UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Automatic Pool Monitor and Regulator

Electrical & Computer Engineering

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ECE 445 - Senior Design Project

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Problem and Solution

- Addresses challenges of manual water testing
- Use sensors to monitor temperature, pH, and TDS
- Wireless transmission to chemical dispenser
- Automatic dispensing of appropriate chemical for balancing
- Reduces maintenance workload, improves pool health

High-Level Requirements

- 1. The pool sensors must accurately measure and output analog readings for the water quality, with temperature between 72-76 degrees, pH between 7.2 to 7.8, and total dissolved solids level (TDS) levels between 0-1000 ppm.

- 1. The microcontroller must be able to calculate and display if readings are in an acceptable range or send a signal to the dispenser unit to release a quantifiable amount of necessary chemicals into the pool otherwise.

- 1. The dispenser unit will release 0.018 cubic inches of chemicals with a 5% standard deviation using stepper motors according to microcontroller instructions.

Requirements/Verification Tables

Water Quality Sensing

Requirements:	Verification:
The subsystem must be able to acquire sensor data from all sensors and transmit it to the microcontroller.	Verify that different values are being collected when the water environment changes. Accuracy will be determined by the sensor PCB system.

Power

Requirements:	Verification:
Must supply 5±0.5V of power to the dispenser unit	Use a multimeter across the ground and power supply to measure the voltage
Must supply 3.3±0.3V of power to the microcontrollers	Use a multimeter across the ground and a power supply to measure the voltage. Include test points on the board to validate trace voltages.

Sensor PCB/Unit

Requirements:	Verification:
Must be able to receive and convert analog data from the sensors into the right units for temperature (F), pH (unit), and TDS (ppm) based on the respective datasheets for the sensors.	We can print values to a screen or the display to verify if the data is correct or within range. Also, acquire multiple readings of the same environment to verify that the standard deviation for temperature (±1°F), pH (±0.1), and TDS levels (±100 ppm) are within a valid range.
Must be able to determine if there are any readings out of bounds. Maintain temperature between 78-82 F, pH between 7.2-7.8, and TDS below 1000 ppm.	We can artificially change the environment of the sensors to produce values that are out of range. We can print if values are out of range.
Must be able to send signals to the dispenser subsystem or computer according to calculations.	Validate with the data received from the dispenser subsystem.

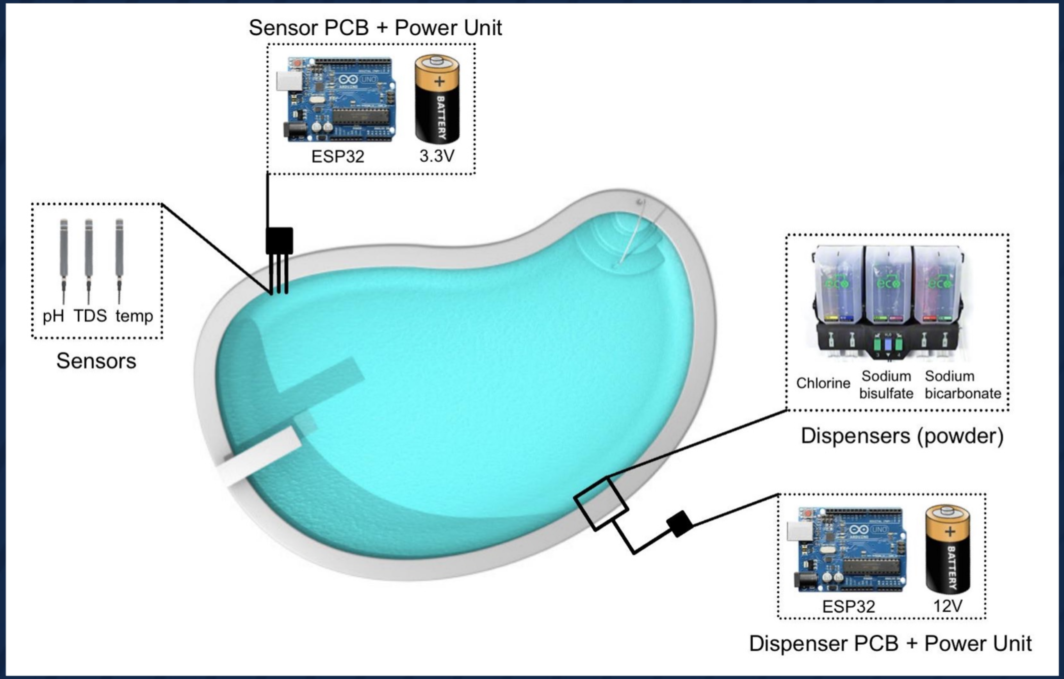
Requirements/Verification Tables

Dispenser PCB/Unit

Requirements:	Verification:
It must be able to receive signals from the microcontroller.	Validate if the data sent from microcontroller Tx is the same as the data received by the dispenser microcontroller.
Must be able to move the right motors to dispense chemicals at the correct amount	Validate visually, use a weight to determine if the correct grams of chemical are released from the dispenser.
The motor must be able to spin 360 degrees ± 5 degrees to maintain consistent performance for repeated actions. 0.018 cubic inches of chemicals will be dispensed every rotation, with 5% standard deviation $0.018 \pm 0.0009 in^3$.	Spin the motor for multiple rotations and see if motor positioning is significantly off or not. Verify this with a real load from the dispenser with powder on top of the shaft/disk.
Dispenser microcontroller must delay dispensing after a chemical is released to avoid spikes in concentration due to repeated releases before water quality updates.	After a dispense, prevent another dispense for another 5 minutes (~30 minutes normally). In normal pools, chemicals will be dispersed uniformly from the built-in pool filter, but for verification/demo, manual dispersion is needed.

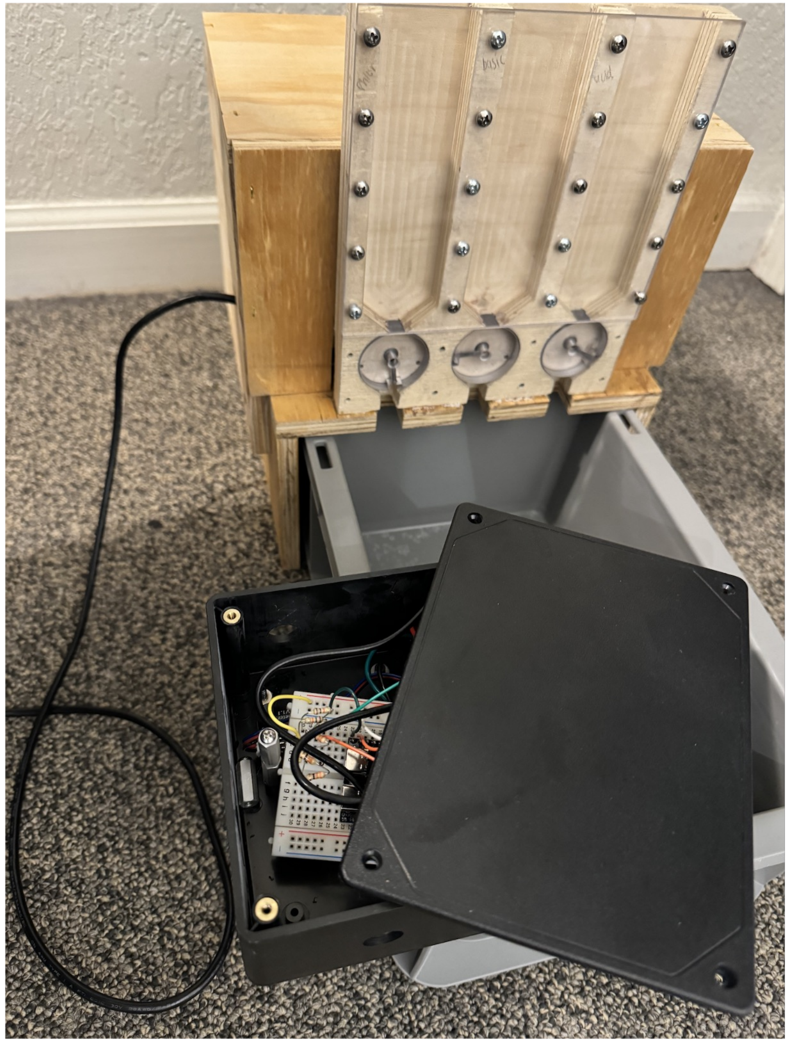
Design Overview

- Two separate physical systems
- Sensor System and Dispenser System

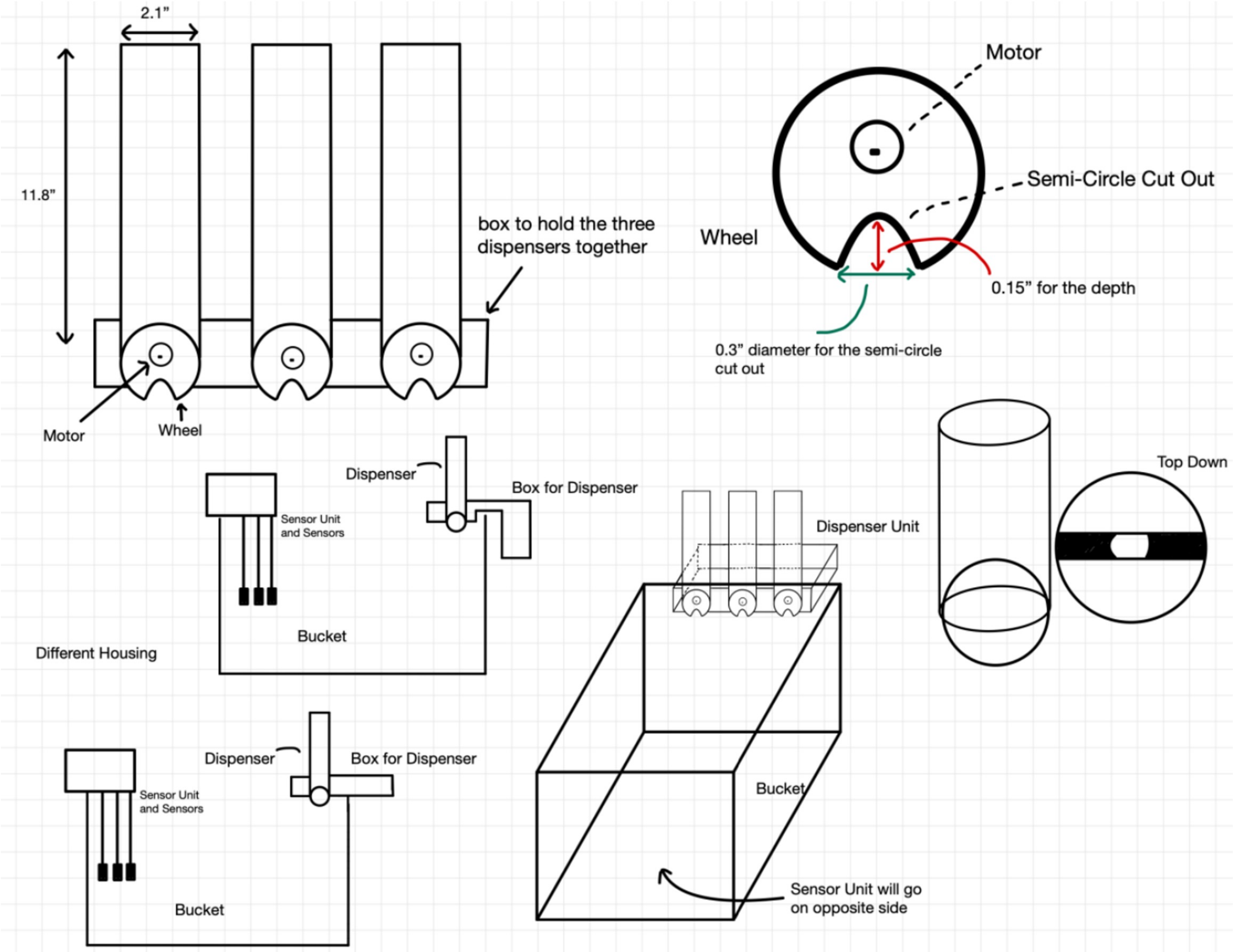


Project Build

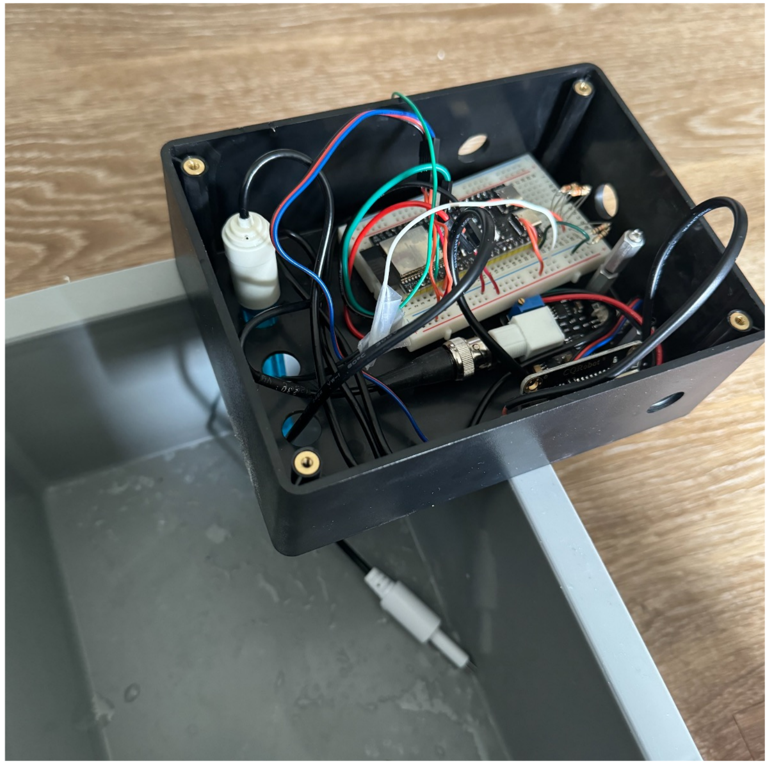
- Sensors and Dispenser on opposite sides of water tub
- Sensor circuitry housed in enclosure with sensors dipped in water
- Dispenser linked with motors connected to our circuitry



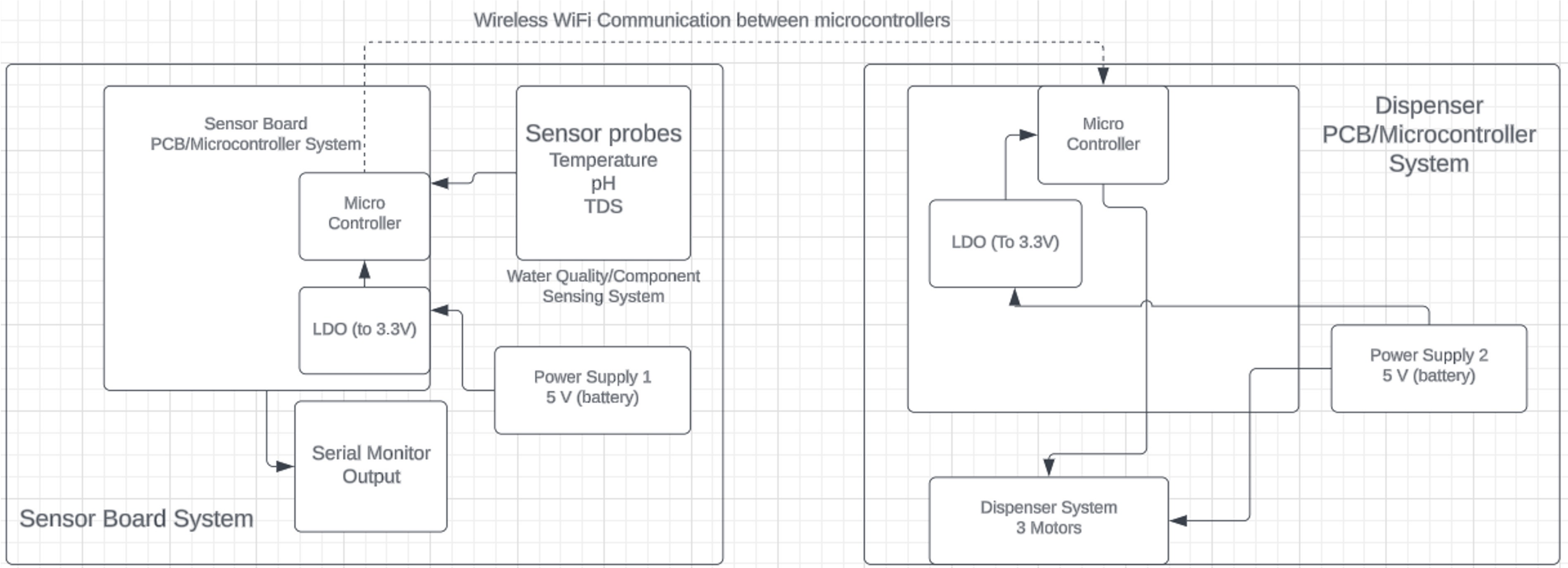
Dispenser Design



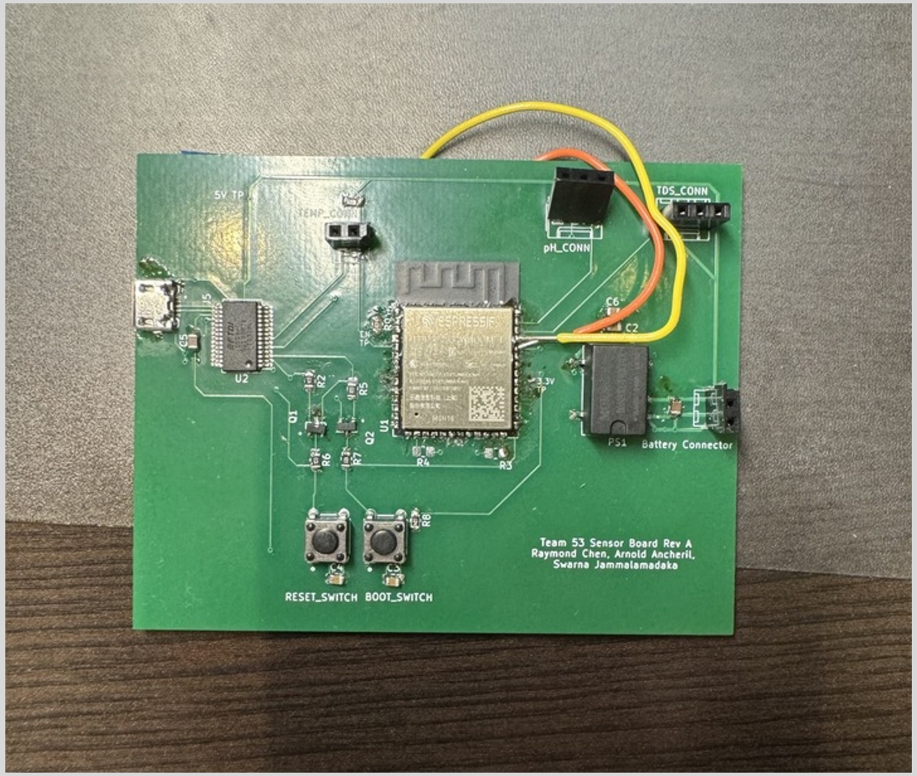
Project Build

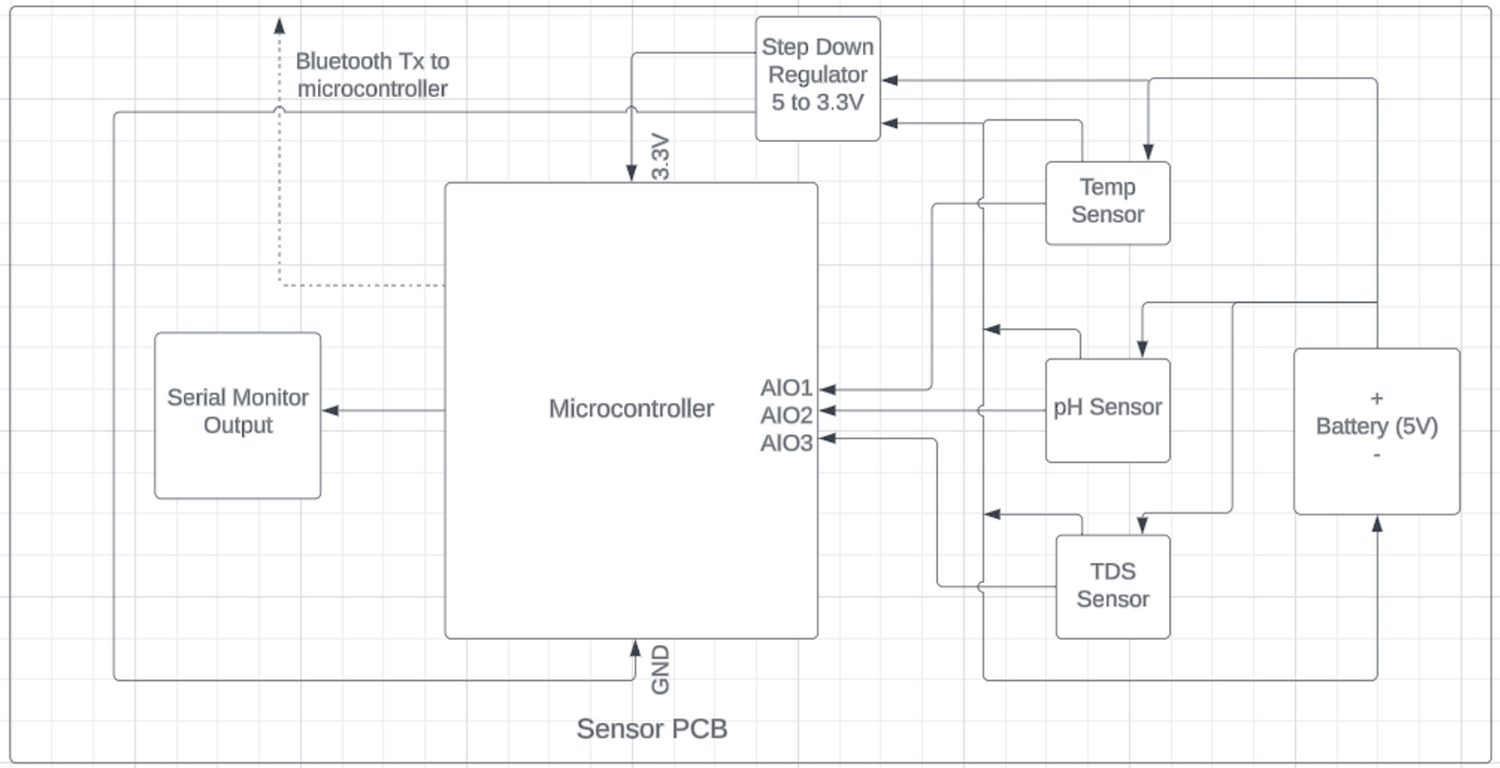


High-Level Block Diagram



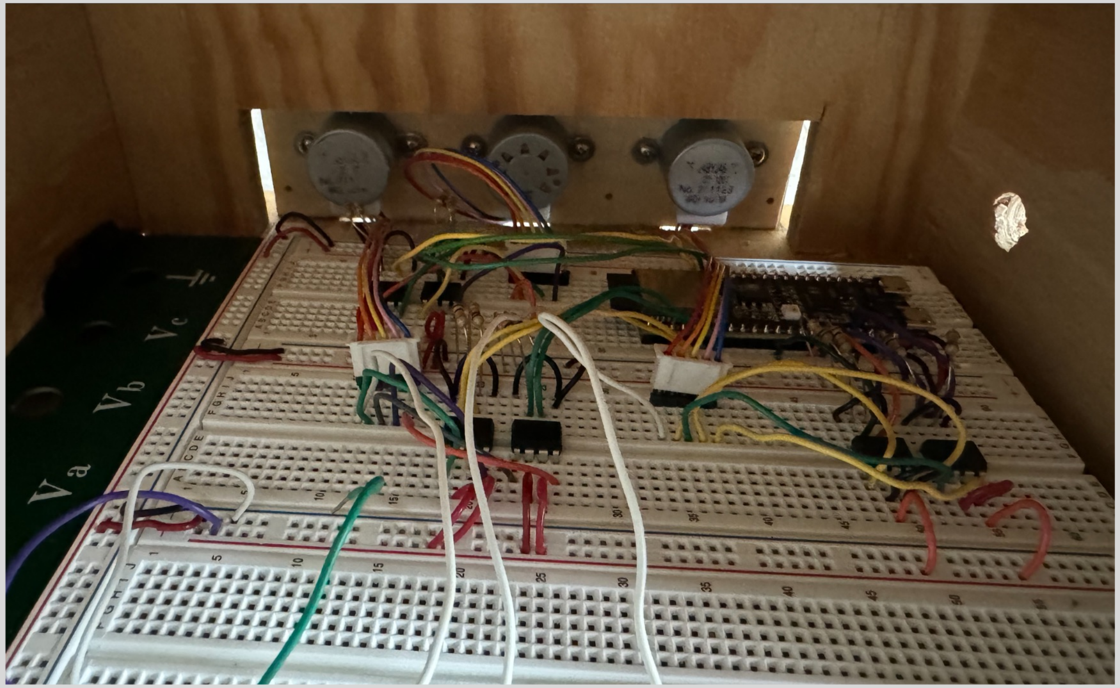
Sensor Board System on the left
Dispenser Board System on the right

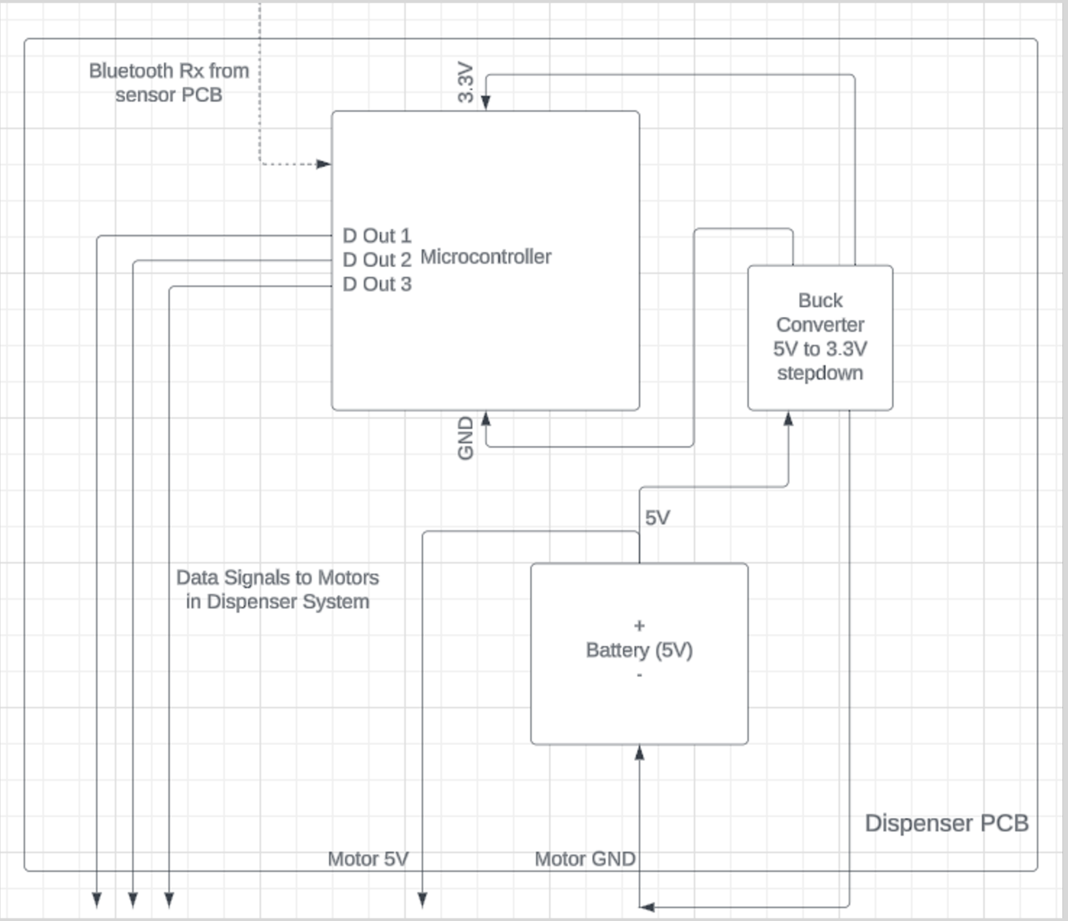




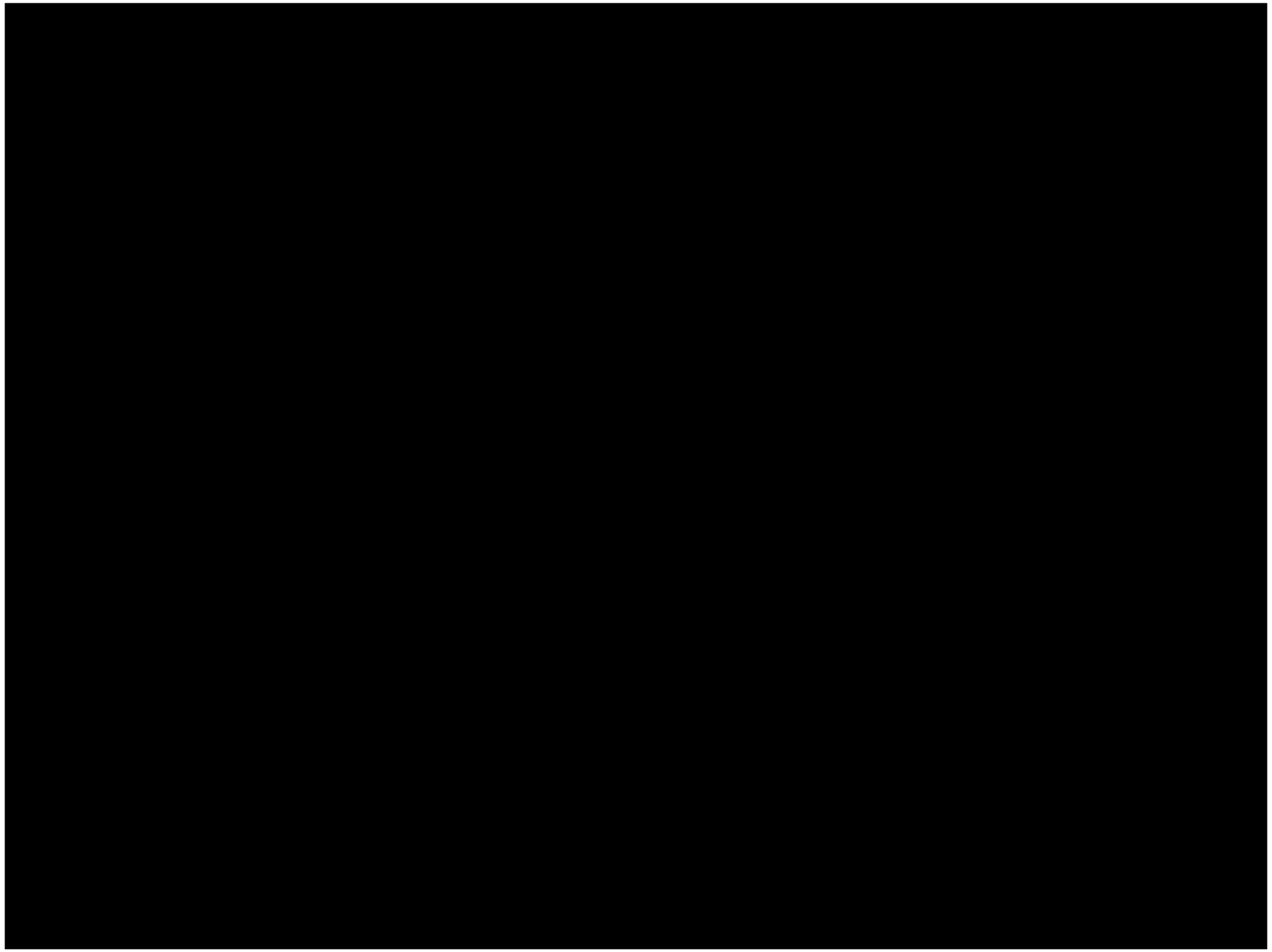
Sensor PCB Overview

Dispenser Unit



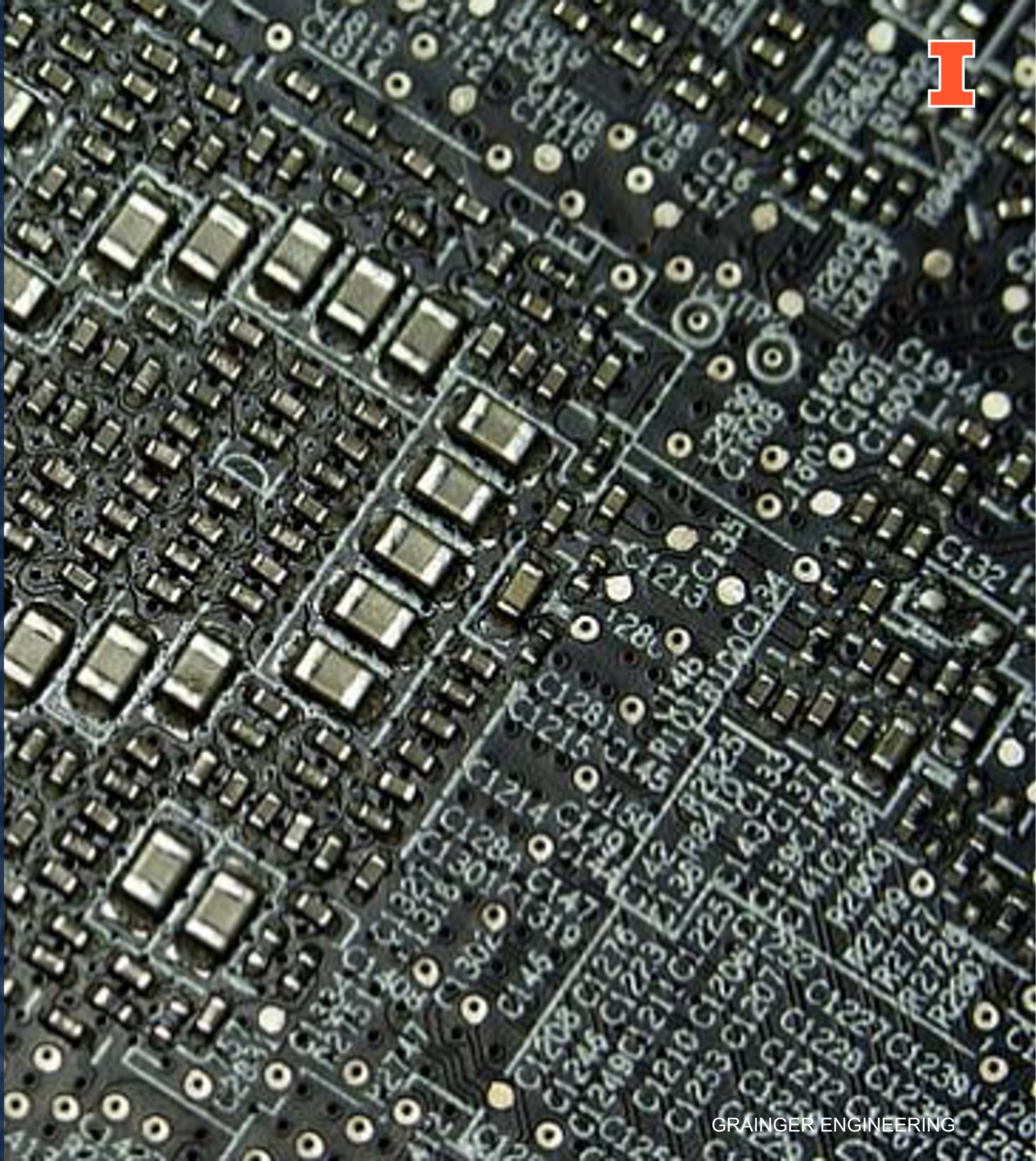


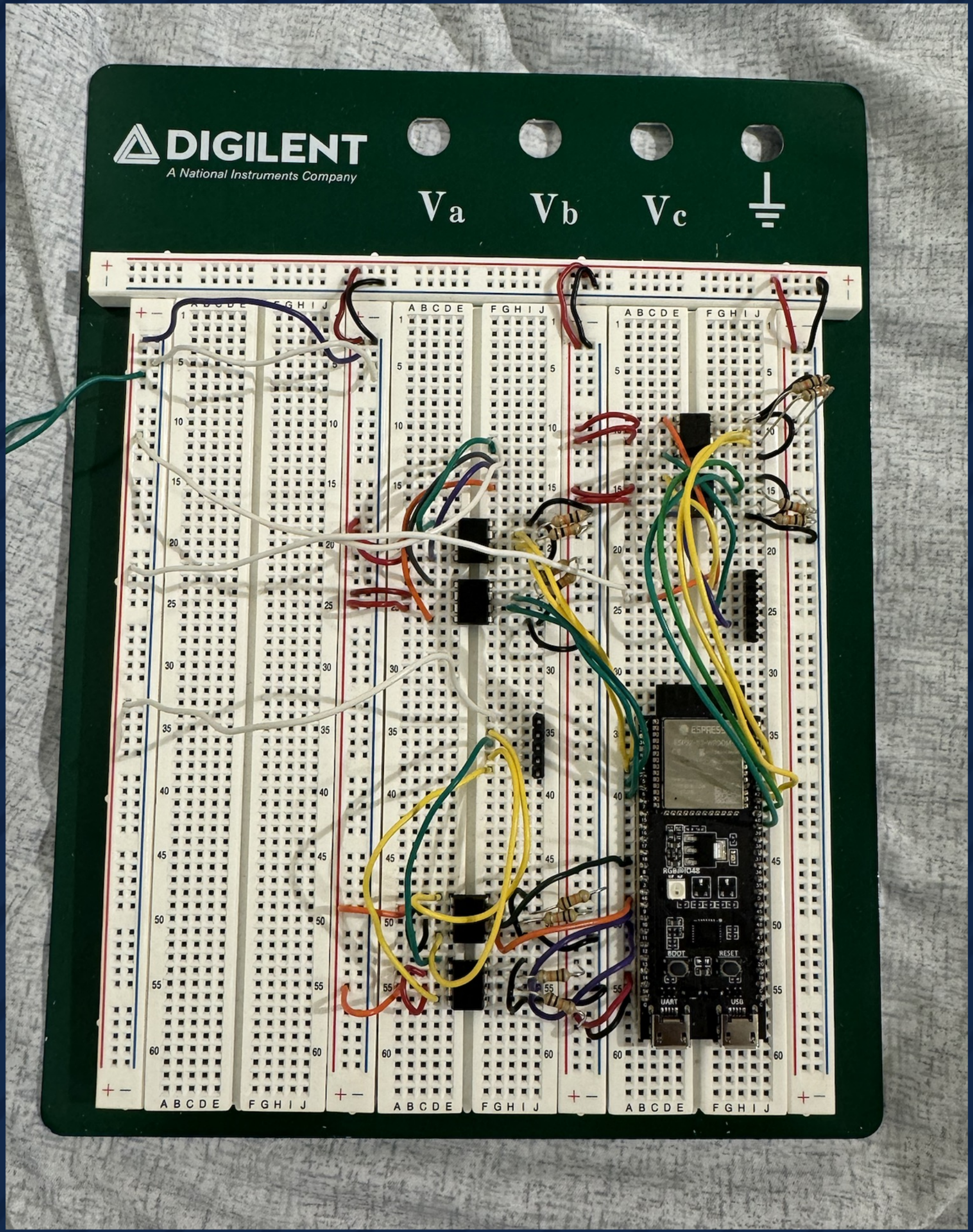
Demonstration Video



Successes

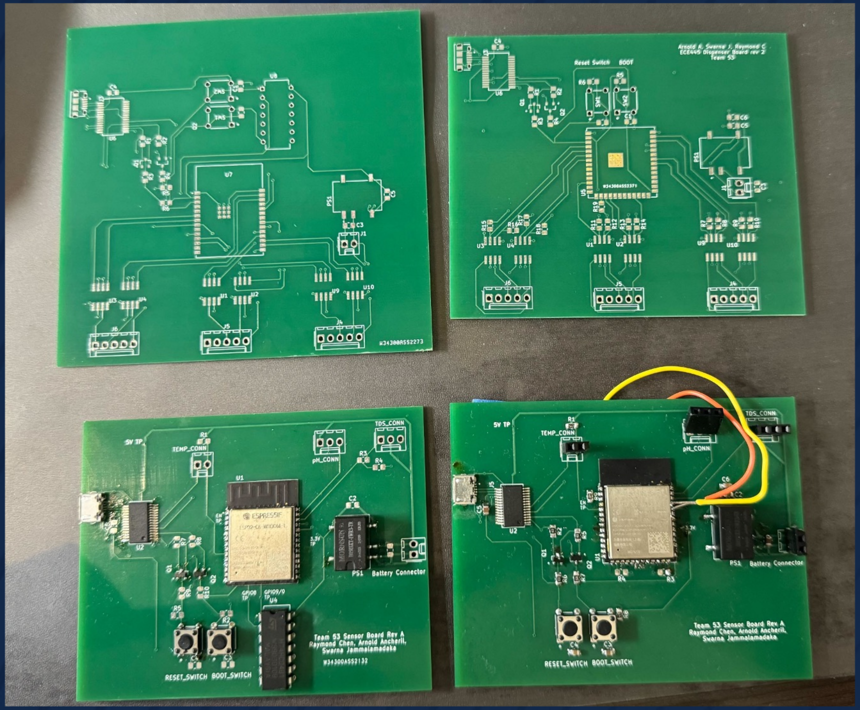
- Collecting sensor data
- Dispenser motor control
- Wireless connection





Failures

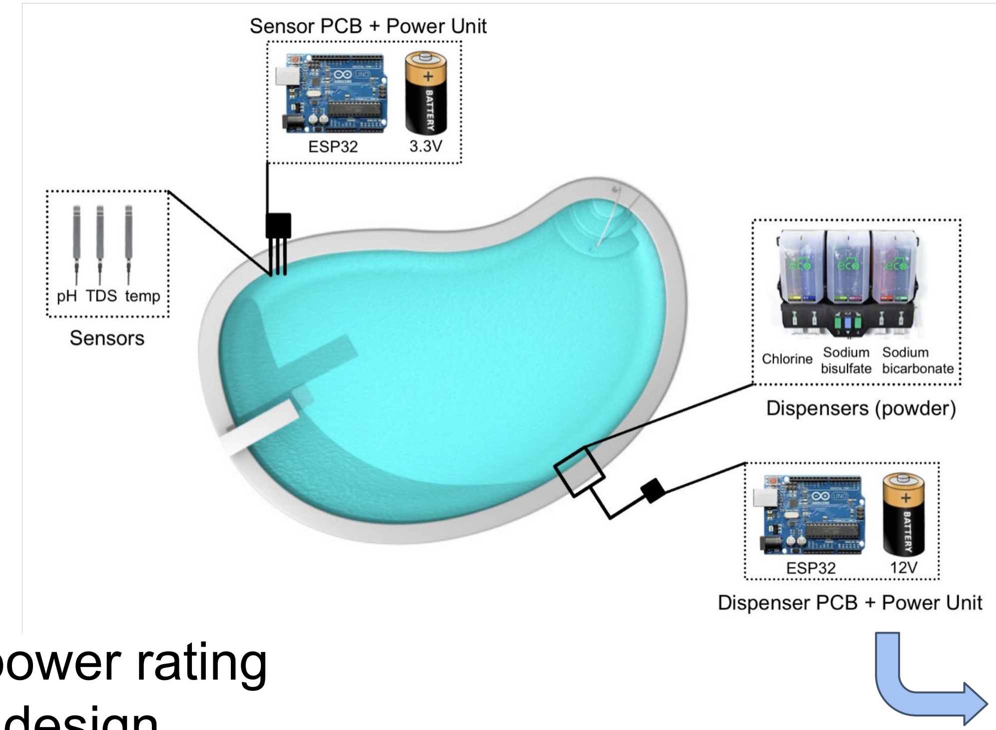
- PCBs did not work
- Friction Issue with Dispenser
- Breadboard caused design/circuitry changes



Conclusion

Learned:
- PCB Design
- Using microcontrollers

Changes:
- 12V stepper motors/higher power rating
- Possible different dispenser design



Expanding Our Project

- Improved sensor suite (Chlorine and Cyanuric Acid)
- Better filtration in pools to mix chemicals
- Develop an app to track data and have real time updates
- Scale up design for large community pools
- Solar power to system to make it self-sufficient and environmentally friendly

Thank You to all the Professors and TAs!

Special thanks to the Machine Shop and Selva!

Thank You!

We would love to answer your questions now.

The Grainger College of Engineering

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