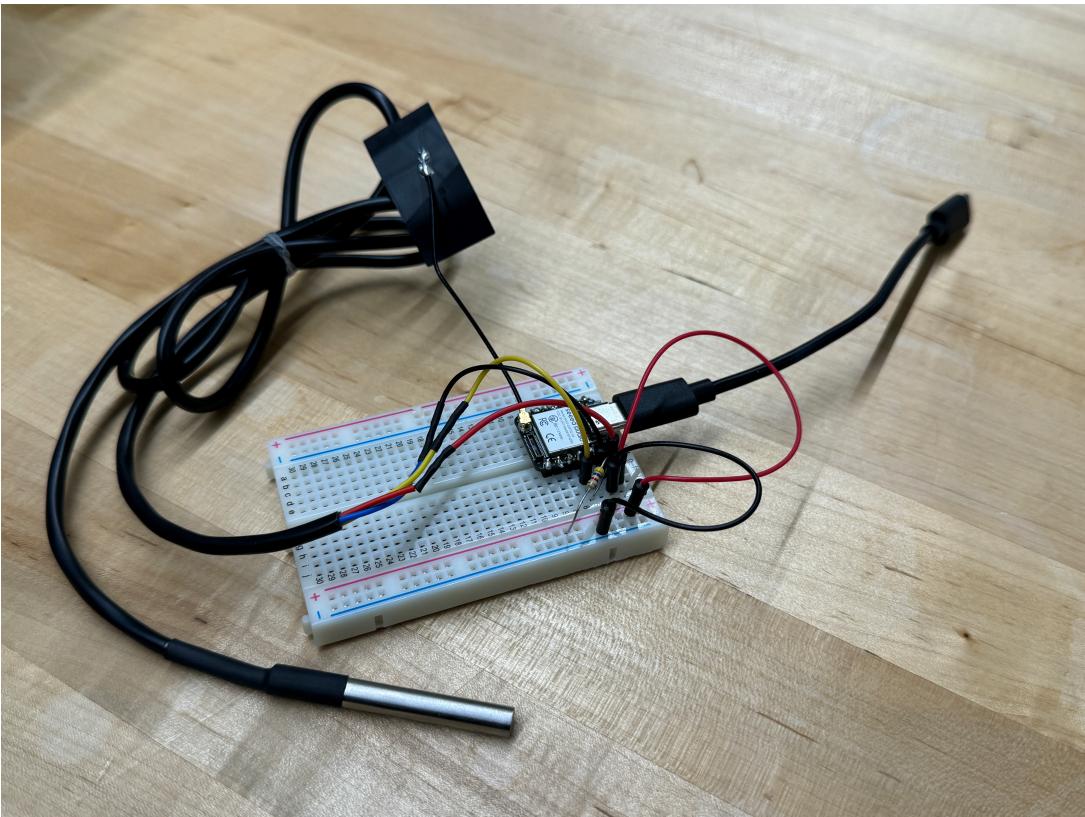


System Architecture

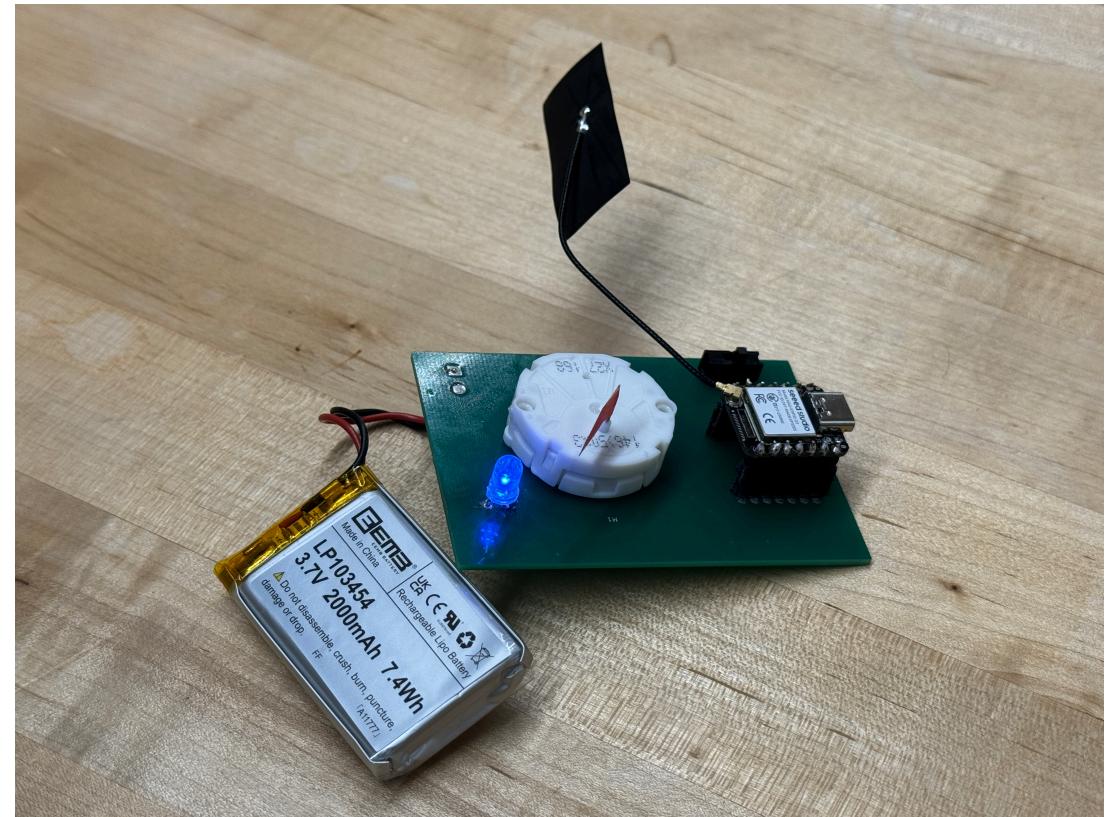


Core Components

- Sensing Device

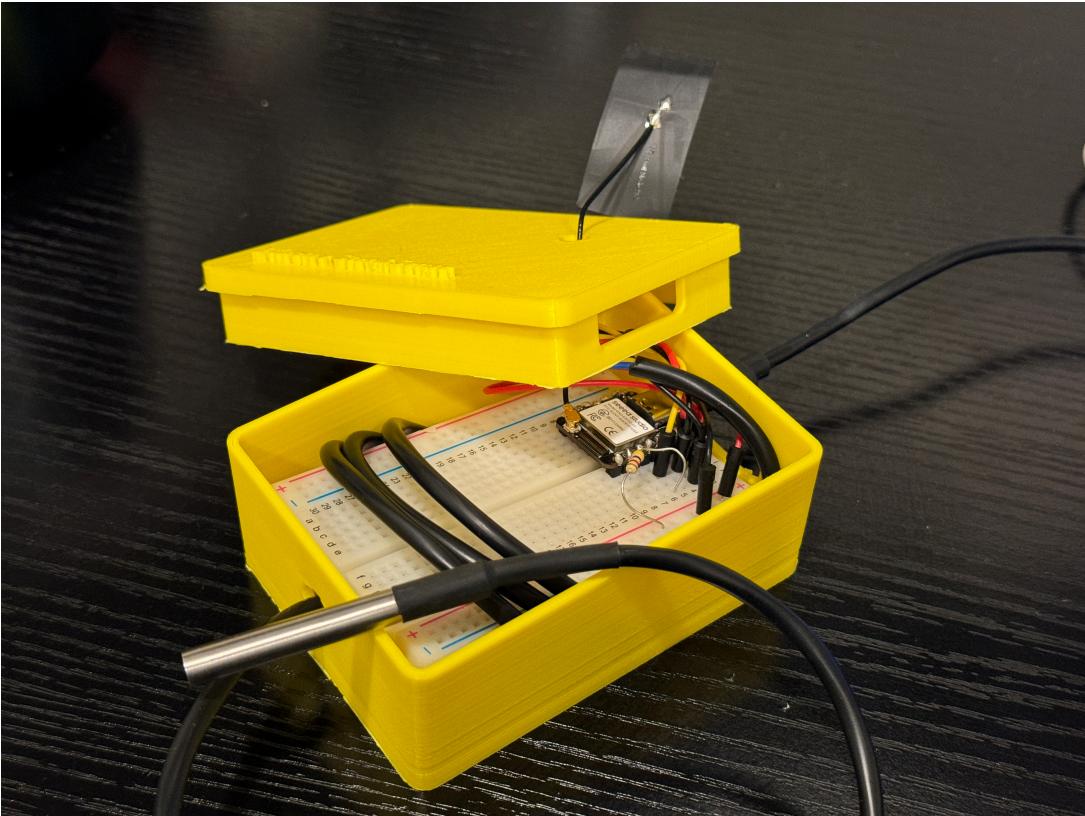


- Displaying Device

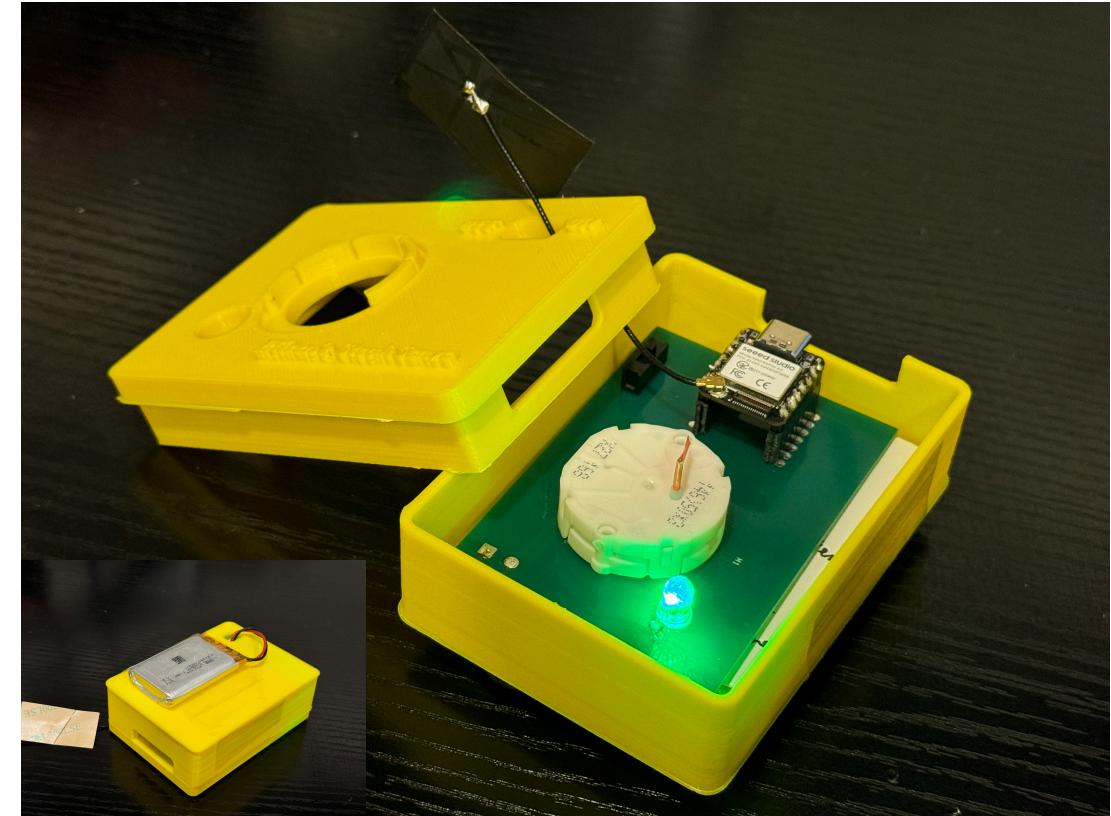


Core Components

- Sensing Device



- Displaying Device



Signal Processing Algorithm

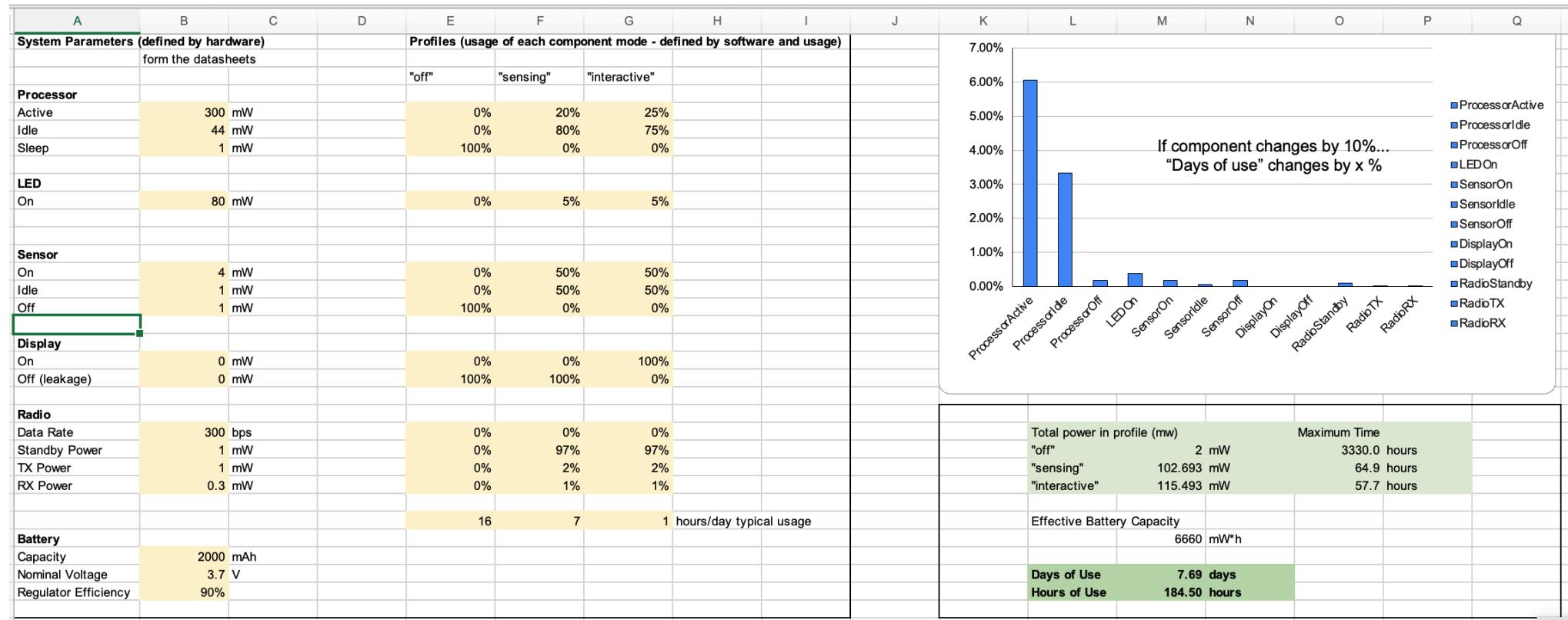
Using a moving average buffer to filter temperature data

Calculate a rolling average of temperature readings in Celsius over a window of 5 values for a microcontroller. Update the total sum and array with each new temperature, cycle the index, and compute the average. Finally, it outputs the filtered temperature to the serial console, enhancing measurement stability.

```
total -= celsiu[myidx];
celsiu[myidx] = celsius;
total += celsiu[myidx];
myidx = (myidx + 1) % 5;
average = total / 5.0;
Serial.print("Filtered Temperature: ");
Serial.print(average);
Serial.print(" Celsius, ");
```

Battery Consideration

- 2000mAh, 3.7V battery is suitable for my device, it can work a week without charging.
- Also there is a switch that can turn on and off the display device at any time, so as to save power.



Budget Summary

- Total: \$ 87.26

Ruiqing Wang	SEED STUDIO XIAO ESP32S3 SENSE	2	\$13.99	\$27.98	1. Digikey
Ruiqing Wang	EEMB Lithium Polymer Battery 3.7V 2000mAh 103454	2	\$13.99	\$27.98	3. Amazon
Ruiqing Wang	NeoPixel 5050 RGB LED with Integrated Driver Chip	1	\$4.50	\$4.50	4. Adafruit
Ruiqing Wang	Automotive Gauge Stepper Motor - x27.168	1	\$9.95	\$9.95	4. Adafruit
Ruiqing Wang	Adafruit Micro-Lipo Charger for LiPoly Batt with USB Type-C	1	\$5.95	\$5.95	4. Adafruit
Ruiqing Wang	Waterproof 1-Wire DS18B20 Digital temperature sensor	1	\$9.95	\$9.95	4. Adafruit
Ruiqing Wang	Breadboard-friendly SPDT Slide Switch	1	\$0.95	\$0.95	4. Adafruit

Future Work

- Increase the system's robustness to ensure that it can work properly at any time.
- Change the stepper motor to a countdown timer to show how much time is needed for the later stage.
- Design a better and more ergonomic enclosure for both devices.

Video Demo

