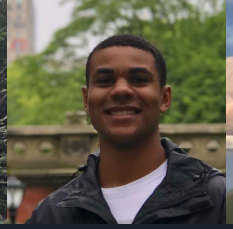



Stem ‘N’ Leaf

Modular Hydroponics

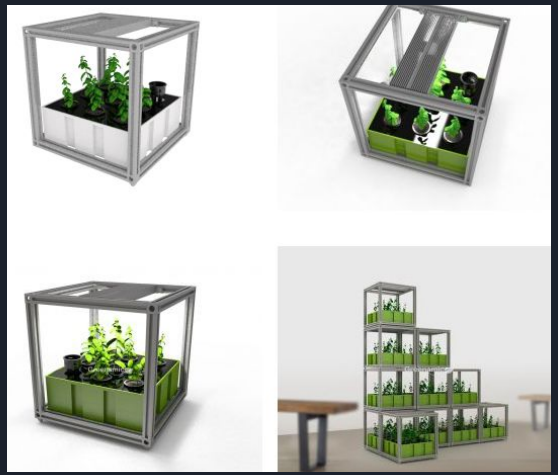
Group 7
Adam Loree
Brandon Mitchell
Don Ellington
Jonathan Rodriguez

Overview

- Description - (Don)
- Motivation - (Don)
- Block Diagrams - (Adam Don Jon)
- Project Goals and Objectives - (Adam)
- Specifications (Brandon)
- Overall Design - (Brandon)
- Hardware Design (Brandon)
- PCB Schematic - (Jon)
- Processor and Firmware - (Adam)
- Webstack- (Don)
- Database - (Don)
- Website Application - (Don)
- Mobile Application - (Don)
- Progress - (Don)
- Work Distribution - (Don)
- Budget - (Jon)

Description

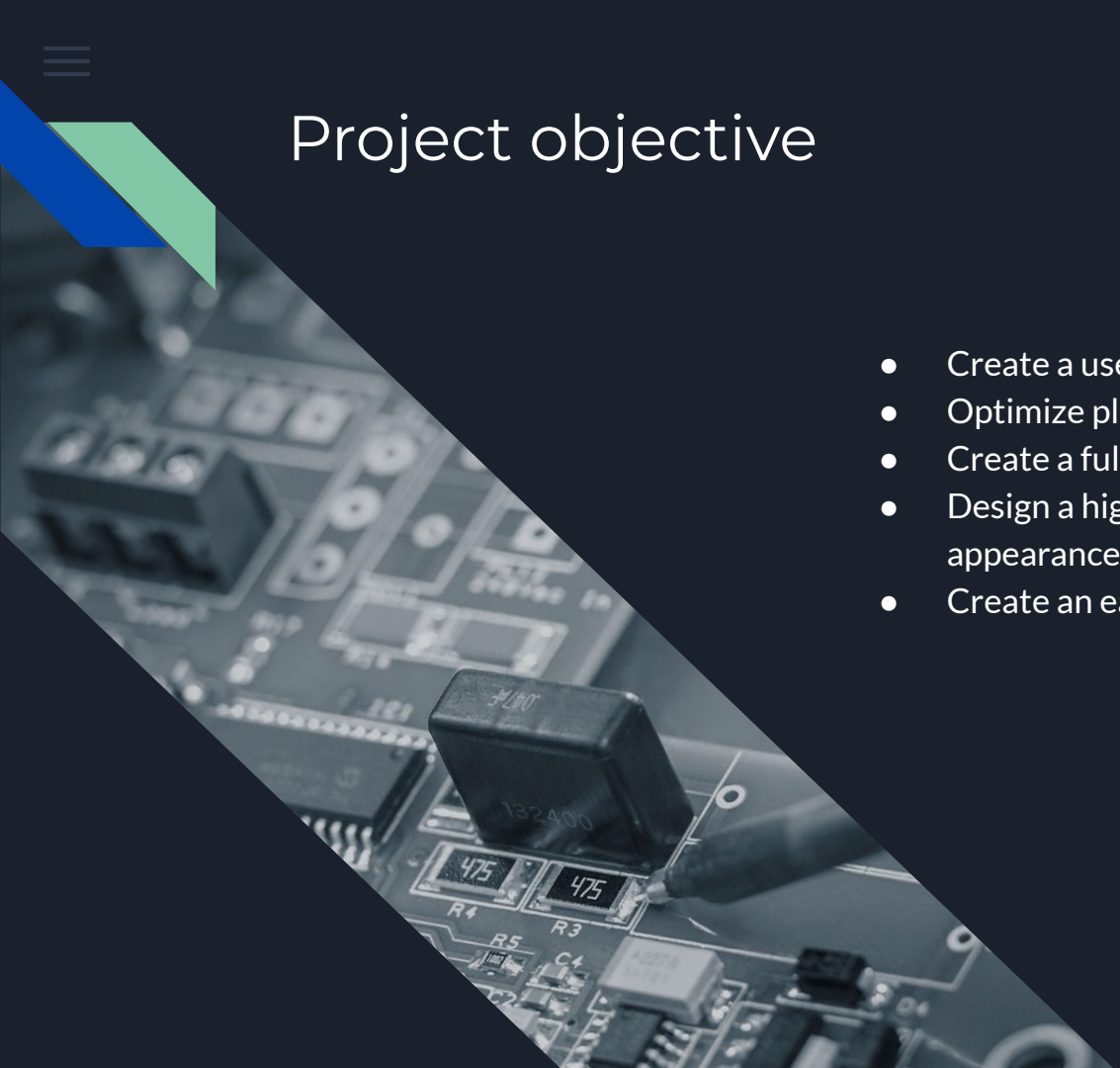
A modular hydroponics system that allows the user to access information about their plant's recent health status through seamless software applications.



Motivation

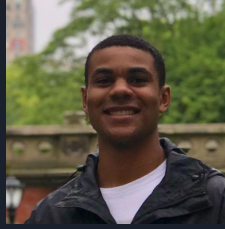
- Improve upon current hydroponics designs
- Increase flexibility and water efficiency of farming
- Increase supply and variety of food in diets
- Accessibility across entire world
- Scalability
- Portability

Project objective



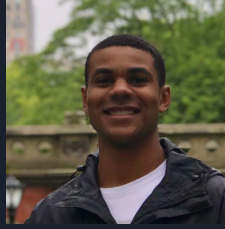
- Create a user friendly hydroponics experience
- Optimize plant growth
- Create a fully automated system
- Design a high performing unit with an aesthetic appearance
- Create an easy to use, modular design

Market Specifications



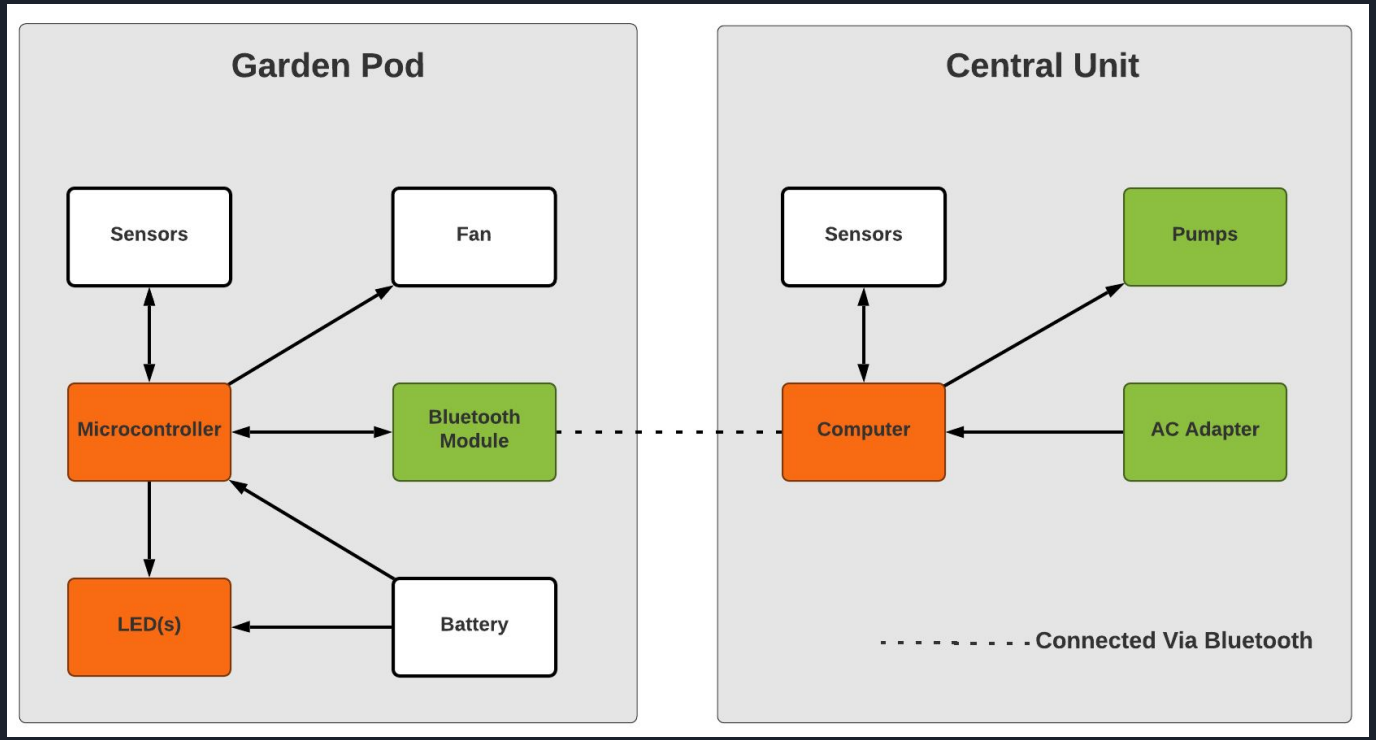
- System must be of reasonable weight (<50lbs per component)
- Display necessary data in a nice user interface
- Effectively communicate with all wireless components
- Able to be controlled remotely
- Must not leak

Engineering Specifications

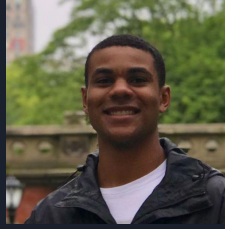


Specification:	**Parameter:**
Self Regulate pH Levels	Within 0.01 increment accuracy (0-14)
Self Regulate Nutrient Levels	Within 1.0 accuracy (mg/L)
Main Reservoir Capacity	5 Gallons
AC to DC Power	120V AC converted to 12V, 5V DC
Bluetooth Communication	1Mbps (up to 9m/30ft)
Total Refill Time	30 seconds

Block Diagram



Overall Design



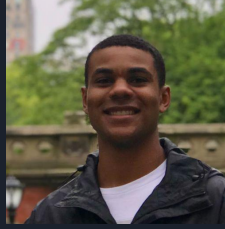
Central Unit

- Communicates with both the user and the plant pod via bluetooth/wifi
- Powered by the user's home
- Contains enough water for 2+ full pod refills
- Contains all necessary nutrients/pH balancing liquids

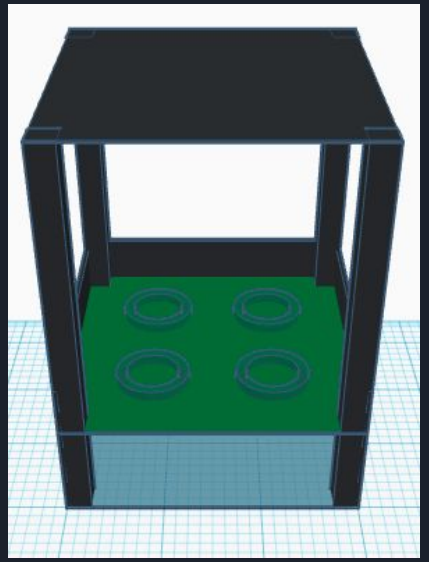
Garden Pod

- Completely modular growing environment
- Transported to/from central unit for refilling

Garden Pod Design



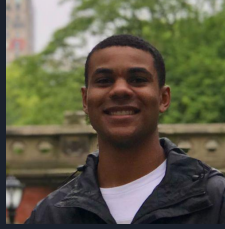
- Dimensions: 11” x 11” x 14”
- Water/Soil Volume: 484 in^3 (2.095 gallons)
- Plant Growth Volume: 1210 in^3
- ⅛” Acrylic sealed with 100% silicone



Concept

Prototyping

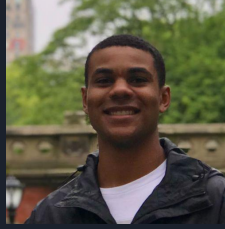
Final Design



Central Unit Design

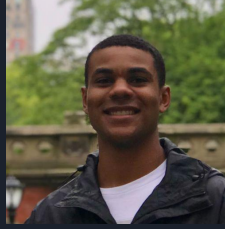
- Water Reservoir Volume: 5 gallons
- Electronics placed in smaller waterproof container for safety
- Peristaltic pumps mounted independent of nutrient bottles
- Button mounted outside for toggling main pump

Central Unit Sensors: pH Sensor



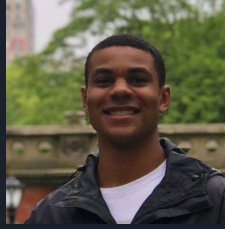
Brand	Response Time	Accuracy	Power
PH0-14 Value Detect Sensor Module + PH Electrode Probe ($44.99)	≤5 seconds	± 0.25pH	≤0.5W
**Gravity: Analog pH Sensor / Meter Pro Kit ($56)	≤60 seconds	± 0.1pH	≤0.15W

Central Unit Sensors: Total Dissolved Solids (TDS) Sensor



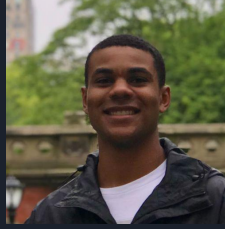
Brand	Parts per Million (PPM) Range	Accuracy	Price
Gravity: Analog TDS Sensor	0 - 1000 PPM	± 10% (25° C)	$16.80
****CQRobot Ocean: TDS Meter**	**0-1000 PPM**	**± 10% (25° C)**	**$13.99**

Garden Pod Sensors: Temperature/Humidity Sensor

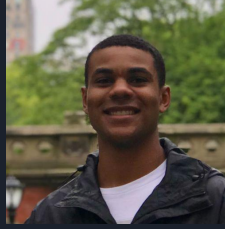


- Resistive
  - Measure conductivity through two electrodes
  - Low cost
  - Sensitive to chemical vapors
- Capacitive
  - Detects changes in capacitance through two electrodes/resonance frequency
  - Limited Range
  - Stable output over long periods of time
- Thermal
  - Measure conductivity of both dry and surrounding air to calculate absolute humidity
  - Durable in a wide range of environments
  - Highly Accurate

Garden Pod Sensors: Temperature/Humidity Sensor



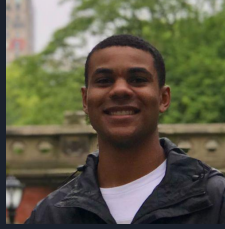
Type	Input Power	Accuracy	Sample Rate
Gravity DHT11 ($5.20)	3-5V 2mA (while requesting data)	Humidity to ±5% (20%-80%) Temperature to ±2°C (0°C-50°C)	1Hz (once every second)
**Gravity DHT22 Capacitive ($9.50)	5V 2mA (while requesting data)	Humidity: ±2% (0%-100%) Temperature: ±0.5°C (0°C-50°C)	0.5Hz (once every 2 seconds)



Garden Pod Sensors: Water Level Sensor

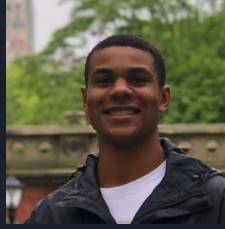
Brand	Type	Detection Area
DGZZI Water Level Sensor Module	Contact	40x16mm (640mm^2)
**CQRobot Ocean: Water/Liquid Level Sensor ($21.99)	Non-contact	31.6x30mm(948mm^2)

Garden Pod Battery: Li-Po vs. Li-Ion



- Lithium-Polymer
  - Pros
    - Lightweight, low profile
    - Suffers less battery aging
  - Cons
    - More expensive
    - Ideal for quick drain applications
- Lithium-Ion
  - Pros
    - Less expensive
    - Ideal for Long-term drain applications
  - Cons
    - Suffers from battery aging
    - Requires protection circuitry

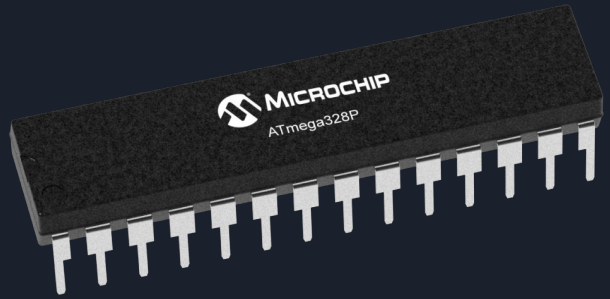
Garden Pod Battery



- DC 12V Lithium Ion 18650
- Rechargeable
- 6800mAh
- Automatic protection system: battery overcharge, over discharge, over current and external short circuit effective protection.
- Suitable for long discharge times

Pod Microcontroller

The microcontroller used in the pod is the ATmega328P chip. This chip is commonly found in arduino devices.

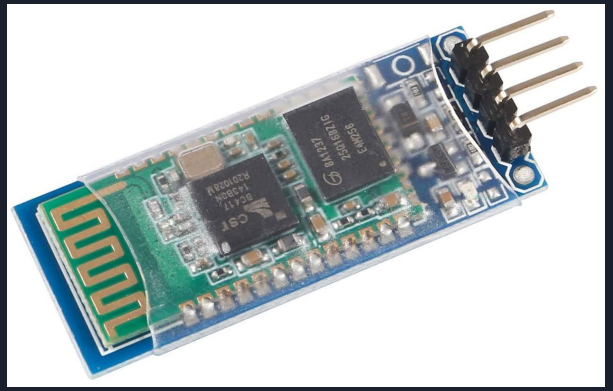


Purpose:
The purpose of this chip starts with taking inputs from sensors then the chip uses these inputs to turn the fan on or off. The chip sends the inputs from other sensors to the main processor in the reservoir via bluetooth.

esp8266	WiFi capabilities but unfamiliar.
ATmega328P	Less features but a familiar language and pins.

Pod Bluetooth

The bluetooth chip is connected to the microcontroller in the pod. We used a HC-06 RS232 4 Pin Wireless Bluetooth Serial Transceiver. This chip supports bi-directional serial communication.



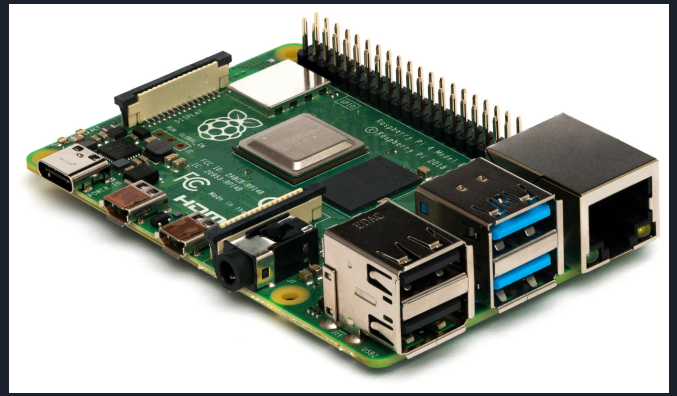
Purpose:
The purpose of the bluetooth module is to send and receive data to and from the processor located in the base via a serial connection.

HC-05	More functionality
HC-06	Just slave mode, ease of use.

Reservoir Microprocessor

The raspberry pi is essentially a tiny computer.

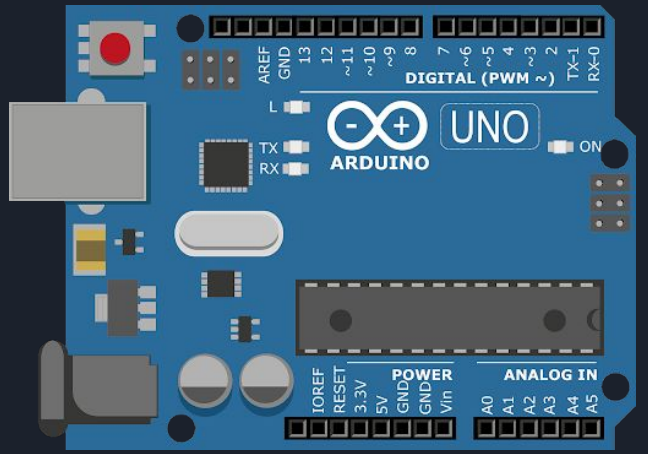
Purpose:
There will be many purposes to this processor. The raspberry pi will get information via bluetooth from each of the pods. The processor will then process this information and display it to the website and application. The pi will also control the ph balancing and nutrient levels for the base. Finally the pi will direct the filling and emptying of the pod when connected to the base.



Reservoir Arduino

The arduino is a microcontroller that hosts the ATmega328P

Purpose:
The purpose of this device is to convert our analog inputs to serial values to the raspberry pi.



Arduino	The arduino converts analog to a serial communication, easily understood by the pi
MCP3008	The MCP3008 is solely an ADC using SPI communication.

Reservoir Bluetooth module

The usb bluetooth module provides the most compatibility and the easiest use for the raspberry pi.

Purpose:
The purpose of this module is to transmit data to and from the pod via bluetooth.

CSR V4.0	The usb connection is easy to use for bluetooth.
HC-05	The HC-05 can also make a bluetooth connection but has less ease of use.

PCB Design

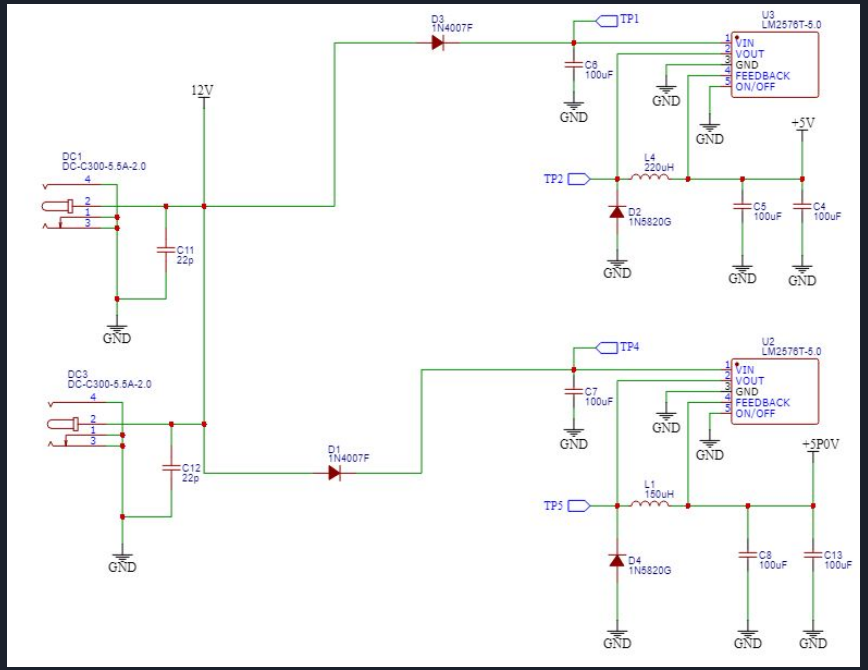
- We designed the PCB for the mobile Garden Pod in two sections.
- The Power PCB will have a voltage regulator circuit
- The Microcontroller PCB will be a breakout bread for our microcontroller.

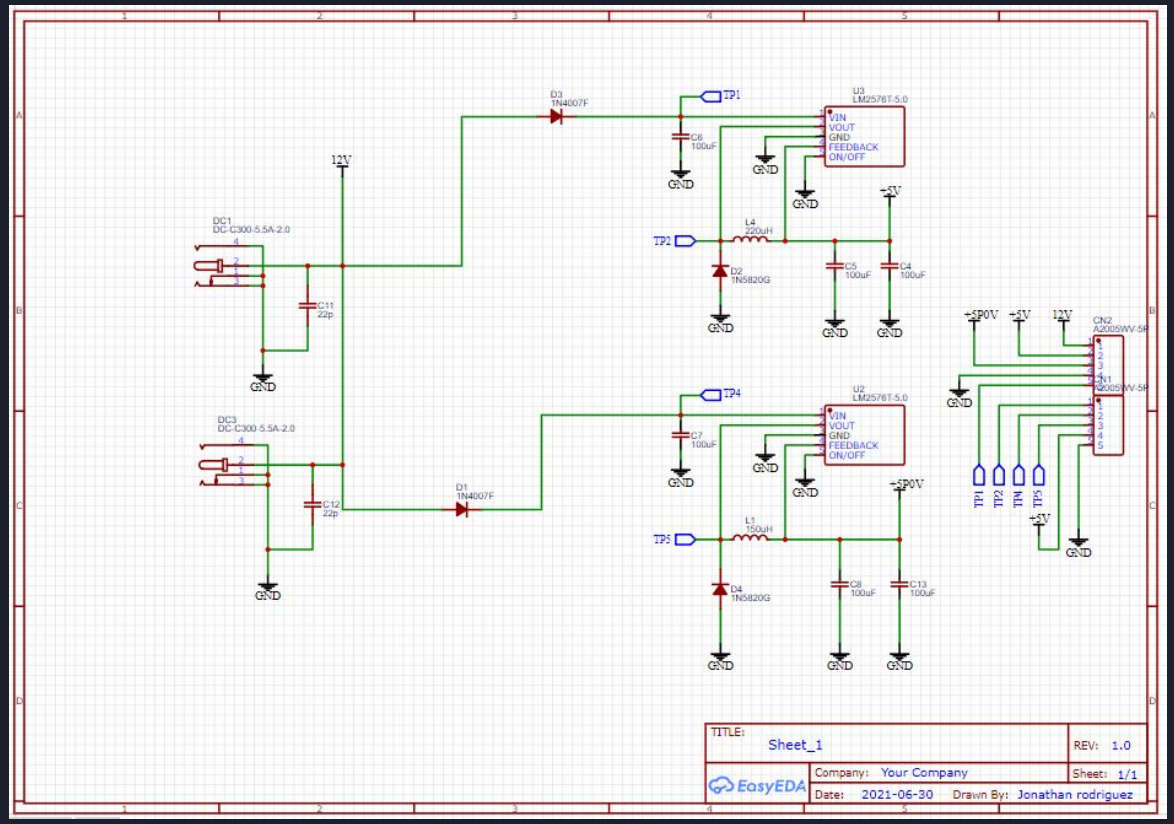
Features:

- Water Level Sensor
- Temperature/Humidity Sensor
- Axial fan
- UV LED Strip
- Bluetooth module

Power Schematic

- The DC power jack is intended for a 12V input.
- The input power source will either be a 12V 6800mAH battery or 12V AC/DC adapter.
- A rectifier diode will limit the input current to 1 Amp.
- The LM2576 will be used as a 5V buck-converter, with a max of 3A.
- For testing purposes, we experimented with two voltage regulators with different inductor and capacitor values.
- The voltage regulator on the top is capable of higher amperage.

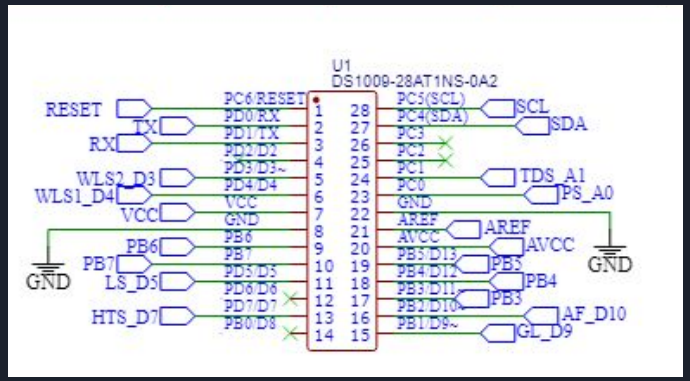


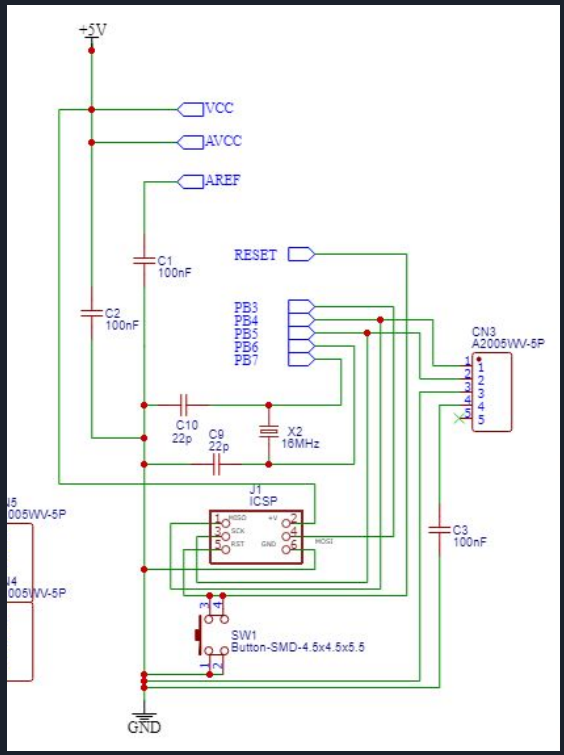


Full view of Power Schematic

Controller Schematics

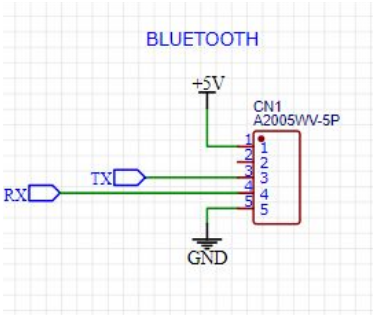
- The main purpose of the Controller PCB is to accommodate the ATMEGA382P-PU.
- The PCB will have an IC-socket so we can reuse the chip from the development board.
- The voltage regulator PCB will feed power to the MCU PCB, which will disperse power to the sensors and other electronics on the garden pod.

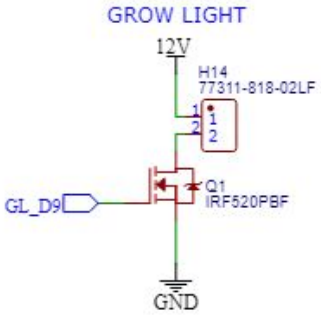


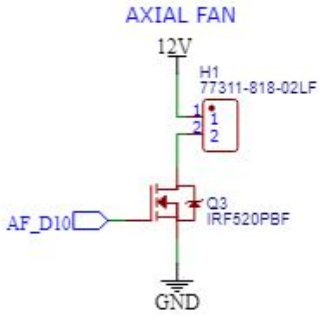


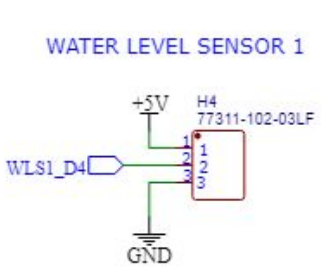
PCB Sensor Schematic

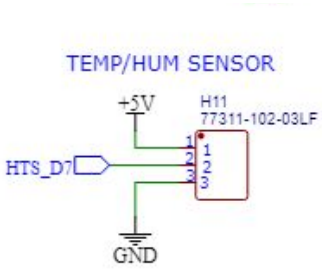
- The Controller PCB will have pin headers to attach to the Garden Pod sensors, and other electronics, to the microcontroller.
- The axial fan and grow light will be controlled by IRF520 Mosfets

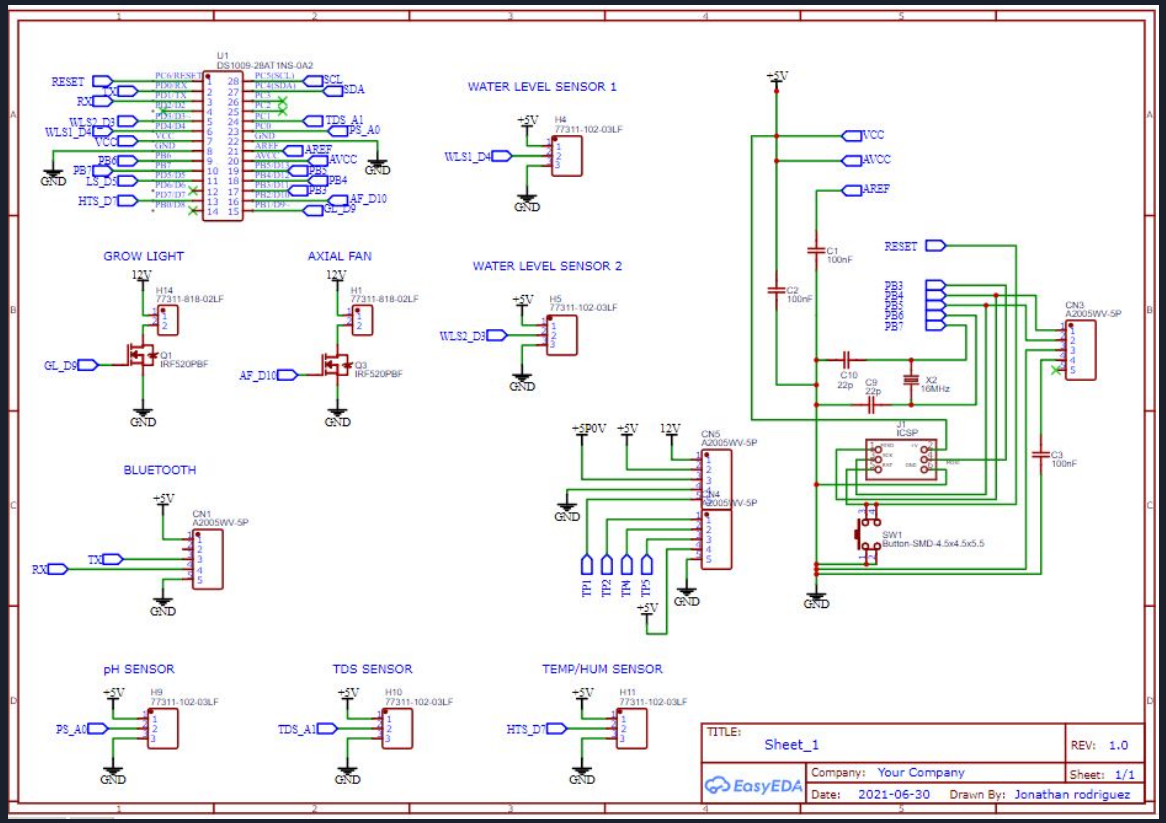










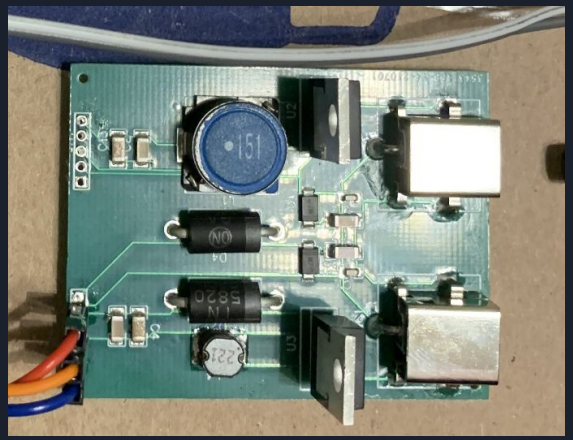


Full view of Controller Schematic

Testing

To simplify testing, we split our PCB in two parts.

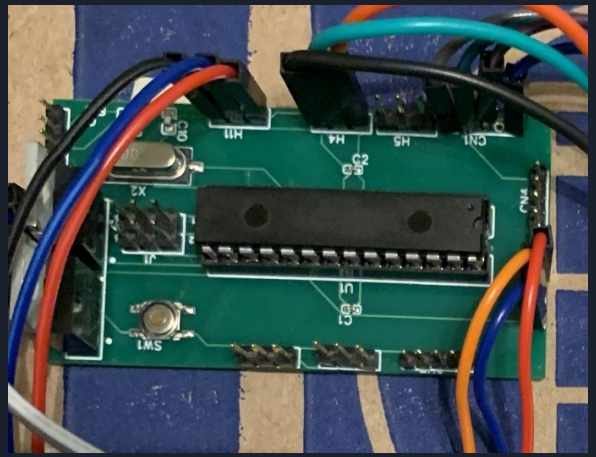
- Power PCB testing
  a. We used a multimeter to measure the output voltages with AC/DC adapter attached.
  b. We used a multimeter to measure the output voltages with battery attached.
  c. Test points were placed at various nodes, in case we ran into any malfunctions.



Testing cont.

To simplify testing, we split our PCB in two parts.

- Controller PCB
  a. The pre-programmed MCU and Power PCB were connected to the Controller PCB
  b. Using the MM, we measured all the voltage pins.
  c. After plugging in sensors, we decided to remove the pin header and solder wires to the board to ensure a stable connection



Conclusion:

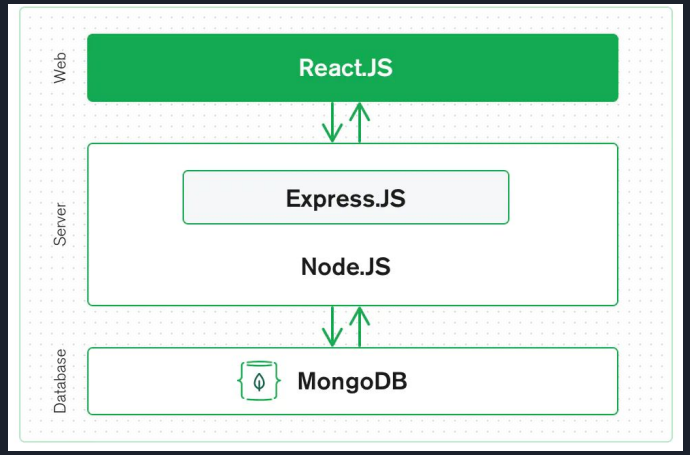
Aside from some faulty pin headers, The PCB's hardware functioned just as planned.

Online Software Applications

- Both
  - Allow the user to create and login to accounts
  - User Authentication
  - View plant health and current sensor data
  - Utilize recipe searching
- Website
  - Additional resources and information
- Mobile App
  - Streamline functions
  - Focused on viewing data

Full Stack Technology - MERN

MongoDB - document database
MongoDB Realm - Mobile app database
Express - Node.js web framework
React - a client-side JavaScript framework
React Native - mobile version of react supporting front end development
Node - the premier JavaScript web server



Database

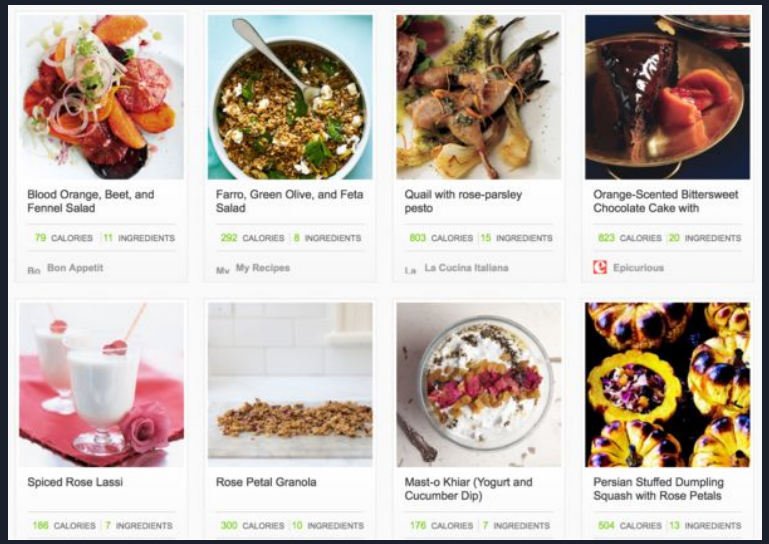
MongoDB - NoSQL database program, which uses JSON-like documents with optional schemas

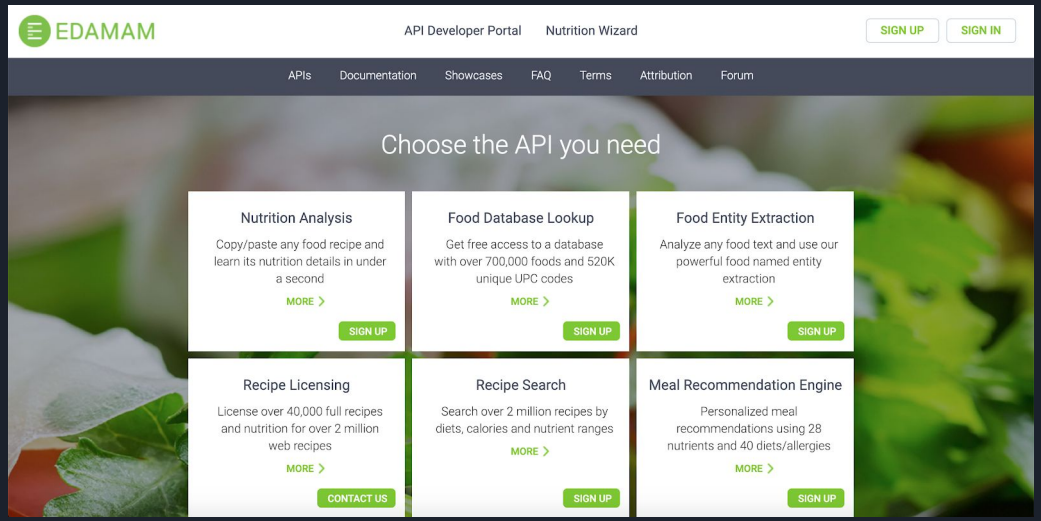
NoSQL - database storage and retrieval system that doesn't use tabular relations used in relational databases

User	
Data	Page Key
Name	
Email	
Password	
ID	

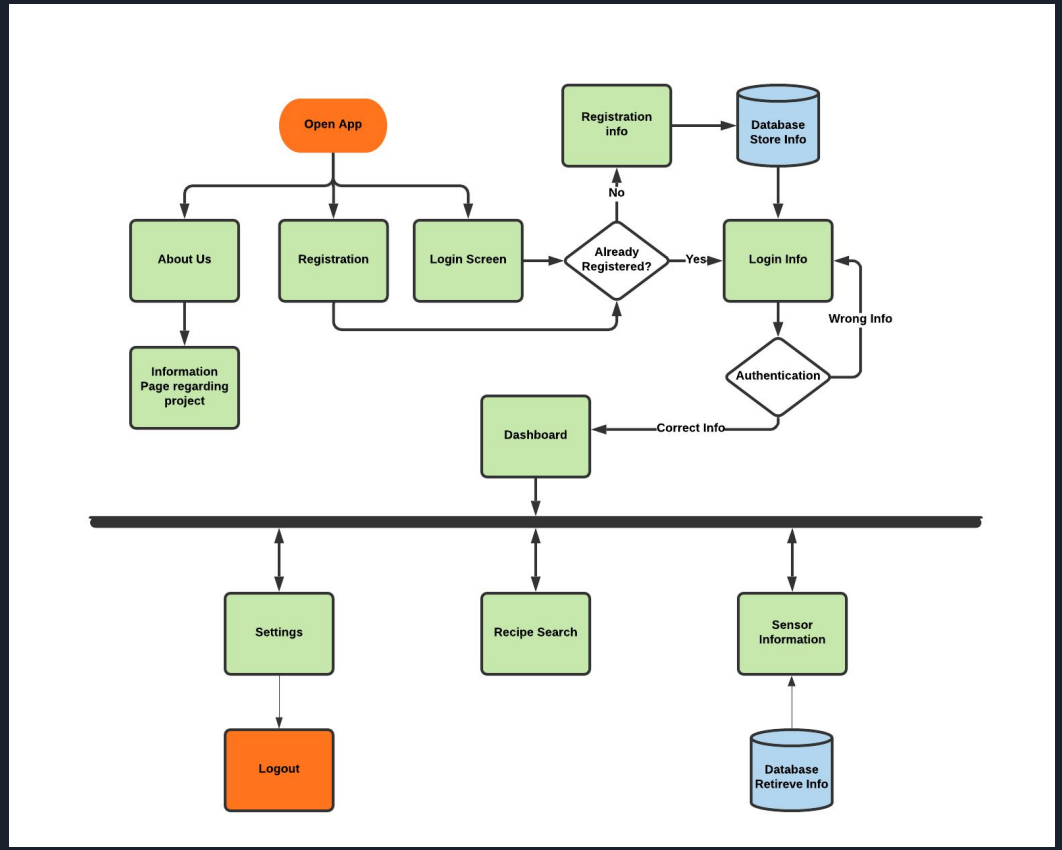
Sensors	
Data	Page key
pH	
tds	
temperature	
light_level	
water_level	
humidity	

Recipe Searching API - EDAMAM

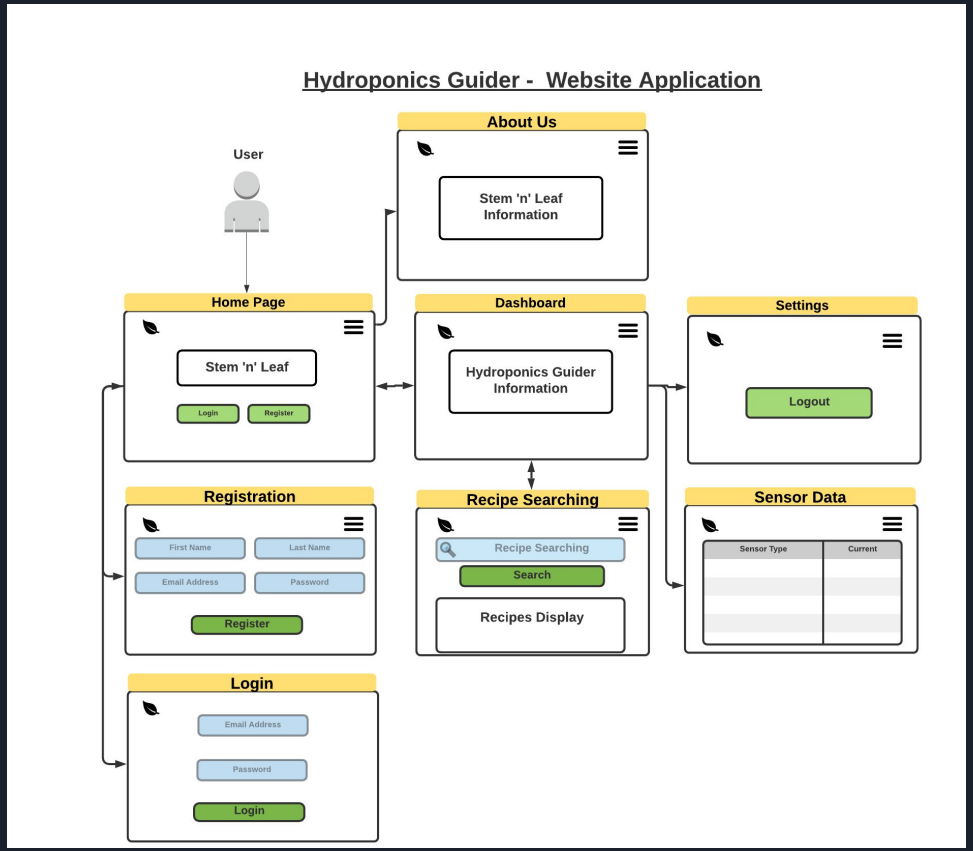




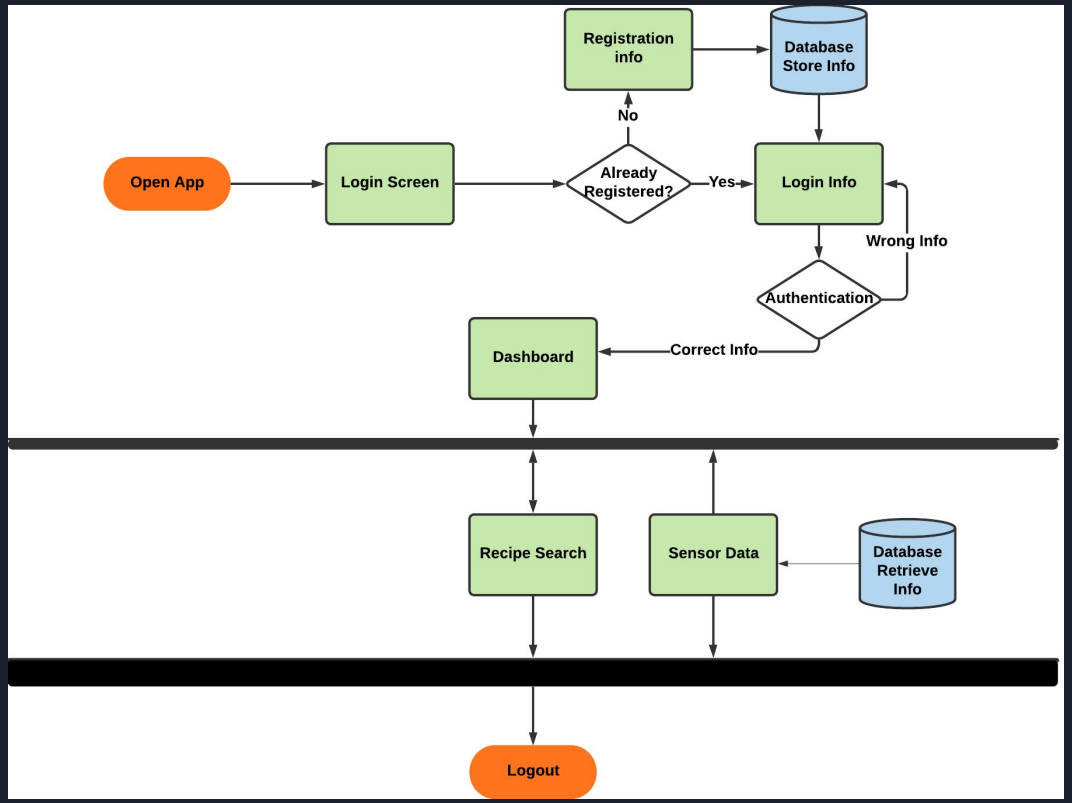
Website Design



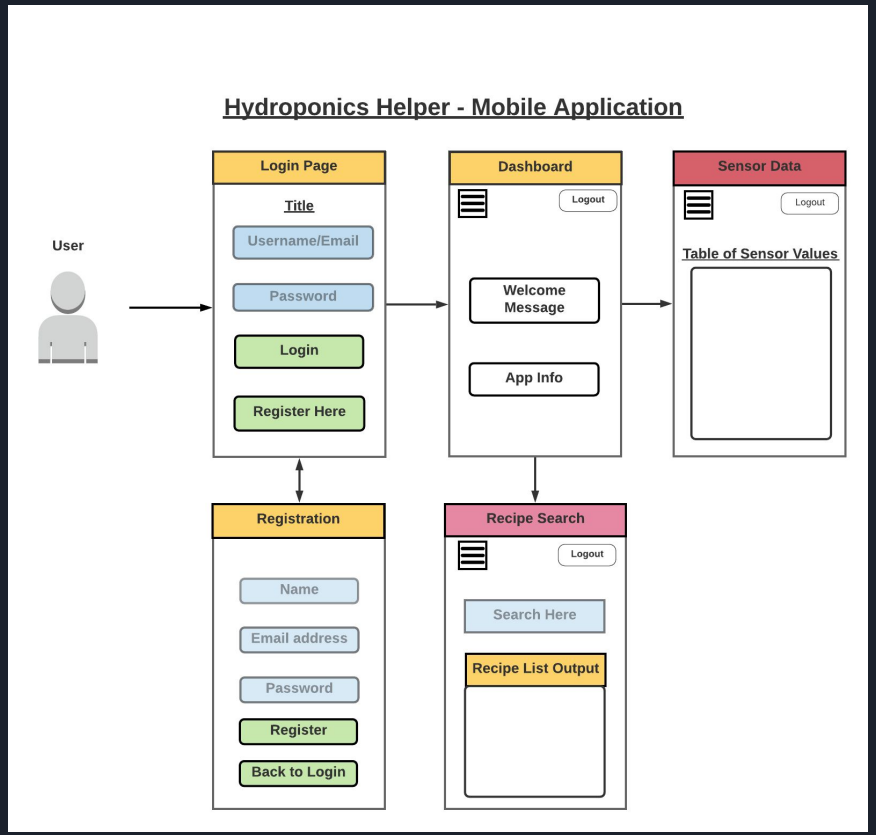
Website Design



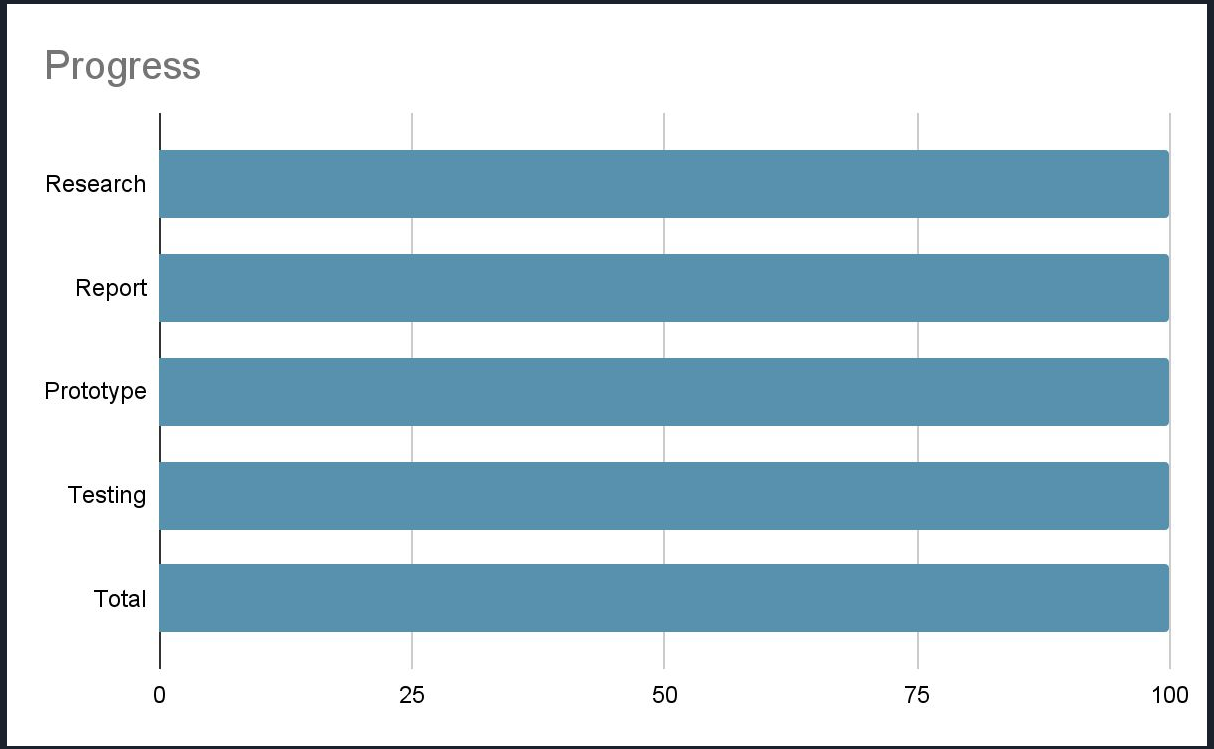
Mobile Application Design



Mobile Application Design



Project timeline



Work Distribution

Team Member	Role	Responsibility
Adam Loree	Hardware/Software	Programming, Design and construction of reservoir hardware and microprocessor/microcontroller software.
Brandon Mitchell	Hardware/Software	R, design, and construction of Stem ‘n’ Leaf garden pod/central unit and microcontroller software
Don Ellington	Software	Focus on building, maintaining, and adapting the online database, website, mobile app, and web server to Stem ‘n’ Leaf
Jonathan Rodriguez	Hardware	Focus on building and designing of Stem ‘n’ Leaf including pcb design and microcontroller software

Budget

Item	Supplier	Price/Unit	Units	Total Cost
Axial Fan	Amazon	$ 12.99	1	$ 12.99
Water Level Sensor	CQ-Robot	$ 21.99	1	$ 21.99
Temperature/Humidity Sensor	Amazon	$ 6.49	1	$ 6.49
UV LED Grow Light Strip	Amazon	$ 19.99	1	$ 19.99
HC-05 Bluetooth Transceiver	HiLetgo	$ 7.99	2	$ 15.98
pH Sensor	DF-Robot	$ 56.90	1	$ 56.90
ATMEGA382P-PU	Amazon	$ 3.30	1	$ 3.30
IRF520 Mosfet	Amazon	$ 1.36	4	$ 5.44
TDS Sensor	CQ-Robot	$ 13.99	1	$ 13.99
Perstaltic Pump	Gikfun	$ 10.43	3	$ 31.29
Subermersible Fountain Pump	Amazon	$ 10.29	1	$ 10.29
Raspberry Pi	Amazon	$ 59.99	1	$ 59.99
12V 6800 mAH Li-ion Battery	Amazon	$ 38.99	1	$ 38.99
Nutrients	Amazon	$ 41.28	1	$ 41.28
Building Materials	-	$ 165.60	1	$ 165.60
PCB Assembly	JLC	$100	1	$ 100.00
Sum				**$ 604.51**

- Initial estimate was between $300 - $475.
- Most expensive items were the pH sensor and PCBs.
- Any materials not mentioned on the table were previously owned.
- Total cost is approximately $604.51.

Questions?