CSCE 5612 Lab 2: Data Logger and Power Consumption

Matt Christiansen

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System Overview

In this lab I built a small data logger that reads IMU acceleration (ax, ay, az), IMU gyro (gx, gy, gz), and temperature at a fixed sampling rate, and I use a real-time clock (RTC) to add timestamps. The main thing I am trying to learn is how much extra power it costs to log to the SD card by comparing two modes and then estimating how long a 500 mAh, 3.7 V LiPo battery would last. [1]

Operating Modes

Mode 1: Sample Only (No SD Writes)

In Mode 1, the board just reads the IMU and temperature at the same frequency (about 100 Hz) and timestamps each sample with the RTC. It does not write anything to the SD card in this mode. The OLED only shows the mode name and sampling frequency, so this mode is basically my baseline for how much power is used just to read sensors and process data.

Mode 2: Sample + Log (SD Logging Enabled)

In Mode 2, the board still uses the same sampling rate and timestamps, but now every record is written to the SD card in CSV format. The OLED again shows the mode and frequency. From my understanding, this mode should draw much more power, and I use it to see how much extra energy the SD logging actually adds.

Power Measurement Method

Now, I put the Mini OLED USB-C Power Analyzer between the USB power source and my board so it can show the USB voltage V_{USB} and current I_{USB}. Then for each mode I let the system run for around 60–120 seconds so the readings settle, then I recorded the average voltage and current from the display.

The USB power is

$$P_{\text{USB}} = V_{\text{USB}} \times I_{\text{USB}}.$$

To estimate the current the 3.7 V LiPo battery would have to supply (with regulator efficiency $\eta = 0.85$), the lab tells us to use

$$I_{\text{batt}} \approx \frac{P_{\text{USB}}}{3.7 \times \eta}.$$

For a 500 mAh battery (0.5 Ah), the estimated runtime is

$$\text{Runtime (hours)} \approx \frac{0.5}{I_{\text{batt}}}.$$

Measured Results

Then, txhe USB analyzer gave me the following average values:

- Mode 1 (Sample Only): $V_1 = 5.16$ V, $I_1 = 0.06$ A.

- Mode 2 (Sample + Log): $V_2 = 5.186$ V, $I_2 = 0.25$ A.

Mode 1: Sample Only

Now For Mode 1,
$$P_1 = V_1 I_1 = 5.16 \times 0.06 = 0.3096 \approx 0.31 \text{ W.}$$

The estimated battery current is
$$I_{\text{batt},1} \approx \frac{0.3096}{3.7 \times 0.85} = \frac{0.3096}{3.145} \approx 0.0985 \text{ A.}$$

So, if my math is right, the runtime is
$$t_1 \approx \frac{0.5}{0.0985} \approx 5.1 \text{ hours.}$$

Mode 2: Sample + Log

Then For Mode 2,
$$P_2 = V_2 I_2 = 5.186 \times 0.25 = 1.2965 \approx 1.30 \text{ W.}$$

The estimated battery current is
$$I_{\text{batt},2} \approx \frac{1.2965}{3.7 \times 0.85} = \frac{1.2965}{3.145} \approx 0.412 \text{ A.}$$

The runtime in this case is
$$t_2 \approx \frac{0.5}{0.412} \approx 1.21 \text{ hours.}$$

My Summary Findings Table

Mode	I_{USB} (A)	V_{USB} (V)	P_{USB} (W)	I_{batt} (A)	Runtime (h)
Sample Only	0.06	5.16	0.31	0.098	5.1
Sample + Log	0.25	5.186	1.30	0.412	1.21

Table 1: My measured USB power, estimated battery current, and runtime for both modes.

Logging Overhead and Interpretation

The lab defines the logging overhead in terms of USB power and current as
$$\Delta P = P_{\text{USB,log}} - P_{\text{USB,sample}},$$
$$\Delta I = I_{\text{USB,log}} - I_{\text{USB,sample}}.$$

Using my numbers,
$$\Delta P = P_2 - P_1 \approx 1.30 - 0.31 = 0.99 \text{ W,}$$
$$\Delta I = I_2 - I_1 = 0.25 - 0.06 = 0.19 \text{ A} = 190 \text{ mA.}$$

So from my understanding, turning on SD logging adds around 190 mA of USB current and about 0.99 W of extra power compared to Sample Only. From my calculations, this extra load cuts the estimated battery life from about 5.1 hours down to about 1.2 hours, which matches the idea that SD card logging is fairly expensive in terms of energy for this little system.

Data Logging Format

In Mode 2 I log each record with a timestamp plus IMU and temperature values in CSV format. The header I used is

time,ax,ay,az,gx,gy,gz,temp.

Conclusion

Overall, I feel this lab helped me connect the theory of power and energy to a real embedded system. I got practice wiring up measurement tools, using a USB power analyzer, and then actually turning those numbers into battery current and runtime estimates. Additionally, I got to spend a lot of time debugging a power issue with a cord that connected my MCU to the measurement tool. But I think the main takeaway is that enabling SD logging has a big impact on power draw and battery life, which is something I will need to keep in mind when designing low-power systems in the future. [1]

References

[1] Lab handout: CSCE 5612 Embedded Hardware/Software Design, Lab #2 Data Logger and Power Consumption, Spring 2026.