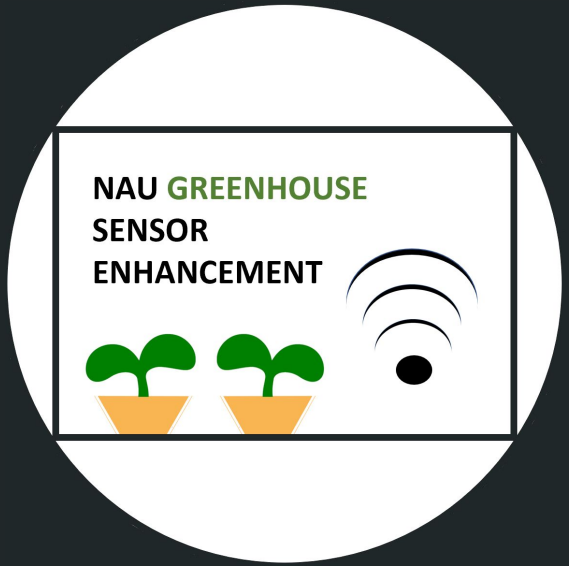
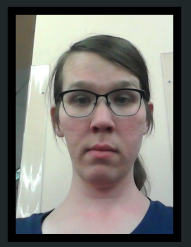
Team Getting Green: Final Presentation

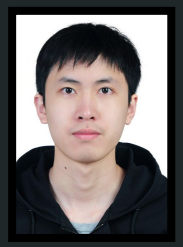
April 22nd, 2022



DATAFORTH


Alexia Risley

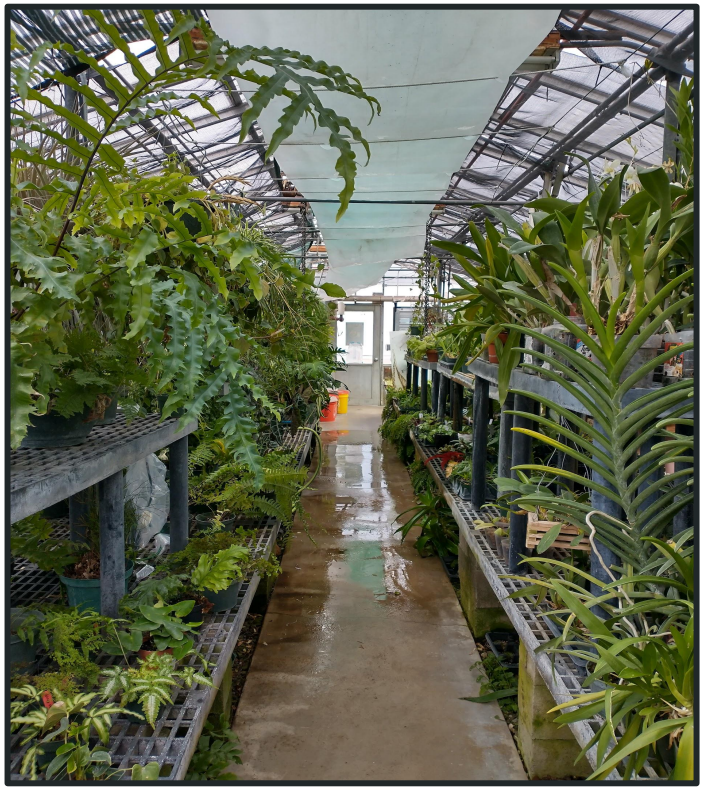

Emilia Connelly


Jiaxin Liu


Ruopeng Jia

Introduction

- Client: Dr. Tina Ayers, Professor of Biology
- Sponsor: Dataforth Corporation
- Motivations:
  - Reduce risk of plant freezing/overheating
  - Reduce nighttime trips to the greenhouse
  - Client peace of mind
  - Reduce undesired vertical temperature gradients

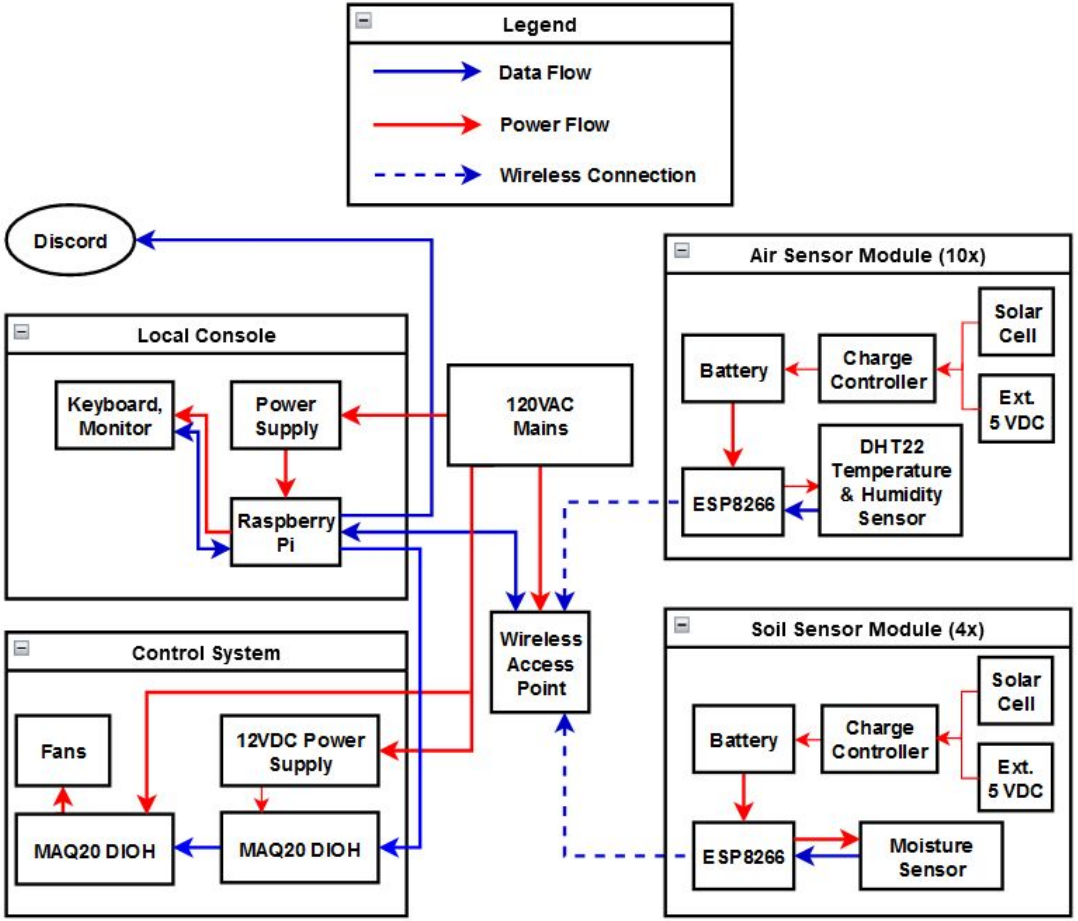


Core Requirements

- Monitor environmental conditions
  - Both sections of greenhouse
  - No more than 15 minute intervals
- Publish sensor data to web interface
  - Accessible from off campus without VPN
- Smartphone alerts
  - Too cold, too hot, sensor failure
- Air mixing fans
  - Reduce temperature gradients
  - User-selectable modes

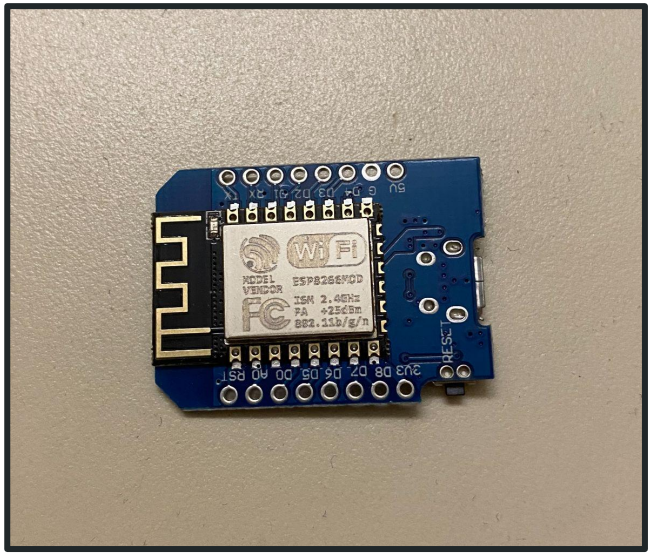
System Architecture

- Air and soil sensors connected to console via WiFi
- Sensor modules to be battery-powered, with solar supplement
- Other components to be powered by AC mains



Communications Units

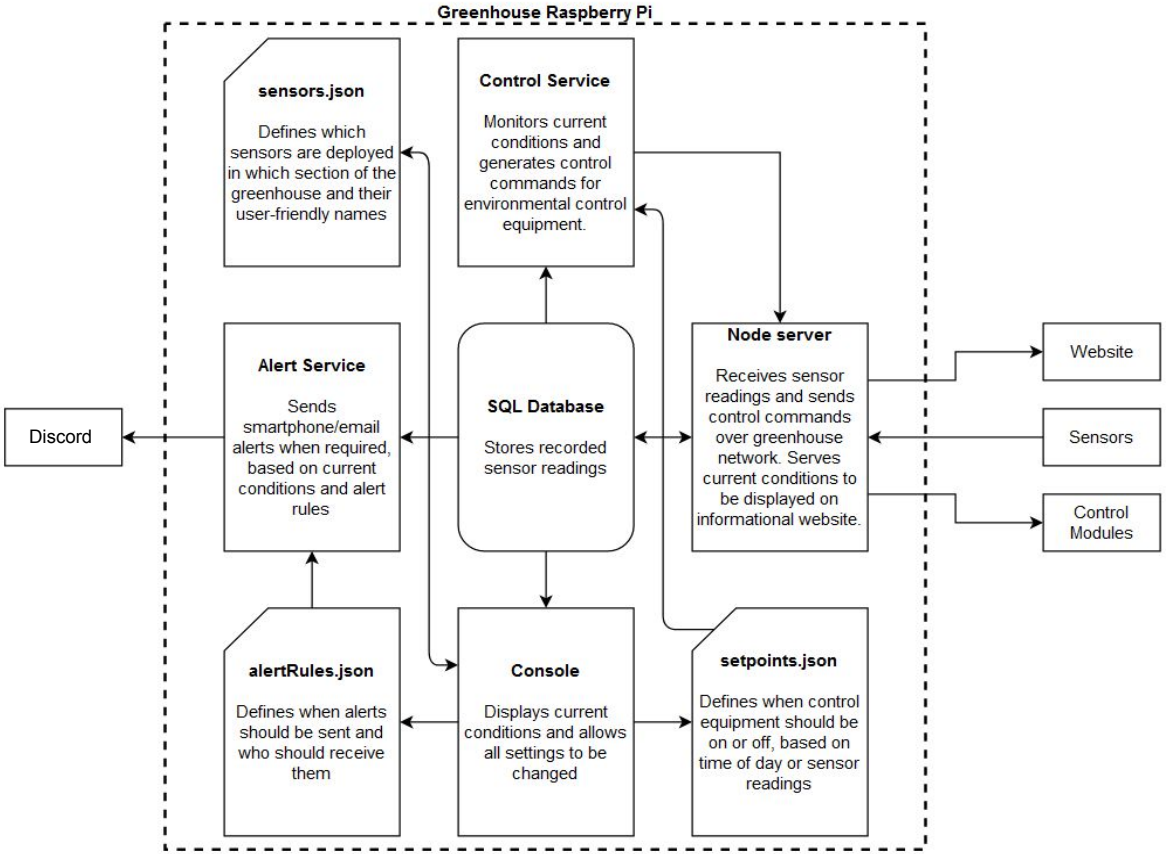
- ESP8266 integrated low power 32-bit RISC processor
- With a standby power consumption of under 1mW (DTIM3)
- Wake up and transmit packets in less than 2ms
- A superior RF performance with RF, green and reliability certifications
- Embedded wireless technology that is web friendly with no use of shields or any peripherals



ESP8266 Board

Software Decomposition

- Diagram shows processes run and files stored on the Raspberry Pi located in greenhouse equipment room
- All traffic in and out is handled by the Node server, except for alerts sent using a Python Gmail client
- All sensor readings stored in the SQL database



MAQ20 Control System

- MAQ20-COM4 uses Ethernet to establish communication between a host computer and a MAQ®20 Data Acquisition System.
- MAQ20-DIOH has the ability to output 24-280VAC under 3A high load
- The two modules are connected through - BKPL8 system backbone network. Communication modules are housed in moisture-proof and sturdy boxes and integrated in the center of the greenhouse for data and power transmission.

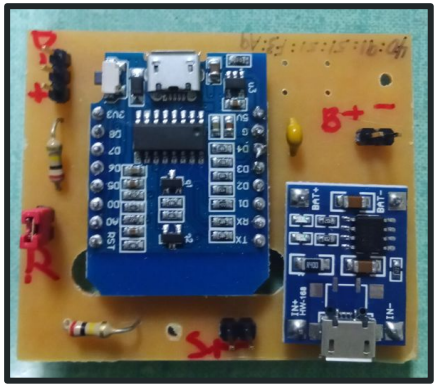
COM4 Module

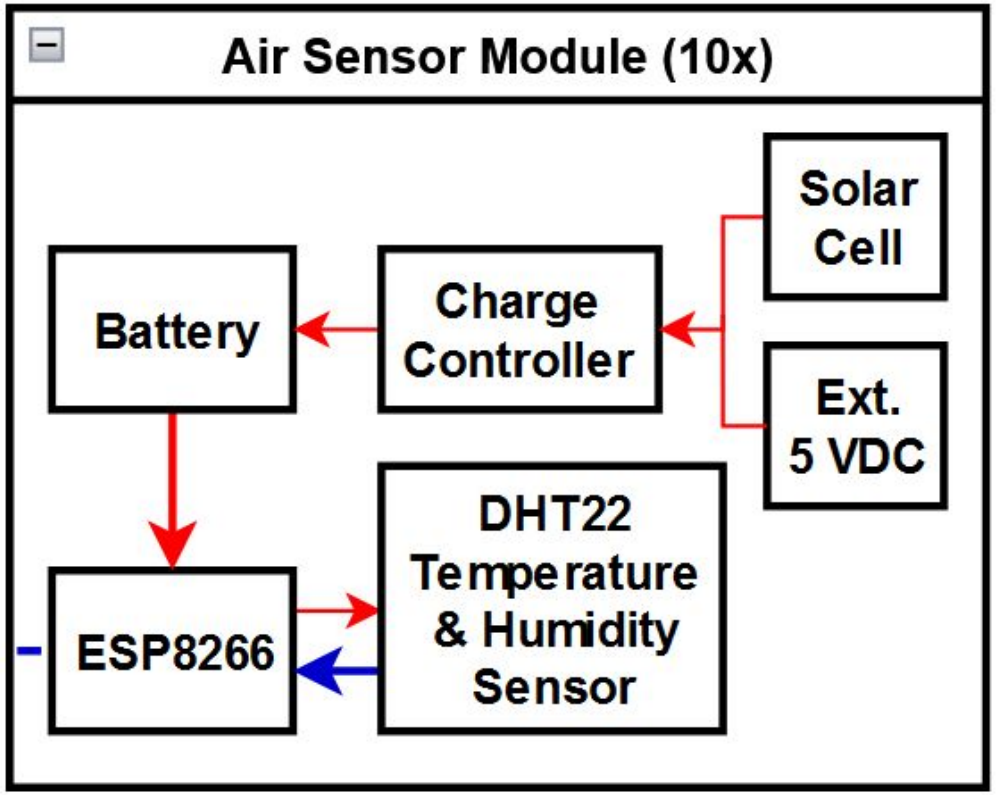
DIOH Module

MAQ20 system installed in greenhouse

Air Sensor Module

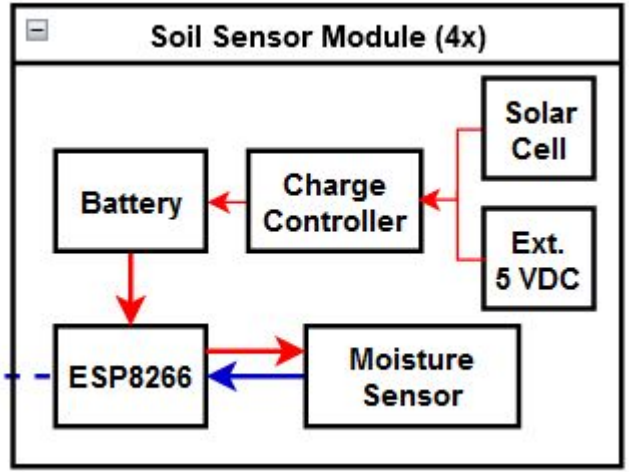
- Power from solar or wall
- All sensor readings and communications are controlled by the ESP8266 microcontroller



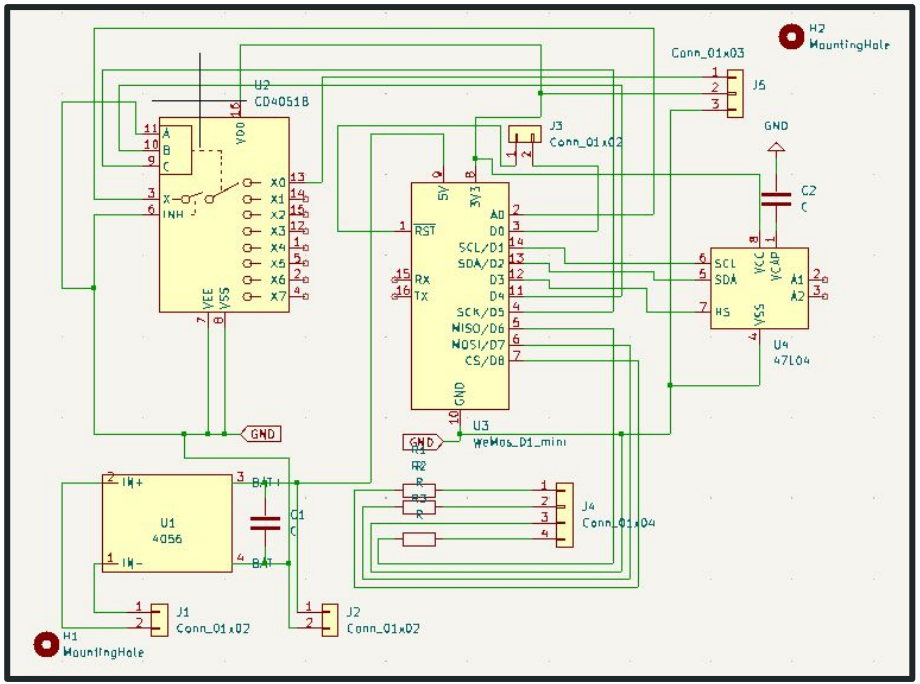


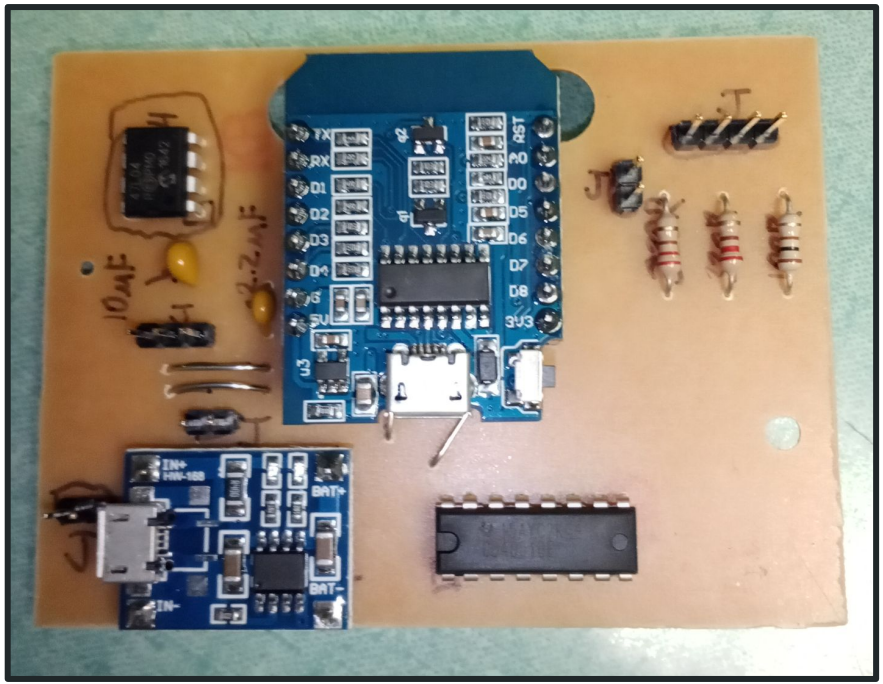
Soil Sensor Decomposition

- Charge controller maintains battery charge from solar or external 5V
- Memory chip stored the soil moisture content so it can be be stored periodically on the chip.
- Lastly, the ESP8266 is wired to the soil moisture sensor so it may receive the soil moisture value and display the value on our Discord server



Soil Moisture Sensor PCB





Alexia Risley

Key Testing Results

Req. #	Description	Test Criteria	Result
1.1.3	Temperature Accuracy	Sensors accurate to ± 2 °F	OK
1.1.4	Humidity Accuracy	Sensors accurate to ± 5% RH	OK
2.1.1	Data Rate	Log data at ≤ 15 minute intervals	OK (5 minutes)
4.1.1	Smartphone Alert	Notify within 5 minutes	OK (< 1 minute)

Testing Results Analysis

- Product is usable and reliable for its primary purpose
- Some “extra” less important goals were not met
  - Soil moisture sensors are not functional
  - Most air sensors are receiving wired power instead of solar

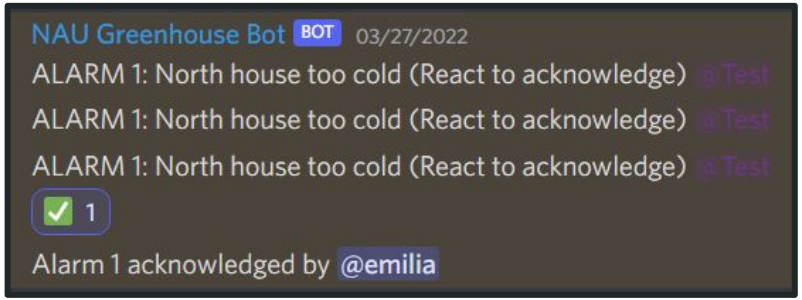
Hygrometer display
during humidity accuracy test

```
16:27:01.177 -> Attempting to connect to DHT22...
16:27:01.177 -> --------------------
16:27:01.177 -> 23.40%
16:27:01.177 -> --------------------
```

Serial Output Humidity Value

Technical Challenges

- Planned to send smartphone alerts via email ➔ SMS
  - Google disabled automated username+password access
  - Switched to Discord bot
- Excessive temperatures encountered in greenhouse (over 100 °F ambient)
  - Higher inside sensor cases
  - Likely unsafe for lithium batteries
  - Presented options; client elected to use wired power supply
  - Solar was a nice-to-have from the beginning
- Printed circuit board fabrication
  - Software issues
  - Ragged trace edges



Conclusion

- The system actively reads results from the temperature/humidity sensors
- 8 out of 10 of them are wired to an outlet for a power source
- 2 out of 10 receive power from their solar panels
- The soil moisture sensors are still being worked on
- Our primary requirements have been met
- The MAQ20 successfully operates the mixing fans
- The system publishes the measured data to a Discord server
- Delivery is in progress, to be completed in next two weeks