UNIVERSITY OF
ILLINOIS
URBANA-CHAMPAIGN

Bike Alert Team 36

Electrical & Computer Engineering

David Youmaran (dcy2)
Diego Herrera (dherr4)
Kenneth Kim (kk67)

Objective

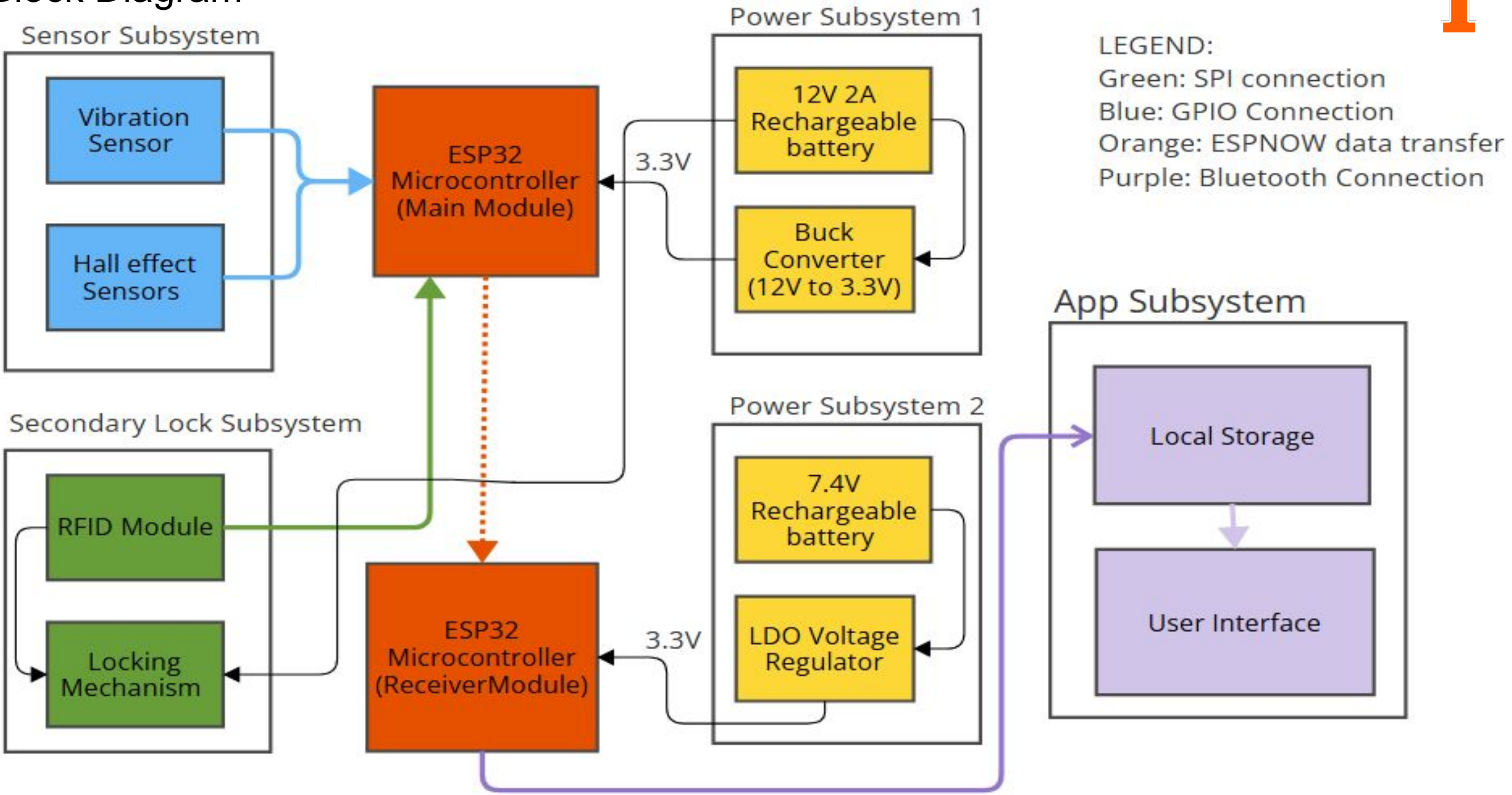
Problem

- Bicycle theft is a major issue, especially on campus.
- Traditional locks provide physical security, they fail to notify owners when theft attempt occurs.

Solution

- Enhance traditional lock using a secondary locking mechanism and collect sensor data using ESP32 microcontroller.
- Sensor data is relayed from a sender ESP32 to a receiver ESP32 via ESP-NOW and alerts are sent from receiver ESP32 to user via Bluetooth.

Block Diagram



Power Subsystems

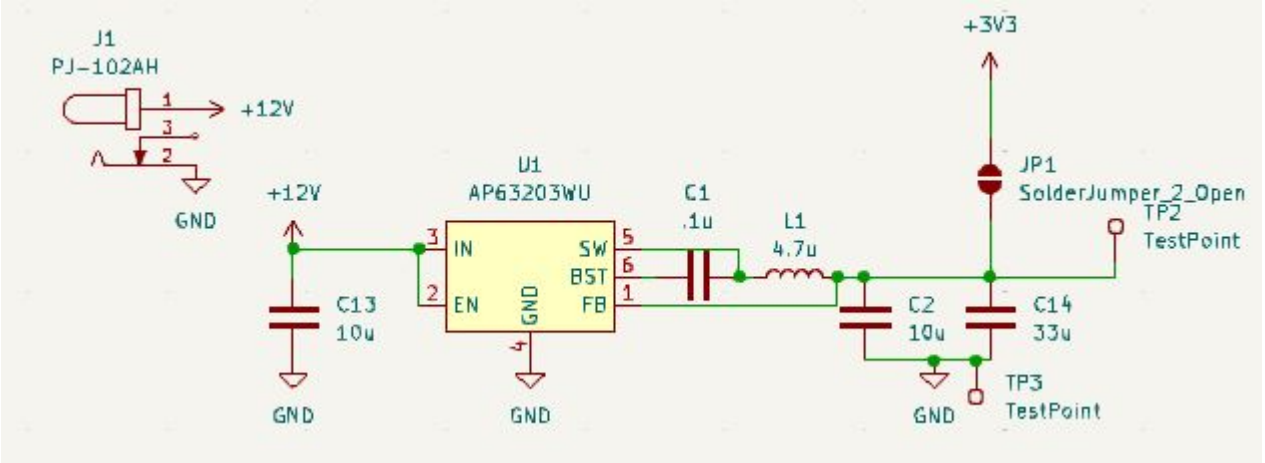
Requirements:

Provide 24 hrs of stable power on a single charge

Original Design:

Main Board: 12vin 3.3v out LDO circuit

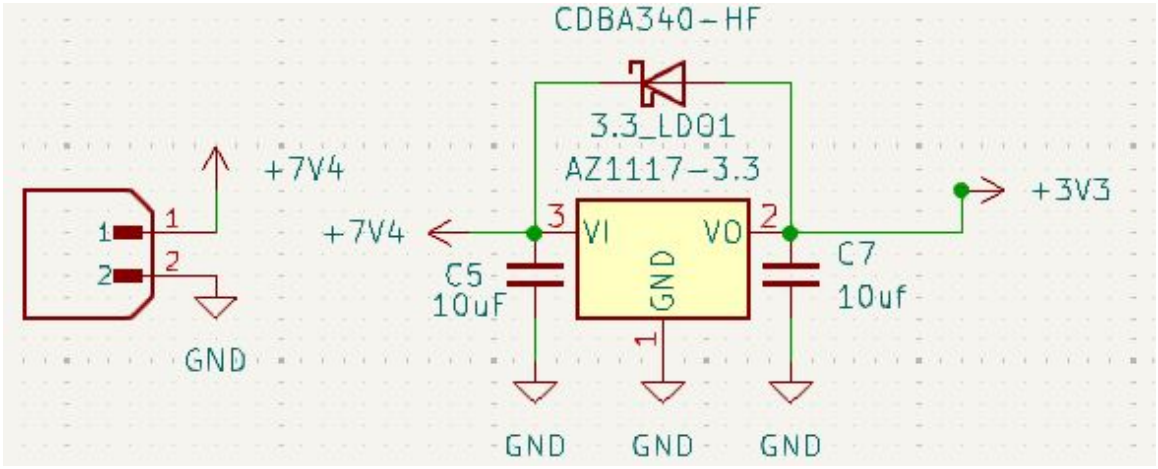
Receiver Board: 3.7v in 3.3v out LDO circuit



Updated Design:

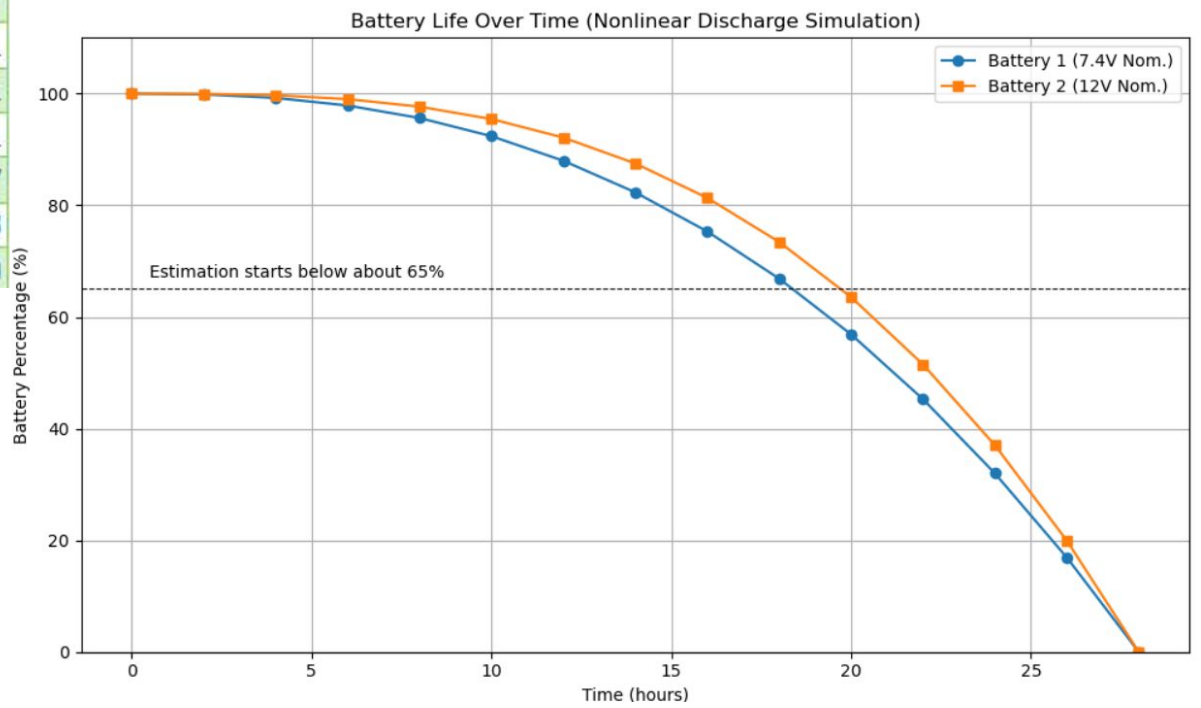
Main Board: 12vin 3.3v out Buck converter circuit

Receiver Board: 7.4v in 3.3v out LDO circuit



Function Test Result - Battery Life

Time (hrs)	Battery 1 Voltage (V)	Battery 1 (%)	Battery 2 Voltage (V)	Battery 2 (%)
0	8.4	100	12.32	100
2	8.39754556	99.86364222	12.31970117	99.96355685
4	8.386115591	99.22864393	12.31760933	99.70845481
6	8.361739067	97.87439263	12.31193149	99.01603499
8	8.321457921	95.63655115	12.30087464	97.66763848
10	8.262792634	92.37736856	12.28264577	95.44460641
12	8.18356348	87.97574891	12.2554519	92.12827988
14	8.081801948	82.32233047	12.2175	87.5
16	7.955698905	75.31660584	12.16699708	81.34110787
18	7.803571086	66.86506031	12.10215015	73.43294461
20	7.623837929	56.87988496	12.02116618	63.55685131
22	7.415004767	45.2780426	11.92225219	51.4941691
24	7.175650154	31.9805641	11.80361516	37.02623907
26	6.904416047	16.91200262	11.6634621	19.93440233
28	6.6	0	11.5	0



- 12V 2.6Ah (31.2Wh) lithium-ion battery
  - 26.8Wh needed
- 7.4v 2.6Ah (19.24Wh) lithium-ion battery
  - 17.825Wh needed

Locking Subsystem

Requirements:

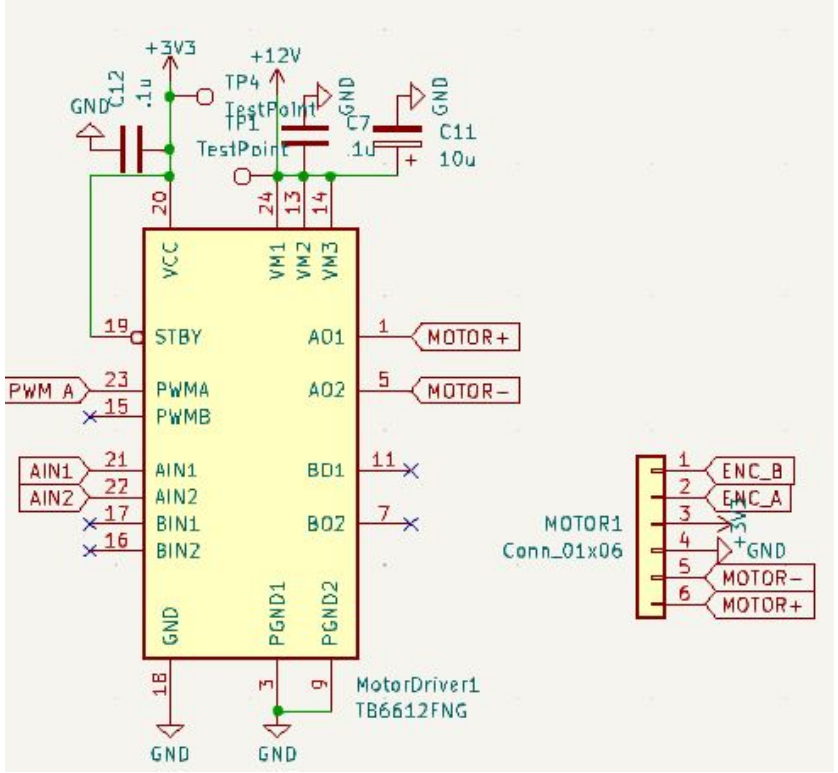
Have a secondary locking mechanism that is controlled via RFID

Original Design:

Motor driver chip (tb6612fng), connected to ESP32 and motor itself. RFID integration is software.

Updated Design:

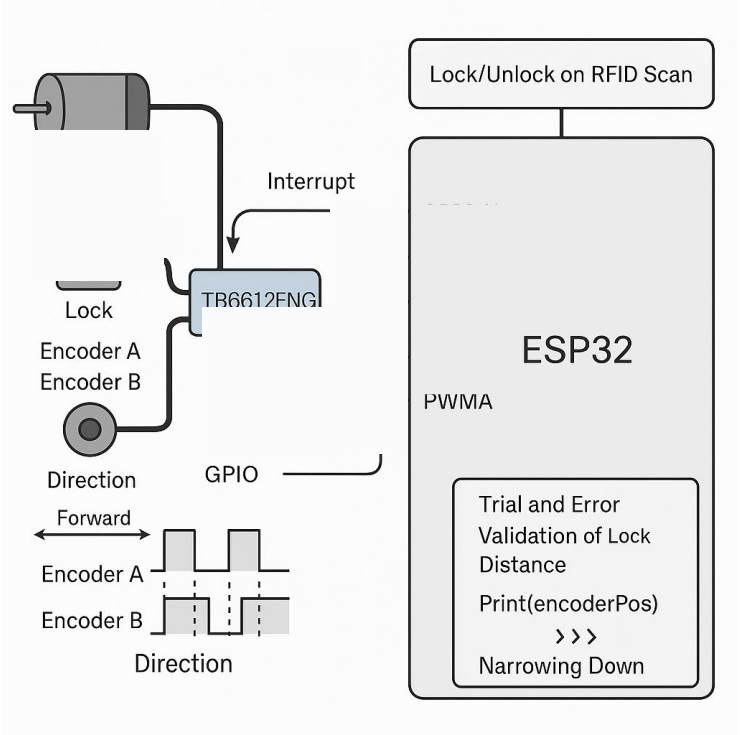
No updates to the circuit, nor physical design.

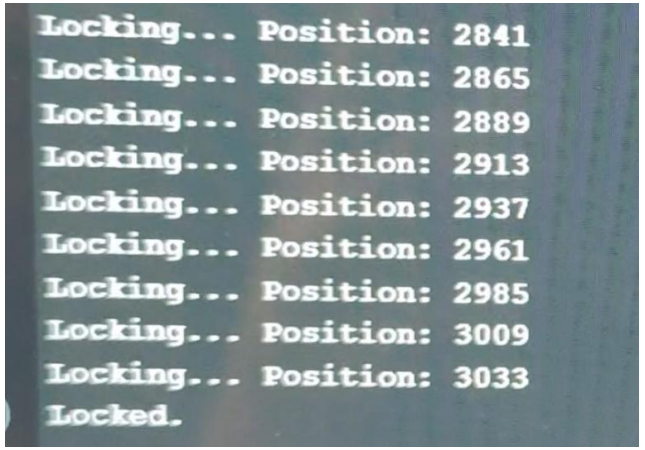


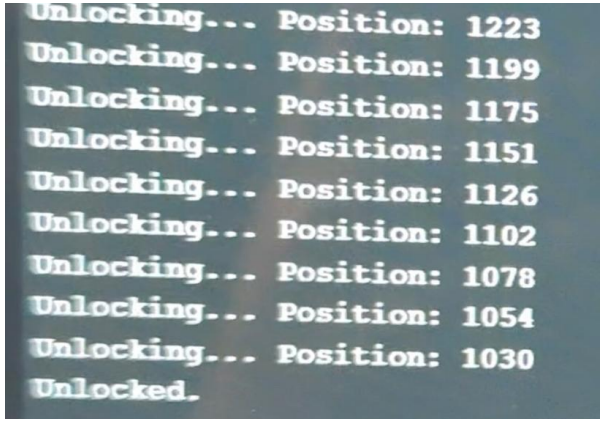
Function Test Result - Motor System

Key Components

- Encoder Position
  - EncoderA, EcoderB
- Locked/Unlock state
- Lock Distance
- Target Position (Encoder Pos.+Lock Dis.)







Sensor Subsystem

Requirements:

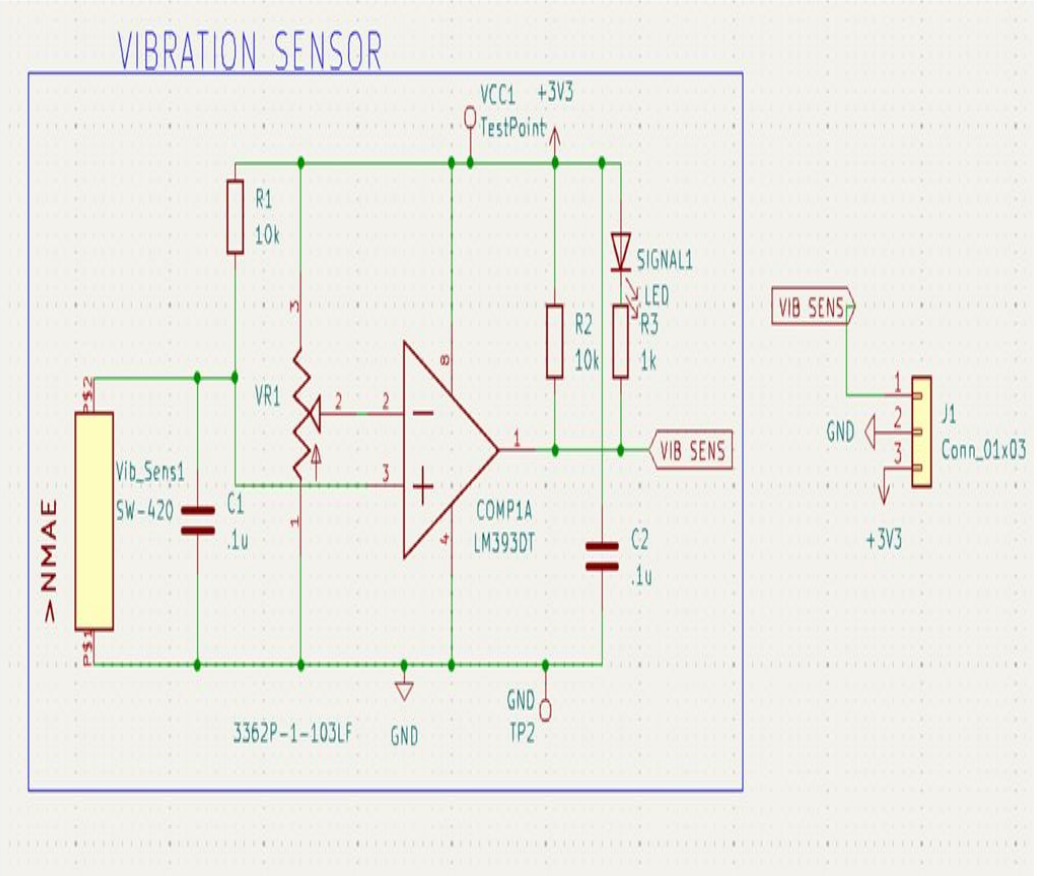
Differentiate between accidental movements and tampering.

Original Design:

Vibration sensor circuit and 2 Hall Effect sensors.

Updated Design:

10k pull up resistors added between +3.3V and output of each sensor.
LM393 comparator of vibration sensor circuit revised (pin 4 connects to GND, pin 8 connects to +3.3V).



Function Test Result - Sensor Triggers

The following sensor trigger data is for the 3 Hall Effect sensors considered in this design.

Sensor Model	Distance away from magnet required to trigger (inches)
SS441R (High Sensitivity)	0.625
SS443R (Medium Sensitivity)	0.5
SS449R (Low Sensitivity)	0.25

Microcontroller Subsystem

Requirements:

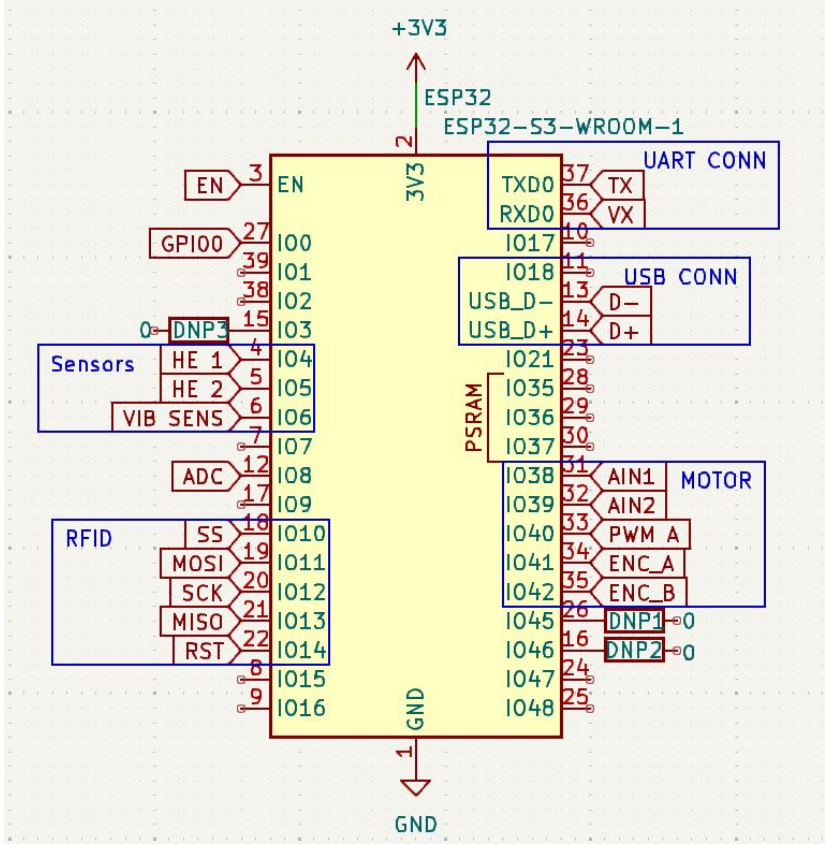
The brain: be able to program in order to manage and process information from all substems while minimizing latency, have access to serial monitor.

Original Design:

Implement dual programing circuit on board (UART and micro USB) based on the ece 445 Wiki.

Updated Design:

Programming was done exclusively via UART



Mobile Application Subsystem

Requirements:

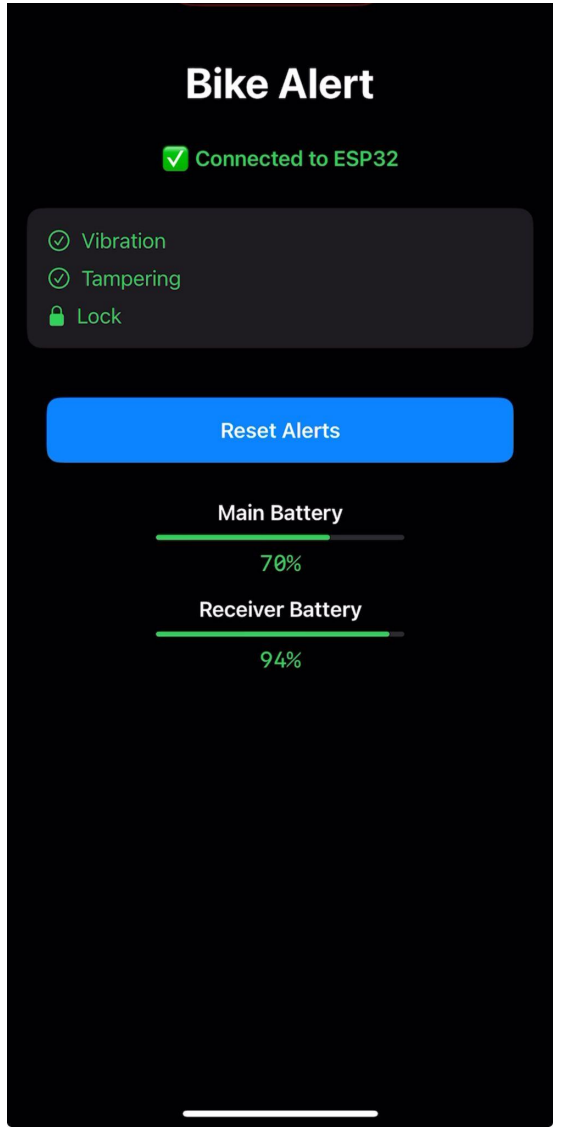
Provide Bluetooth Low Energy (BLE) communication and send real time alerts from the main PCB.

Original Design:

IOS app that received sensor data via ESP-NOW and displays monitoring for the vibration, tampering and whether the lock is engaged or not.

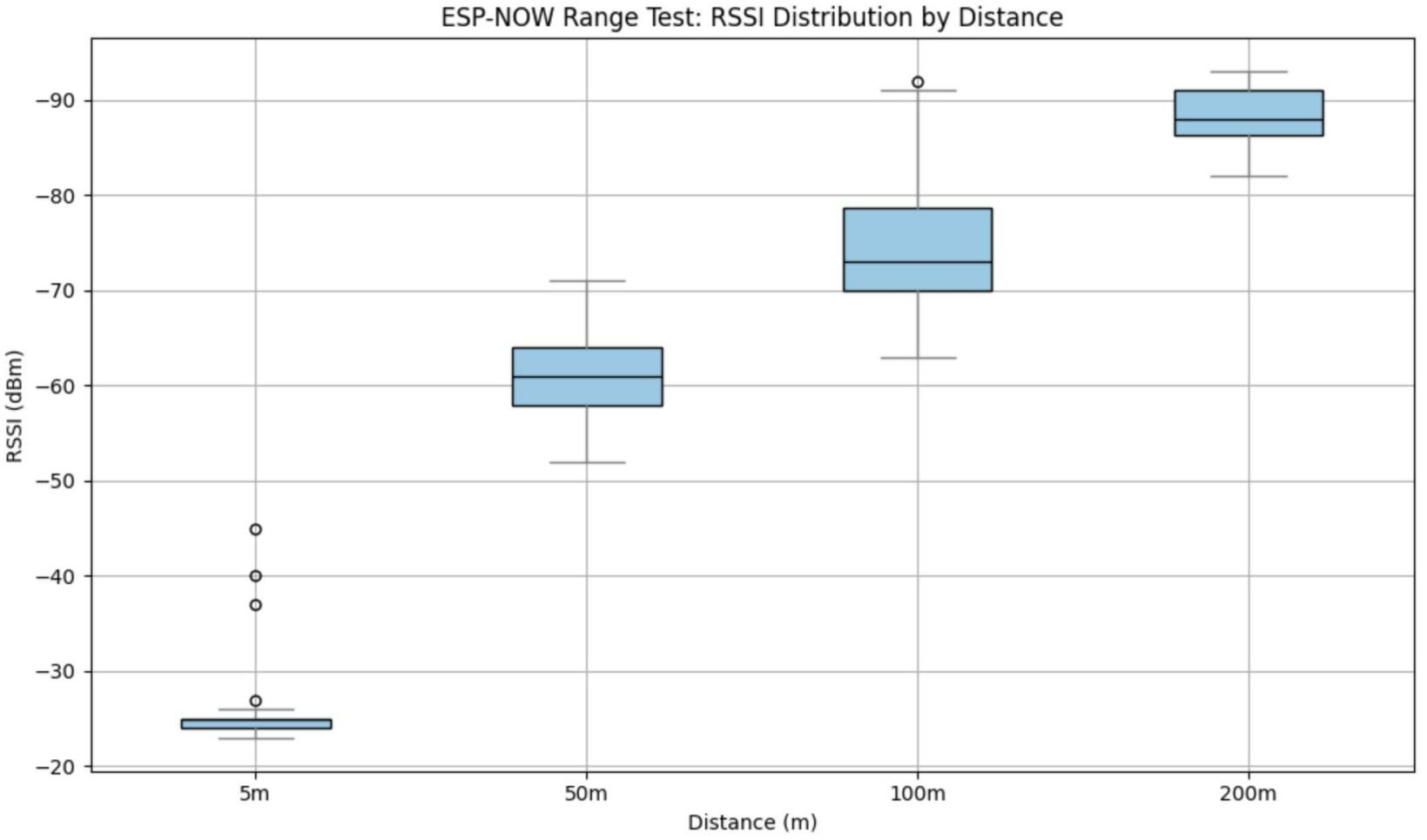
Updated Design:

Battery monitoring for the main and receiver battery, as well as a reset alerts button.



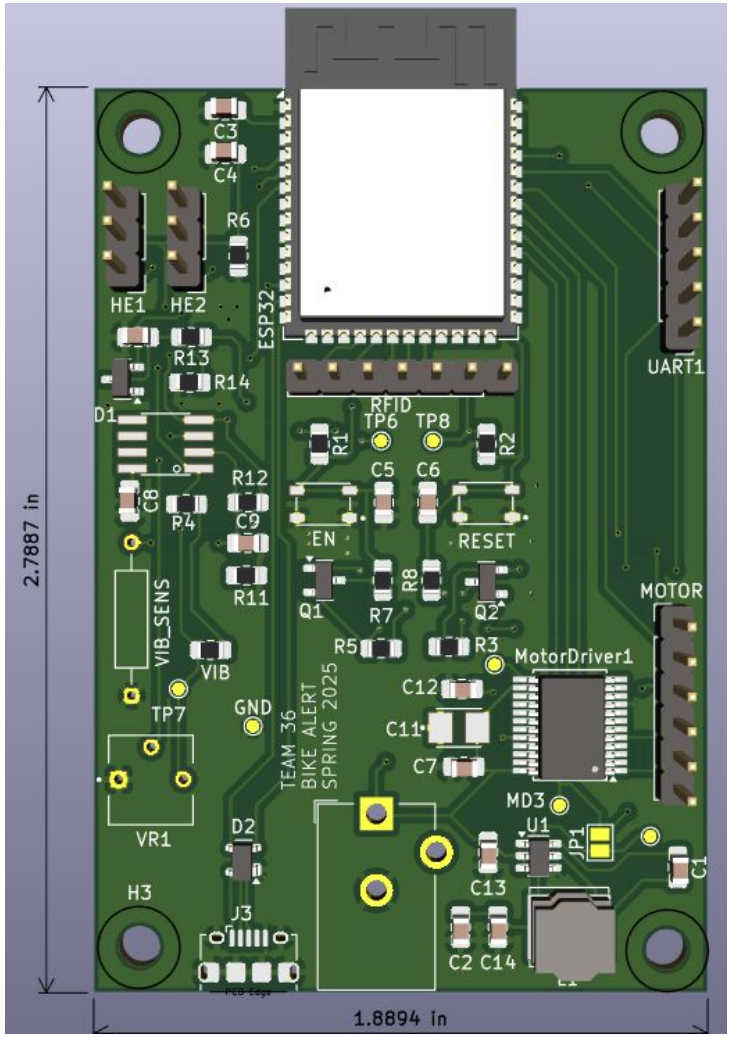
Function Test Result - Range and Signal Strength

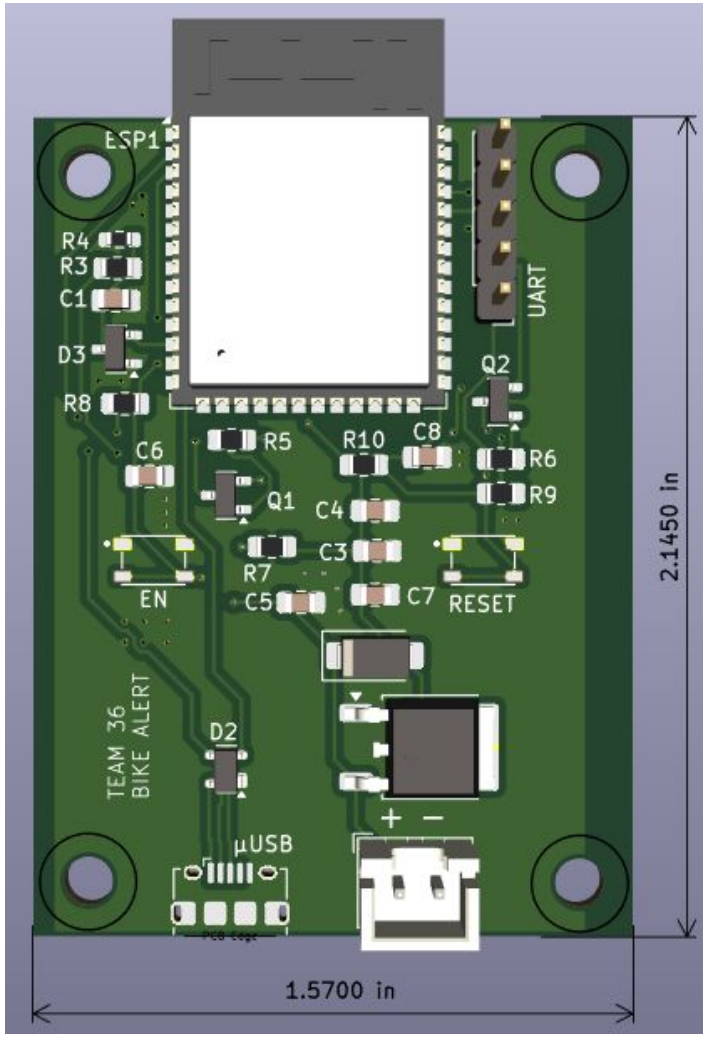
RSCP	Signal Strength
-60 to 0	Excellent
-75 to -60	Good
-85 to -75	Fair
-95 to -85	Poor
-124 to -95	Very poor



Physical Design

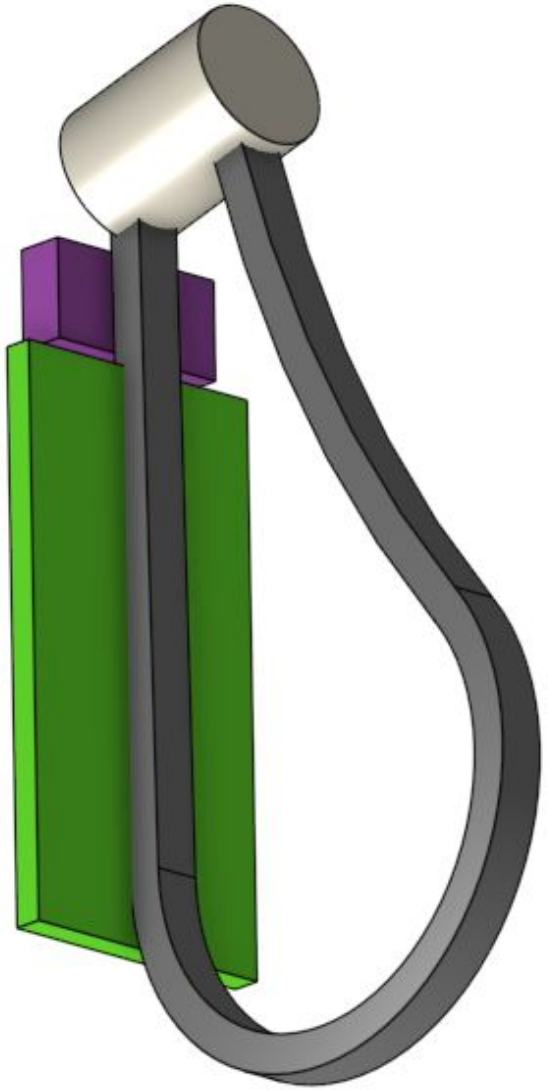
Main Board

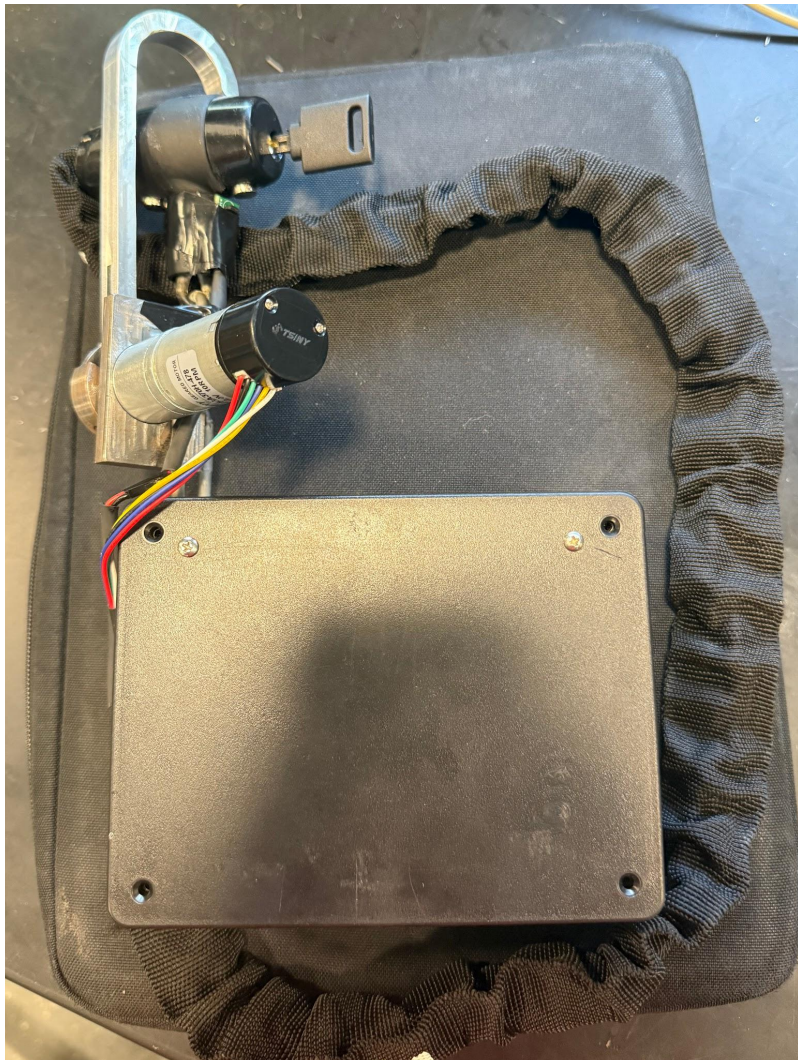




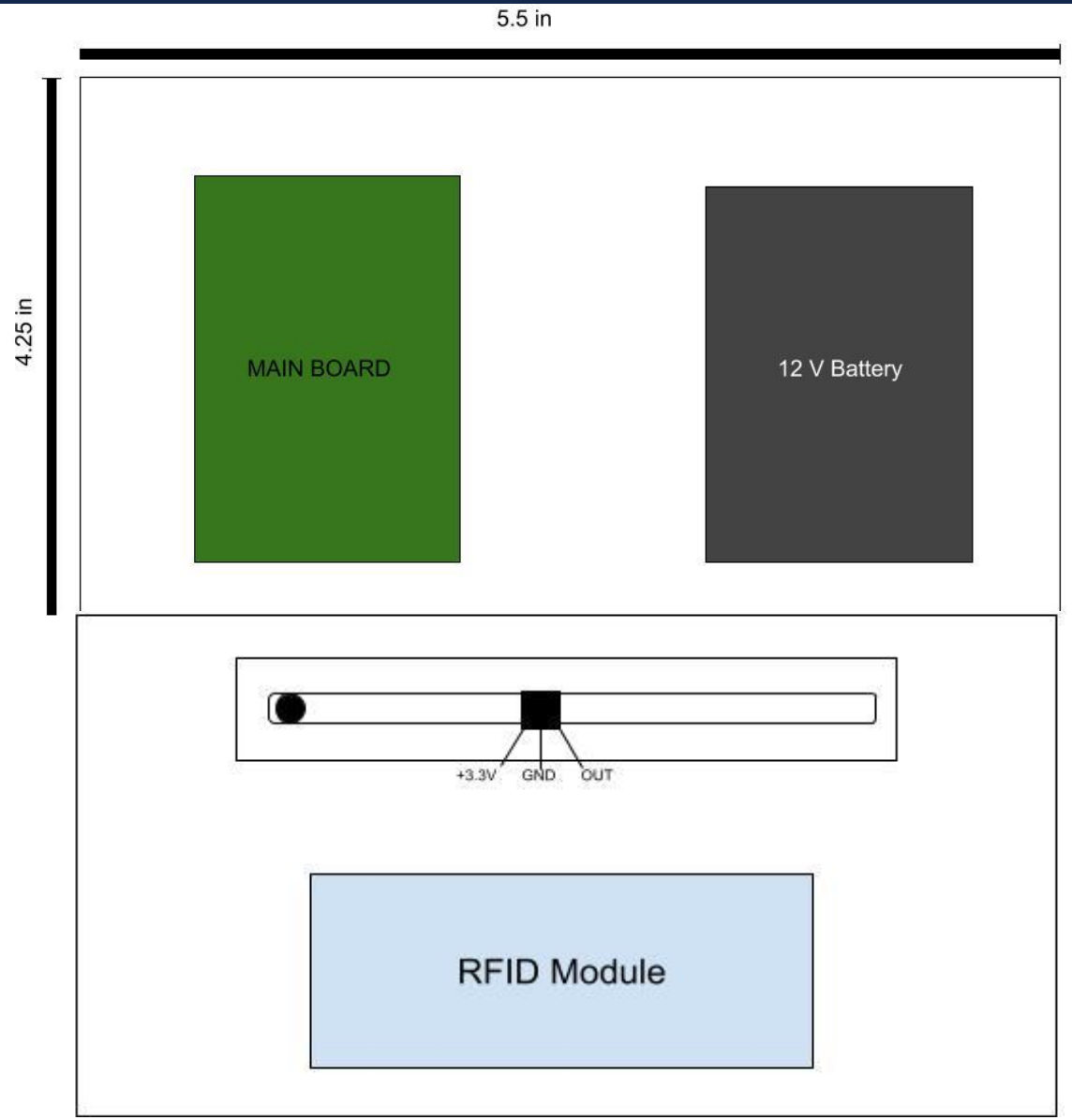
Receiver Board

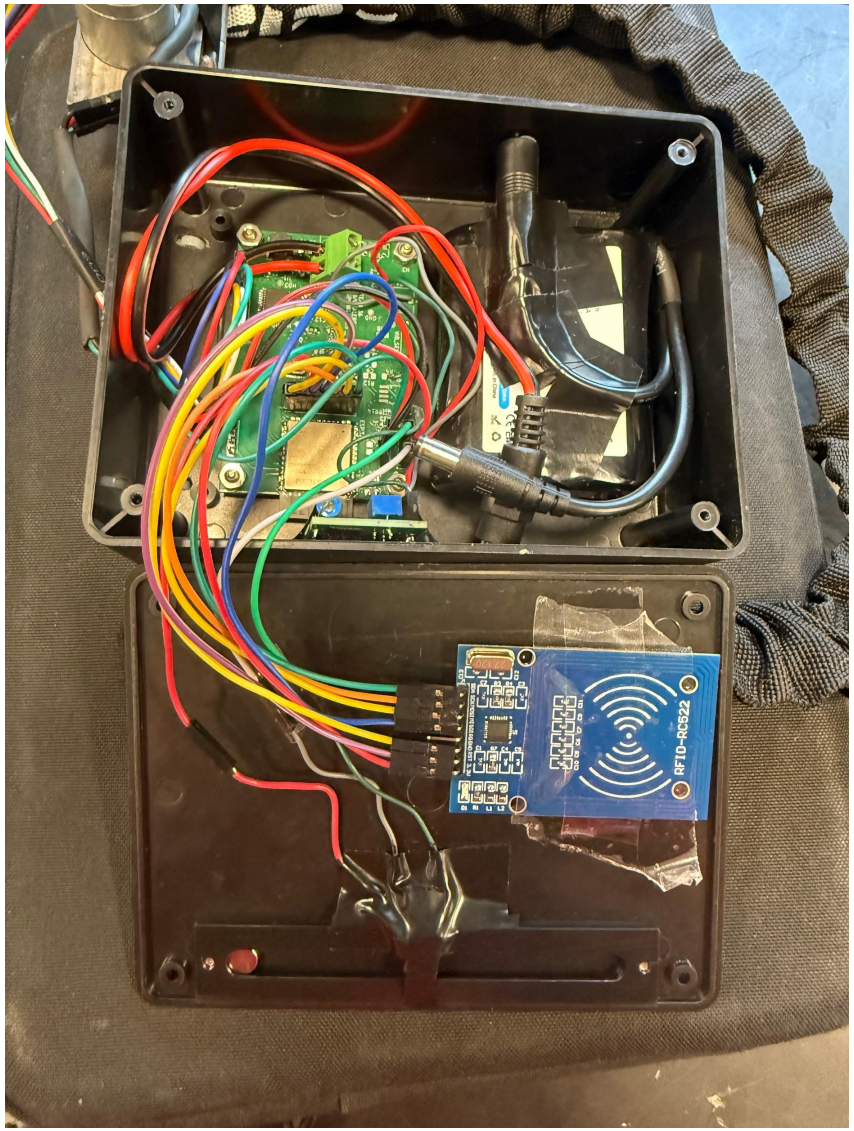
Physical Design





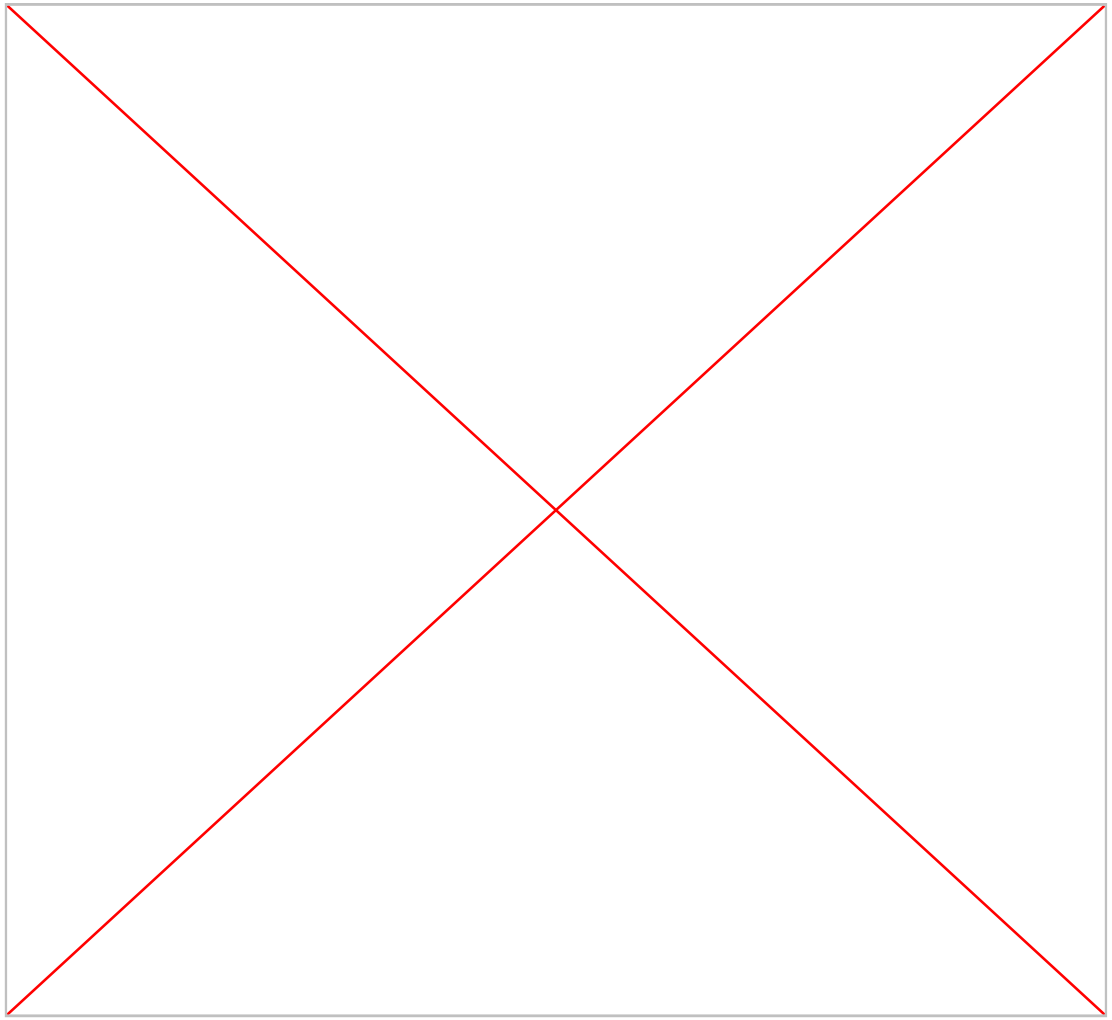
Physical Design



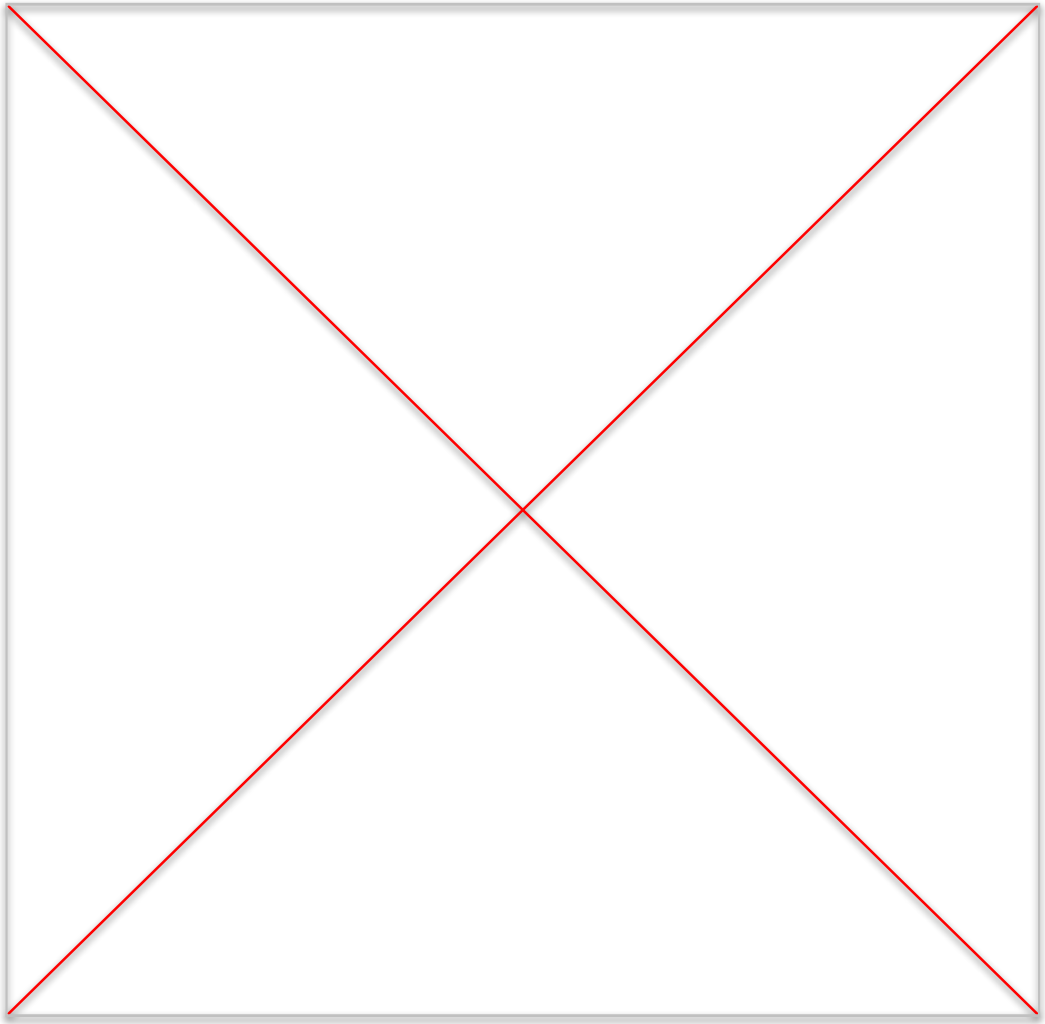


Project - Demo

BLE Connection



Demo



Successes and Challenges

Successes

- Dataflow pipeline working as expected
- Low latency alerts
- Hall Effect sensors work as intended
- Physical Implementation
  - First iteration worked, room for improvement
- Battery Life
  - Power consumption was as expected/lower

Challenges

- Motor Issues
  - Cheaper motor, Gears Slipped
- Soldering
  - Hand solder difficulties with good connections
- Debugging ESP-NOW and BLE
- Vibration Sensor Circuit

Thank You

Any Questions?

The Grainger College of Engineering

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN