Dwight Look College of ENGINEERING
TEXAS A&M UNIVERSITY

Team 0: Growable Space Habitat

Robert Dye
Justin Blankenhorn
Andrew Yang
Adam Pameron

Sponsor: Dr. John Lusher II, Dr. Hope Rising
TA: Rohith Kumar

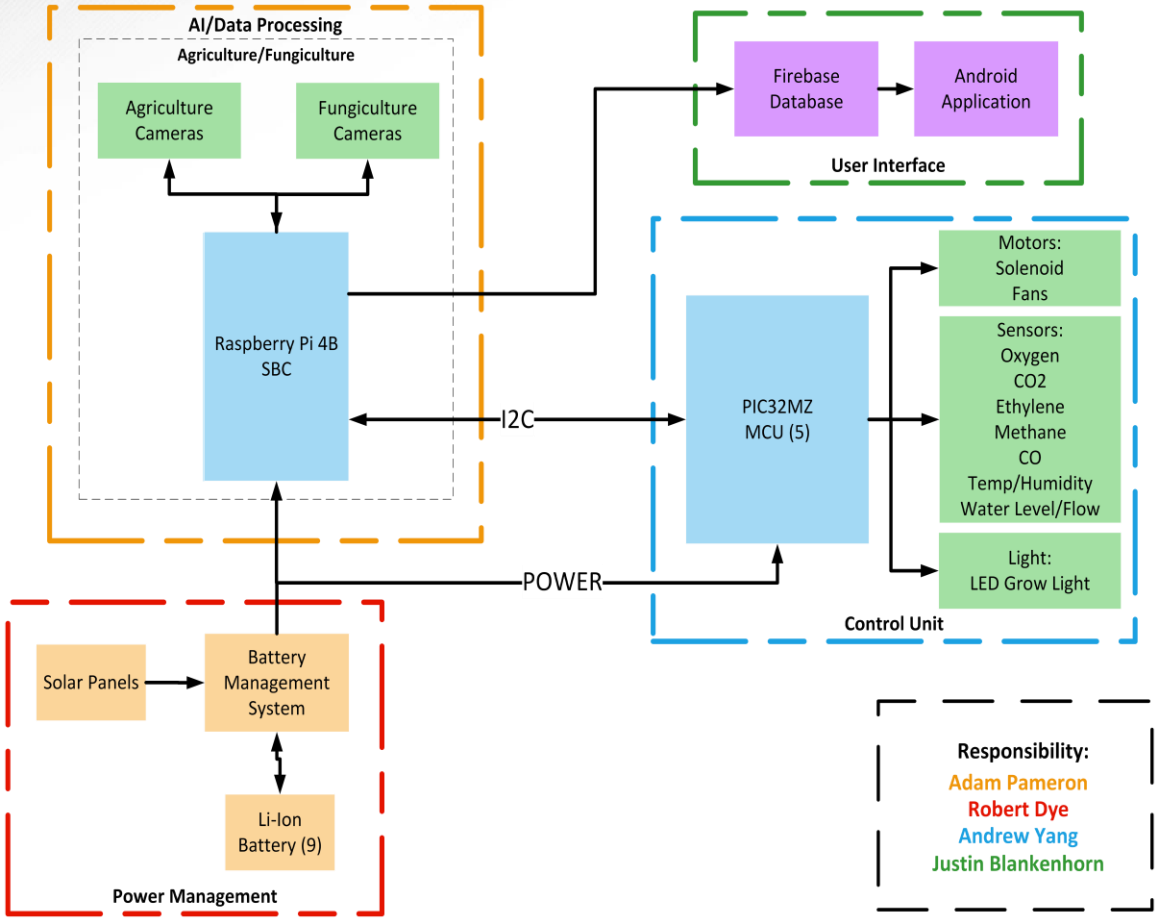
Project Overview

- Current space operations require constant resupply
  - Costly ($20,000 per kg)
  - Inefficient and wasteful
- Long term space missions need a sustainable food source
- Project provides electrical infrastructure for a self-sustaining system capable of recycling agricultural products

System-Level Requirements

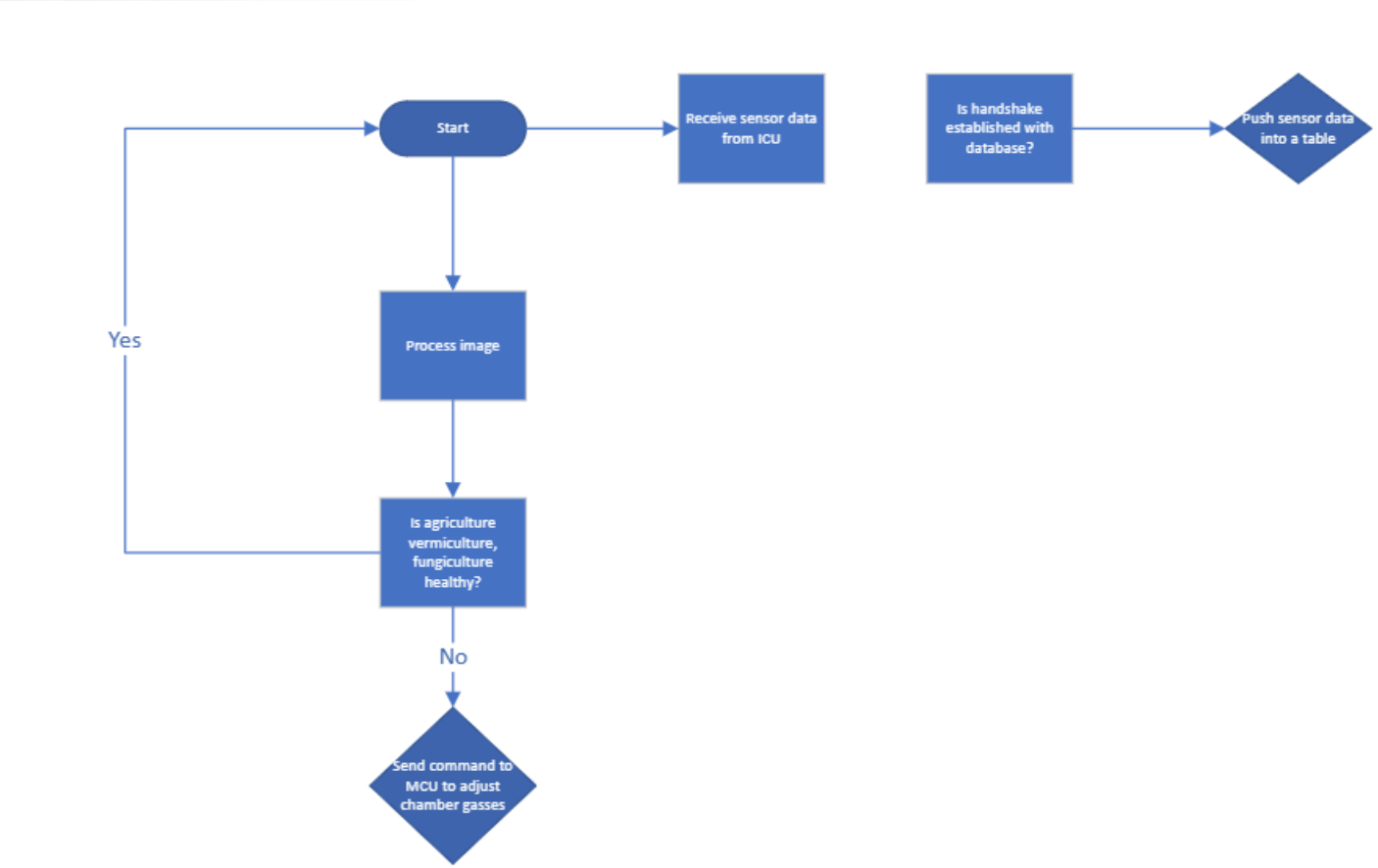
- Power Management-
  - Power MCU, AI/Data Processing
  - Charge battery through solar panel
  - Monitor battery pack
- MCU-
  - Control Peripherals
  - 1 of each type of sensor (I2C, Analog, UART, Digital (External clock)
  - Replacing 1 analog with 2 extra others (Temp/Humidity, solenoid)
- AI/Data Processing-
  - Binary Classifying model for tomato leaf as well as oyster mushroom (proxy data)
  - Reliably request data from MCU and send the data to the database
- User Interface-
  - Display data from MCU sensors on an app
  - Graph sensor values over time, Graph health of plant (1-healthy, 0-not)
  - Display camera pictures

Project/Subsystem Block Diagram



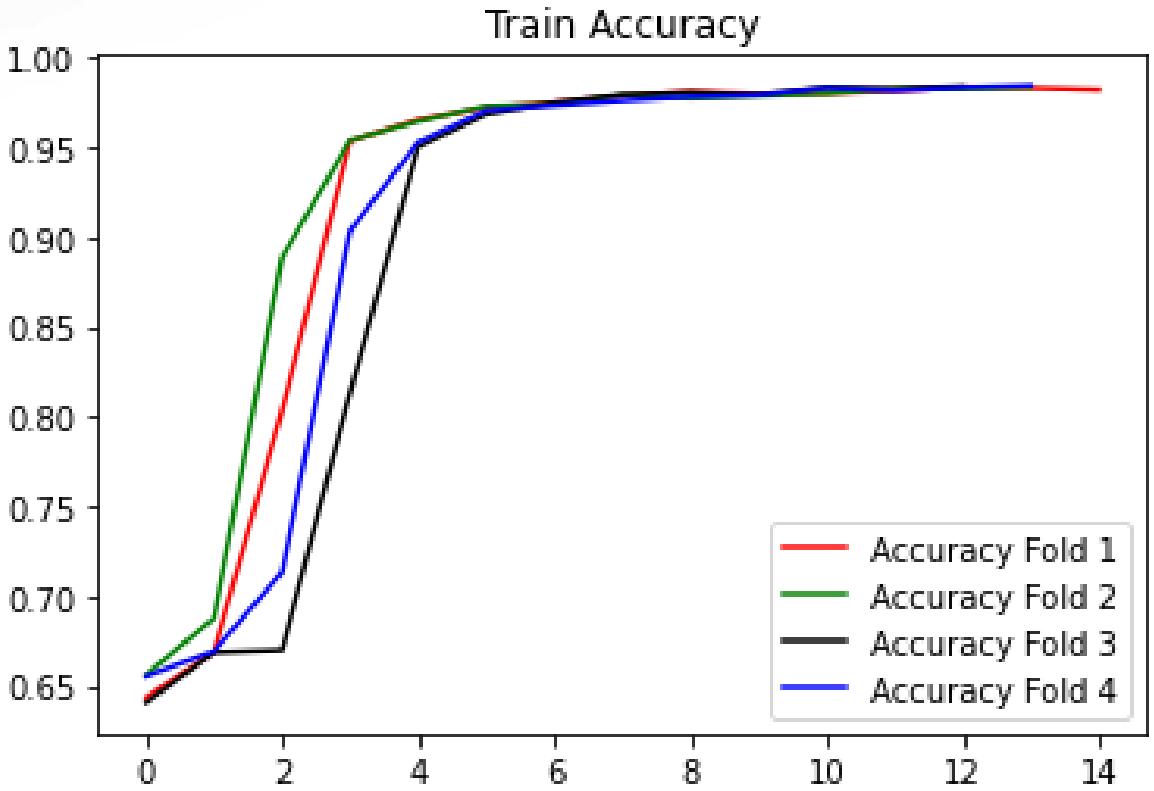
AI/Data Processing Accomplishments

Adam Pameron



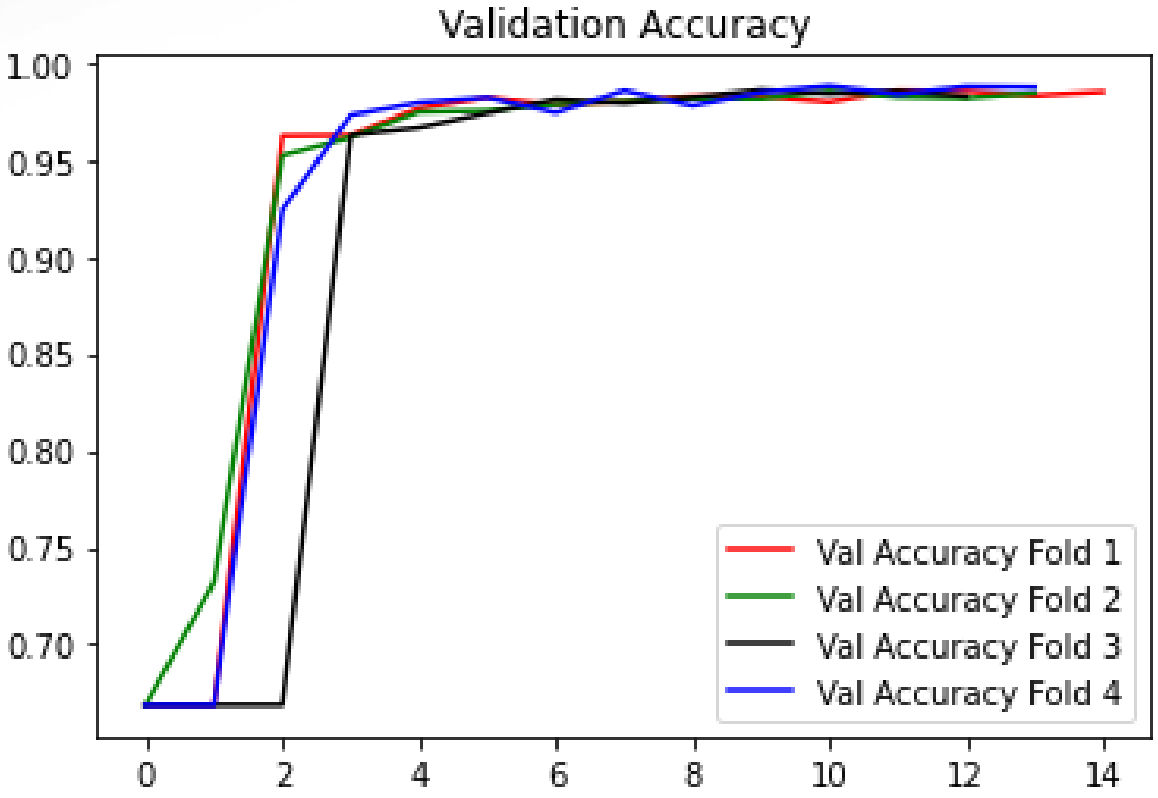
AI/Data Processing Subsystem – Train Accuracy 4 Folds

Adam Pameron



AI/Data Processing Subsystem – Validation Accuracy 4 Folds

Adam Pameron



AI/Data Processing Subsystem – Validation Accuracy 4 Folds

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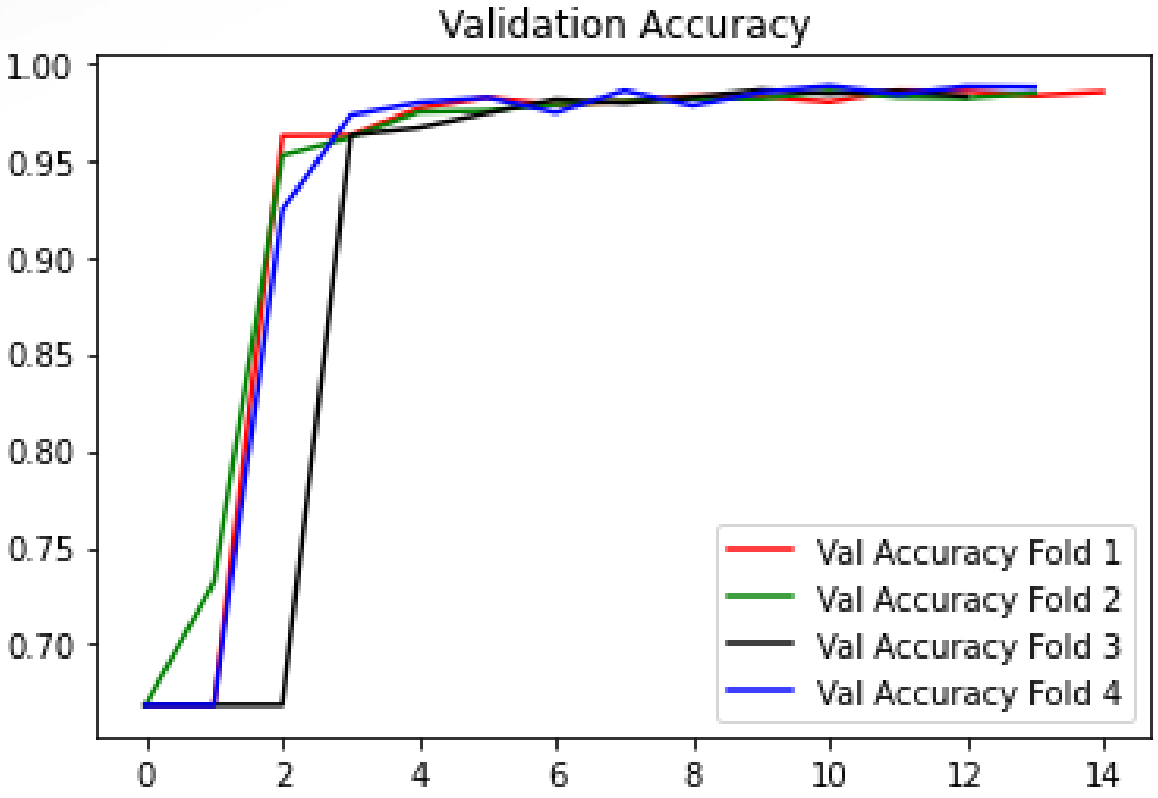
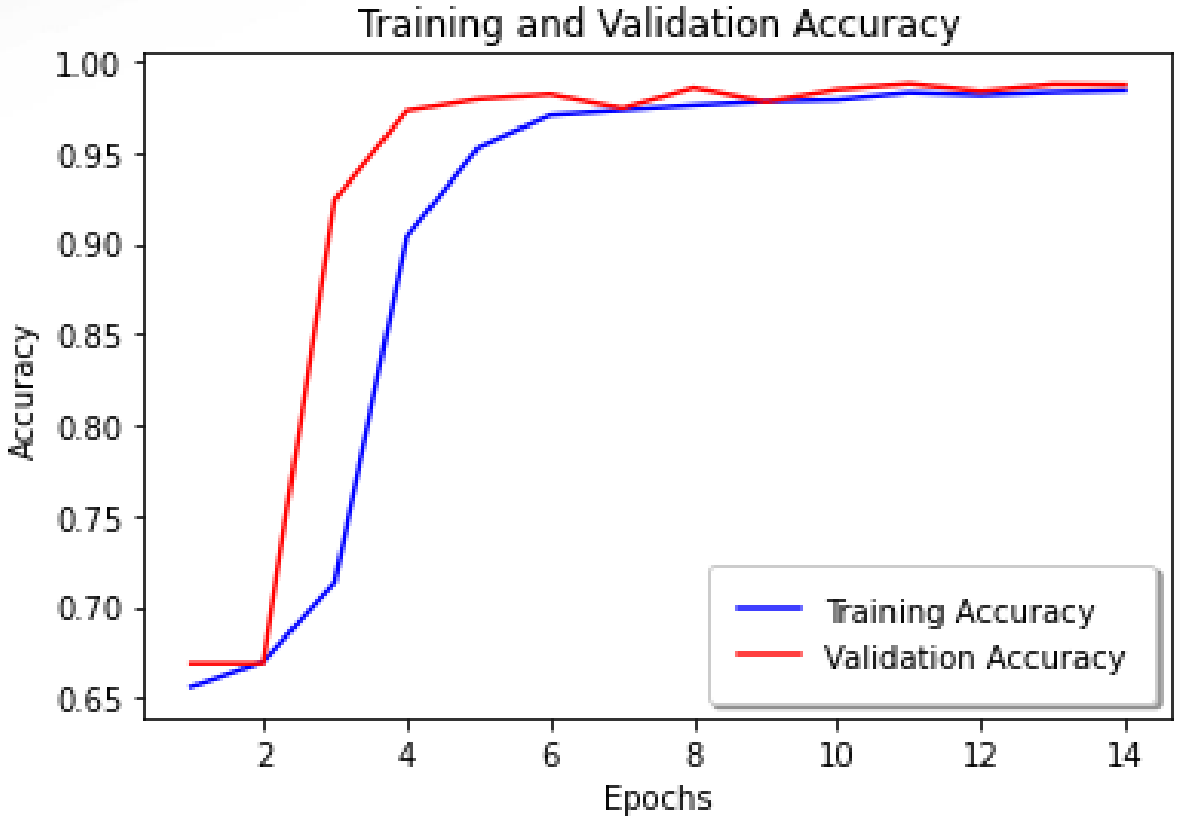


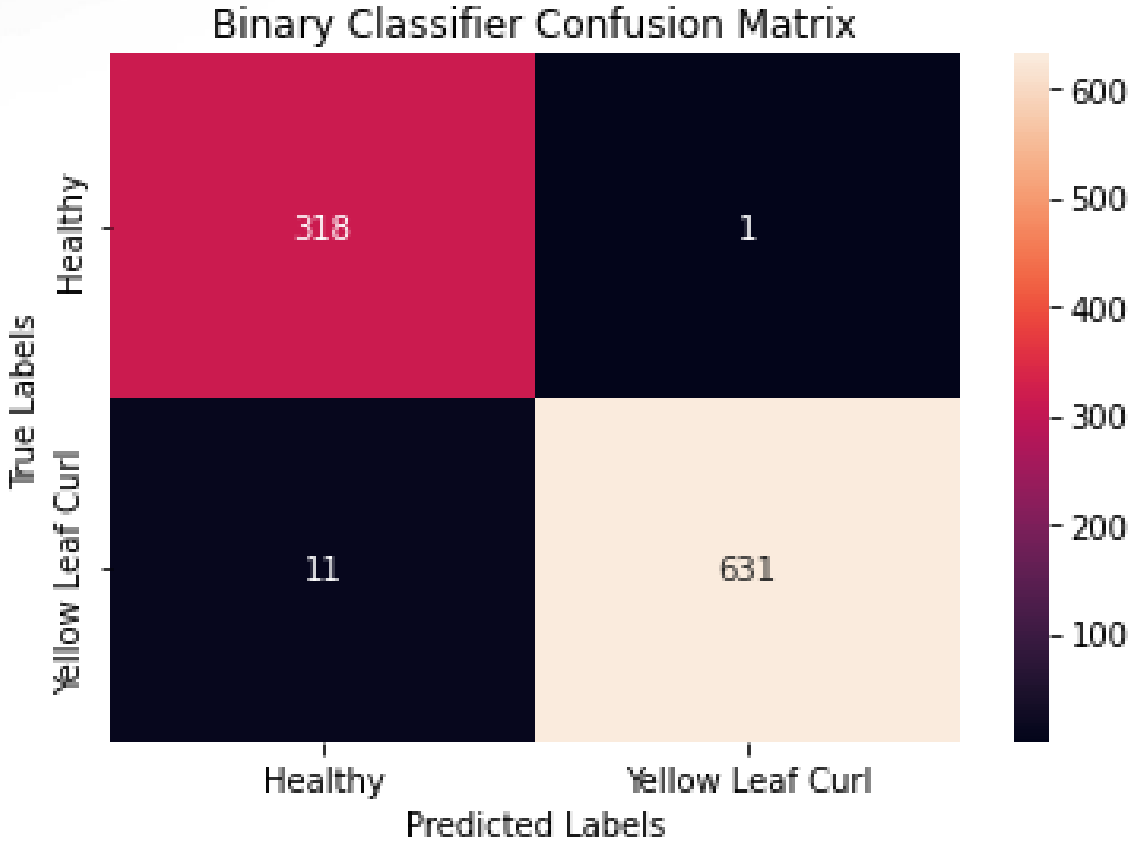
AI/Data Processing Subsystem – Training and Validation Accuracy Fold 4

Adam Pameron



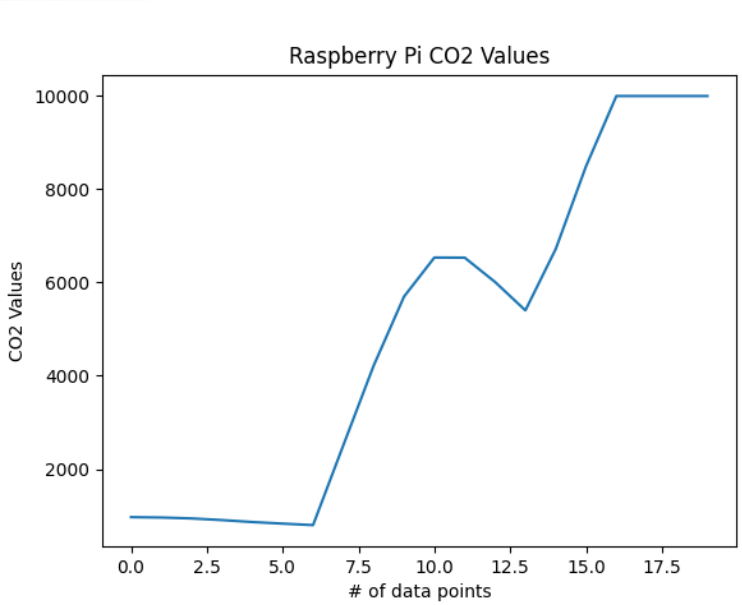
AI/Data Processing Subsystem – Confusion Matrix Fold 4

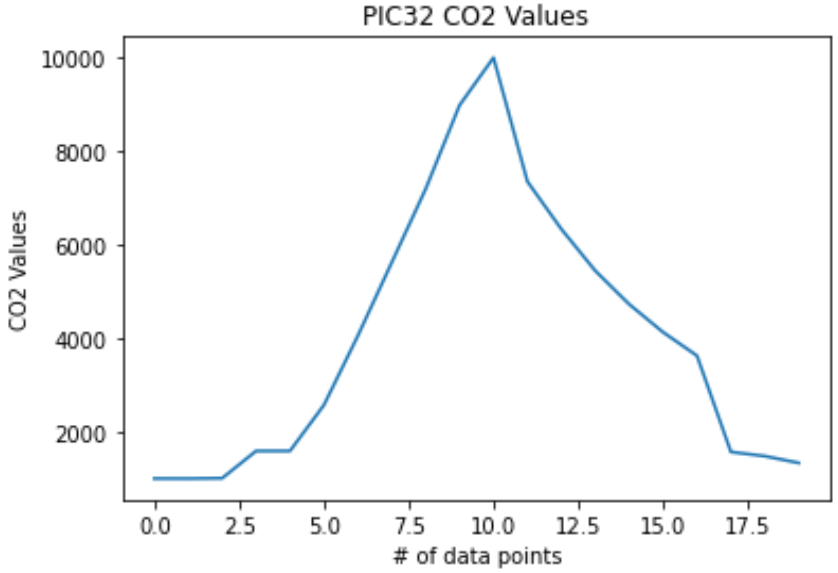
Adam Pameron



AI/Data Processing Subsystem – Pi and PIC32 CO2 Values

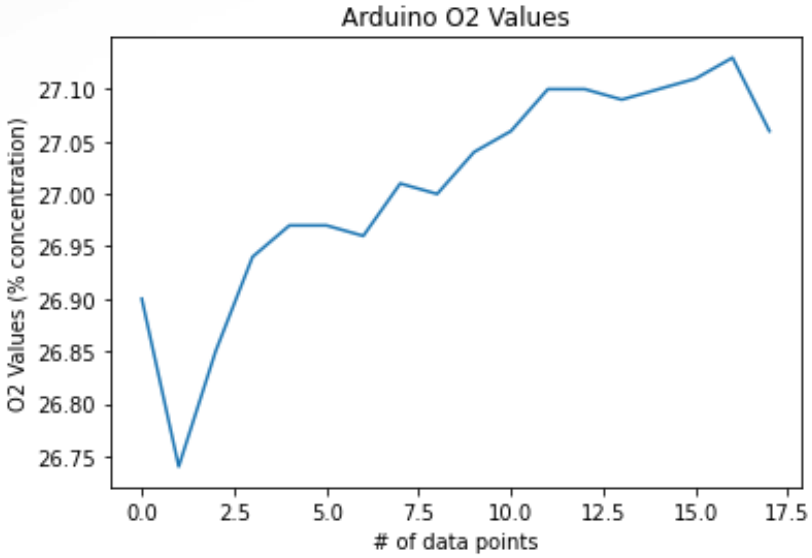
Adam Pameron

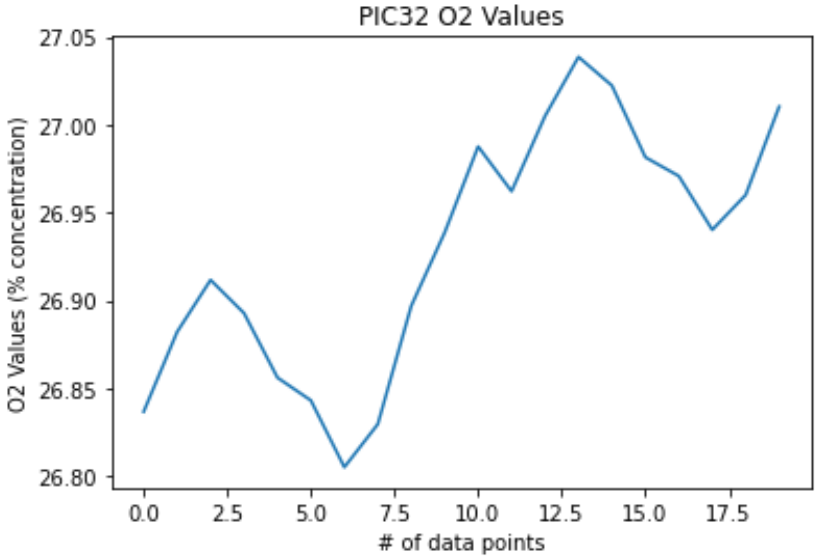




AI/Data Processing Subsystem – Arduino and PIC32 O2 Values

Adam Pameron





AI/Data Processing Subsystem

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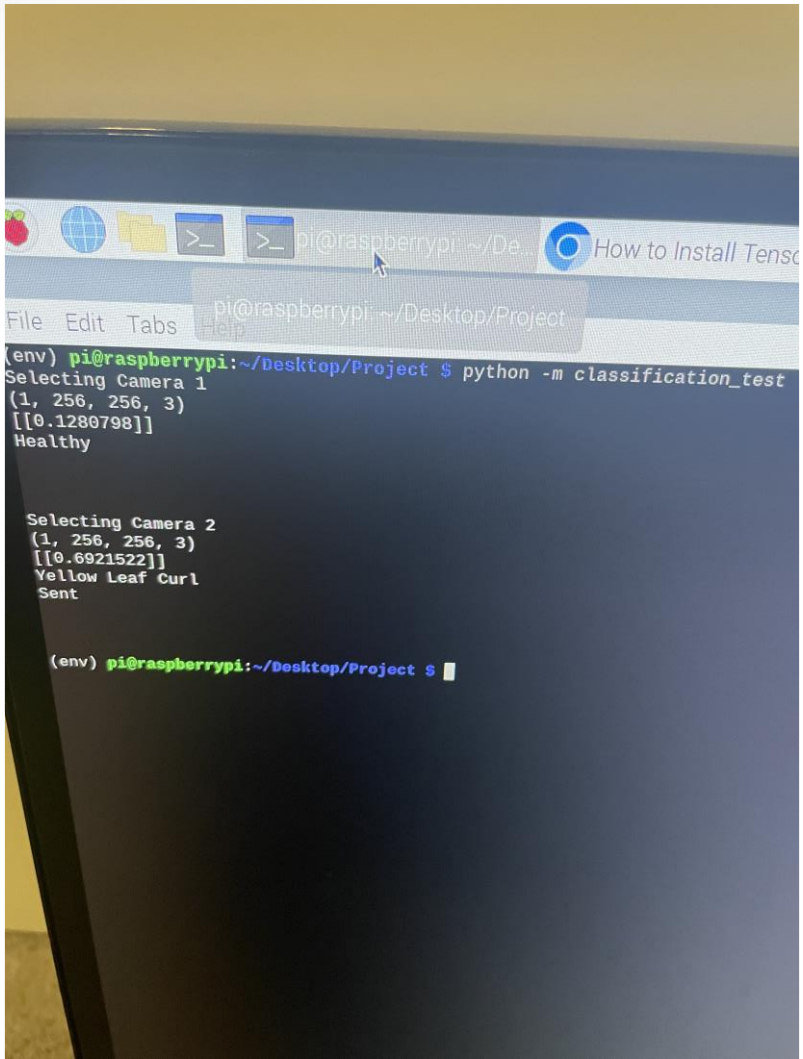
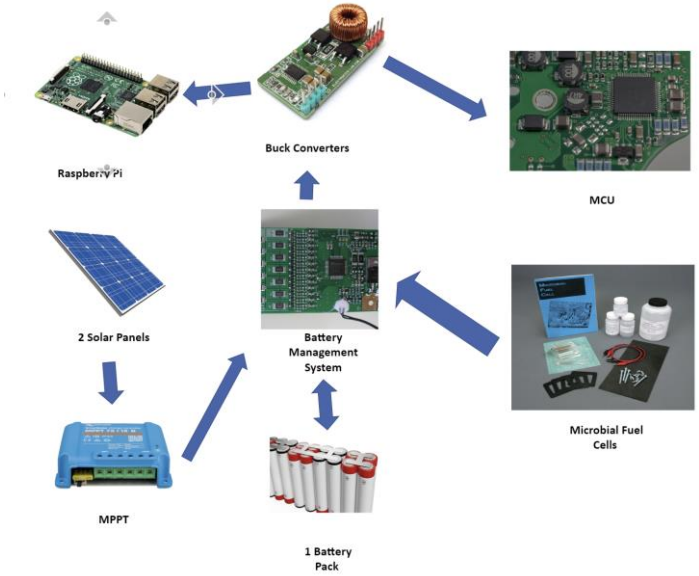


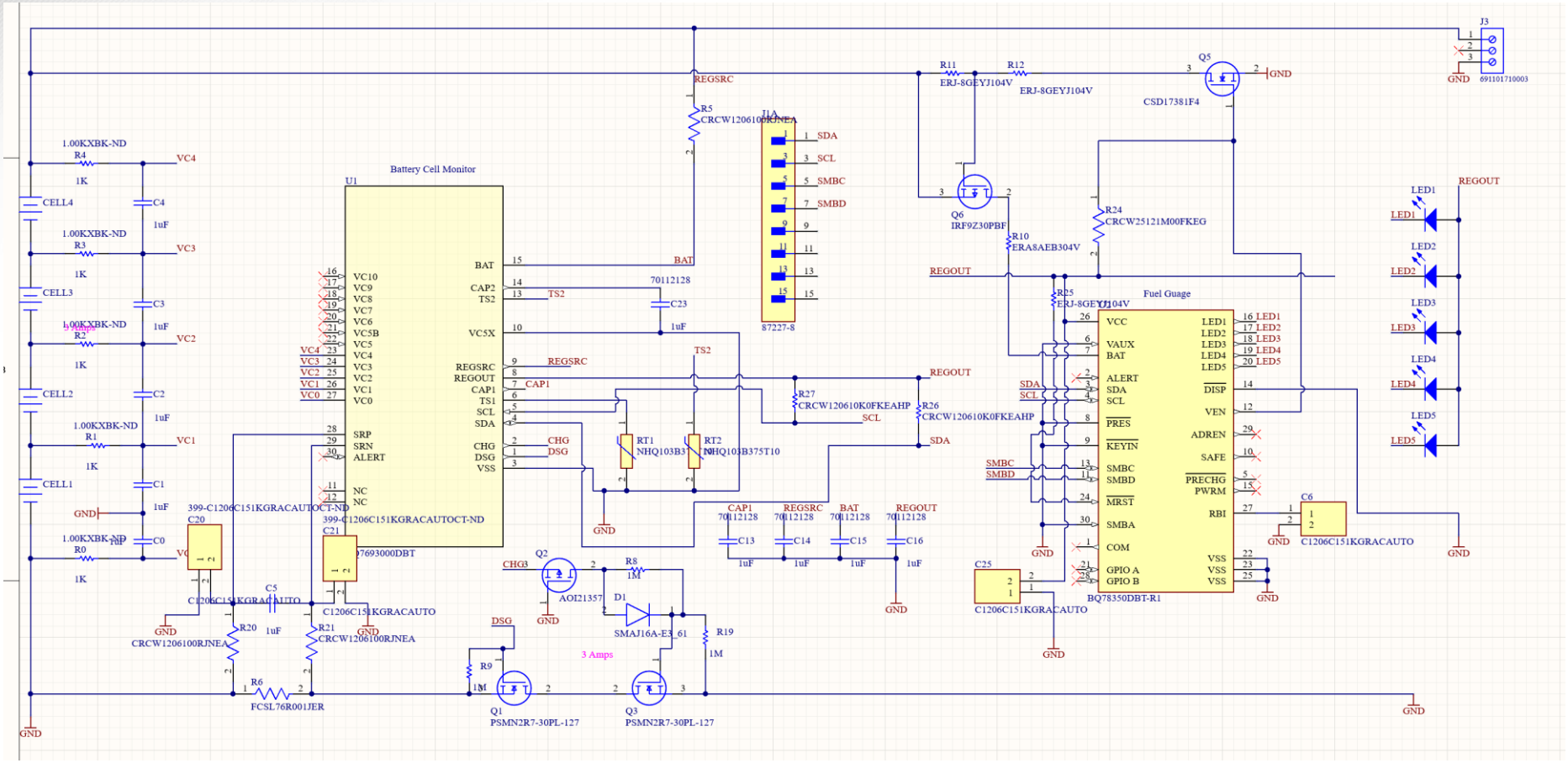
Power Management Accomplishments

Robert Dye

- BMS PCB
- Charging/discharging/power delivery
- Overcurrent Protection
- Design and solder 4 analog sensor circuits and PCBs with Andew



Power Management Accomplishments
Robert Dye



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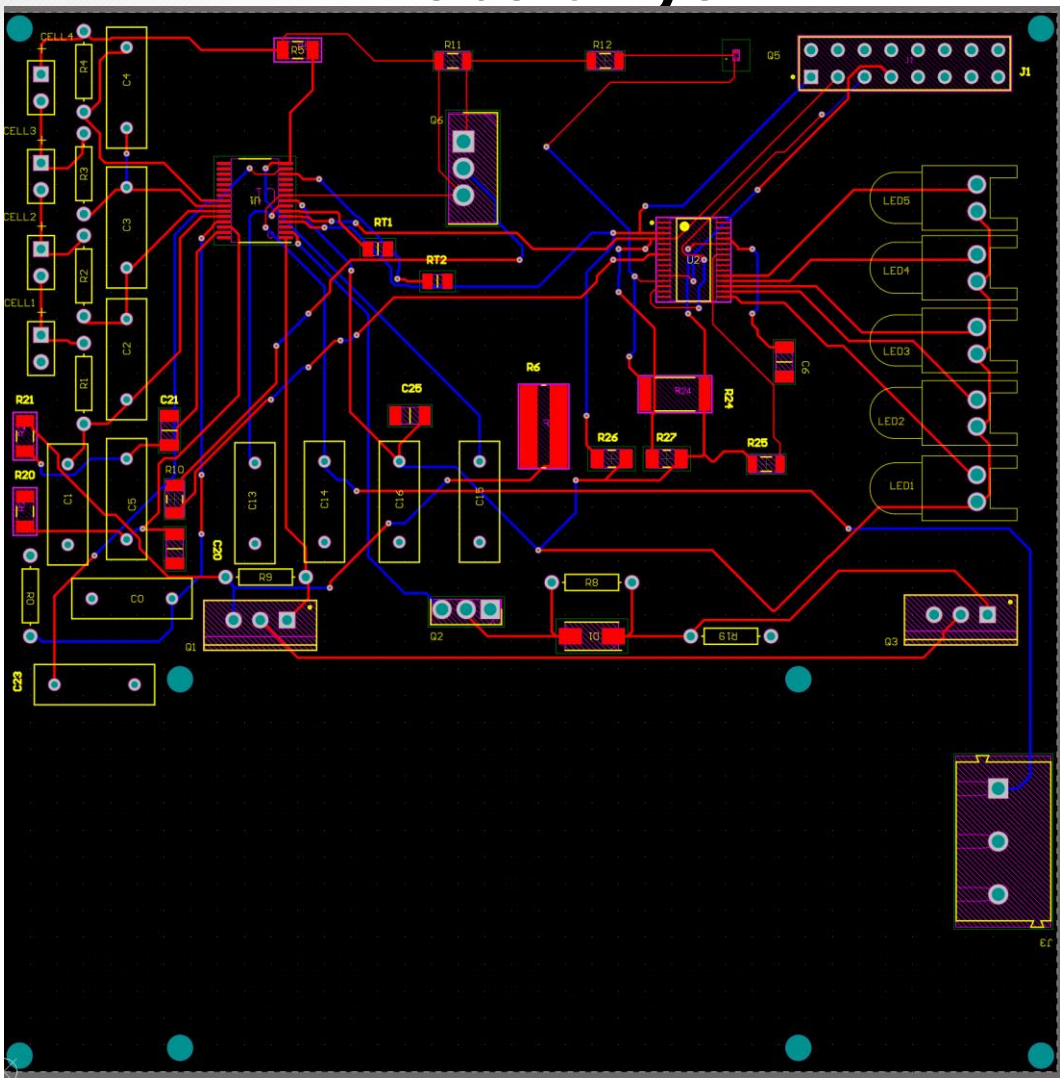

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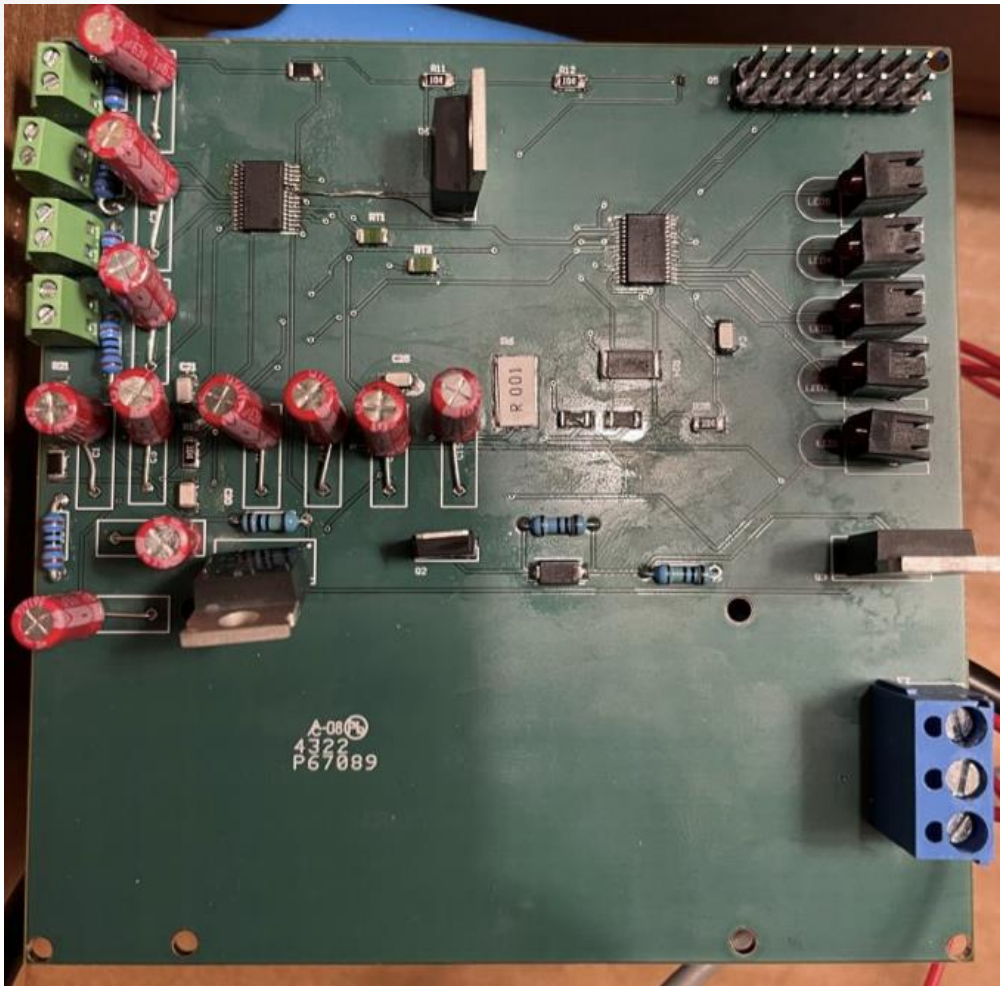

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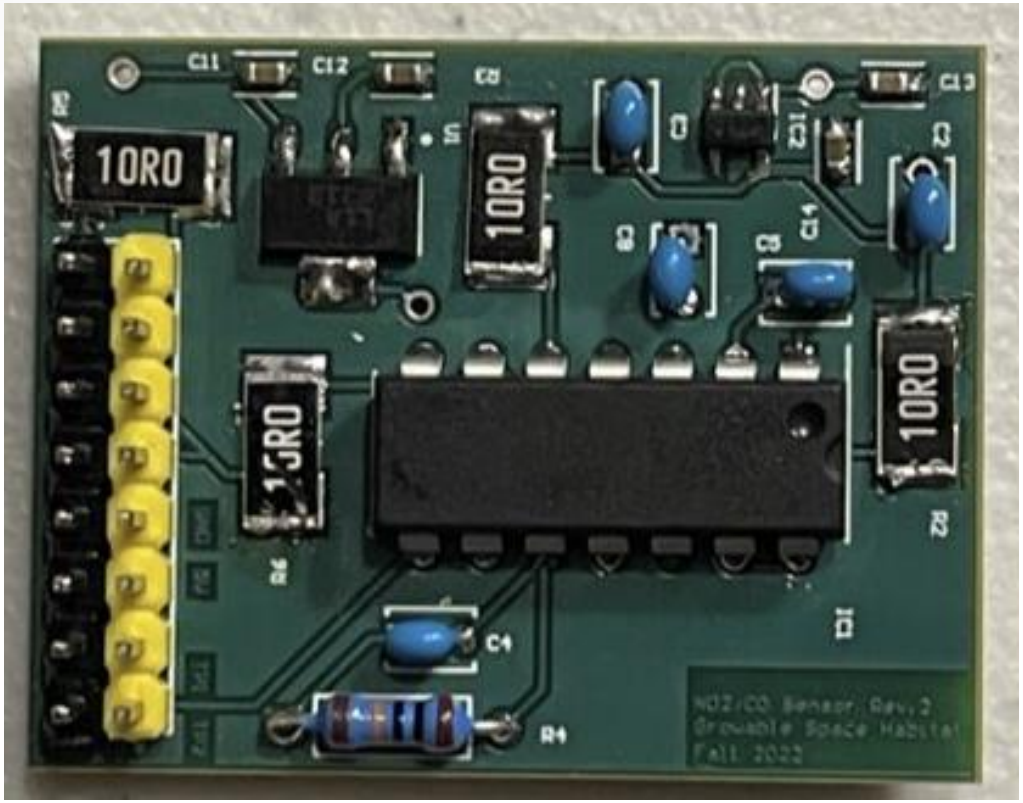

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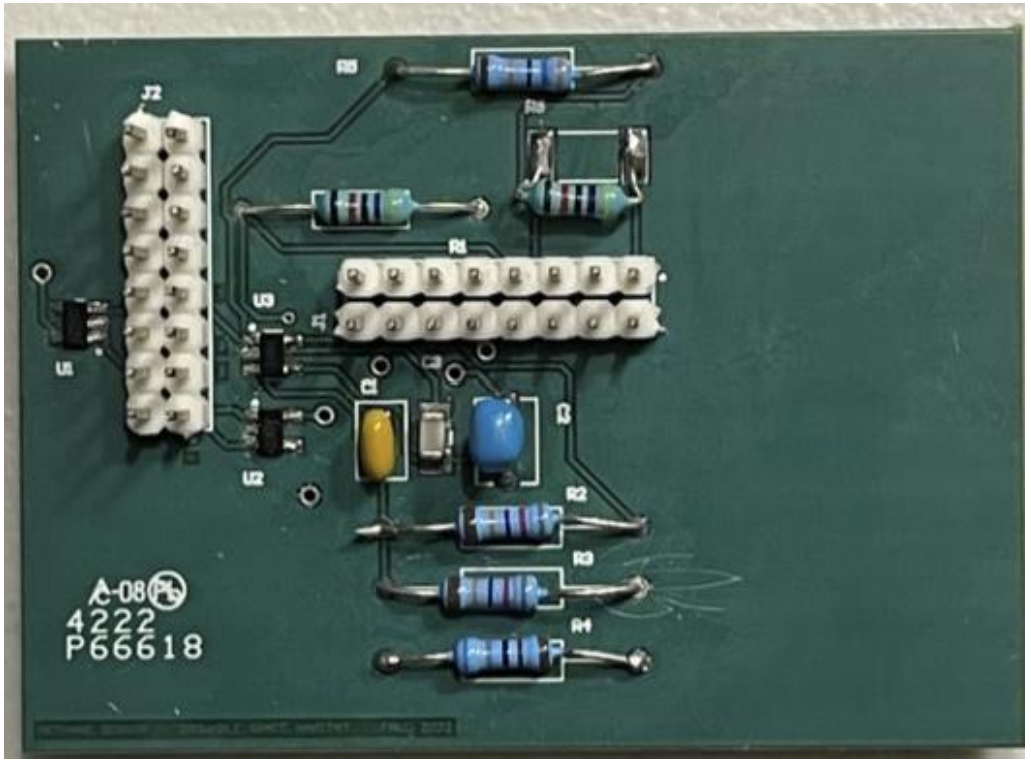


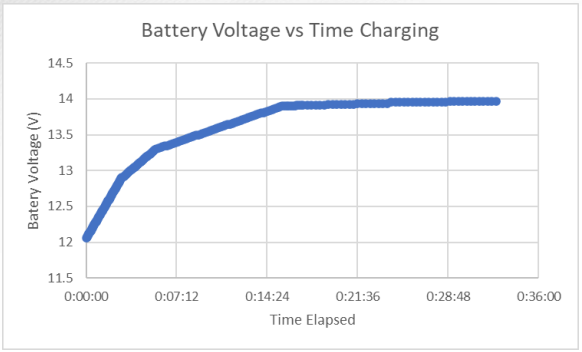
Power Management Accomplishments
Robert Dye

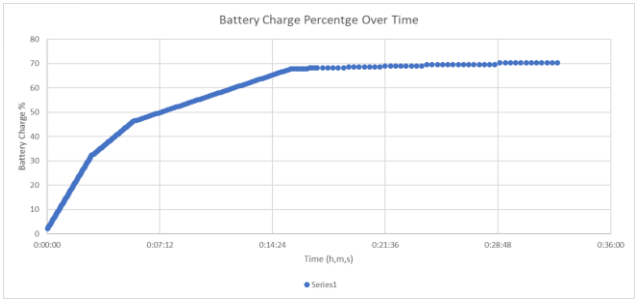
Power Management

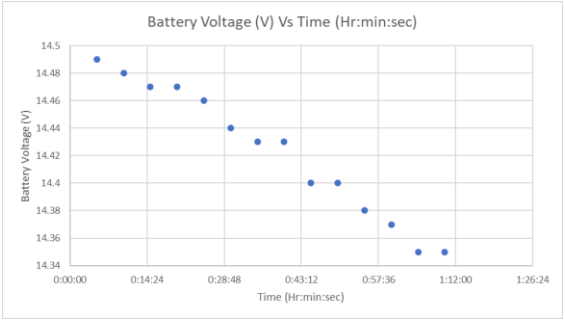
Robert Dye

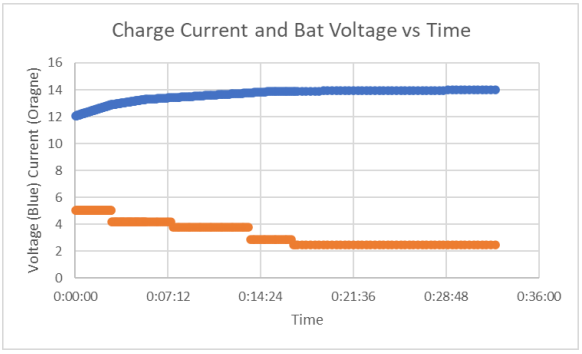
Power Management Previous Graphs

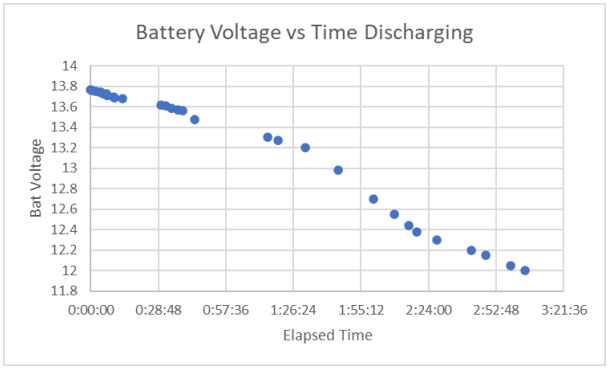
Robert Dye

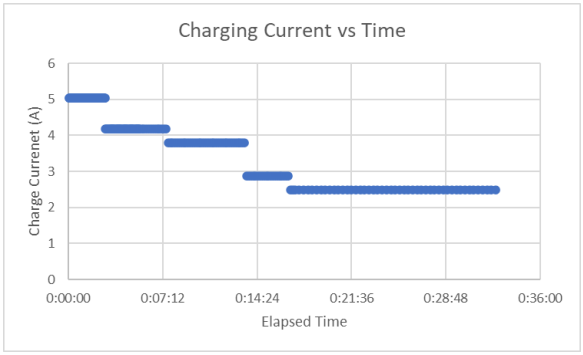






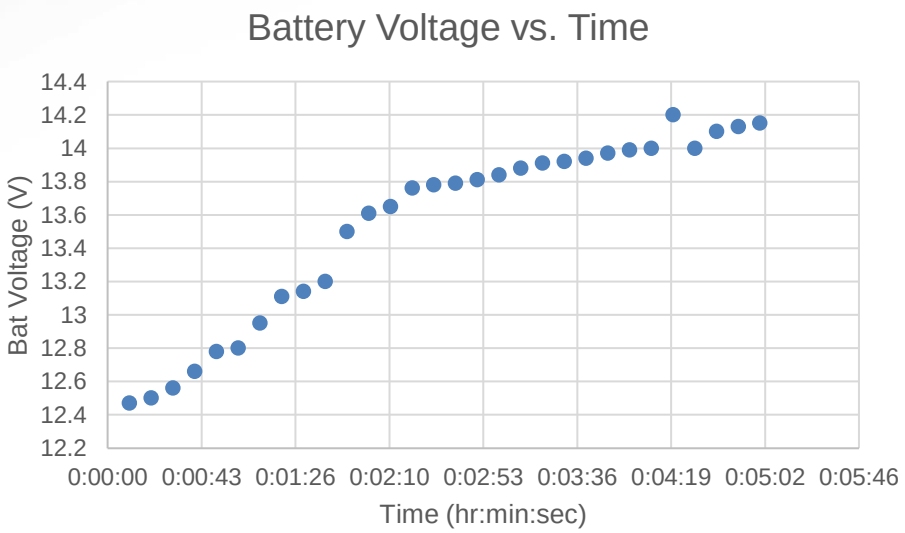


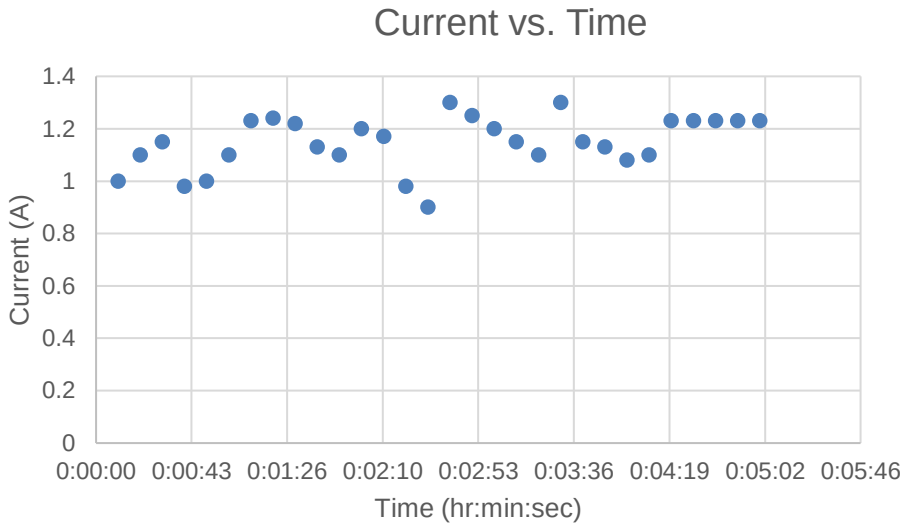




Power Management
- Graphs from video

Robert Dye

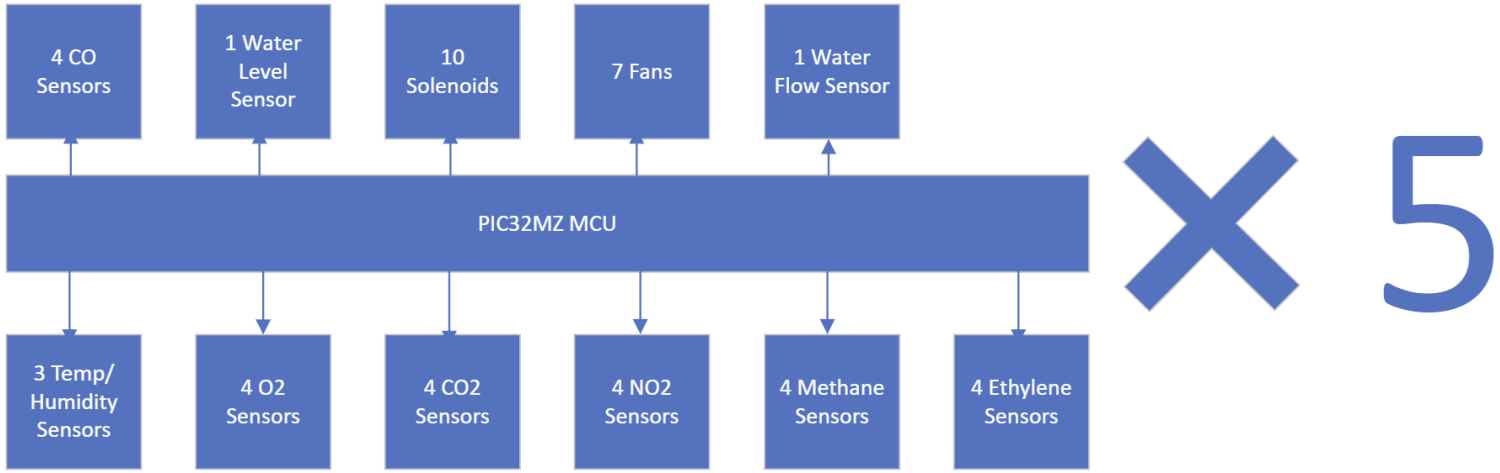




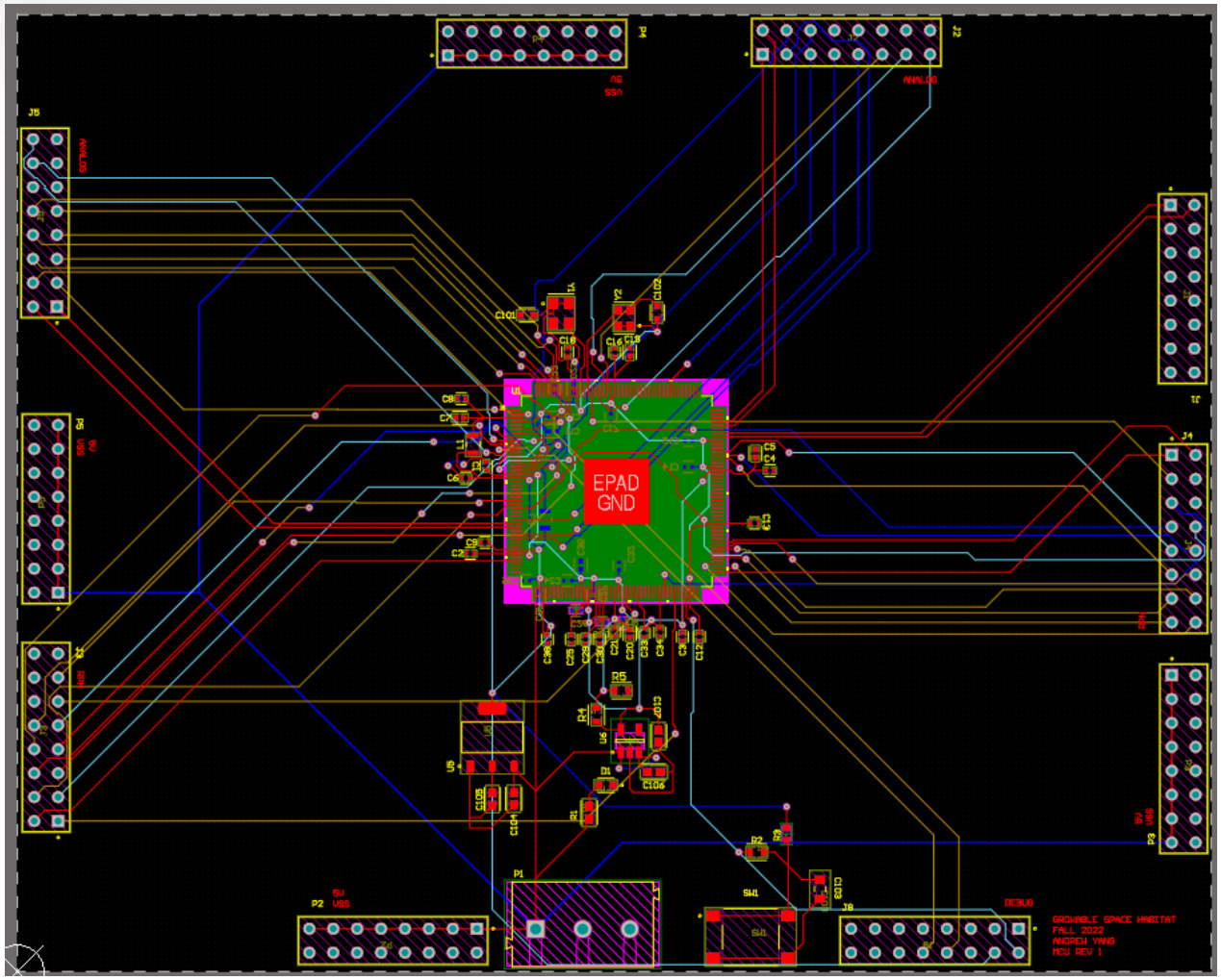
Microcontroller Accomplishments

Andrew Yang

- Designed and soldered PIC32MZ microcontroller
- Designed and soldered 3 analog sensor circuits and PCBs with Robert
- Wrote firmware to operate water flow, temp/humidity, CO2, O2, water level, water flow sensor, solenoid, and fan with Adam



Microcontroller Accomplishments
Andrew Yang



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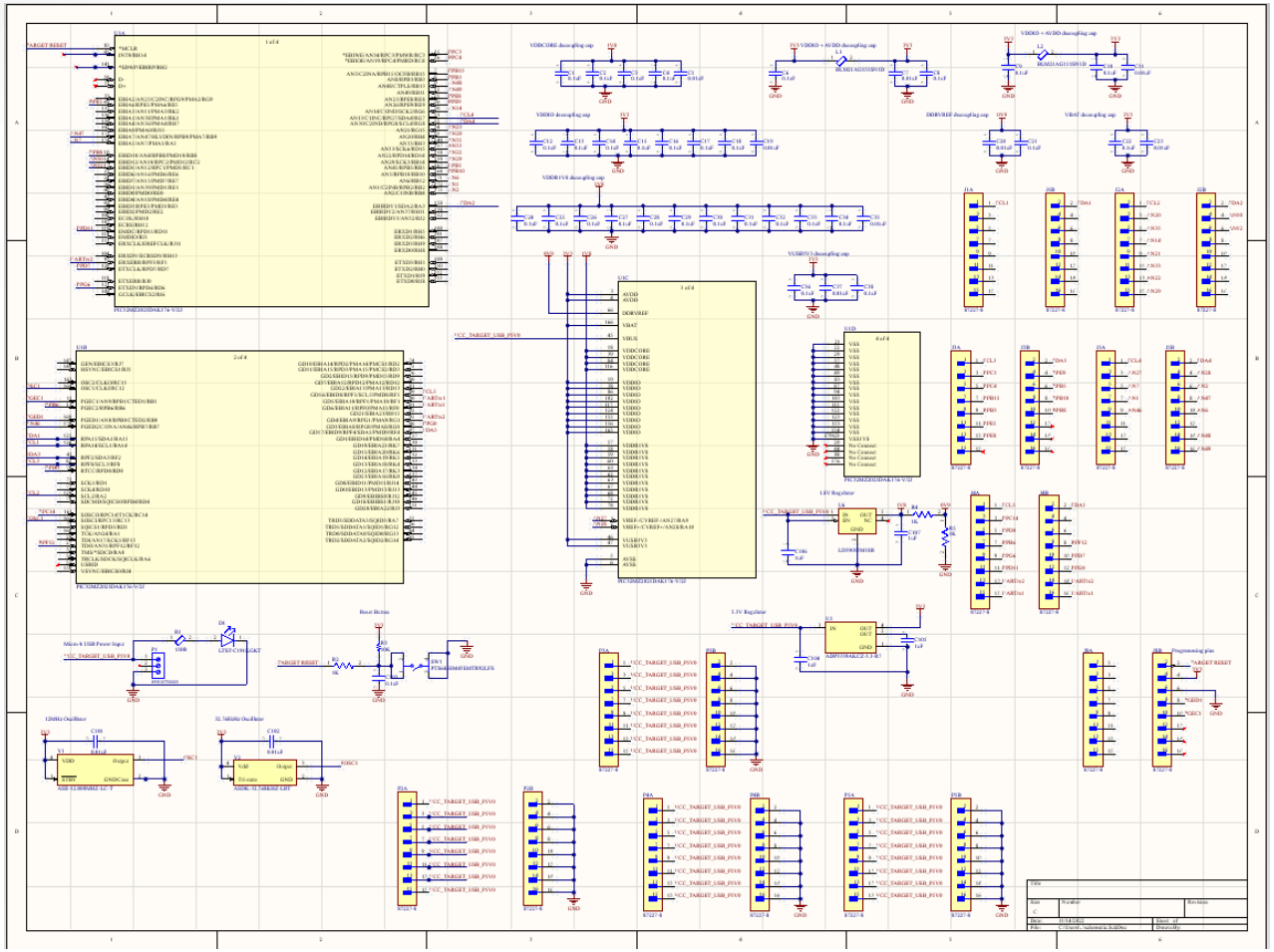

Microcontroller Accomplishments
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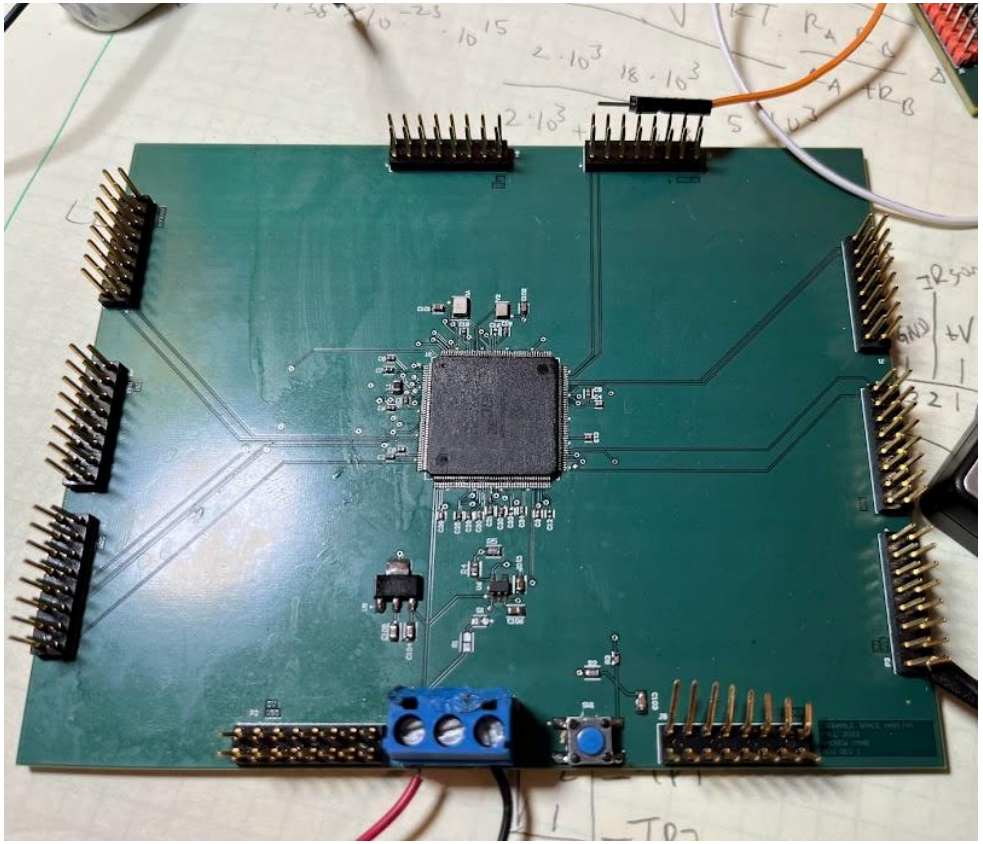

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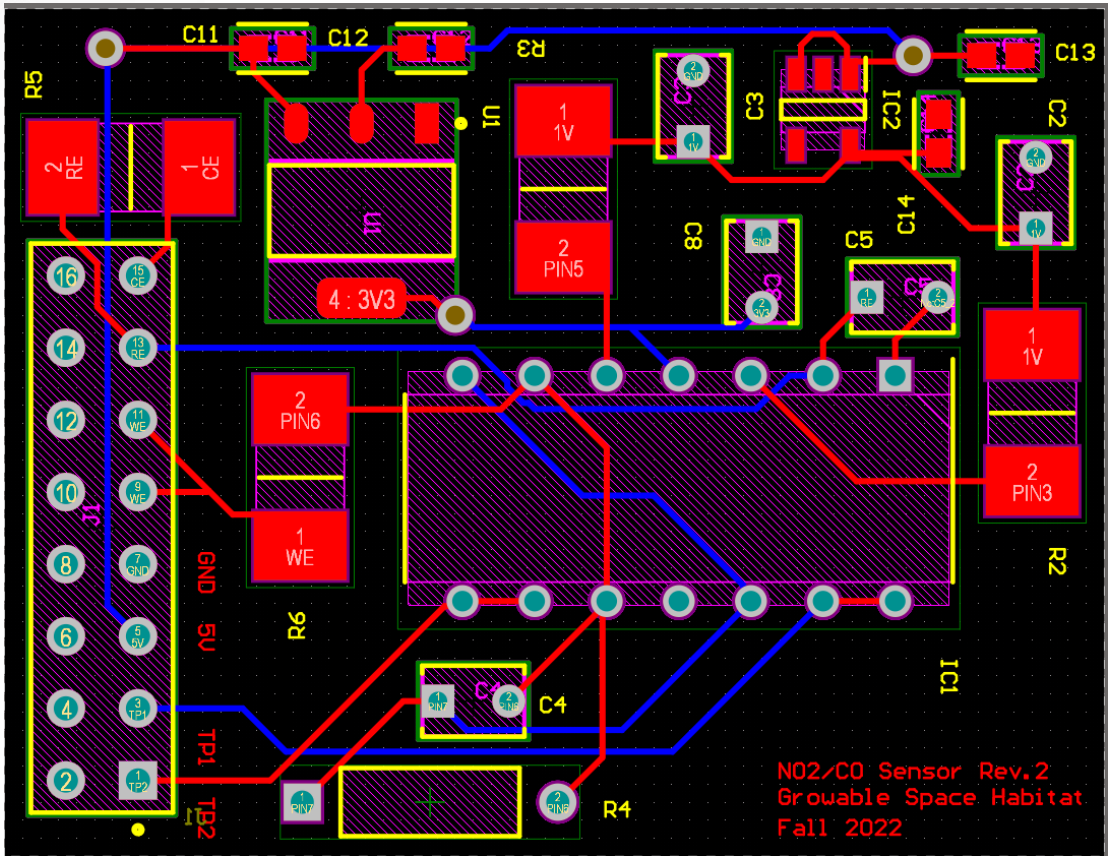

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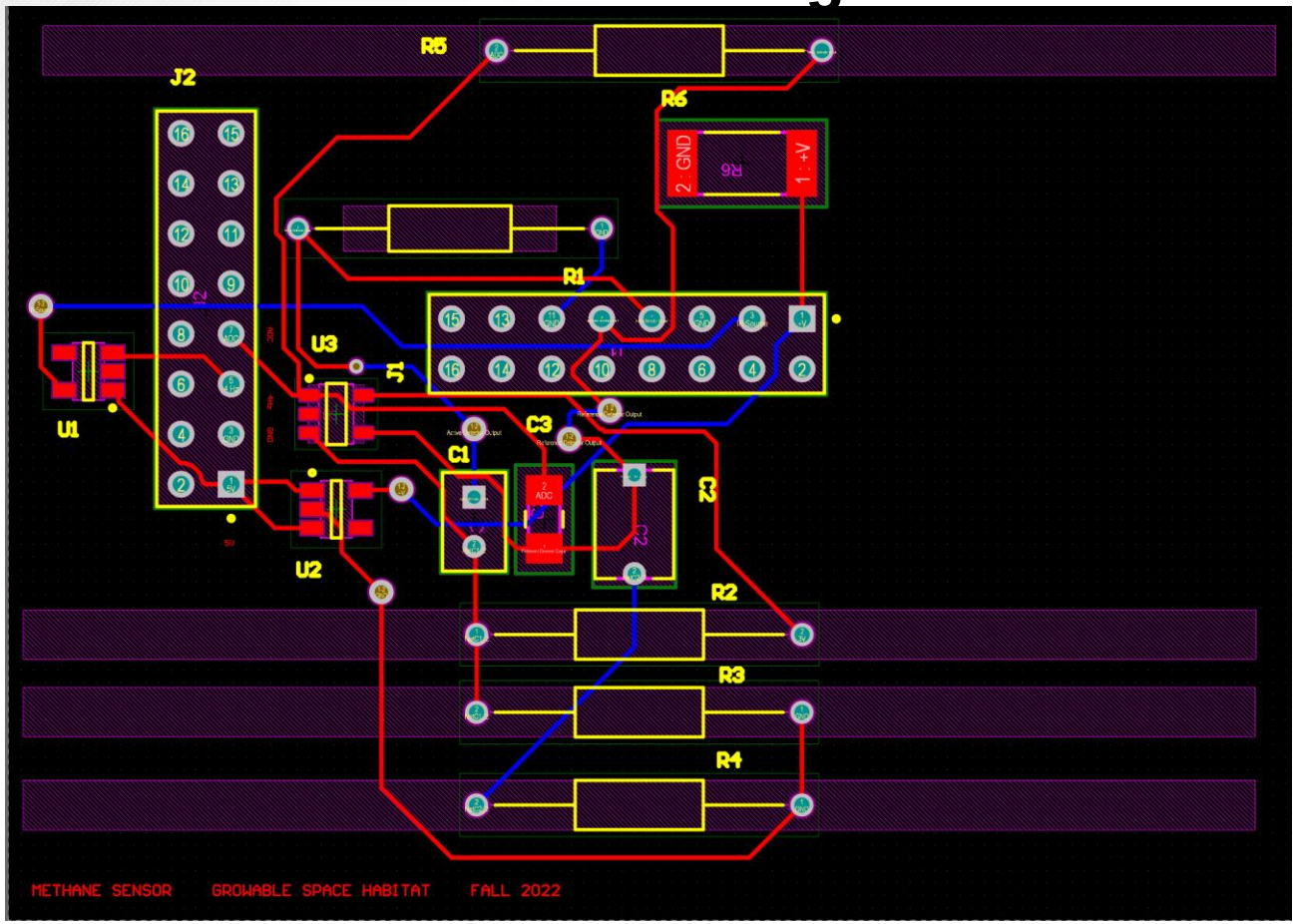

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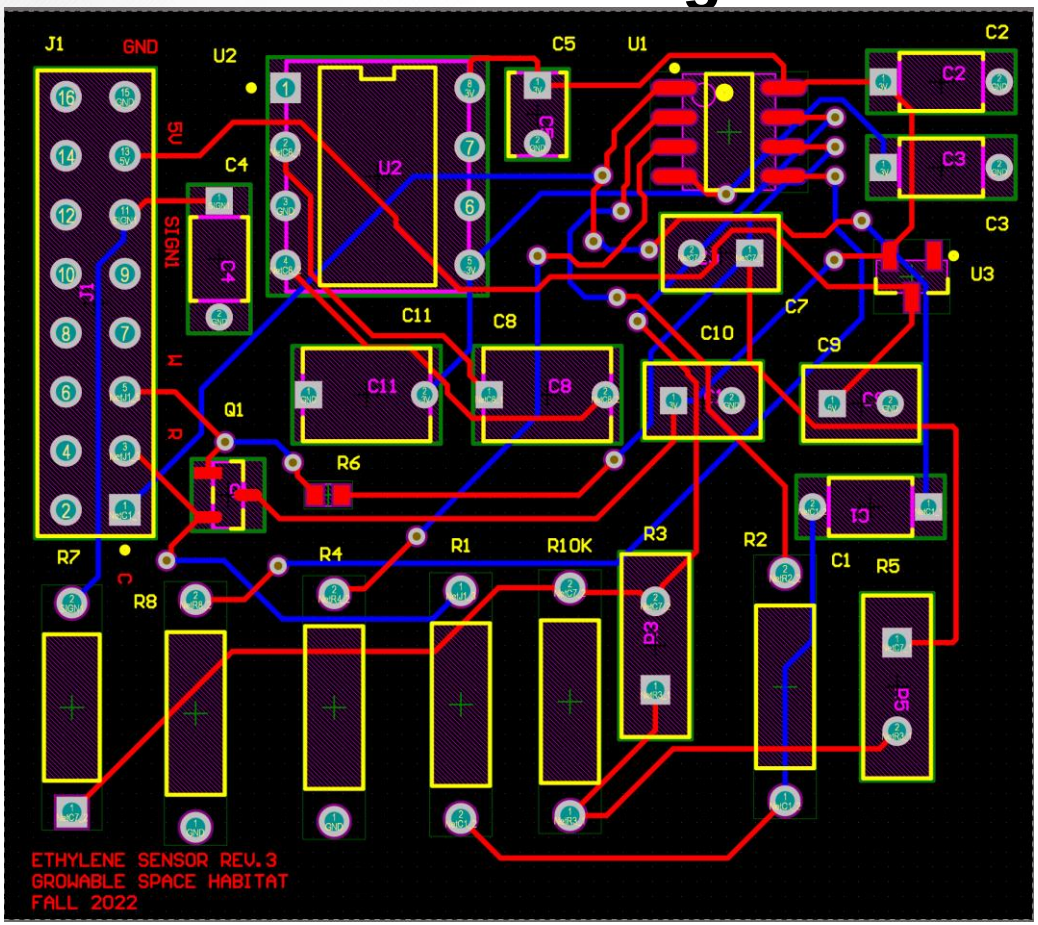
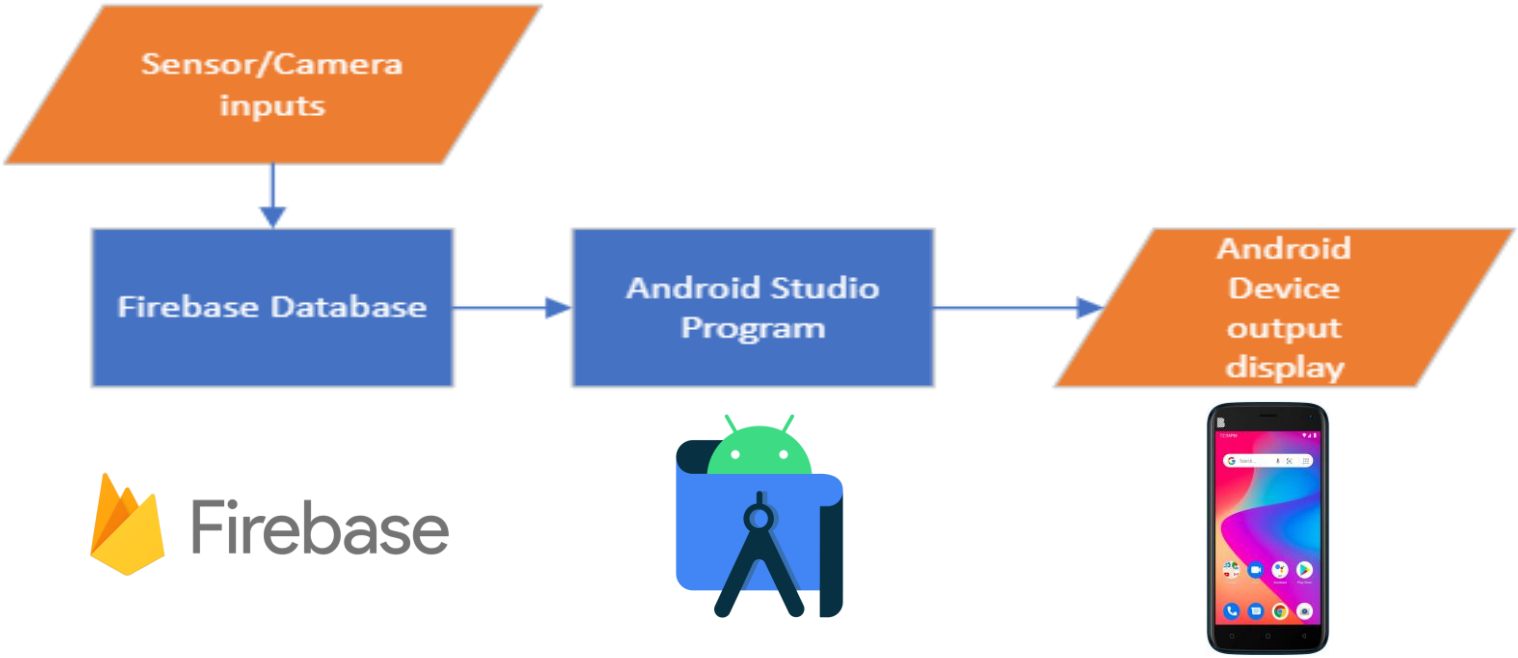


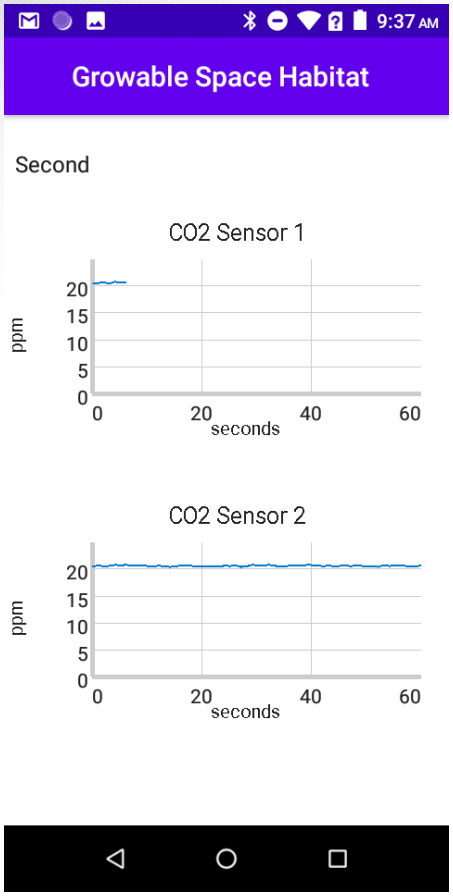
User Interface Accomplishments

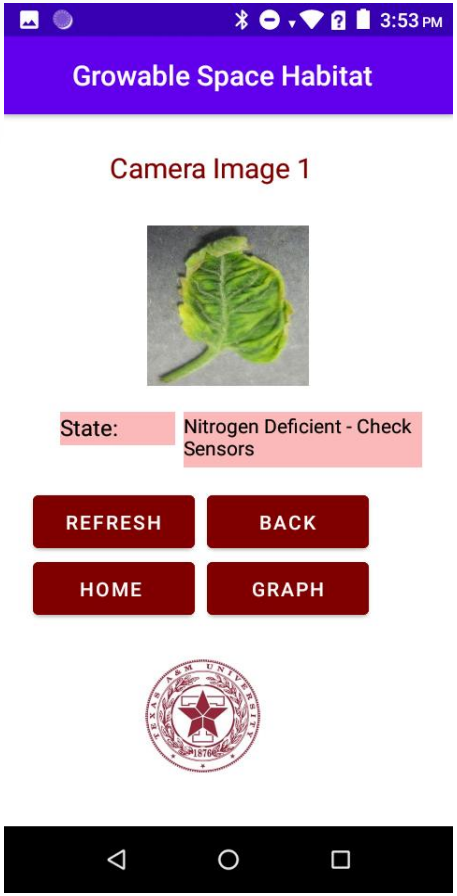
- Display real time sensor data
- Displaying graph's of sensor data of time, with different windows of duration
- Display camera pictures

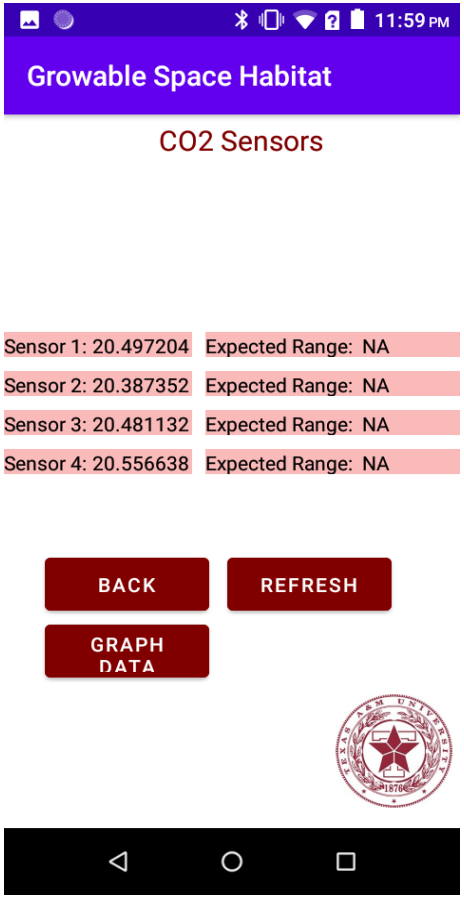


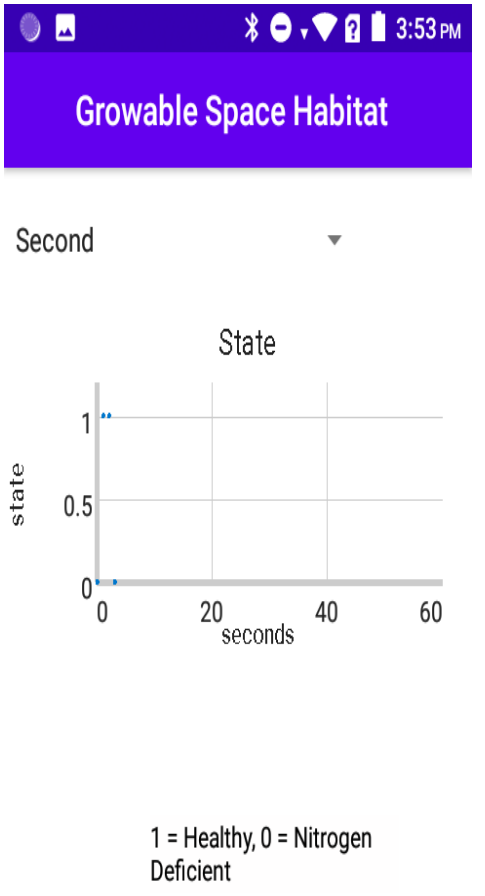
User Interface – General Format

Justin Blankenhorn



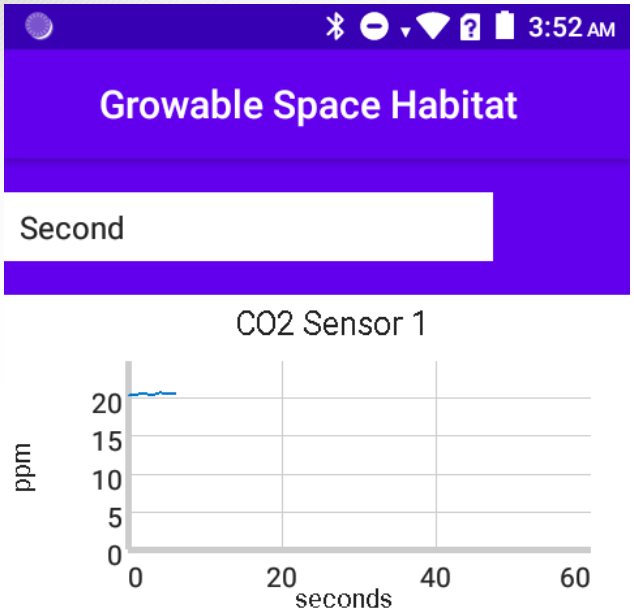


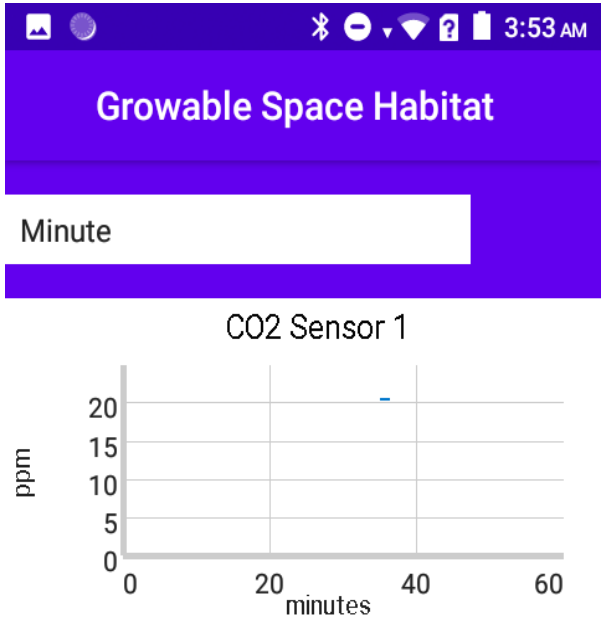


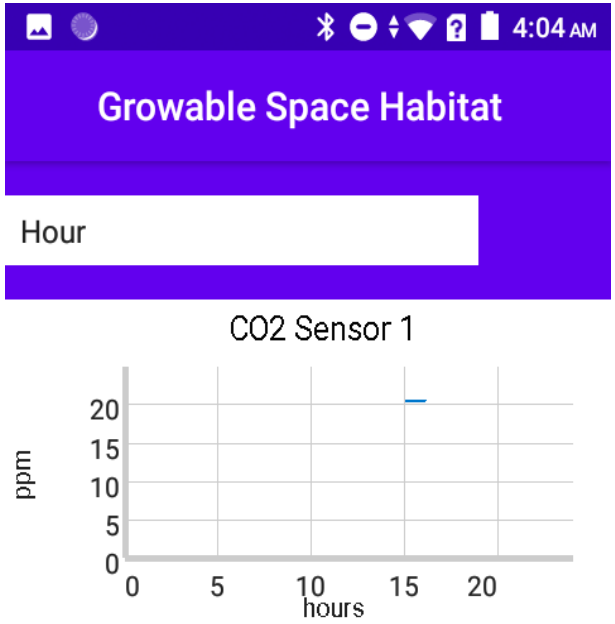


1 = Healthy, 0 = Nitrogen Deficient

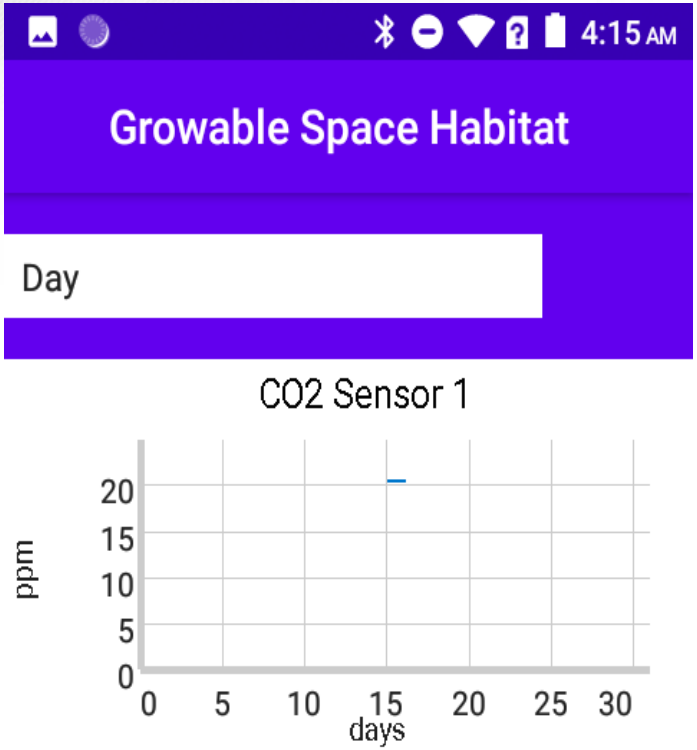
User Interface – Validating edge cases 1

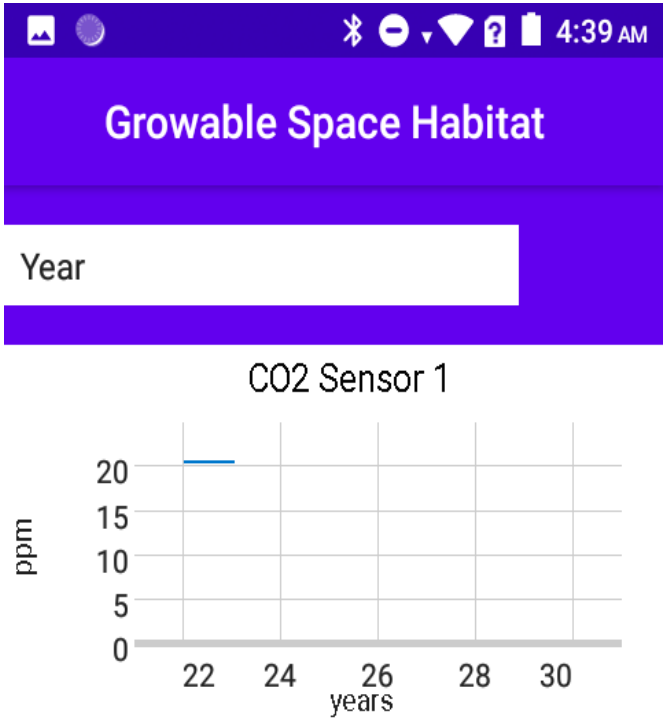






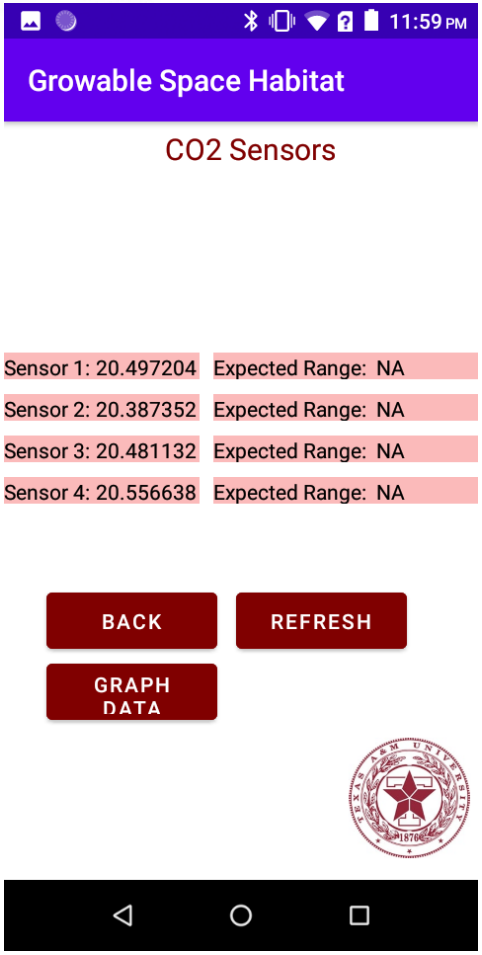
User Interface – Validating edge cases 2



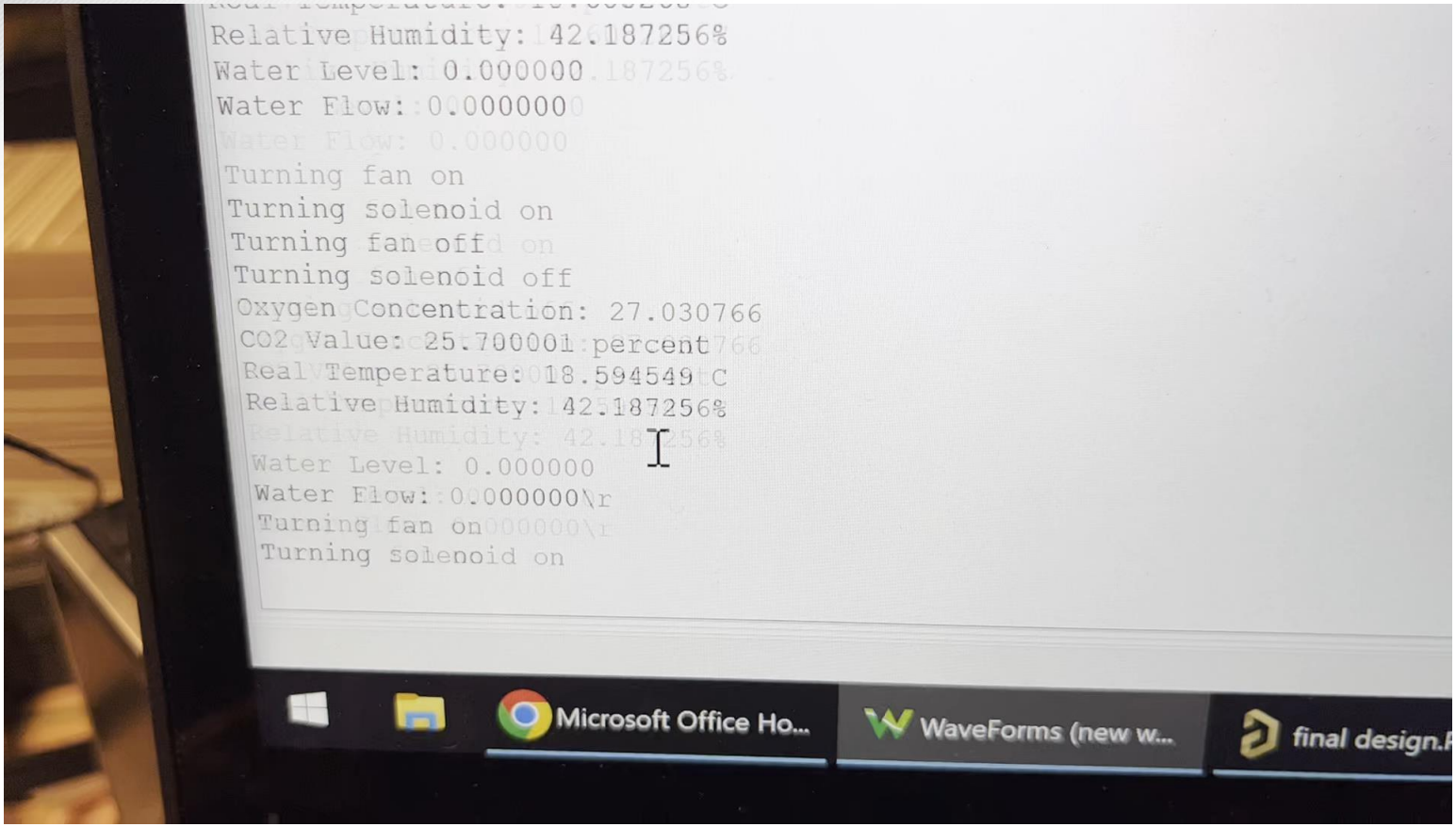


Data Integration

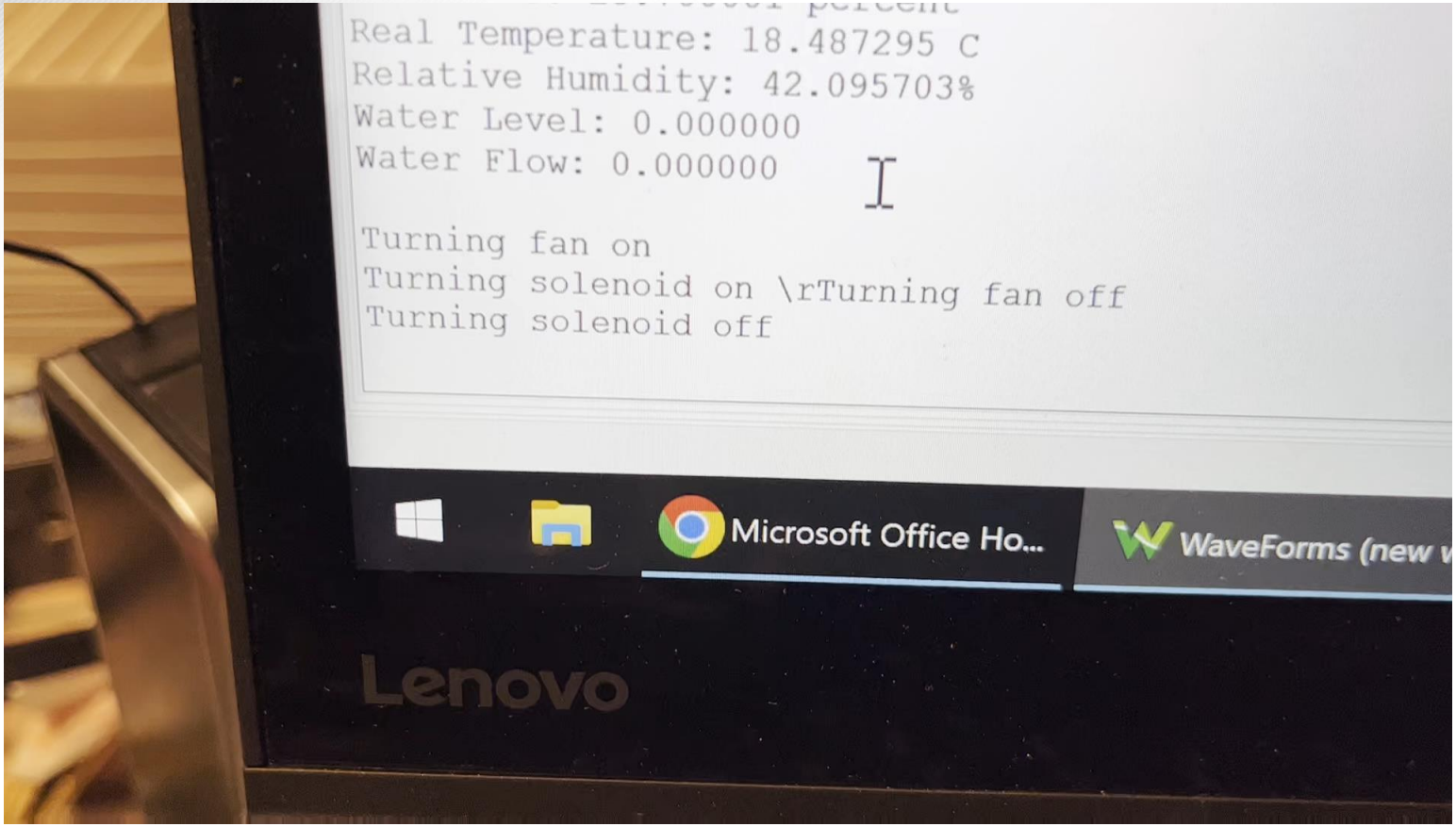
Data Integration



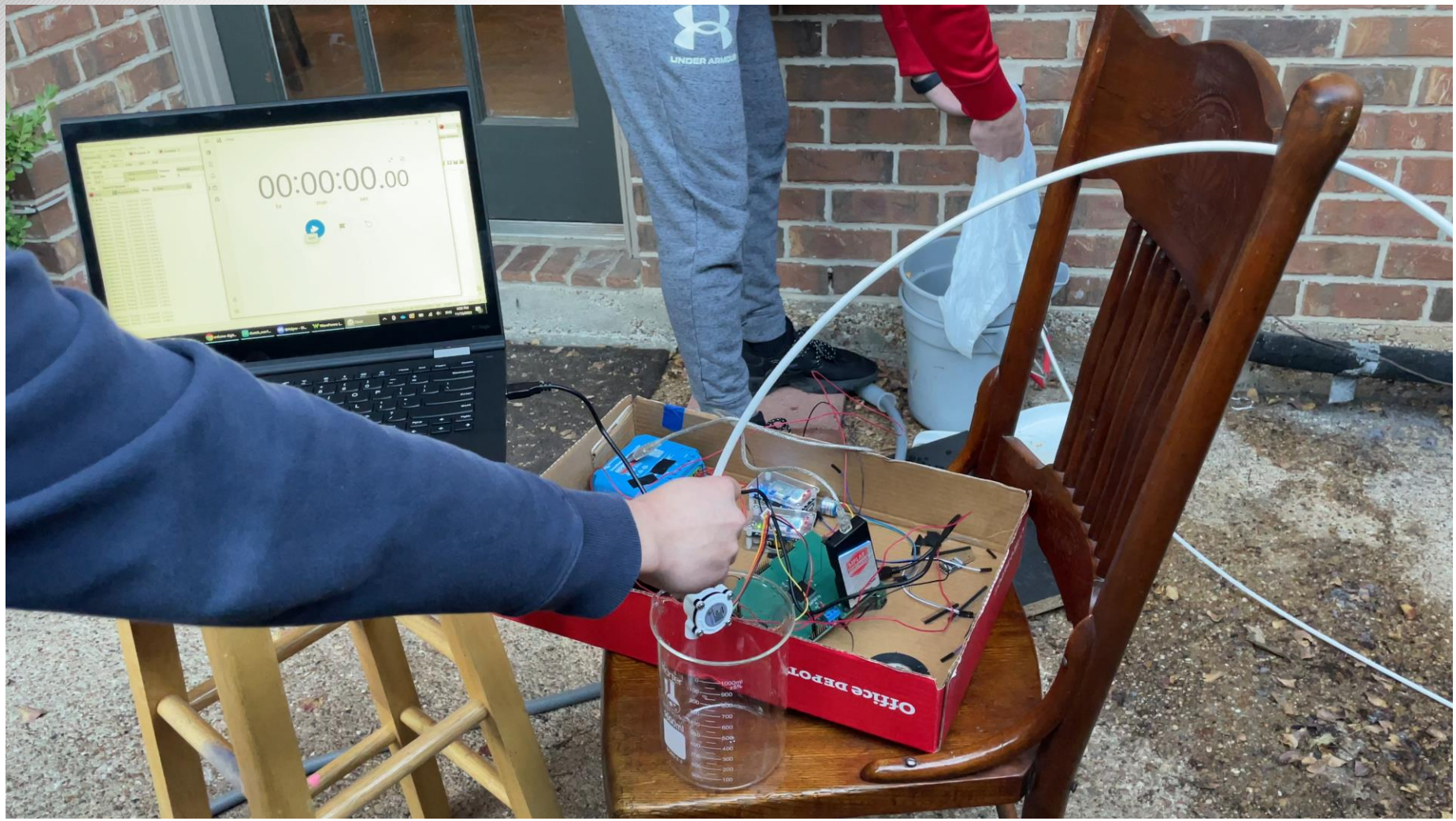
System and Validation Results Videos



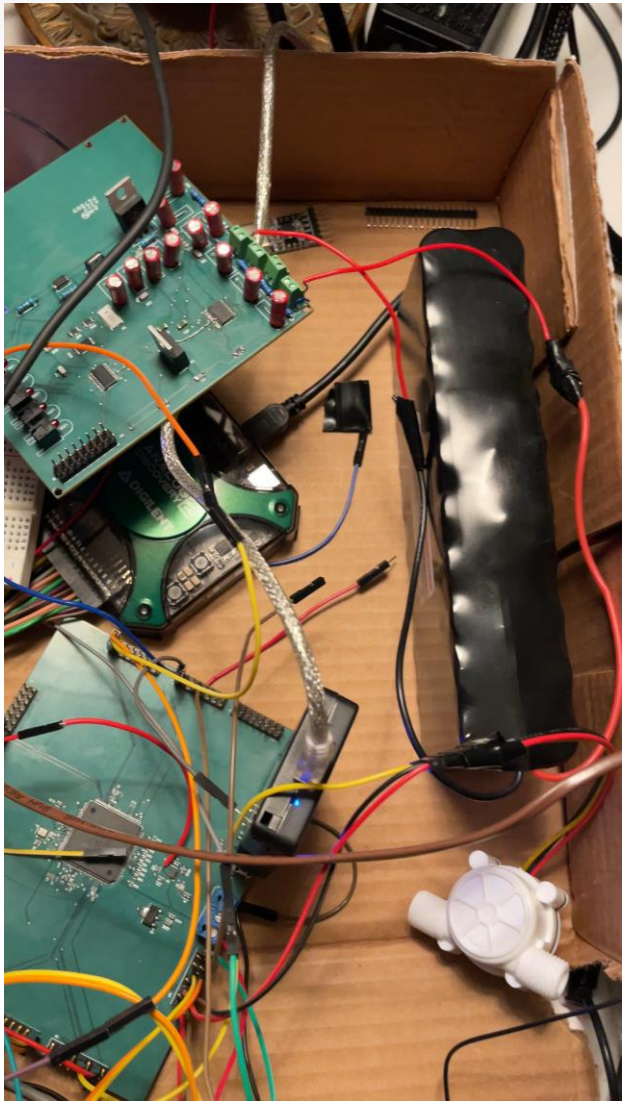
System and Validation Results Videos



System and Validation Results Videos



System and Validation Results Full Video



Conclusion Requirements

- Power Management-
  - Built a BMS PCB that can power 2 other systems and charge battery via solar through BMS
  - Built separate sensor circuits required to run the sensors
- MCU-
  - Built PCB that can control various peripherals
  - Built separate sensor circuits required to run the sensors
- AI/Data Processing-
- User Interface-
  - Created and app and database where data can be displayed, analyzed, and pushed through

Conclusions Learned

- Designing of PCB schematics and boards
- Microchip programming
- Concise reading of datasheets
- Reading convolution and neural networks
- Database/app creation and integration
- Sensor configurations, sensor amplifying techniques
- Microcontroller coding
- Cross team communication
- Project and time management skills
- If it can go wrong, it will go wrong

Conclusion What Went Right and Wrong

- Rights-
  - AI/Data Processing machine learning model classification
  - App/Database Creation
  - Integration of all 4 subsystems went smoothly
  - Powering/Charging
  - Control of different peripherals through both dev board and MCU

- Wrongs:
  - Multiple design errors and other issues caught after PCBs soldered, had to re do designs
  - Monitoring of pack and cell issues (contact with Dr. Lusher and TI) no resolutions
  - Initial approach with mySQL database, changed to firebase for easier integration

Project Mitigation

- Tasks to try to get done by demo
  - Potentially 1 of the Analog sensors to work (replace with 2 others)
  - Potential battery pack monitoring

THANK YOU!