



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

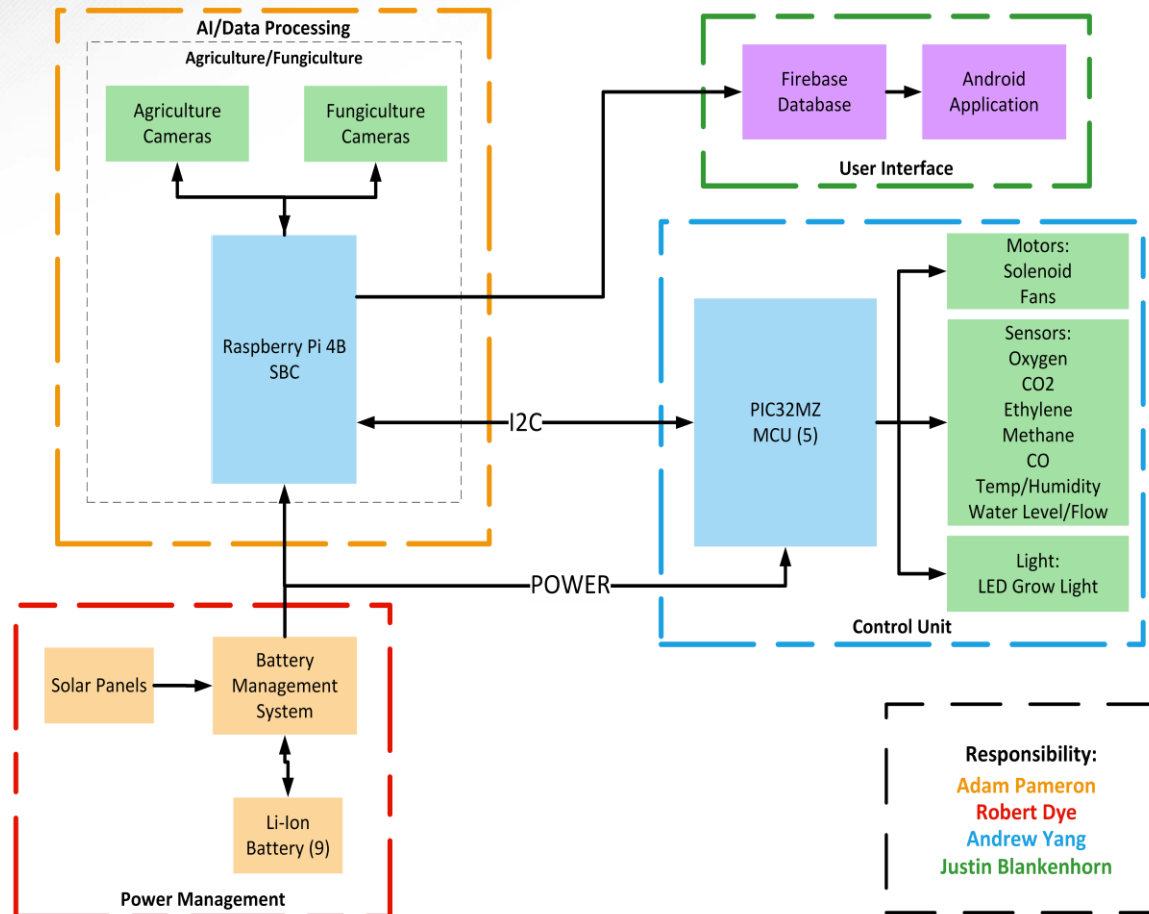
- Current space operations require constant resupply
 - Costly (\$20,000 per kg)
 - Inefficient and wasteful
- Long term space missions need a sustainable food source
- Project provides electrical infrastructure for a self-sustaining system capable of recycling agricultural products



System-Level Requirements

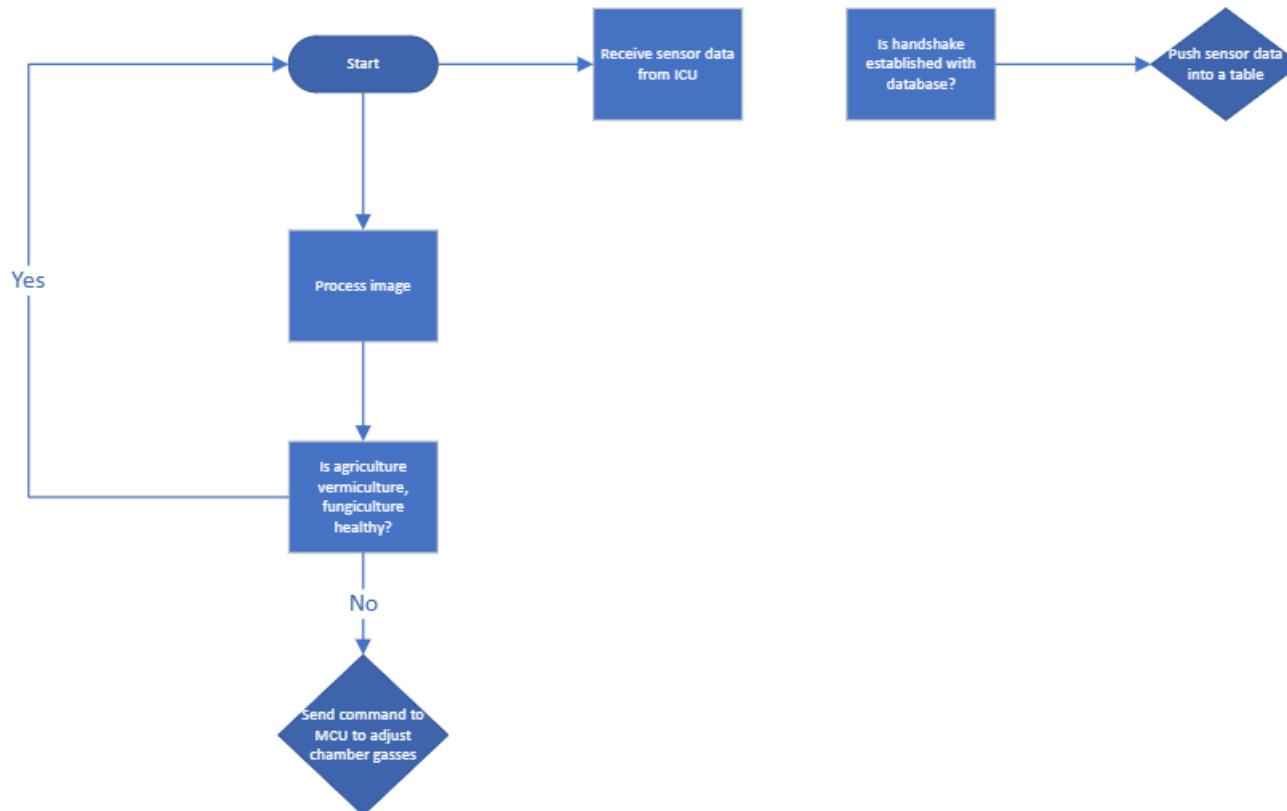
- Power Management-
 - Power MCU, AI/Data Processing
 - Charge battery through solar panel
 - Monitor battery pack
- MCU-
 - Control Peripherals
 - 1 of each type of sensor (I2C, Analog, UART, Digital (External clock))
 - Replacing 1 analog with 2 extra others (Temp/Humidity, solenoid)
- AI/Data Processing-
 - 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

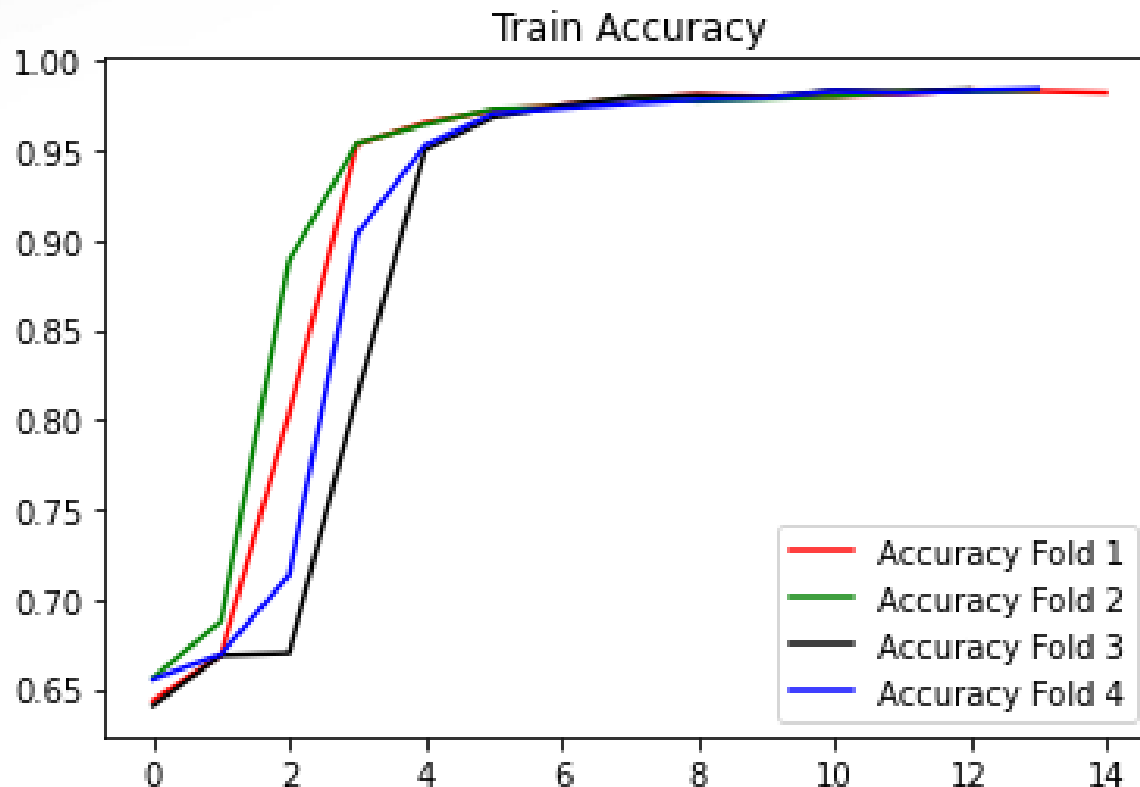
Adam Pameron



AI/Data Processing Subsystem

– Train Accuracy 4 Folds

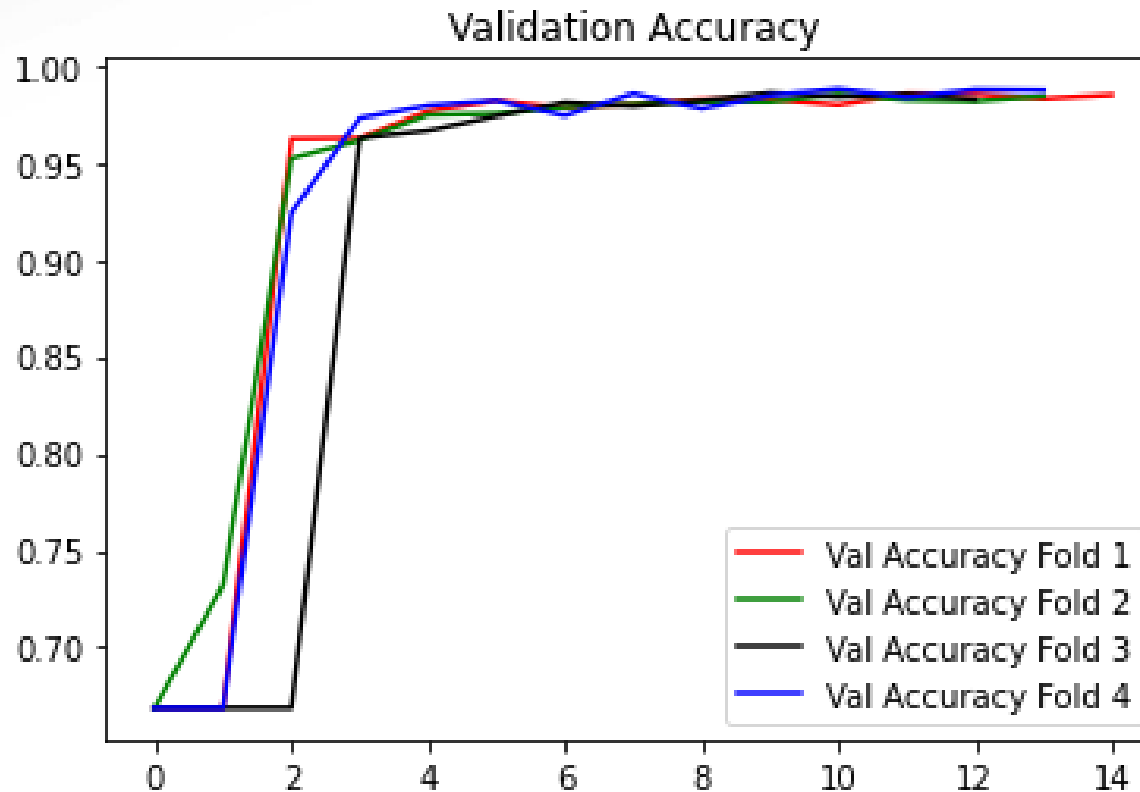
Adam Pameron



AI/Data Processing Subsystem

– Validation Accuracy 4 Folds

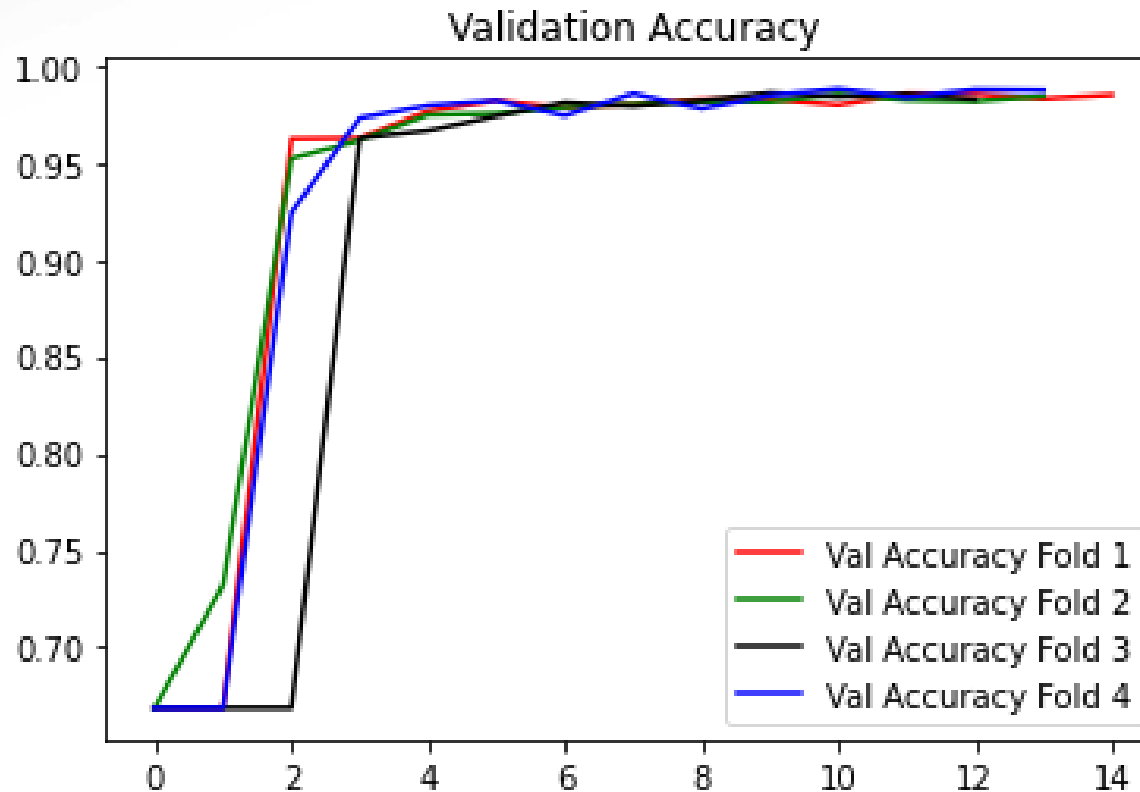
Adam Pameron



AI/Data Processing Subsystem

– Validation Accuracy 4 Folds

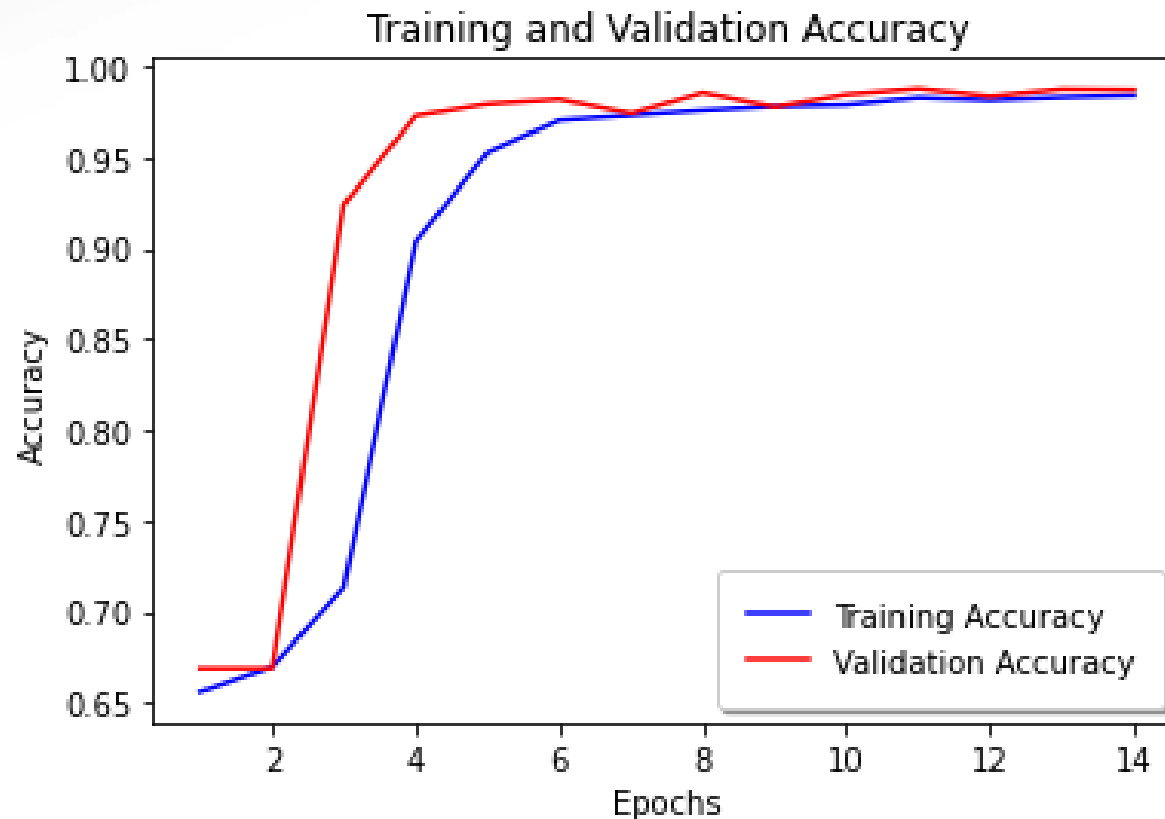
Adam Pameron



AI/Data Processing Subsystem

– Training and Validation Accuracy Fold 4

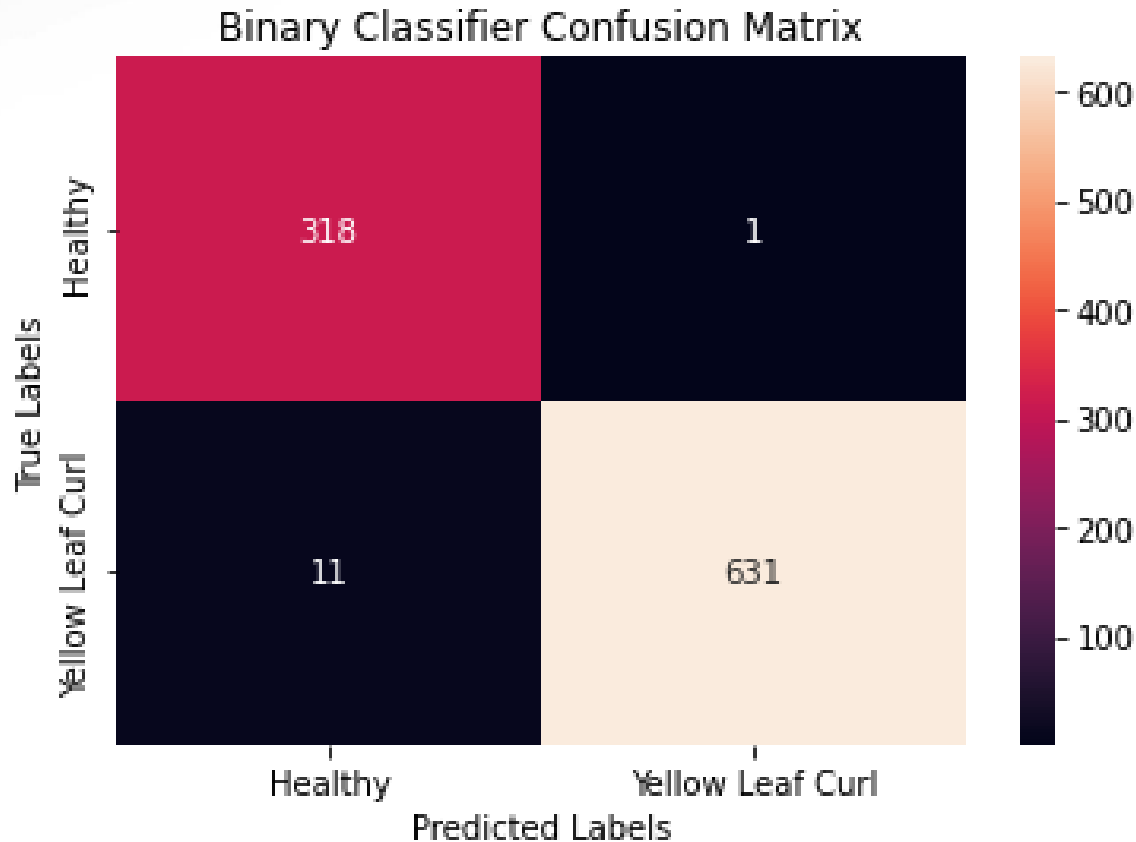
Adam Pameron



AI/Data Processing Subsystem

– Confusion Matrix Fold 4

Adam Pameron

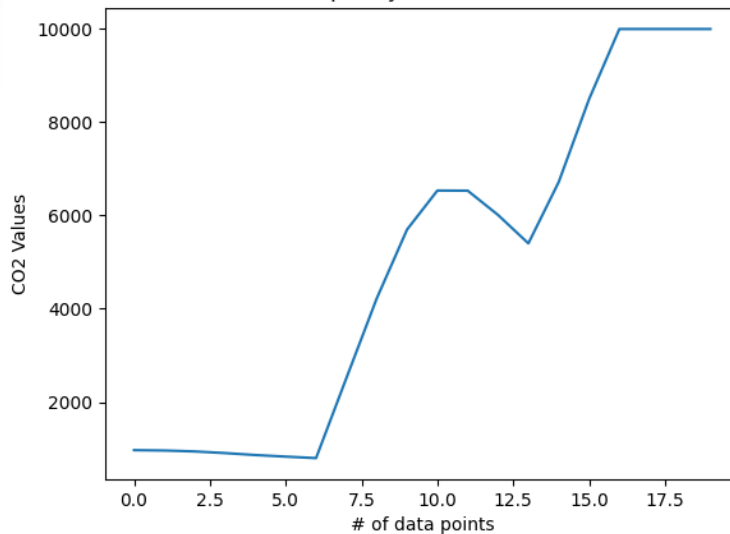


AI/Data Processing Subsystem

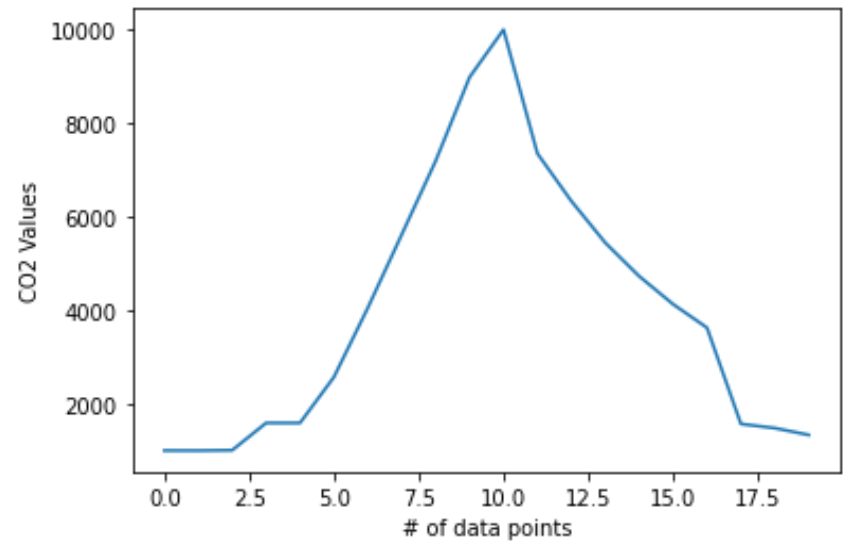
– Pi and PIC32 CO2 Values

Adam Pameron

Raspberry Pi CO2 Values



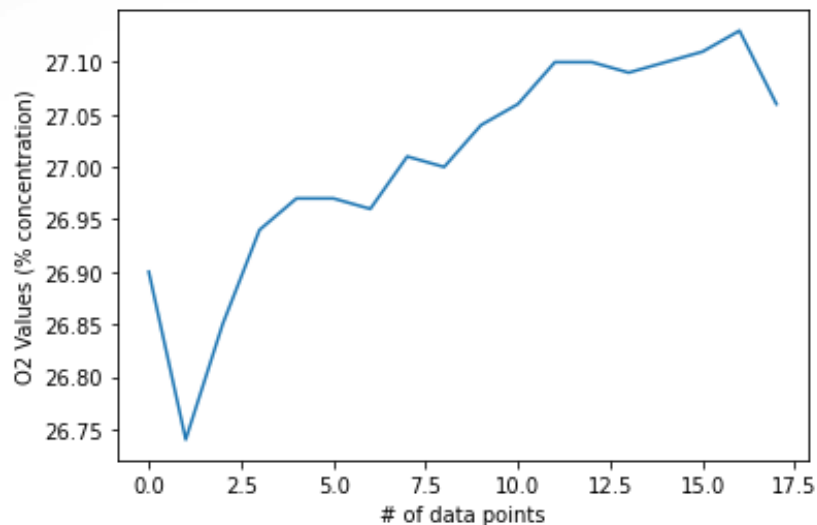
PIC32 CO2 Values



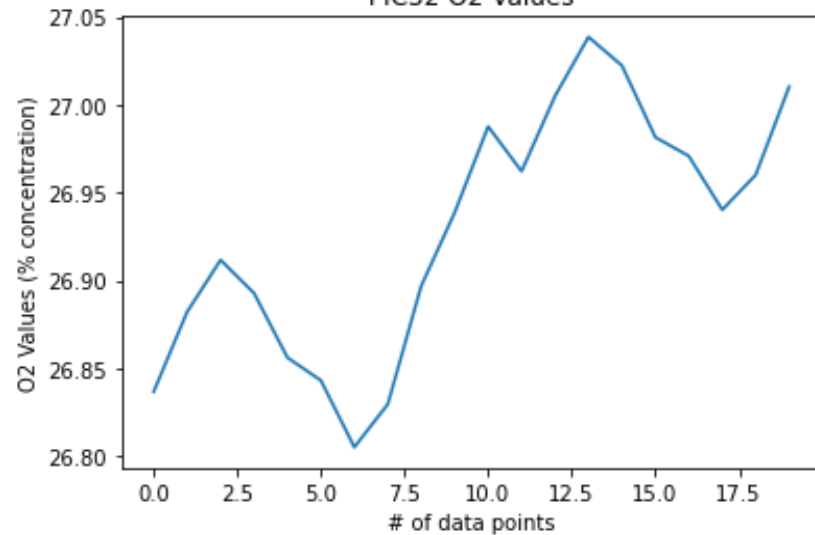
AI/Data Processing Subsystem – Arduino and PIC32 O₂ Values

Adam Pameron

Arduino O₂ Values

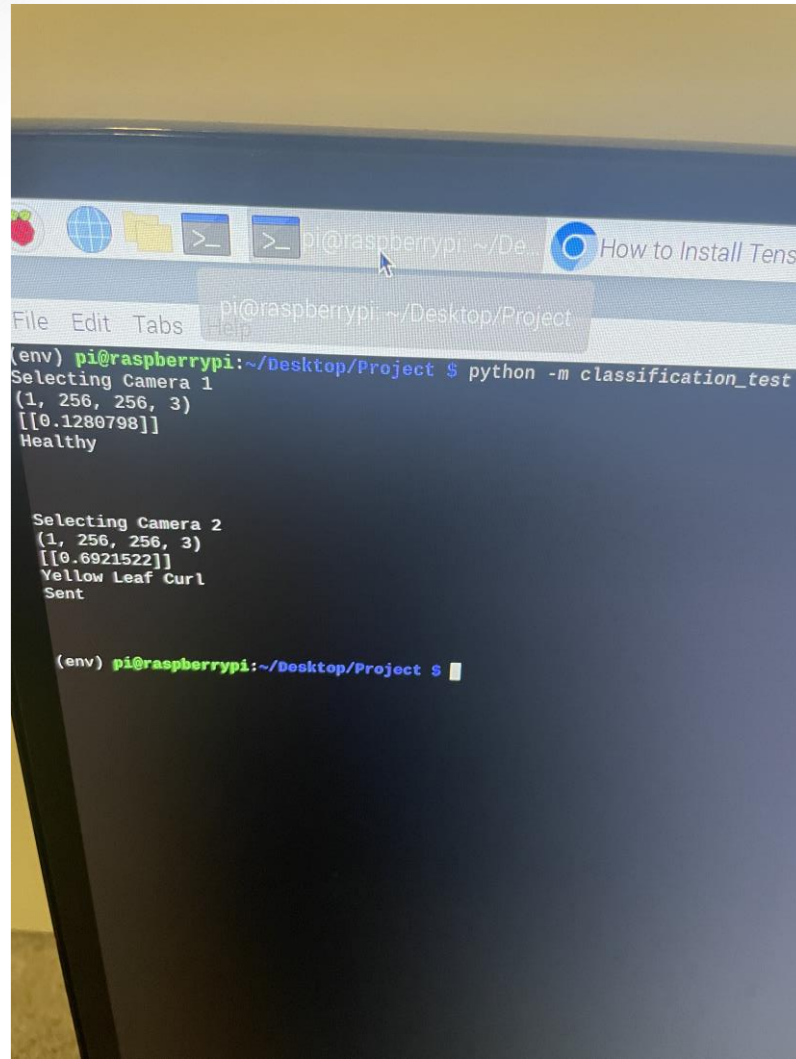


PIC32 O₂ Values



AI/Data Processing Subsystem

Adam Pameron



```
(env) pi@raspberrypi:~/Desktop/Project $ python -m classification_test
Selecting Camera 1
(1, 256, 256, 3)
[[0.1280798]]
Healthy

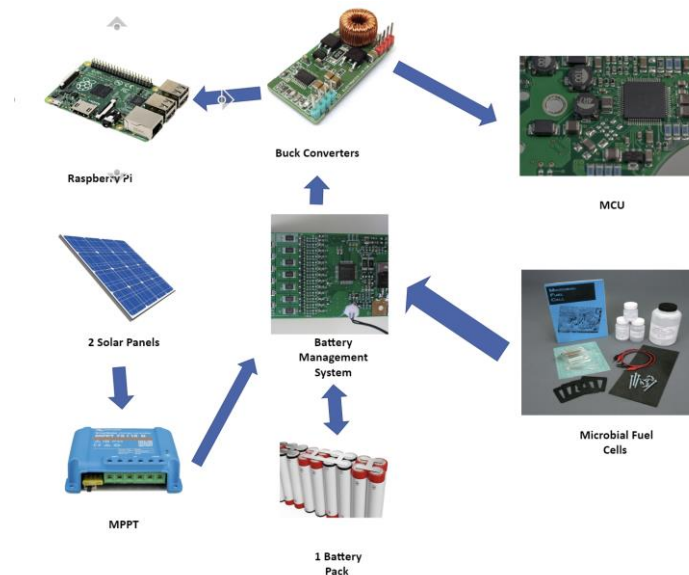
Selecting Camera 2
(1, 256, 256, 3)
[[0.6921522]]
Yellow Leaf Curl
Sent

(env) pi@raspberrypi:~/Desktop/Project $
```

Power Management Accomplishments

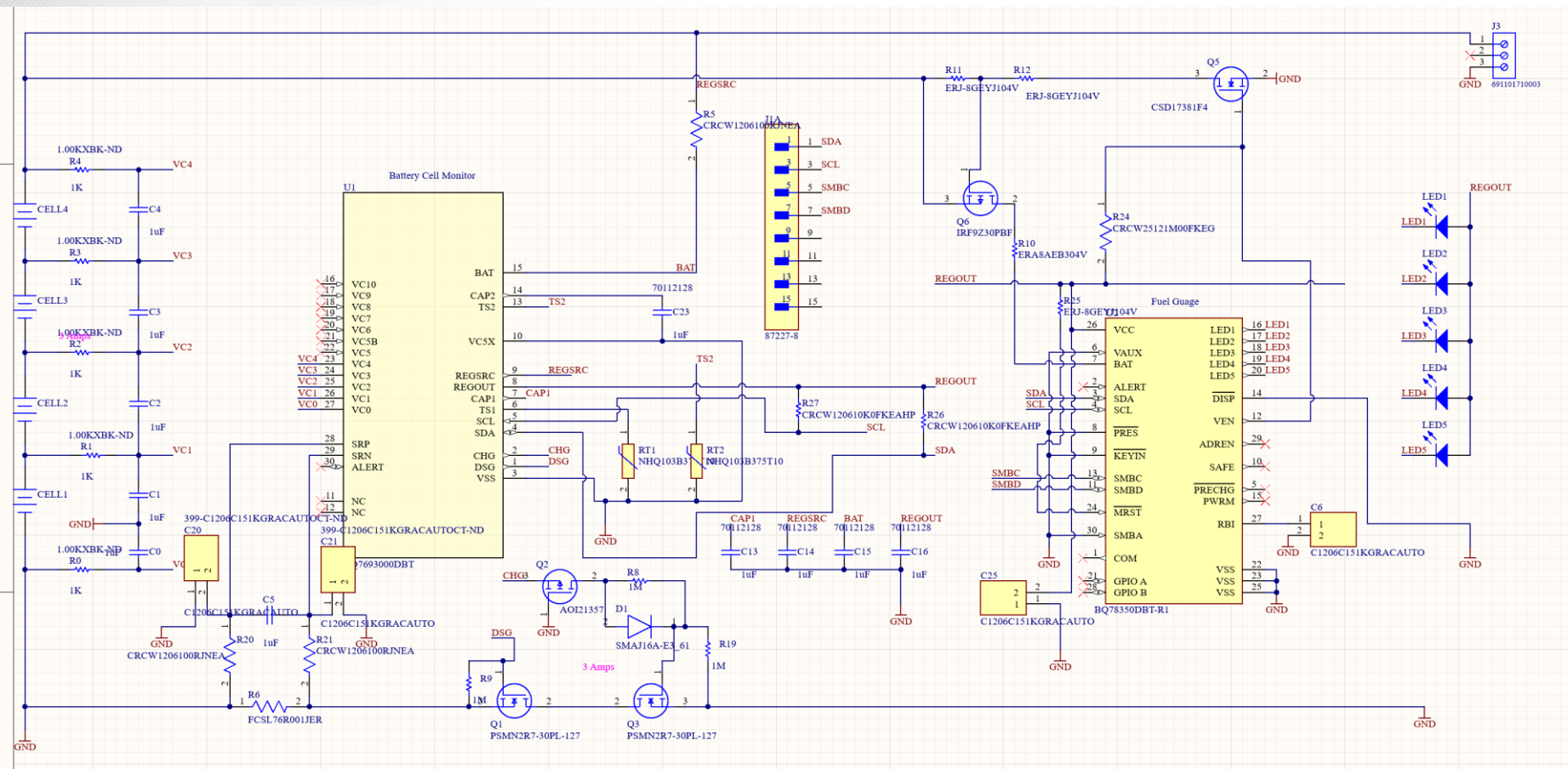
Robert Dye

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



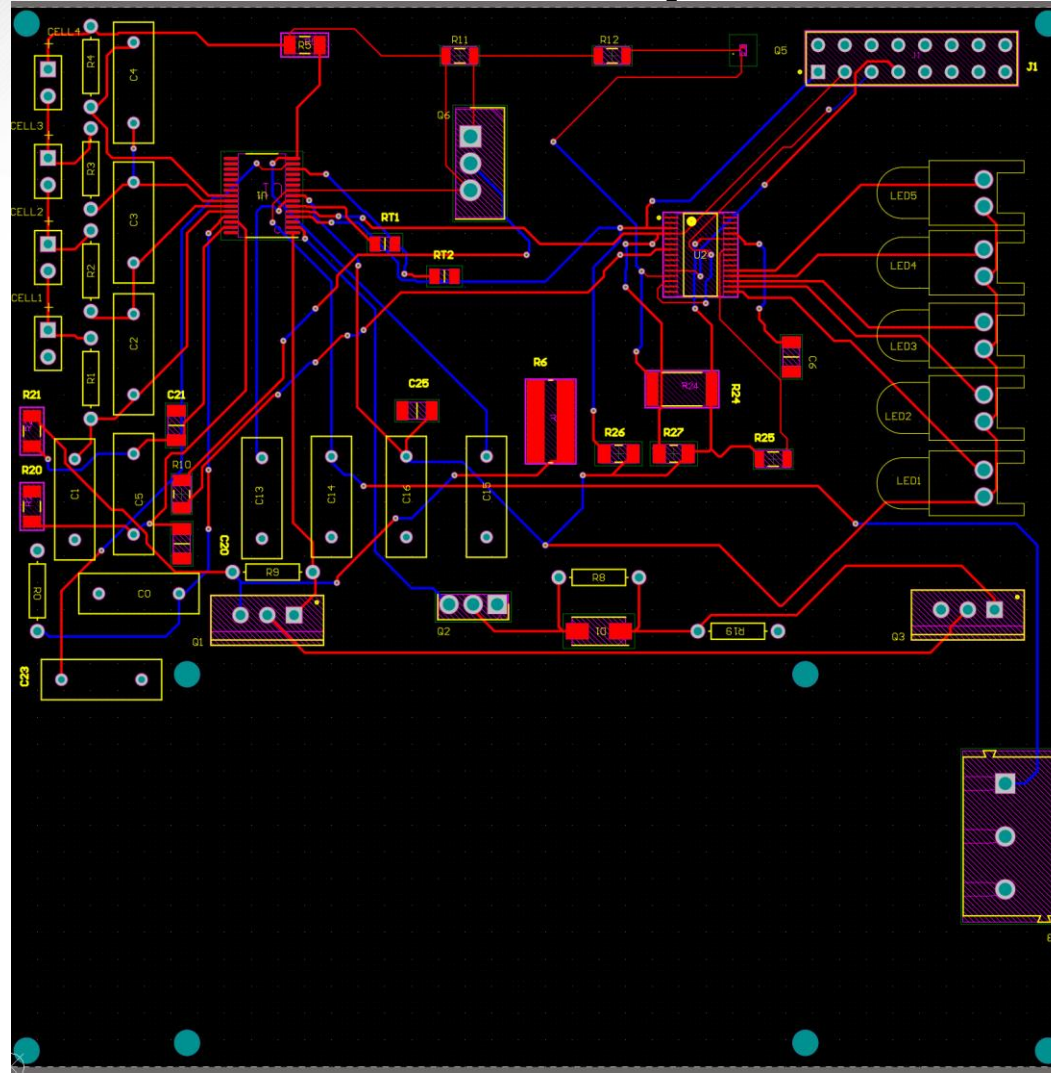
Power Management Accomplishments

Robert Dye



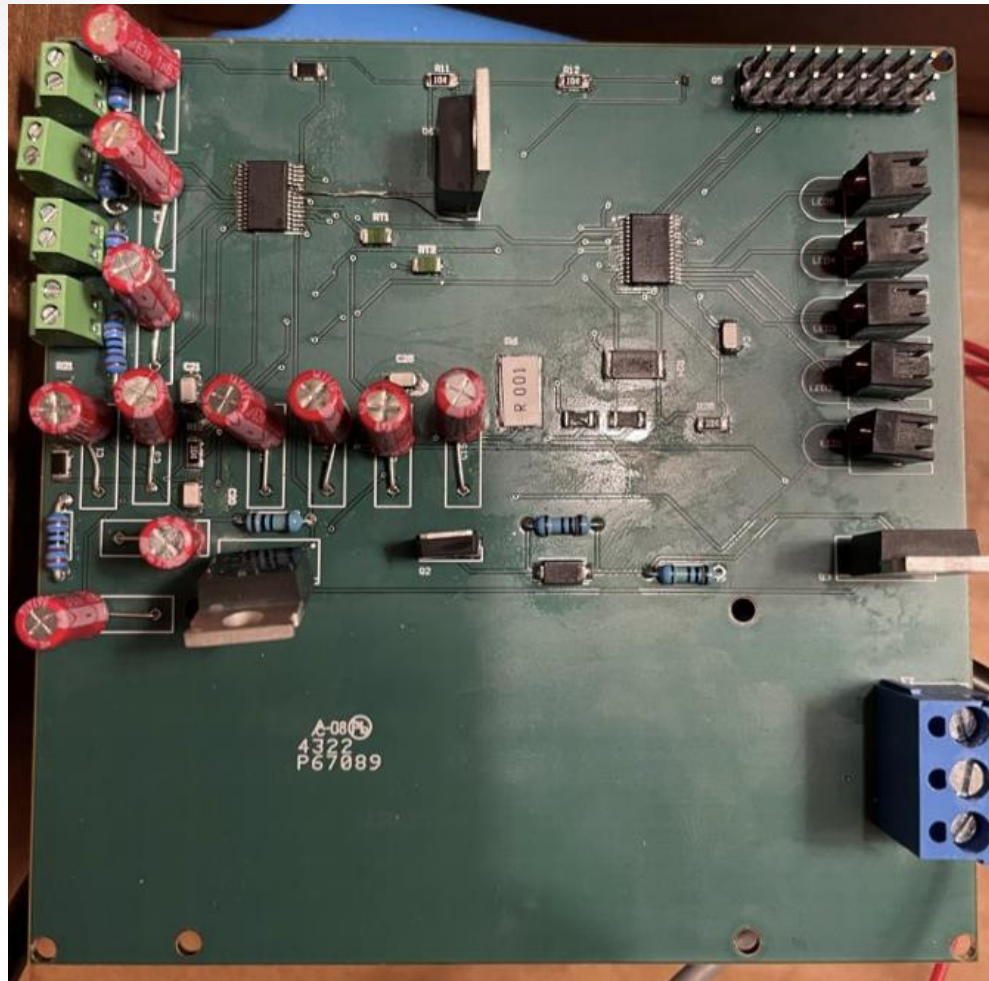
Power Management Accomplishments

Robert Dye



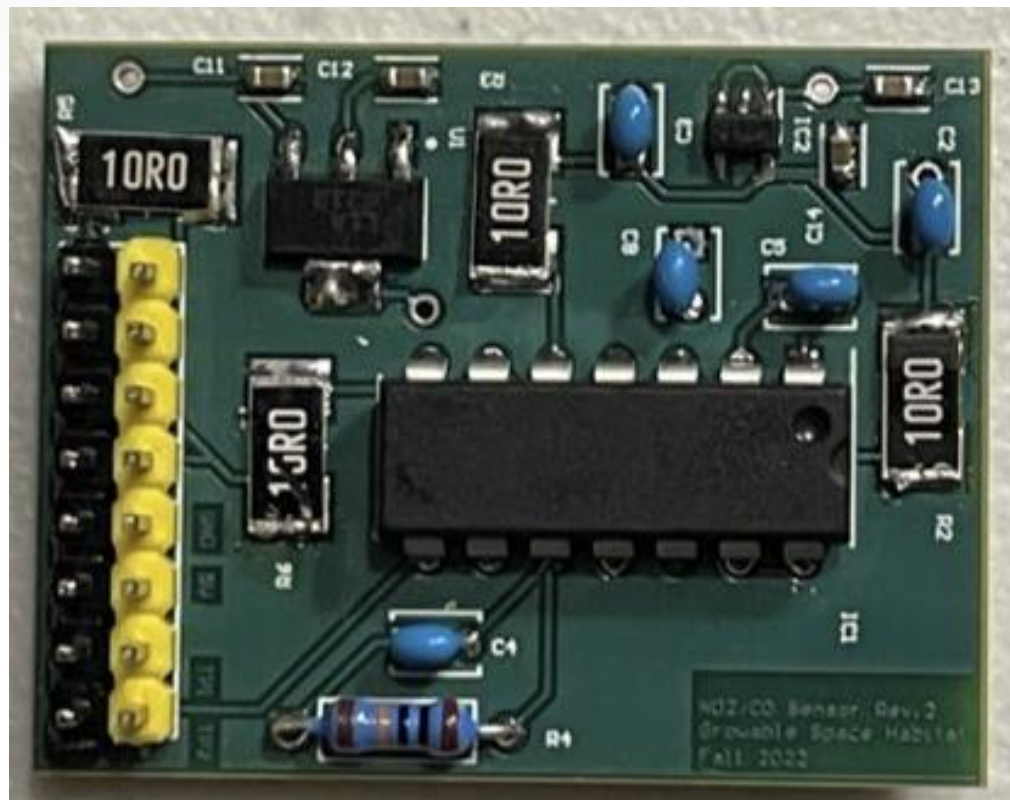
Power Management Accomplishments

Robert Dye



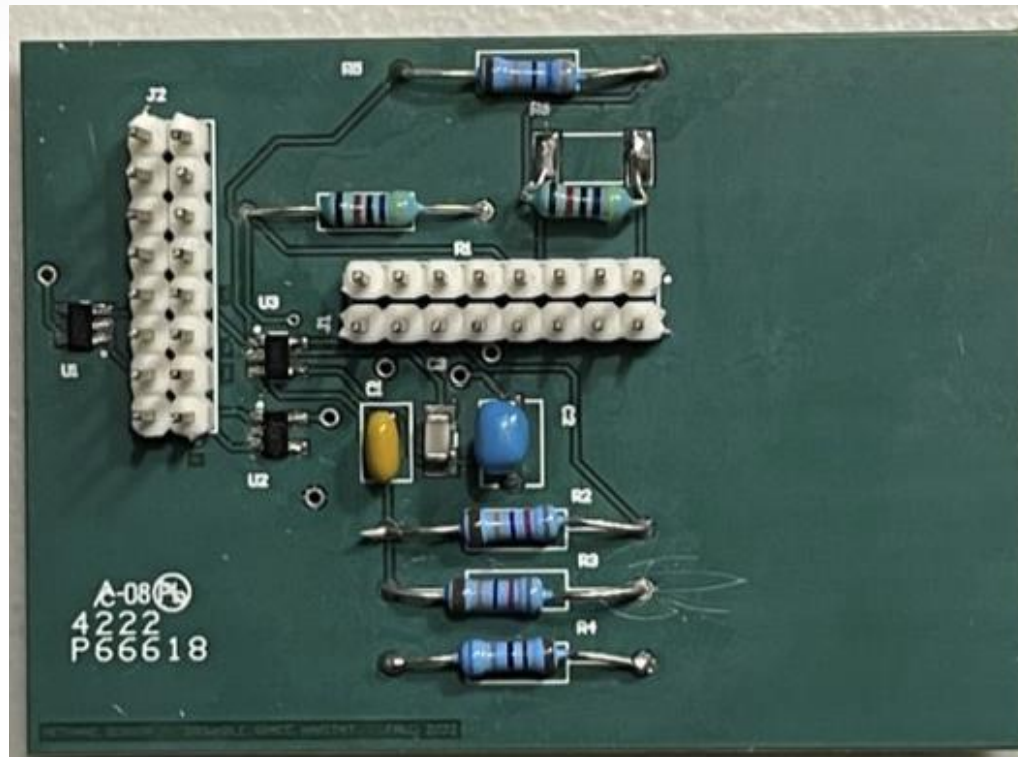
Power Management Accomplishments

Robert Dye



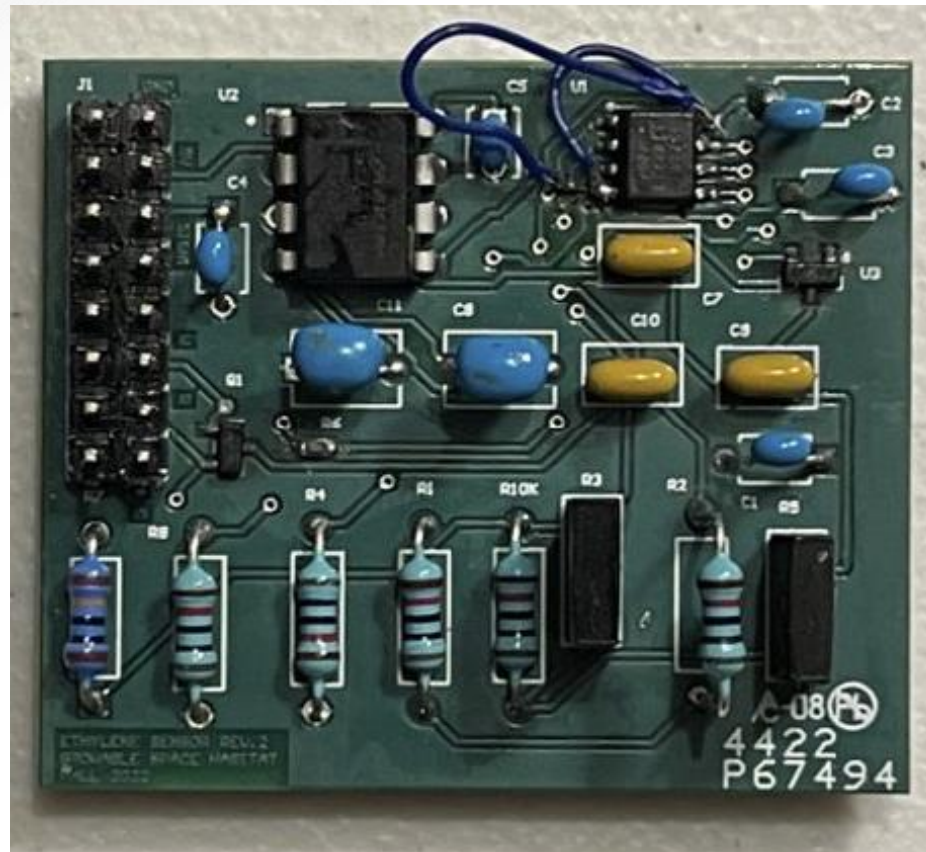
Power Management Accomplishments

Robert Dye



Power Management Accomplishments

Robert Dye





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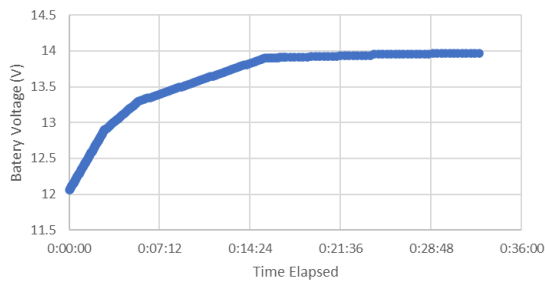
Power Management

Robert Dye

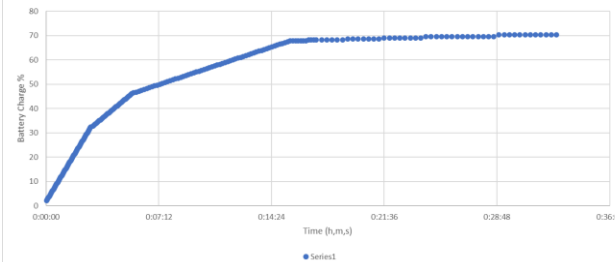
Power Management Previous Graphs

Robert Dye

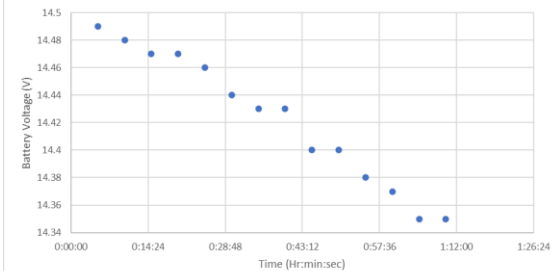
Battery Voltage vs Time Charging



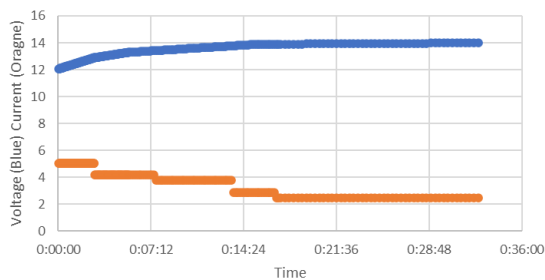
Battery Charge Percentage Over Time



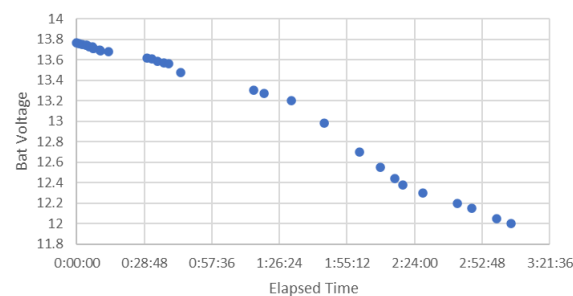
Battery Voltage (V) Vs Time (Hr:min:sec)



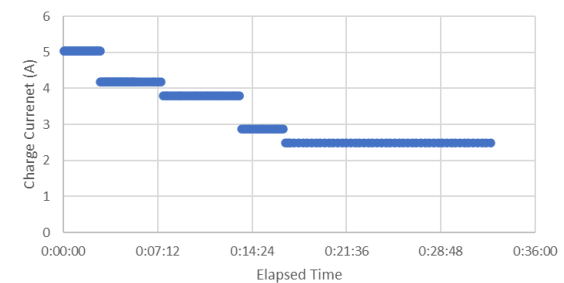
Charge Current and Bat Voltage vs Time



Battery Voltage vs Time Discharging



Charging Current vs Time

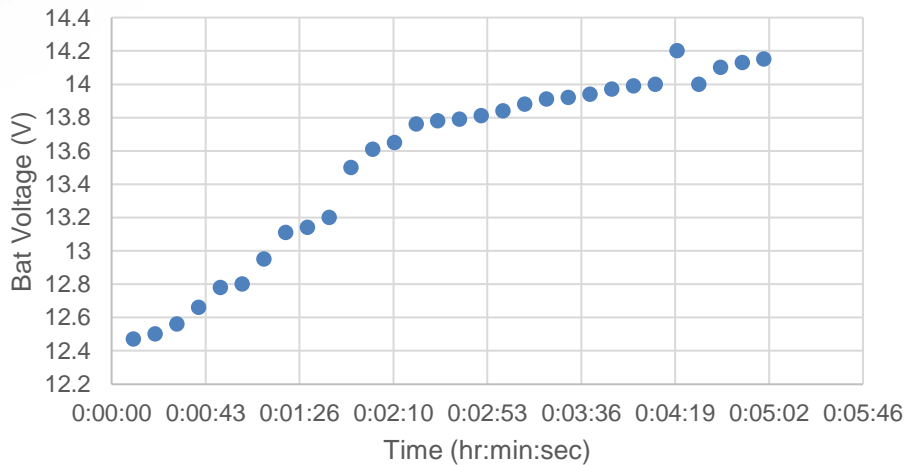


Power Management

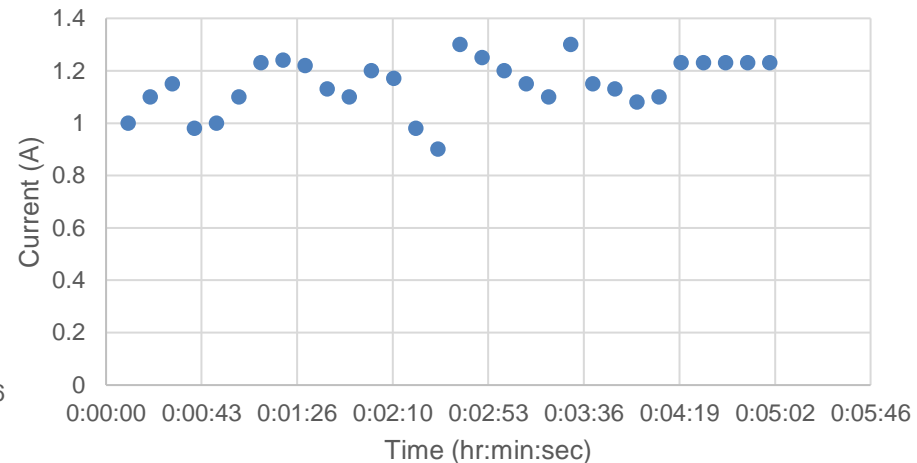
- Graphs from video

Robert Dye

Battery Voltage vs. Time



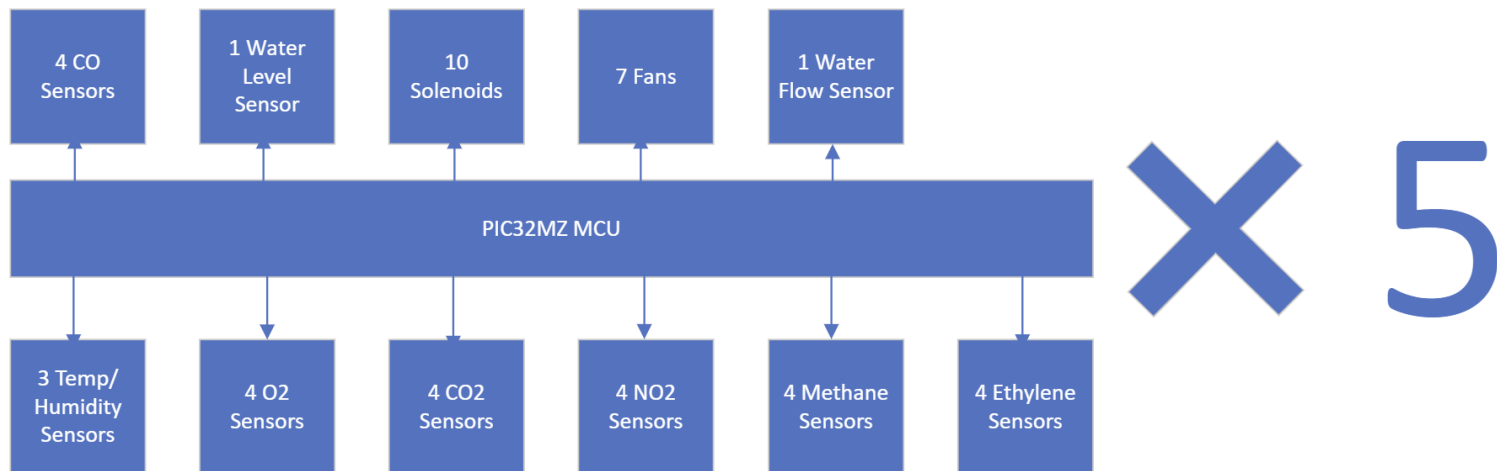
Current vs. Time



Microcontroller Accomplishments

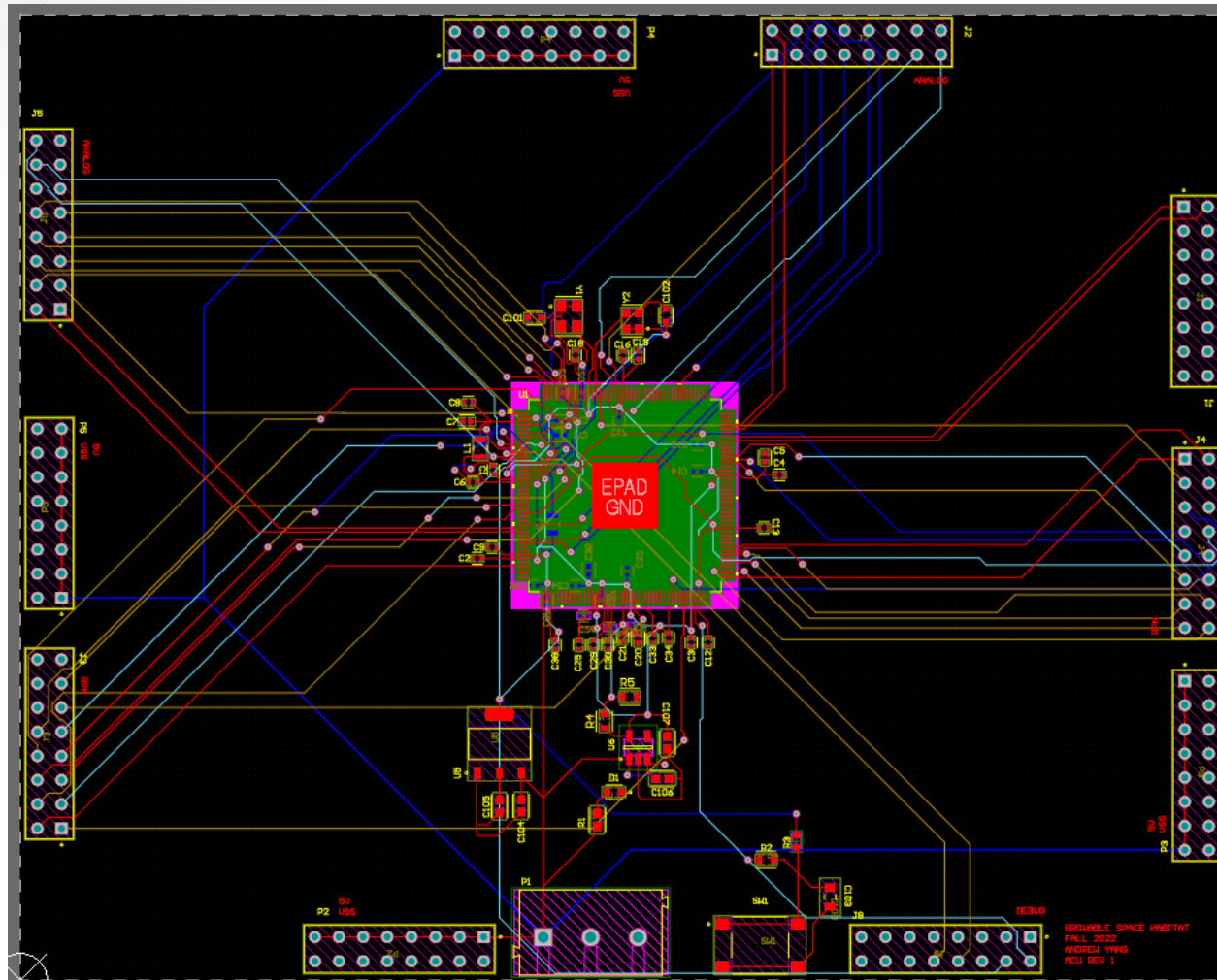
Andrew Yang

- 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



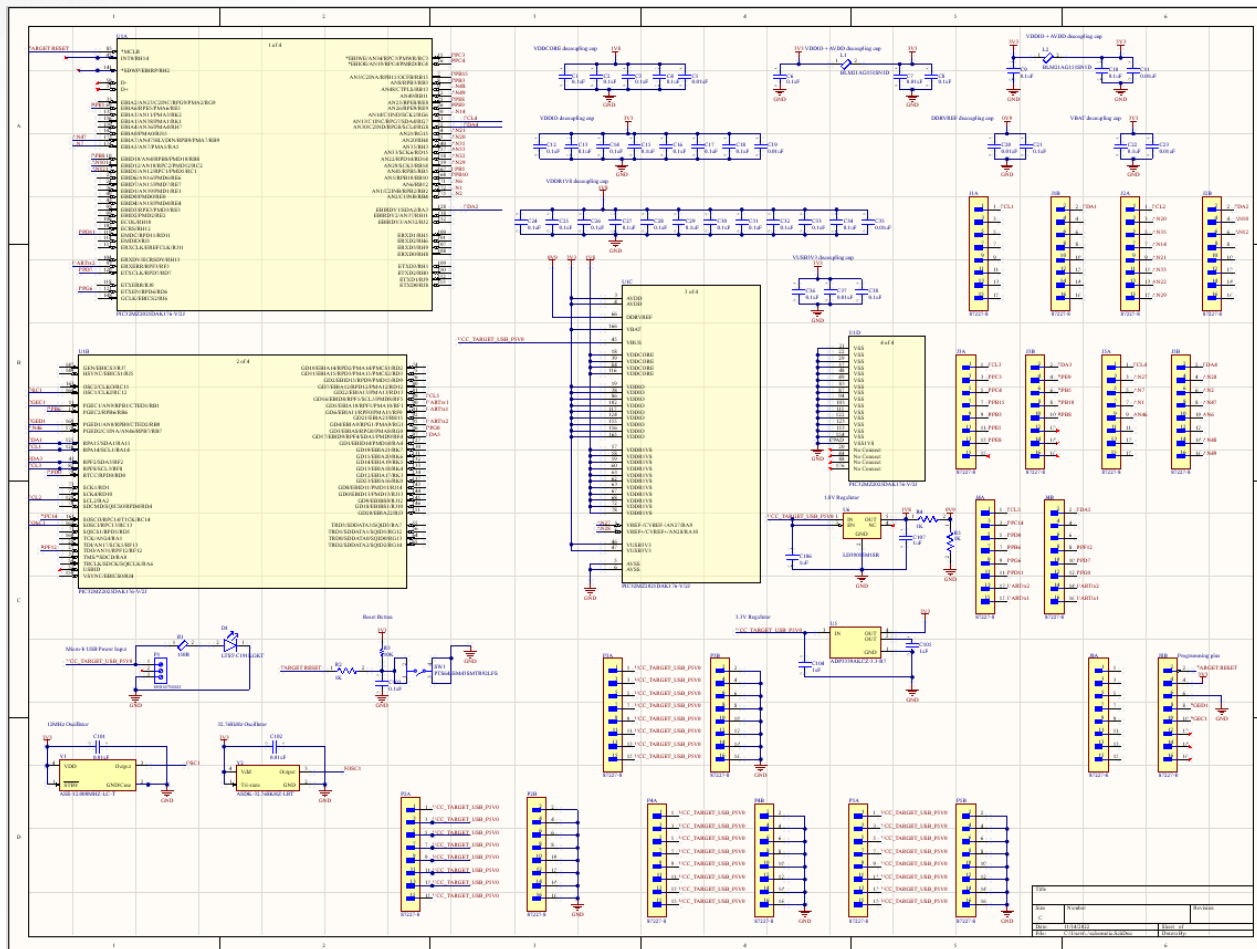
Microcontroller Accomplishments

Andrew Yang



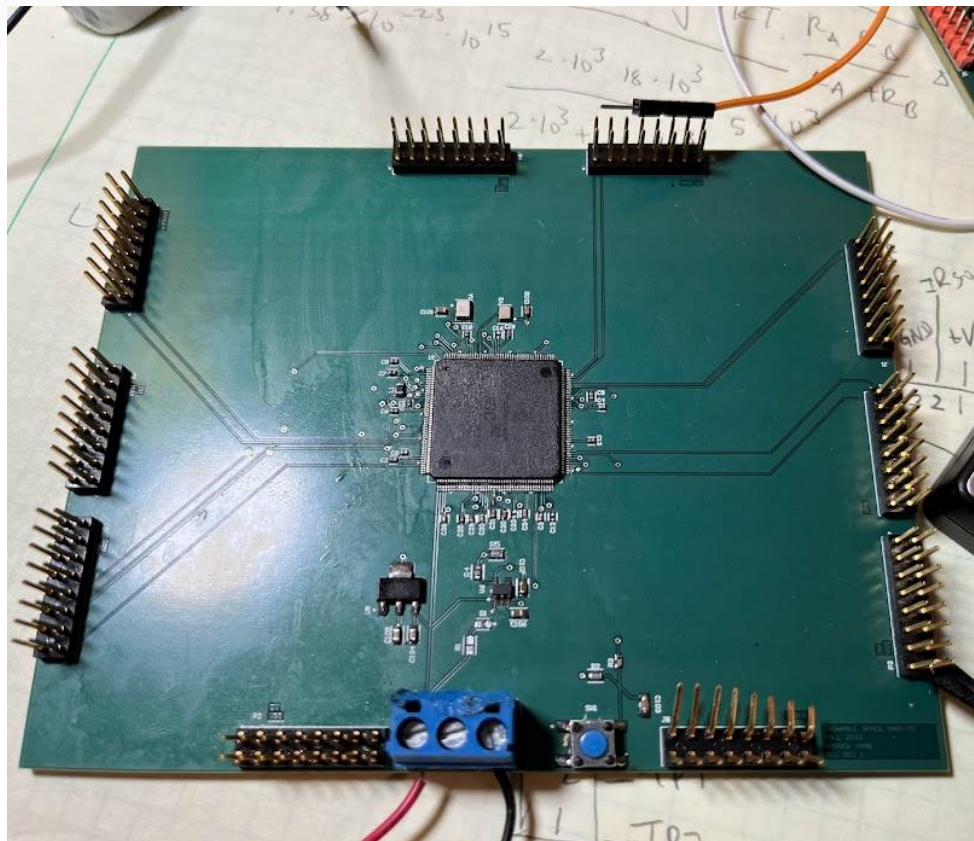
Microcontroller Accomplishments

Andrew Yang



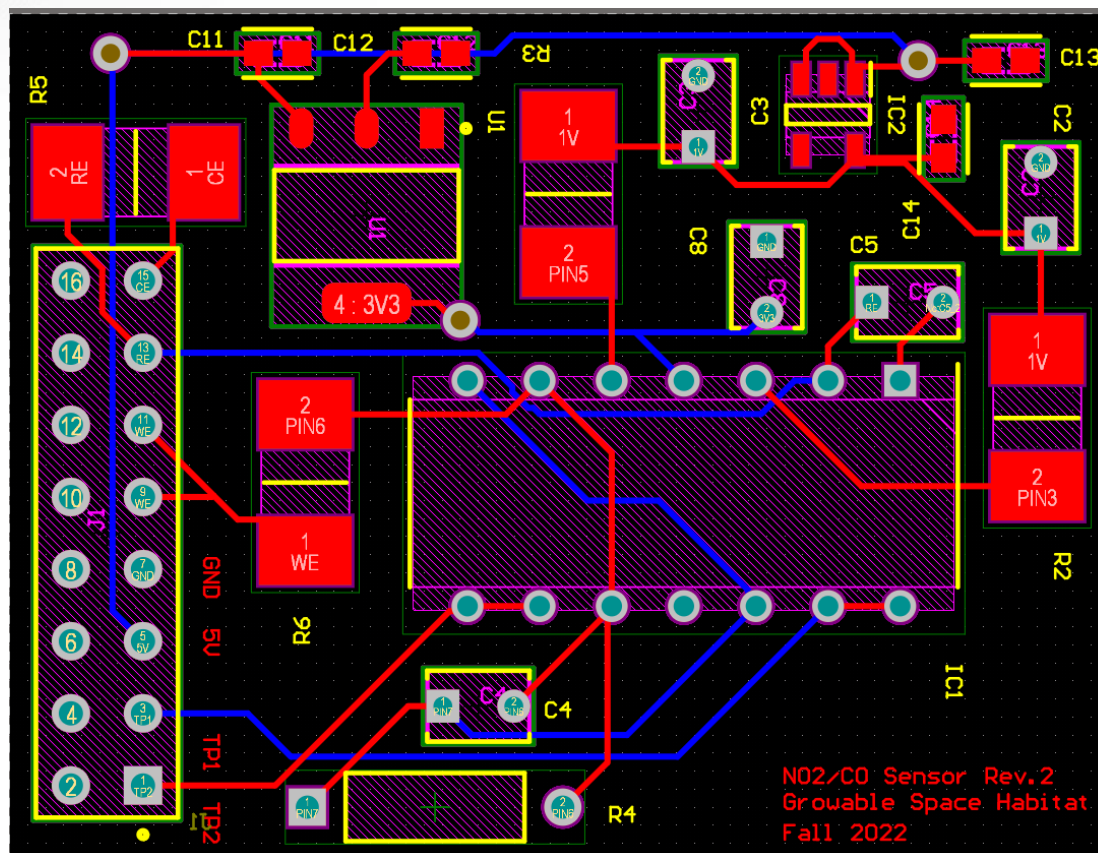
Microcontroller Accomplishments

Andrew Yang



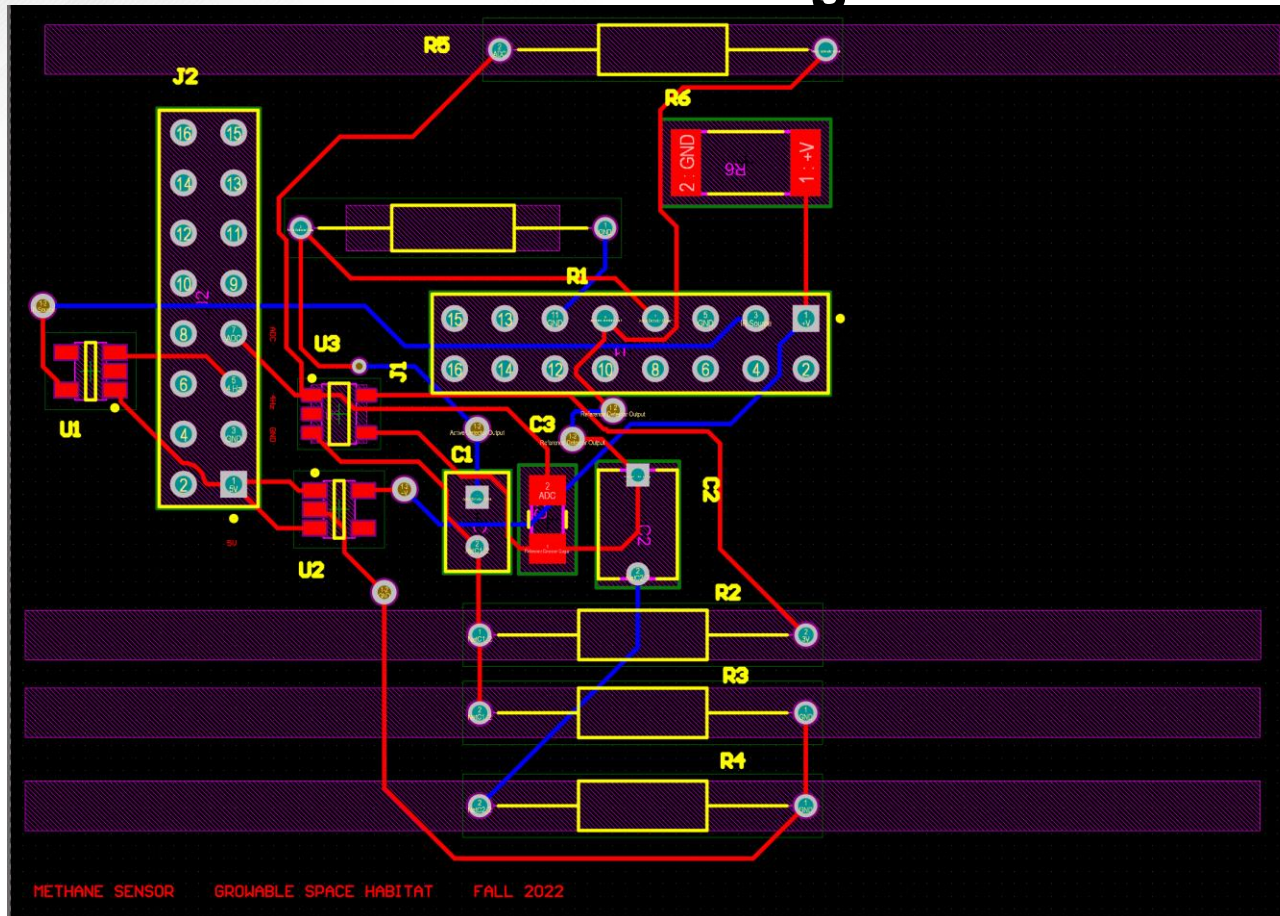
Microcontroller Accomplishments

Andrew Yang



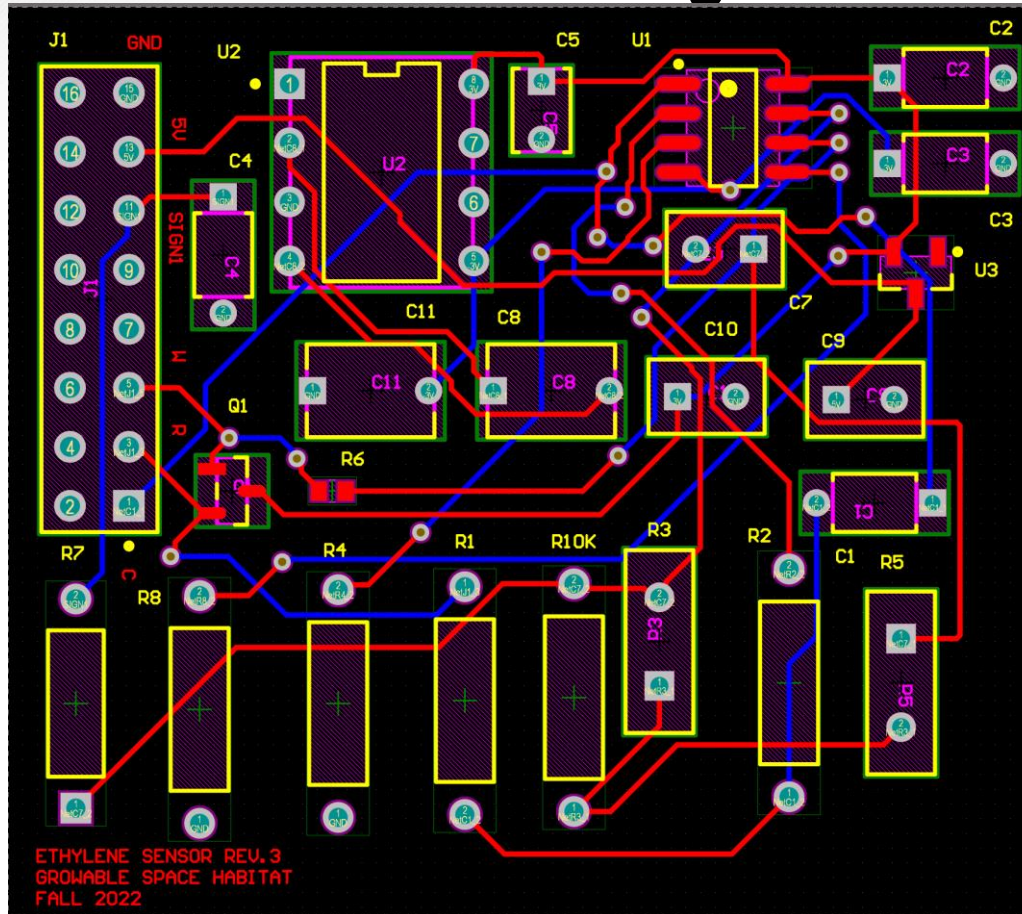
Microcontroller Accomplishments

Andrew Yang



Microcontroller Accomplishments

Andrew Yang



User Interface Accomplishments

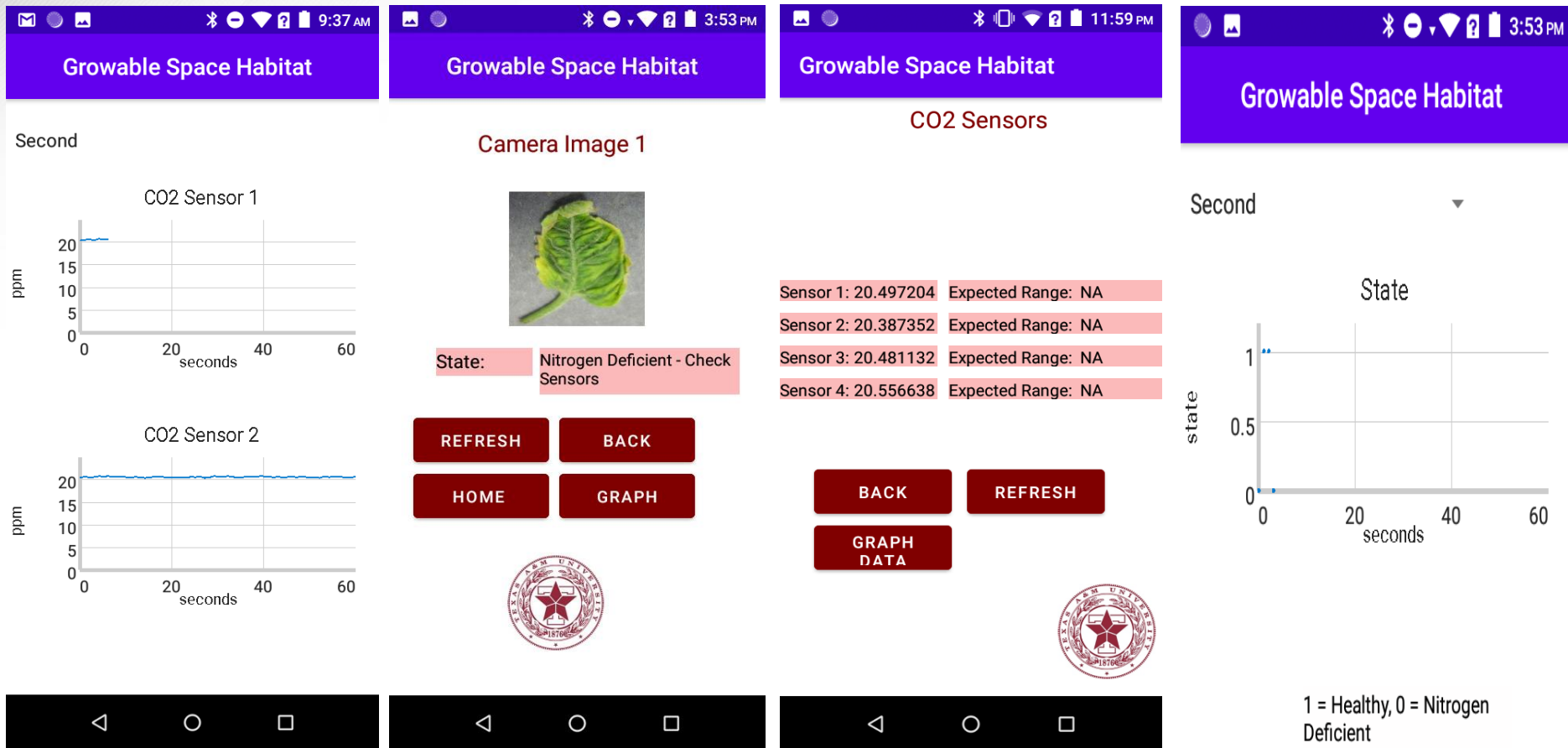
- Display real time sensor data
- Displaying graph's of sensor data of time, with different windows of duration
- Display camera pictures



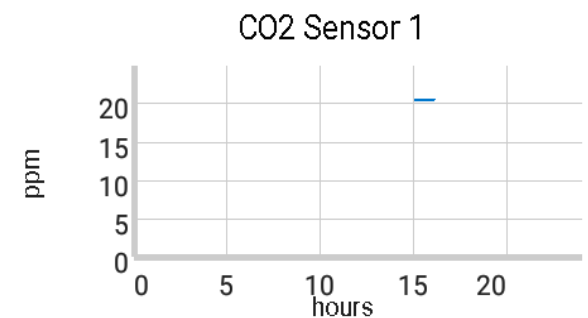
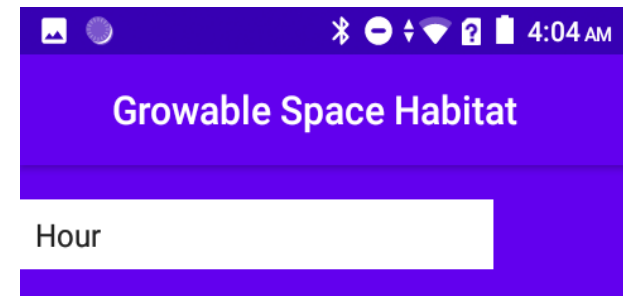
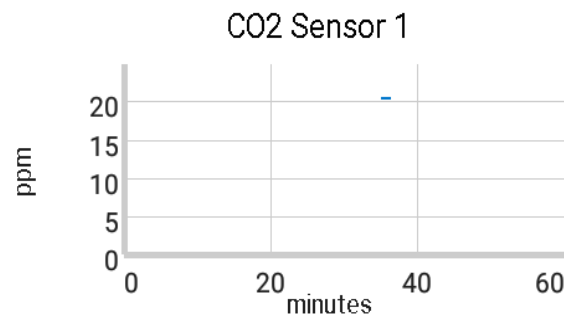
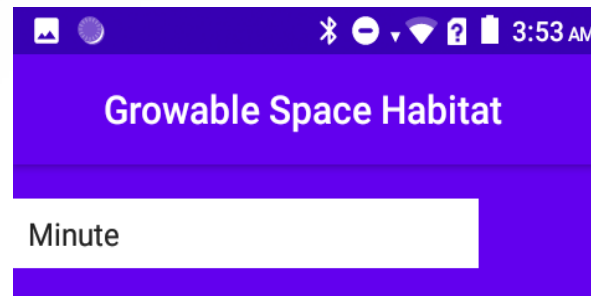
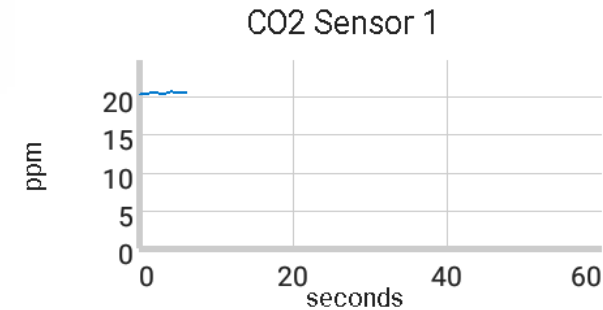
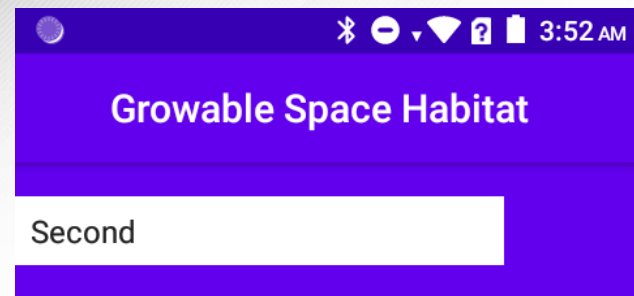


User Interface – General Format

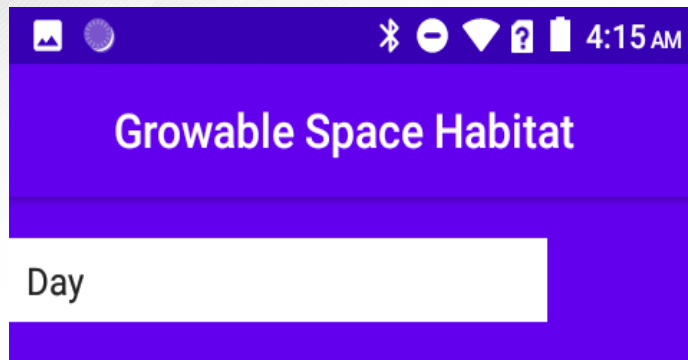
Justin Blankenhorn



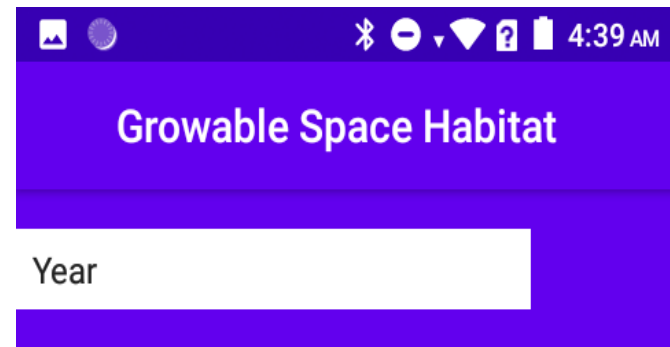
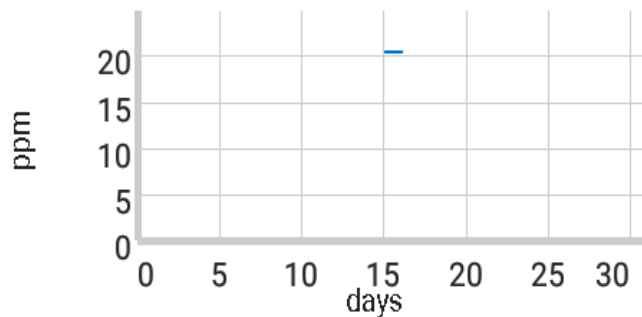
User Interface – Validating edge cases 1



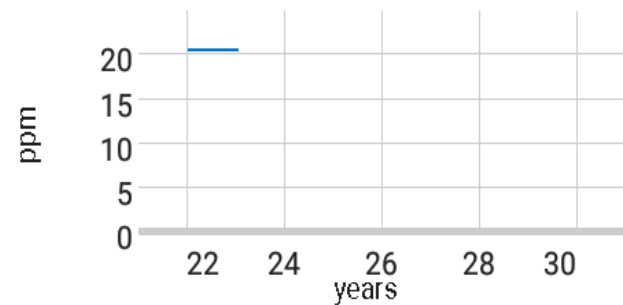
User Interface – Validating edge cases 2



CO2 Sensor 1





CO2 Sensor 1





Data Integration

 <https://growable-space-habitat-default-rtdb.firebaseio.com>

 Your security rules are defined as public, so anyone can steal, modify,

▶ -NDP00N3Xfjq1UXUK-W0

▶ -NDP000hLwSIvkwqKhK1

▶ -NDP00QHk6m7Niml2w_z

▶ -NDP00Rsd7Gi6lQ5xgvi

▼ -NDP00TVcjRd4ptakvSH

— concentration: 20.497204605687745

— time: 99

▶ Sensor 2

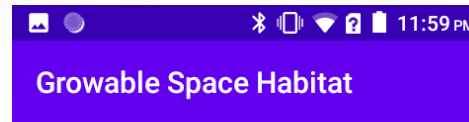
▼ Sensor 3

▼ -NETjsXWWvaYyVCdIyDf

— concentration: 20.546331352745128



Data Integration



CO2 Sensors

Sensor 1: 20.497204	Expected Range: NA
Sensor 2: 20.387352	Expected Range: NA
Sensor 3: 20.481132	Expected Range: NA
Sensor 4: 20.556638	Expected Range: NA

BACK

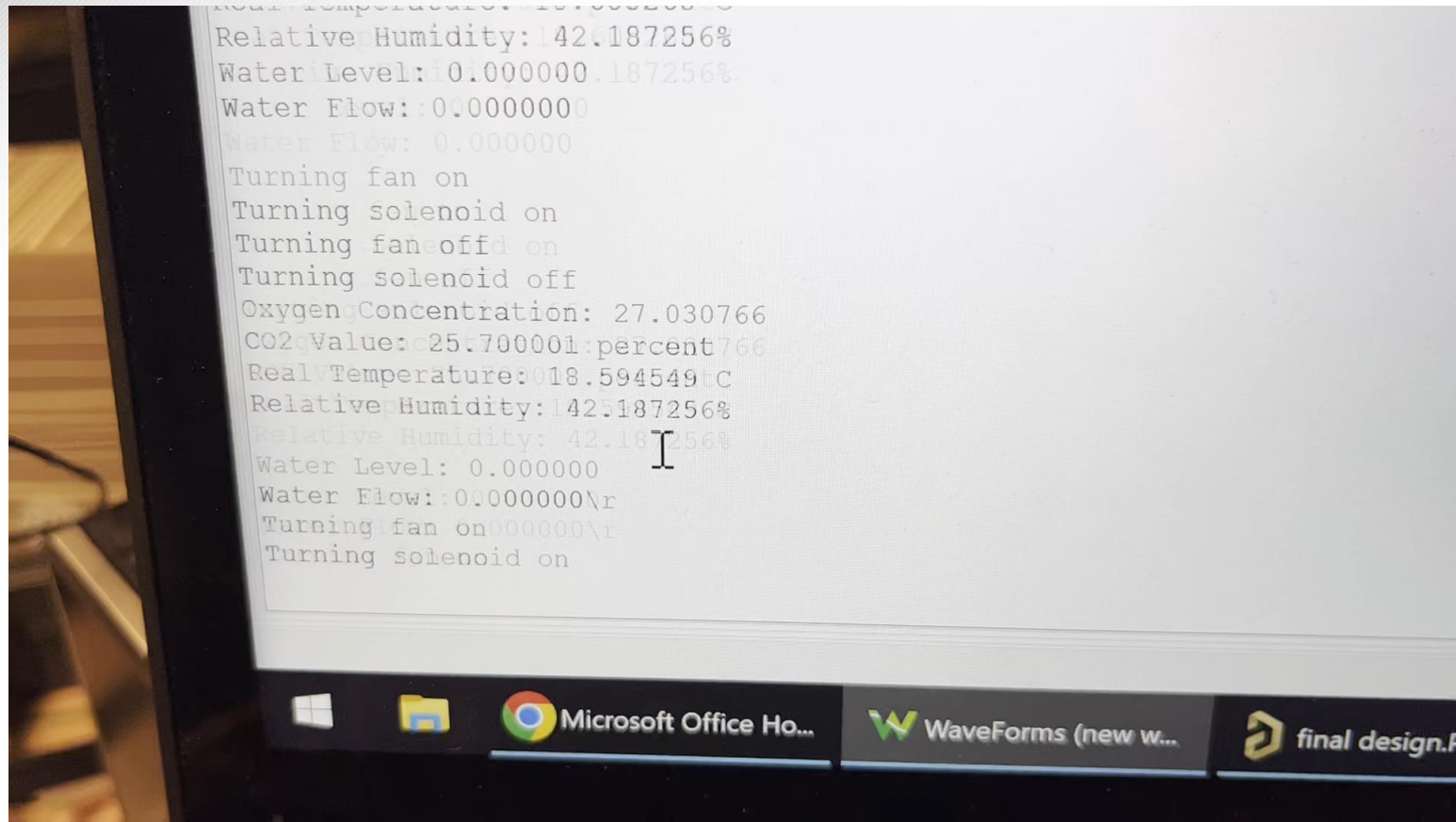
REFRESH

GRAPH
DATA

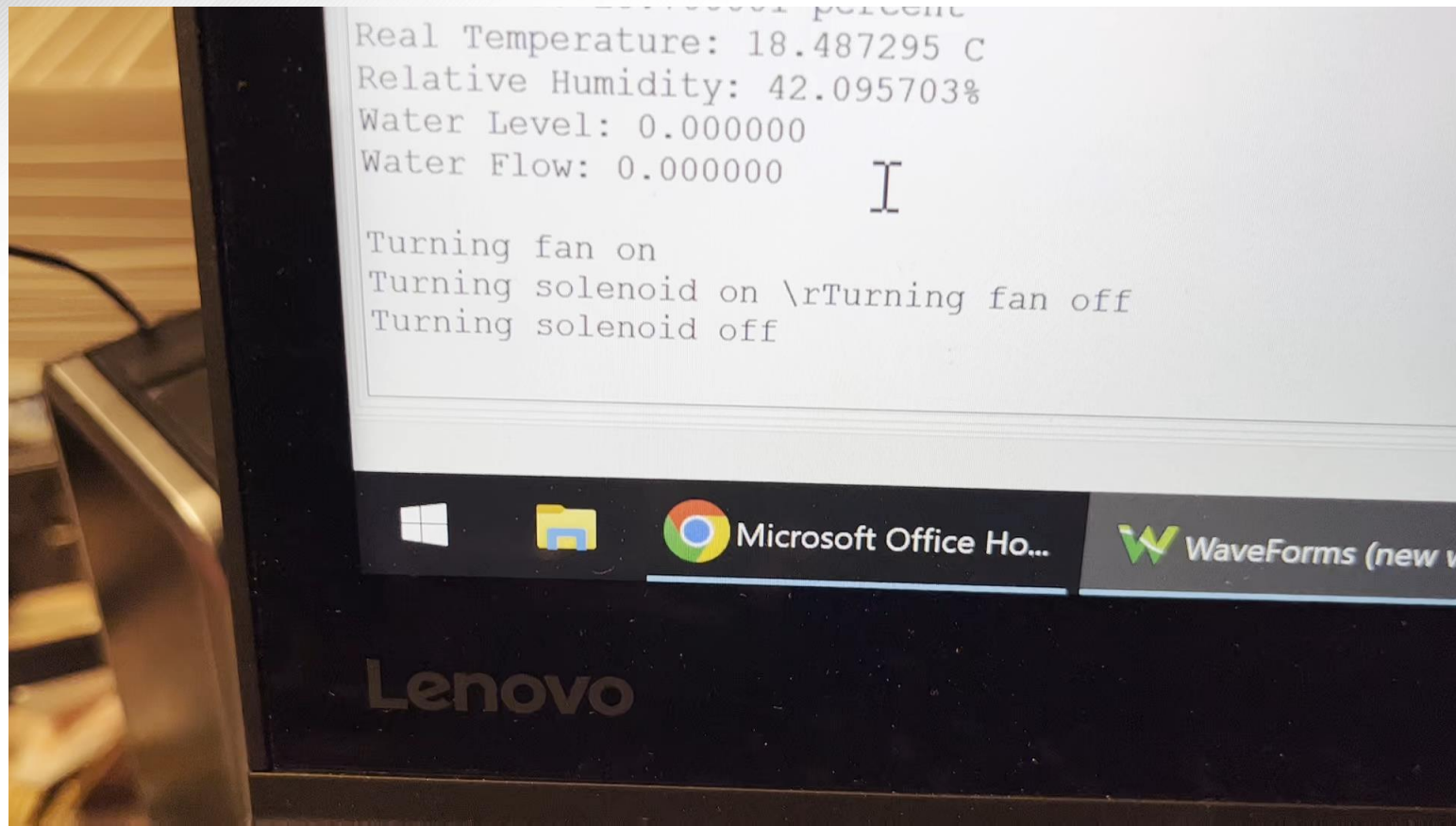




System and Validation Results Videos

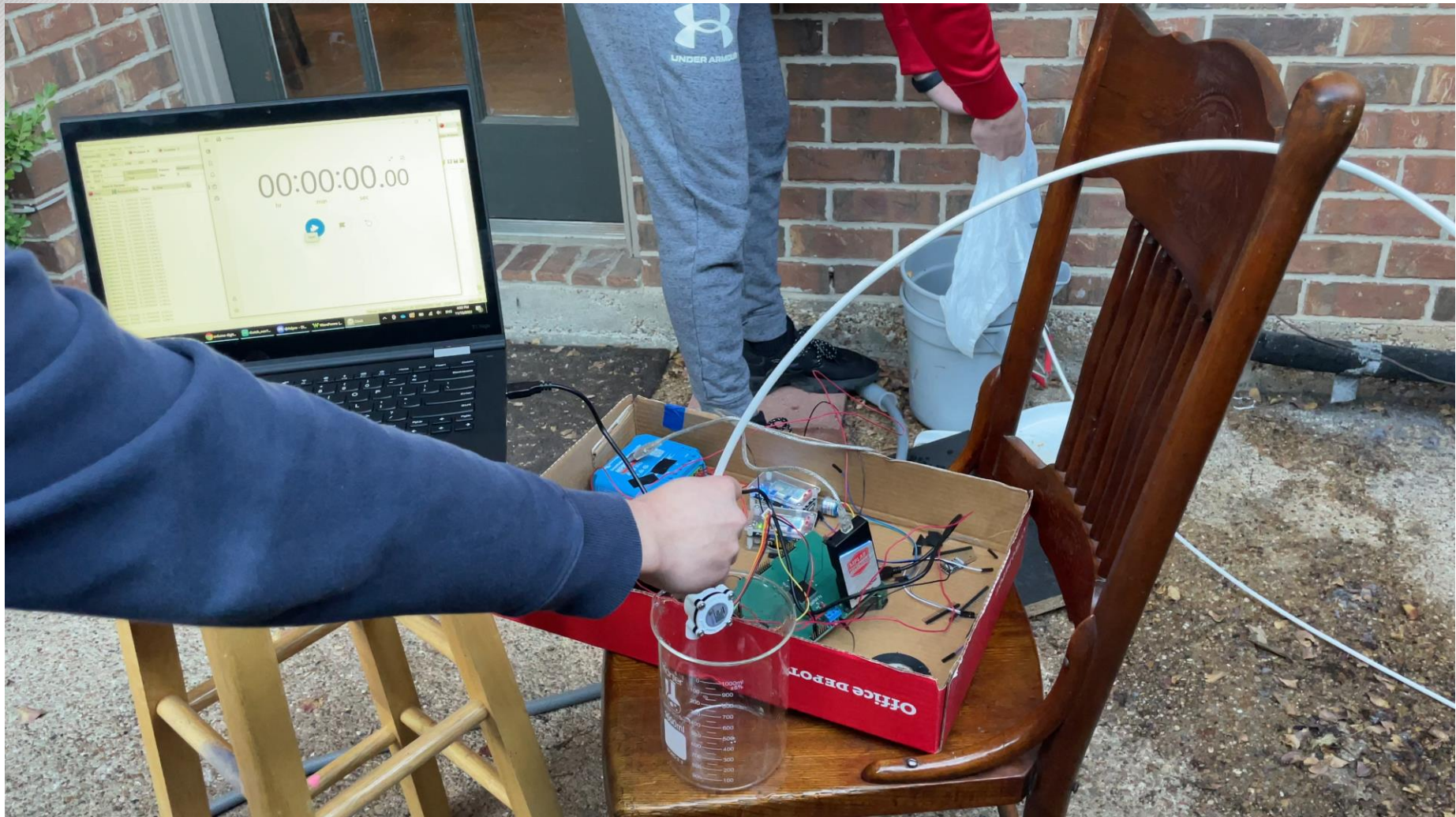


System and Validation Results Videos

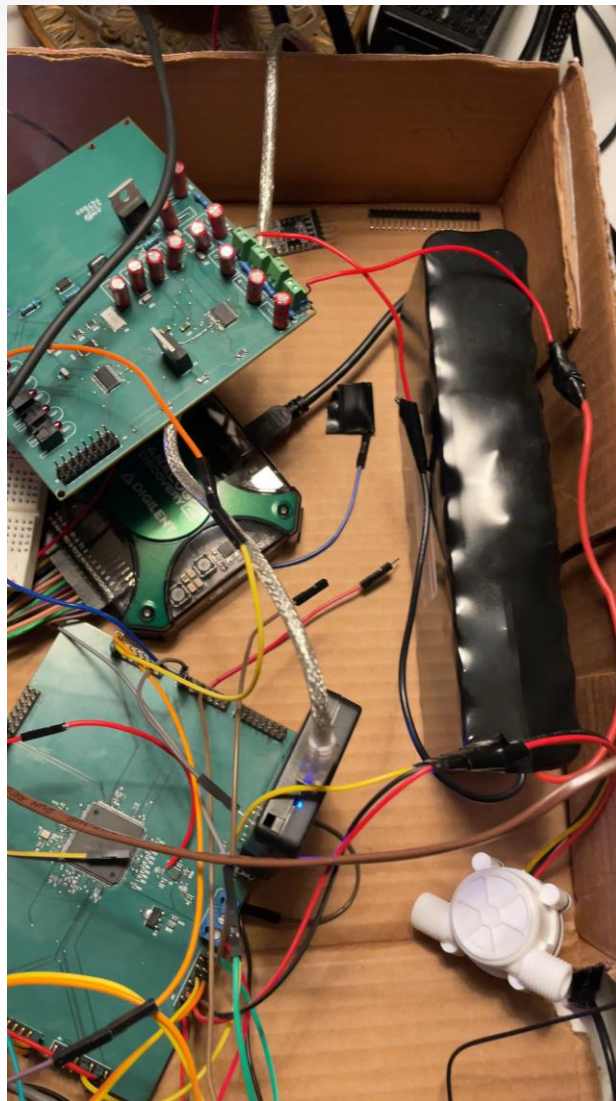




System and Validation Results Videos



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 an 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



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THANK YOU!