EasyHerb

Group 7

Luna Vazquez-EE

Lindsey Feldman-EE

Chris Hernandez-EE

Kyle Patrick Magboo-CpE

Motivation

CH

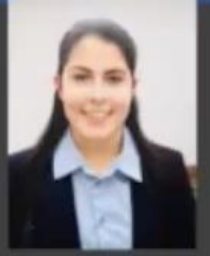
- Herbs grown outside face multiple hardships
- Design a hydroponic system that can grow herbs in a house or apartment
- Additional features to differentiate from other systems
- Easy to use system that an average person can maintain

Goals and Objectives

CH

- System should be automated only requiring minimum observation
- Make the system lightweight and portable
- System should be user-friendly and convenient
- Herbs will be grown in a constant optimal environment

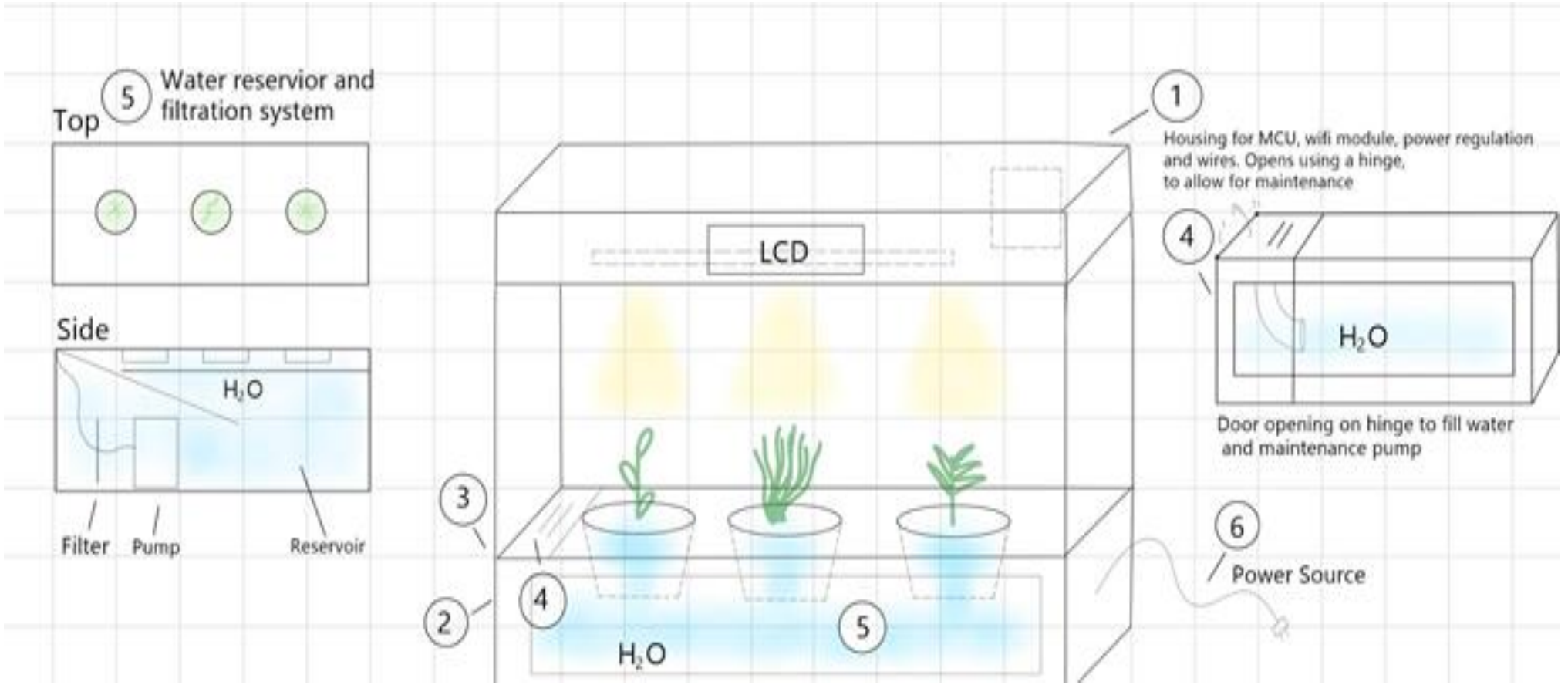
Engineering Specifications



LV

Attribute	Value
The system should measure gallons of water with precision	± 0.1 gallons
The light system should change accordingly within a specified time after an event triggers	5 seconds
User can remotely change state of lights within a specified time	Within 3 seconds
The PCB regulates the input power supplied down to a specified voltage that is supplied to the rest of the system	12V to 5V
Accurate ambient temperature readings within specified range	± 0.5 degrees
Bluetooth connection to speakers within specified time	Within 3 seconds

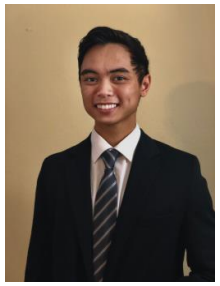
Design Overview



LV

Work Distribution

Group Member	Corresponding Color
Luna Vazquez	
Lindsey Feldman	
Chris Hernandez	
Kyle Patrick Magboo	



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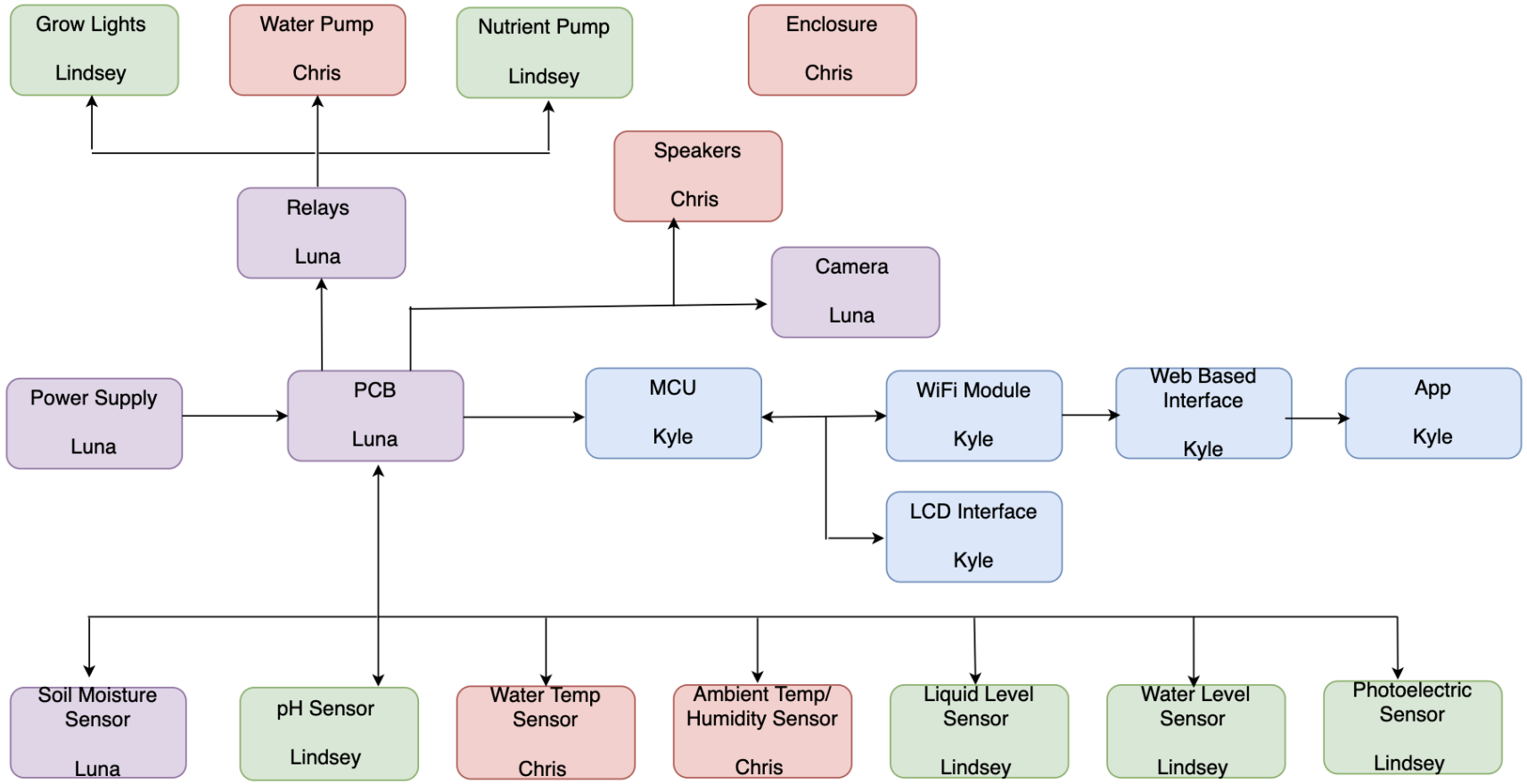

Enclosure Design

- **Top Enclosure:**
  - Will contain PCB, LCD screen, speakers
  - Grow lights will hang from the bottom
- **Middle Area:**
  - Will house herbs
  - Will contain temperature/humidity sensor, soil sensor and camera
  - Will contain Irrigation system
- **Bottom Enclosure:**
  - Will contain water and nutrient pumps
  - Will contain water and nutrient reservoirs
  - Will house water level sensor and water temperature sensor

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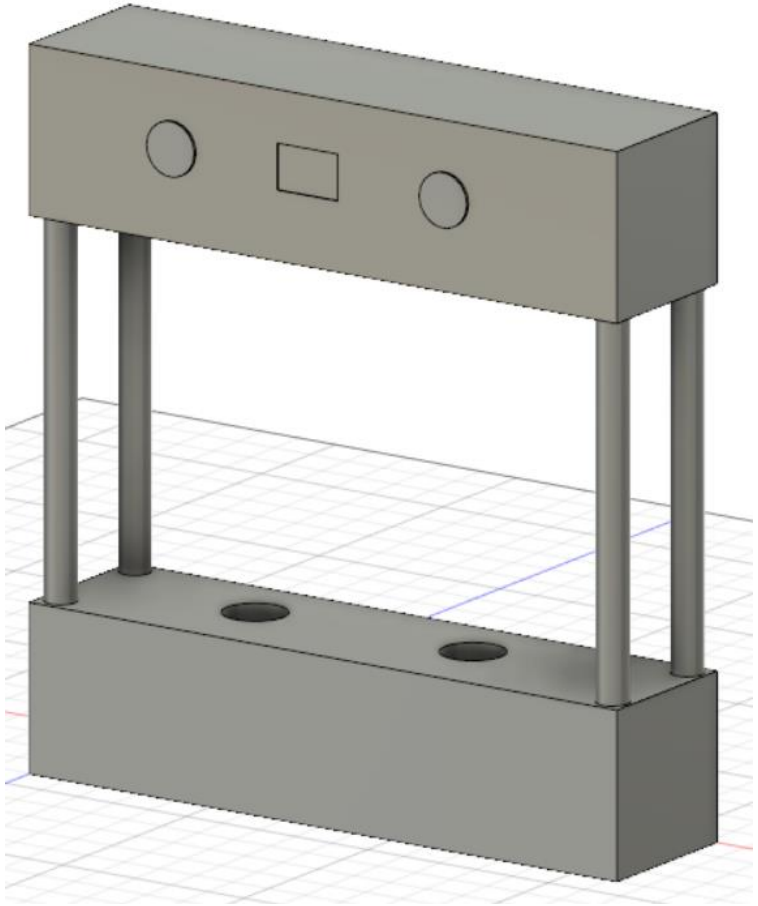
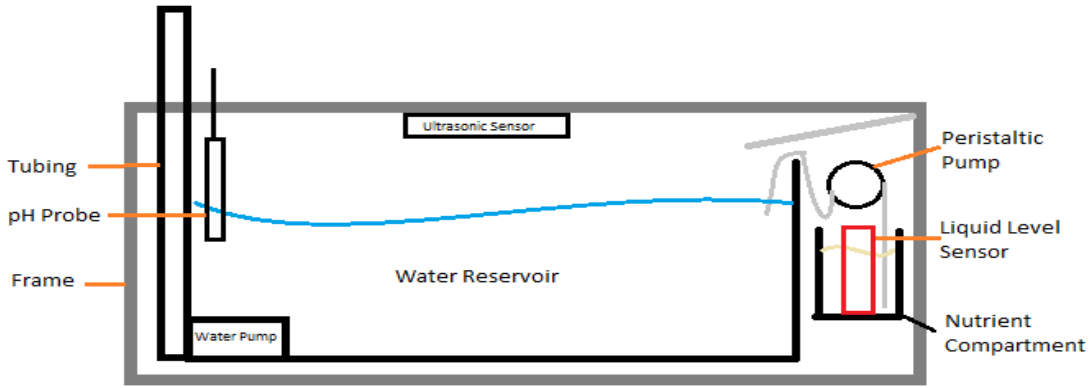
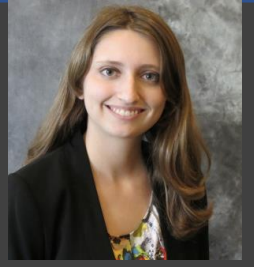




Nutrient System



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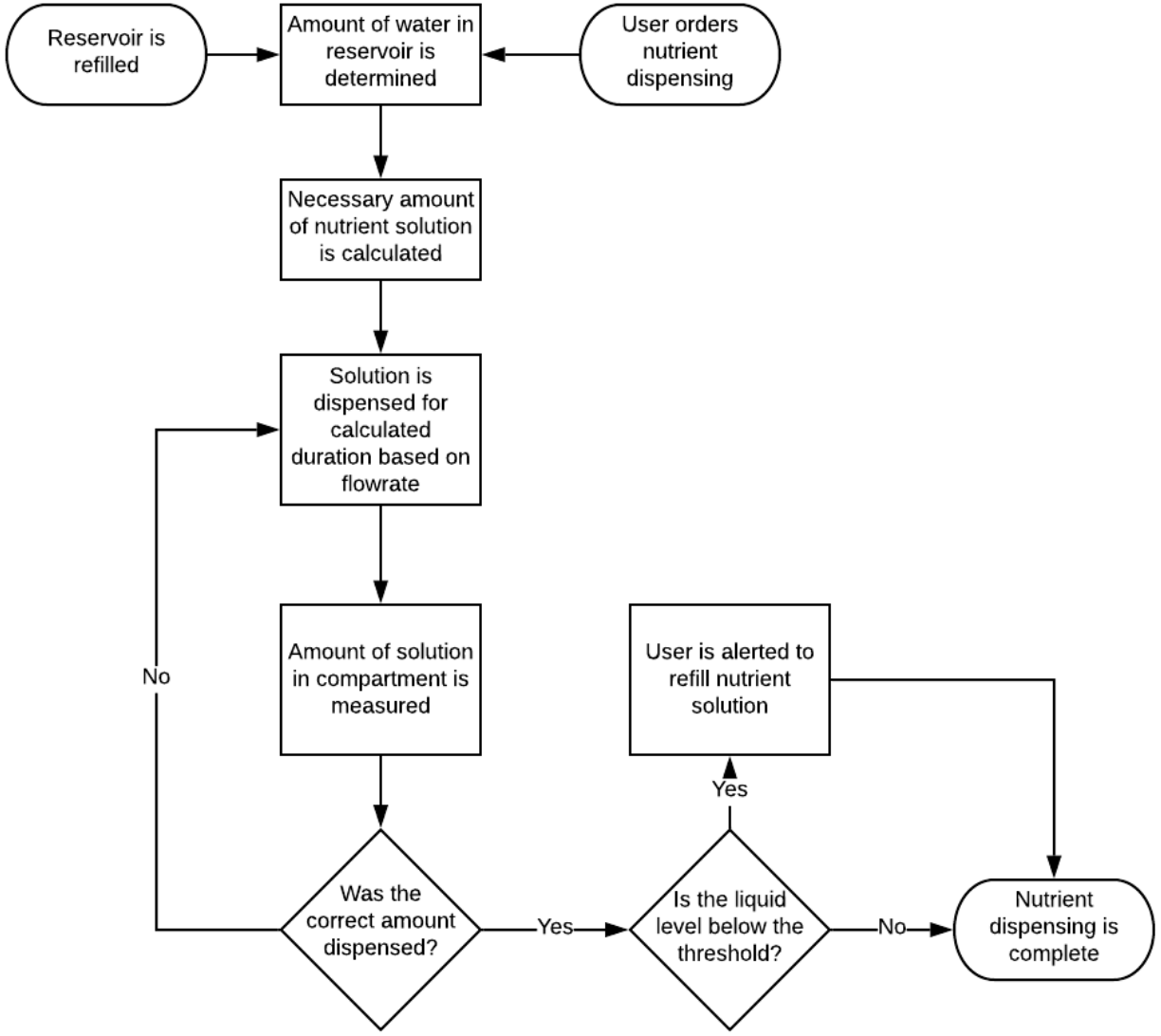
Supplemental nutrient solution is essential for hydroponic growing

Dispenses necessary nutrients into water reservoir

Measures amount of water in reservoir and dispenses the correct amount of nutrient solution

Peristaltic pump transports solution to reservoir from compartment

Liquid level sensor monitors amount of solution in compartment

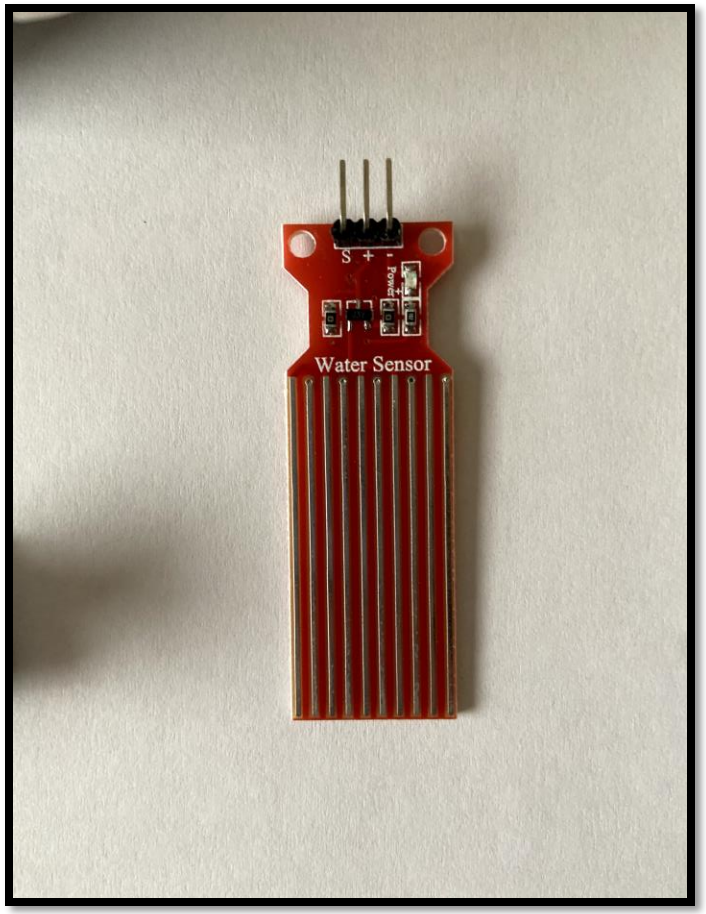


Nutrient Level Sensor

Part	Water Level Sensor	Mini Liquid Level Sensor
Manufacturer	SUKRAGRAHA	Waveshare
Operating Voltage	3 – 5 V DC	2.0 – 5.0 V DC
Operating Current	< 20 mA	< 20 mA
Operating Temperature	10 – 30 °C	10 – 30 °C
Dimensions	2.5” x 0.75”	2.48” x 0.75”
Cost	$5.99	$4.99

LF

Selected Component



Nutrient Pump

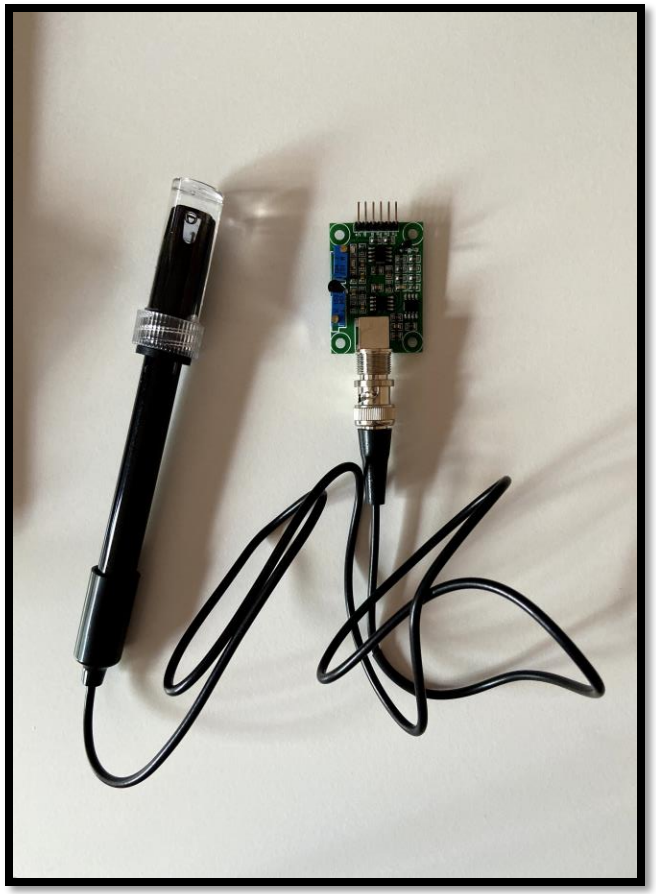
Part	Peristaltic Liquid Pump	Gravity: Digital Peristaltic Pump (DFR0523)	Peristaltic Liquid Pump (1150)
Manufacturer	INTLLAB	DFRobot	Adafruit
Working Temp.	0 – 40 ℃	0 – 40 ℃	0 – 40 ℃
Voltage	12 V DC	5 – 6 V DC	12 V DC
Current	400 mA	1.8 A	200 - 300 mA
Flowrate	19 – 100 mL/min	>= 45 mL/min	<= 100 mL/min
Dimensions	3 mm ID x 5 mm OD	27.4 x 28.7 mm	27 mm diameter, 72 mm total length
Cost	$9.80	$59.50	$24.95

LF

Selected Component

pH Sensor

Part	SEN0161-V2	E-201-C
Manufacturer	DFRobot	GAOHOU
Supply Voltage	3.3 ~ 5.5 V	5 V
Operating Temperature	5 ~ 60 ℃	-10 ~ 50 ℃
Detection Range	0 – 14	0 – 14
Zero Point	7 ± 0.5	7 ± 0.25
Response Time	< 2 min	< 5 s
Internal Resistance	< 250 MΩ	≦ 250 MΩ
Output	Analog	Analog
Module Dimensions	42 x 32 mm	42 x 32 x 20 mm
Cost	$39.50	$33.99



Selected Component

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Watering System

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Hydroponic drip irrigation system

Water containing nutrients is pumped from the reservoir and dripped onto plants

Water will be circulated through the system using drip irrigation

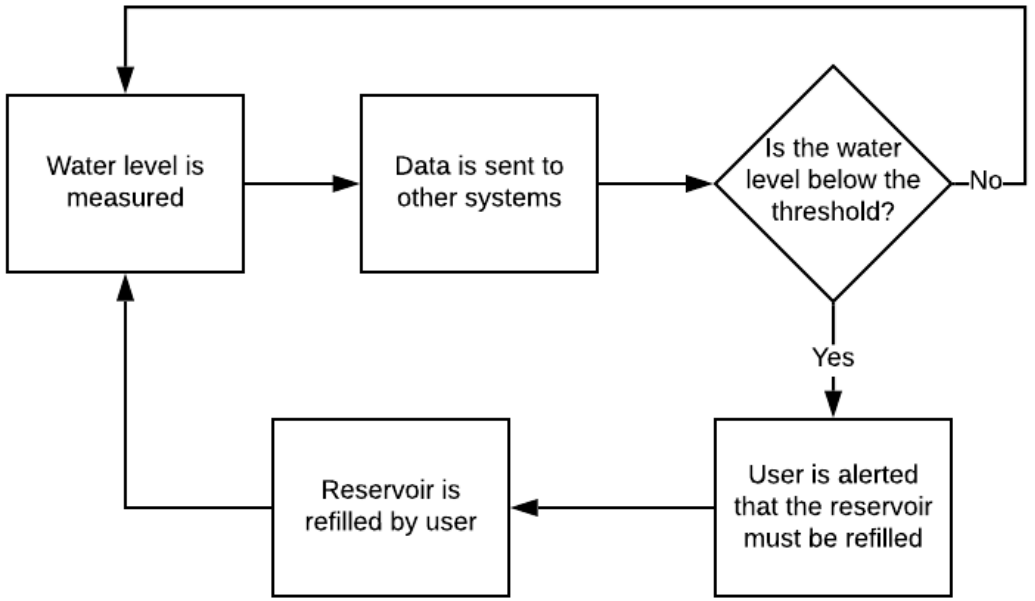
Will distribute the nutrients the herbs need in the solution

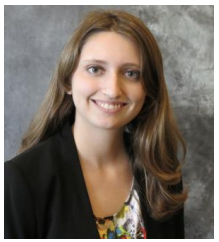
Water pump will be controlled by relay

Water Level Monitoring

Water level in reservoir is monitored, and user is alerted when it is low

Ultrasonic distance sensor measures the distance to the surface of the water, which determine the water level





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Water Temperature Sensor

Manufacturer	Hilitchi
Digital Thermometer	DS18B20
Temperature Testing Range	-55 to 125 degrees Celsius
Cable length	100 cm
Cost	$12.99 for 5 sensors
Power Supply Range	3 to 5 V
Weight	3.2 ounces

Selected Component

CH

Water Pump

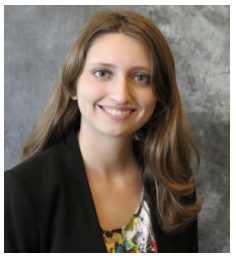
Manufacturer	Active Aqua	Sunshower	Mountain_Ark	Total Pond
GPH Rating	160 GPH	18 GPH	63 GPH	140 GPH
Cost	$18.33	$14.99	$9.99	$16.84
Power Rating	9.5 W	5.75 W	4.5 W	6.5 W
Head Height	5 feet	4 feet	9.8 feet	4 feet
Fittings	½ inch	¼ inch	¼ inch	½ or 3/8 inch

Selected Component

CH

Water Level Sensor

Part	eTape Liquid Level Sensor	JSN-SR04T	HC-SR04
Manufacturer	eTape	KeeYees	Adafruit
Operating Temperature	-9 ~ 65 °C	-20 ~ 70 °C	-20 ~ 70 °C
Voltage	Vmax = 10 V	3.0 – 5.5 V DC	5 V DC
Distance Range	0 – 31.5 cm	20 – 600 cm	2 – 400 cm
Ultrasonic Frequency	N/A	40 kHz	40 kHz
Working Current	N/A	< 8 mA	15 mA
Resolution	0.25 mm	1 mm	0.3 cm
Dimensions	361 x 25.4 x 0.38 mm	42 x 29 x 12 mm	45.5 x 20 x 15.5 mm
Cost	$17.47	$11.99	$3.95



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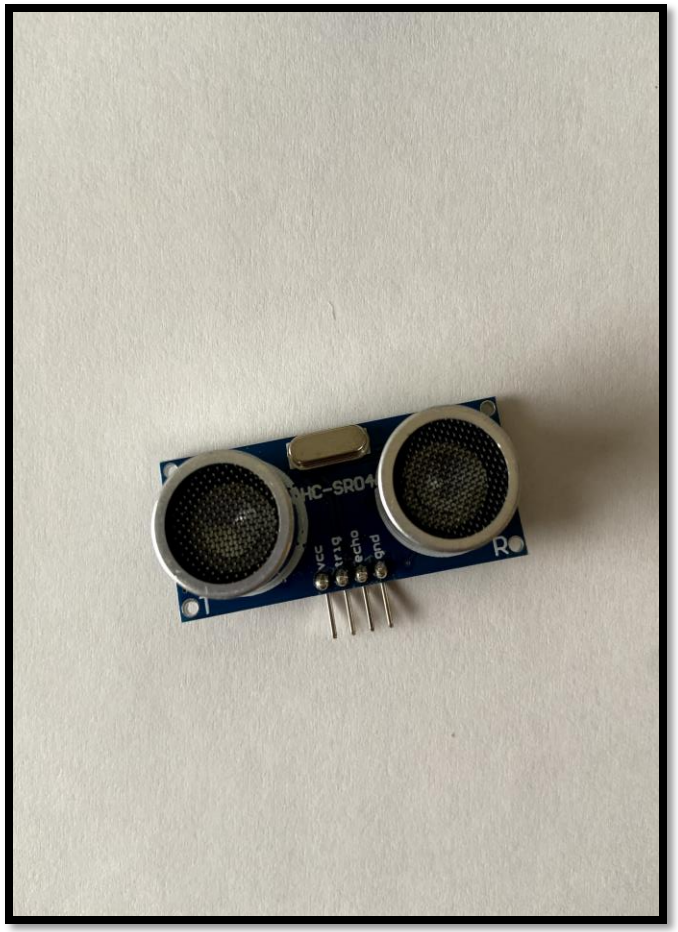
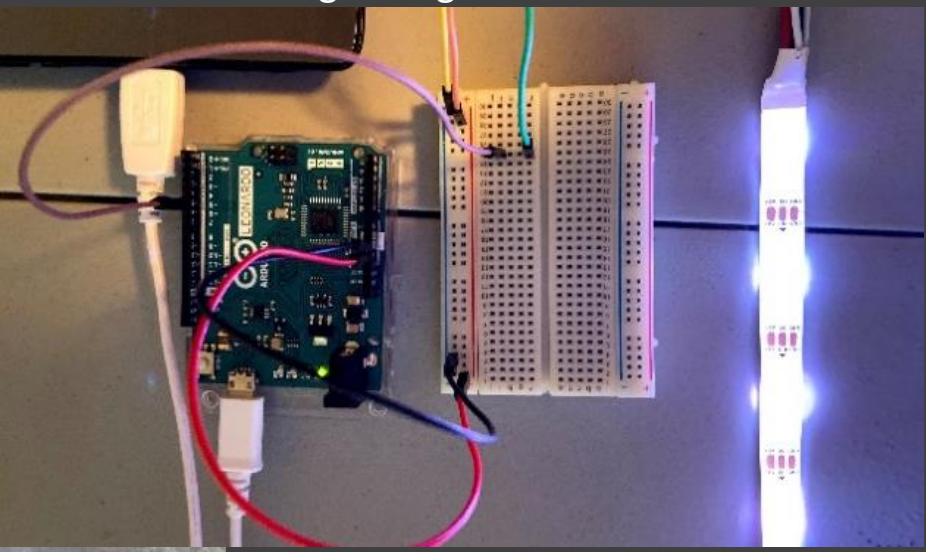
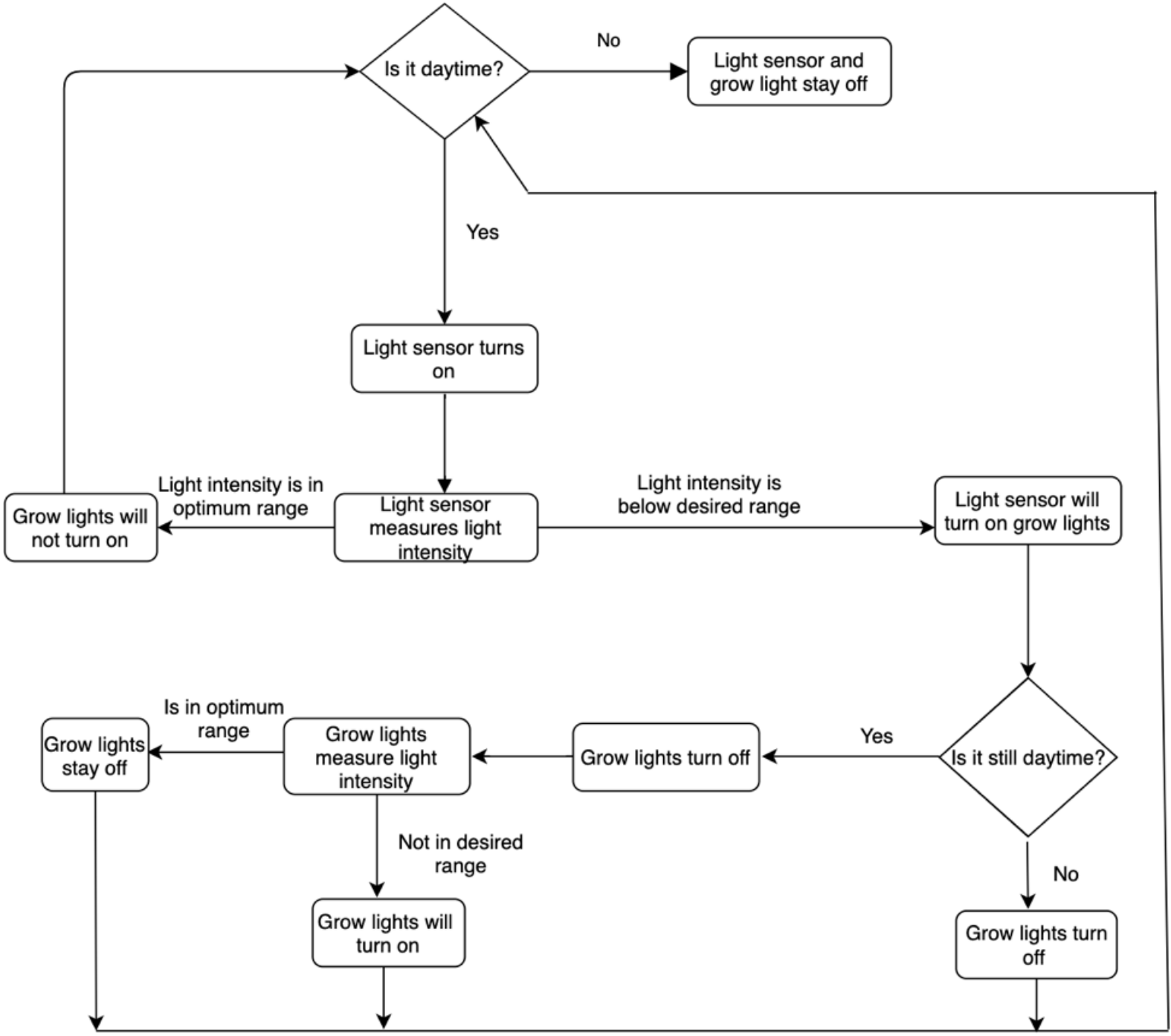


Selected Component

Lighting System

- Provides artificial grow lighting to plants
- WS2812b individually addressable LED strip
- Using a relay and LM393 light sensor array to determine when to turn on and off the grow lights





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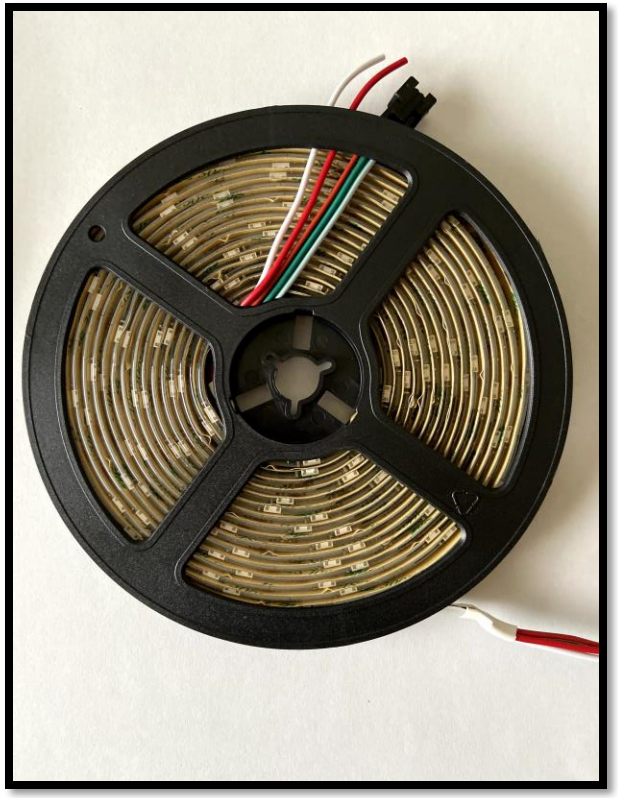
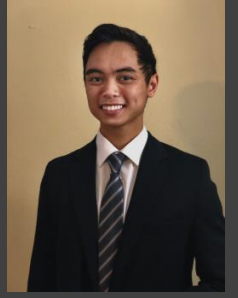
Grow Lights

Selected Component

Brand	BTF-LIGHTING	BTF-LIGHTING	BTF-LIGHTING
IC Type	WS2812b	WS2811	SK6812 RGBW
Addressable	Individually addressable LEDs	Addressable in groups of 3 LEDs	Individually addressable LEDs
Length	5 m	5 m	5 m
LED Density	30 LEDs/Pixels / m	30 LEDs/Pixels / m	60 LEDs/Pixels / m
Color Order	GRB	RGB	GRBW
Input Voltage	5 V (DC)	12 V (DC)	5 V (DC)
Power	0.3 W/LED; 45 W total	0.3 W/LED; 45 W total	18 W/m; 90 W total
Operating Temperature	-20 °C ~ +40 °C	-20 °C ~ +40 °C	-20 °C ~ +50 °C
Dimensions	5000 mm x 10 mm x 3 mm	5000 mm x 10 mm x 3 mm	5000 mm x 10 mm x 3 mm
Wavelengths	Red: 650 nm Green: 520 nm Blue: 460 nm	Red: 650 nm Green: 520 nm Blue: 460 nm	Red: 650 nm Green: 520 nm Blue: 460 nm
Light Intensity	Red: 390 – 420 mcd Green: 660 – 720 mcd Blue: 180 – 200 mcd	Red: 390 – 420 mcd Green: 660 – 720 mcd Blue: 180 – 200 mcd	Red: 700 – 1000 mcd Green:1500 – 2200 mcd Blue: 700 – 1000 mcd
Gray Level	256	256	256
Color	Full color 24-bit	Full color 24-bit	Full color 32-bit
View Angle	120 degrees	120 degrees	120 degrees
Waterproof Level	IP65	IP65	IP65
Cost	$22.88	$15.99	$52.88



Microcontroller



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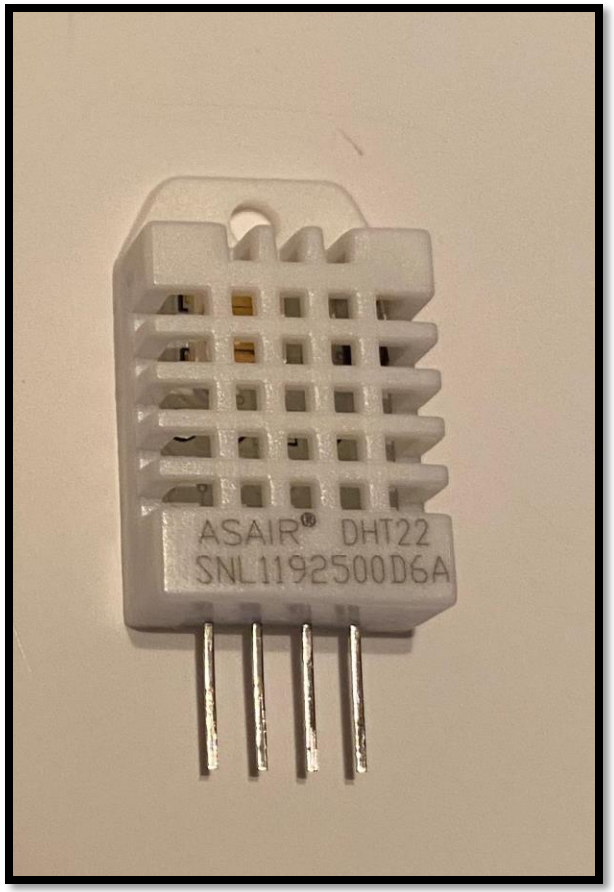
	CPU Frequency	Memory	Additional Features	Communication*
Texas Instruments MSP430	25 MHz	512 KB	Low power consumption	Serial
Texas Instruments ARM Cortex-M3	150 MHz	1 MB of flash EEPROM		I2C/SCI/SPI
ATmega2560	16 MHz	256 KB flash memory 8KB RAM	54 Digital I/O pins 16 Analog input pins	USART SPI I2C
Atmel SAM3X8E ARM Cortex-M3	84 MHz	512 K bytes flash memory 2KB RAM	54 digital I/O pins	USART SPI TWI

Selected Component

Temperature/Humidity Sensor

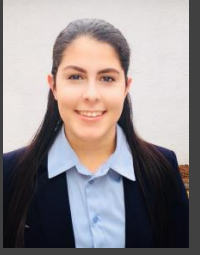
CH

Manufacturer	Adafruit	Adafruit
Model	DHT11	DHT22
Body size	15.5mm x 12mm x 5.5mm	27mm x 59mm x 13.5mm
Rated voltage	3 to 5V	3 to 5 V
Cost	$5	$10
Accuracy	readings ±2°C accuracy 20-80% humidity readings with 5% accuracy	readings ±0.5°C accuracy 0-100% humidity readings with 2-5% accuracy



Selected Component

Moisture Sensor



LV

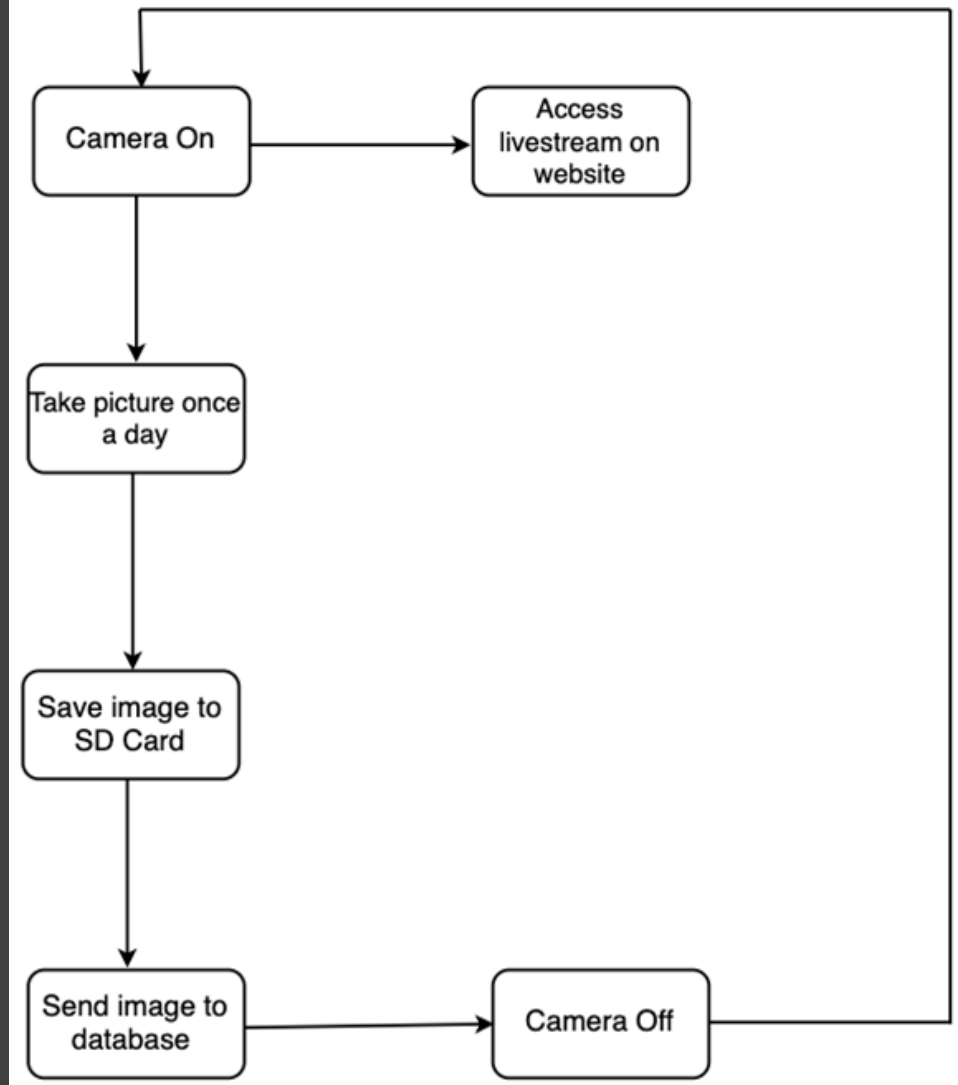
Part	Sparkfun	Elecrow crowtail	Adafruit	Parallax
Operating DC Voltage	3.3-5 V	3.3-5 V	3-5 V	2.0V-5.0V
Output Type	Analog	Analog	Analog	Analog
Dimensions	6 cm x 2.5 cm	40 mm x 20 mm x 20 mm	76.2 mm x14 mm x 7mm	20.0mm x 51.0mm
Cost	$5.95	$2.50	$5.90	$4.99

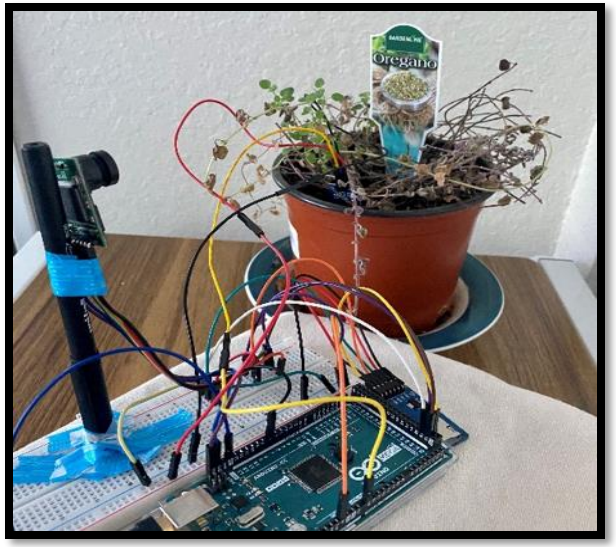
Selected Component

Camera System

- Using the Arducam 2MP Plus OV2640
- Improved user experience
- Daily image of system to track plant growth
- Live feed available
  - Allows user to ensure that system is functioning properly while away
  - Ensures that plants are maintained and unharmed

LV

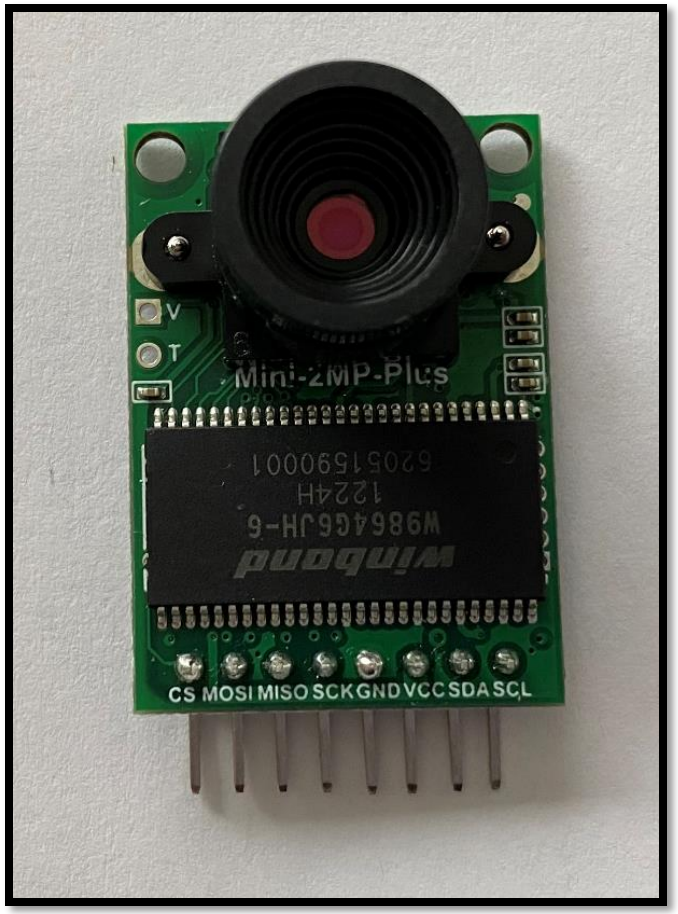




Camera

Manufacturer	ARDUCAM OV7670	ARDUCAM 2MP OV2640 MINI	ARDUCAM 5MP PLUS OV5642 MINI	RASPBERRY PI CAMERA MODULE
Megapixel	0.3	2	5	8
Video Capability	No	Yes	Yes	Yes
Color Image	Yes	Yes	Yes	Yes
Cost	$10.99	$25.99	$39.99	$27.91

Selected Component



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Speakers

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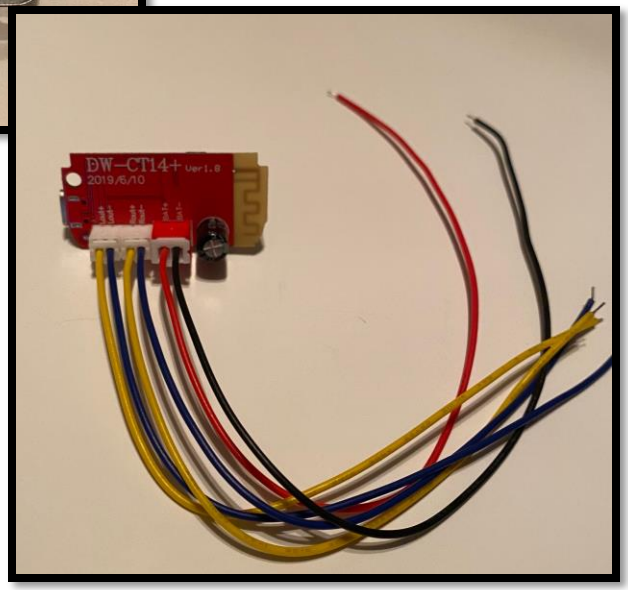
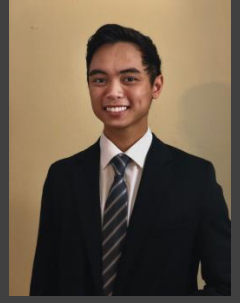
Brand	Visaton
Cost	$4.68
Nominal Diameter	2.5”
Max Rated Power	5Watts
Impedance	4 Ohms
Frequency Response	130 to 20,000 Hz
Depth	1.14”

Manufacturer	Hyuduo	Icstation
Cost	$8.99	$10.99
Dimensions	1.6 x 1.3 x 0.5 inches	1.6 x 0.8 x 0.5 inches
Rated Power	5 Watts per speaker	5 Watts per speaker
Supplied Voltage	3.7V-5V	3.7V-5V
Cost	$8.99	$10.99



Selected Component

LCD Screen



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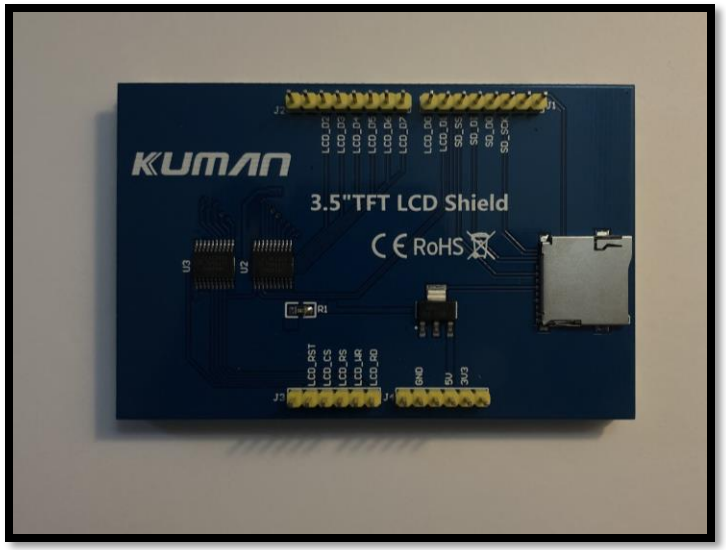
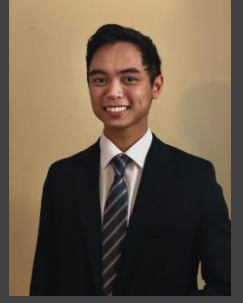
Manufacturer	Kuman	HiLetgo	Elegoo
Screen Size	3.5 inches	2.8 inches	2.8 inches
Glass Type	TFT	TFT	TFT
Resolution	480x320	320x240	480x320
Cost	$17.80	$13.99	$15.99
Dimensions	83.5 x 55.6	85 x 48 mm	50 x 69.2
Weight	3.2 ounces	1.6 ounces	1.76 ounces

Selected Component

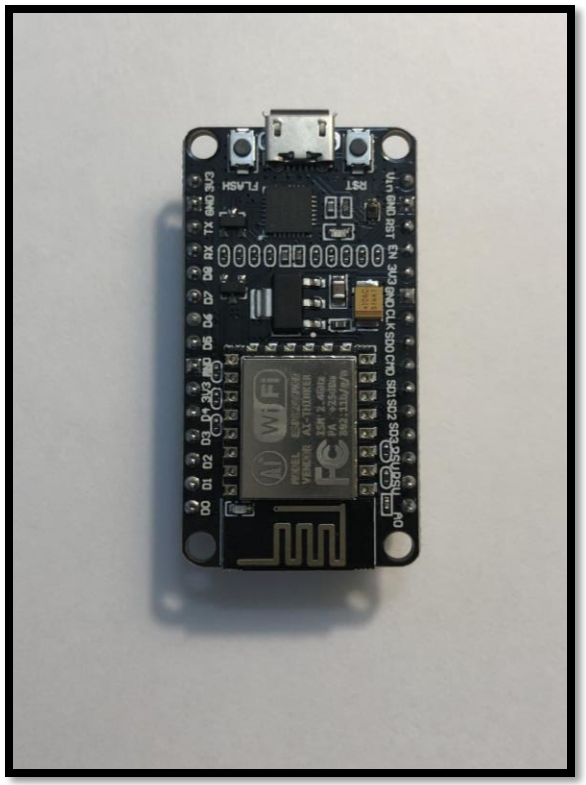


Wi-Fi Module

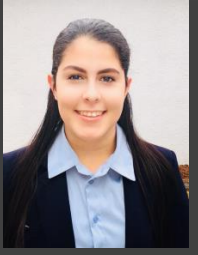


Manufacturer	HiLetgo	KeeYees
Model	ESP8266 NodeMCU CP2102 ESP-12E	ESP8266 NodeMCU CP2102 ESP-12E
Data Rate	6Mbps - 54Mbps	6Mbps - 54Mbps
Rated Voltage	3.3V - 5V	3.3V - 5V
Weight	0.986 ounces	1.58 ounces
Cost	$6.49	$7.67

Selected Component



System Power Overview



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Total System Maximum Power consumption:

≈ 26 Watts

Pumps ≈ 8.4 Watts

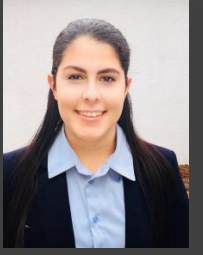
LEDs ≈ 4 Watts

Remaining system components ≈ 14 Watts

System Max Power Consumption is based off each individual component running simultaneously, unlikely to occur

To ensure that the system will not fail the proper AC adapter must be selected

AC/DC Adapter



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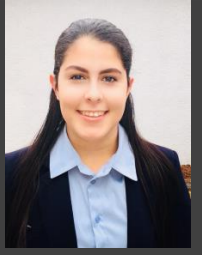
- 12 V
- 2.5 Amp
- 30-Watt Power supply will ensure that the system is functioning properly
- Using a wall outlet allows the system to be highly versatile
- Connects to PCB to power entire system
- Jack Size: 5.5 mm x 2.1 mm

Power Circuit



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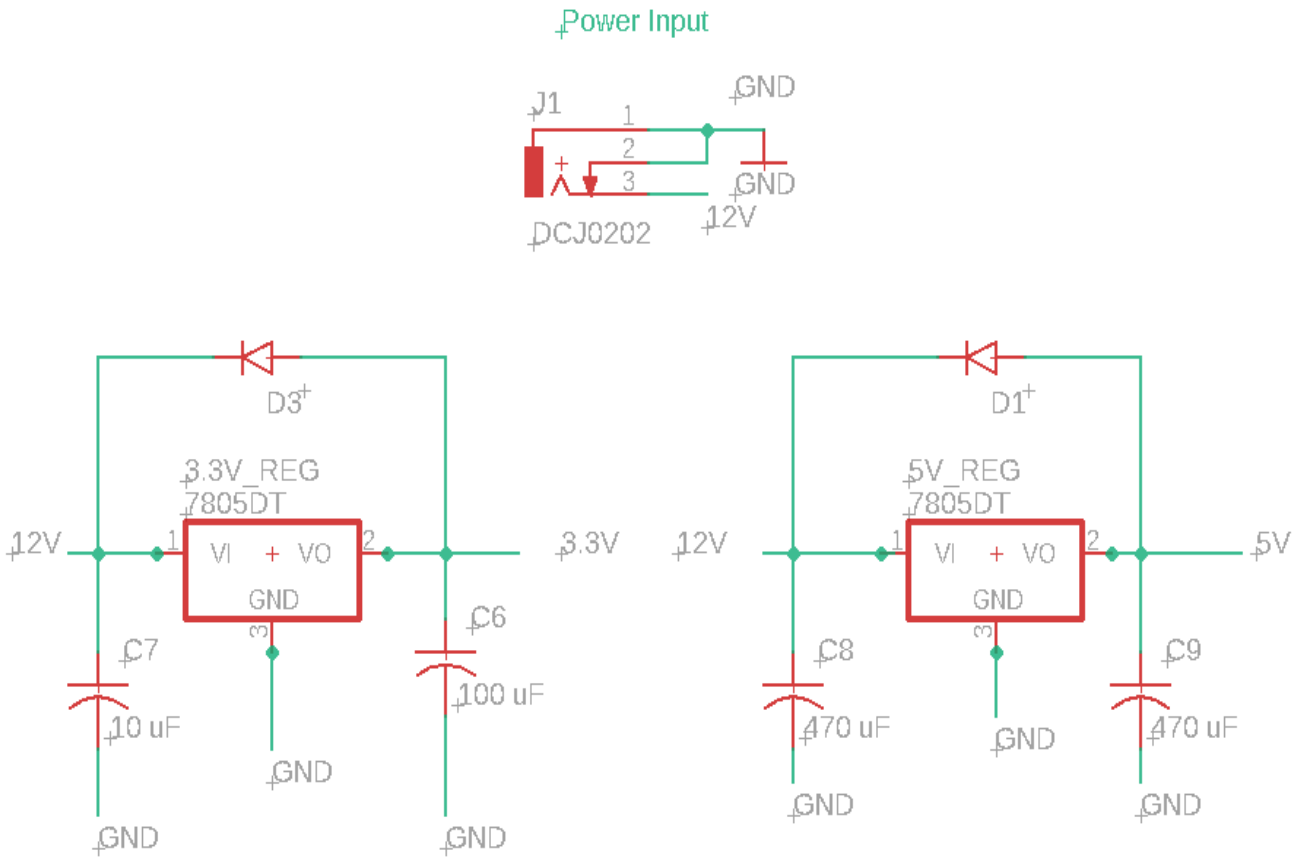
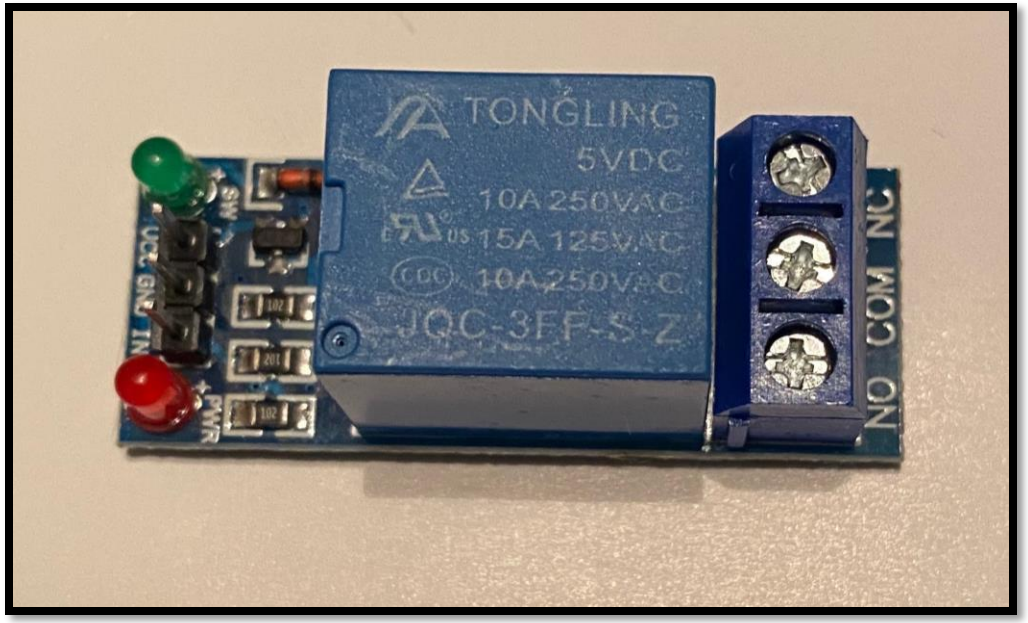


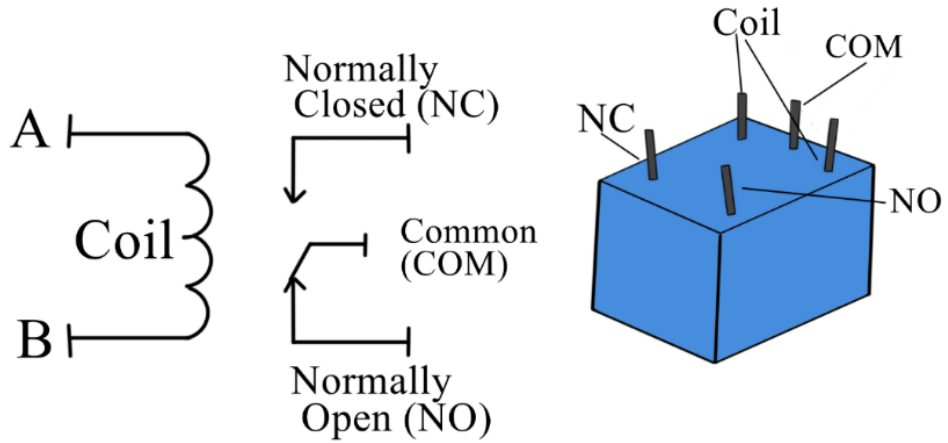
- 12 V input from a wall AC/DC adapter to supply power via a DC barrel connector to entire system
- 12 V will power the water pump and nutrient pump
- Step down to 5 V using a LM7805 voltage regulator and use this to supply voltage to the rest of the system
- Step down to 3.3 V using a LD1117V33 voltage regulator to power ESP8266 WiFi module
- Reverse current protection via diode and bypass capacitors

Relay Modules

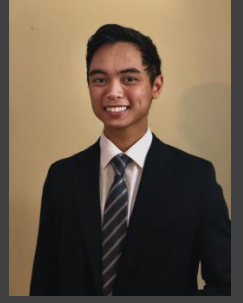
- Relays will be used to control the pumps, grow lights, and speakers
- Trigger Voltage: 5V DC
- Trigger Current: 70 mA
- Max DC Load Current: 10 A @ 30/28 V DC
- Trigger Time: 5-10 msec

LV





Software Overview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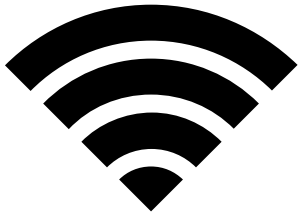
Microcontroller

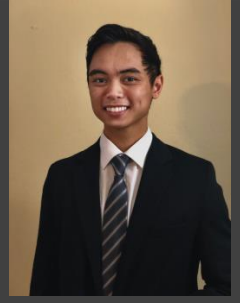
- The software programmed on the microcontroller manages various pumps, lights and sensors within the system.
- Readings collected from the sensors will trigger different actions to ensure that the system is operating under ideal growth conditions.

Remote Access

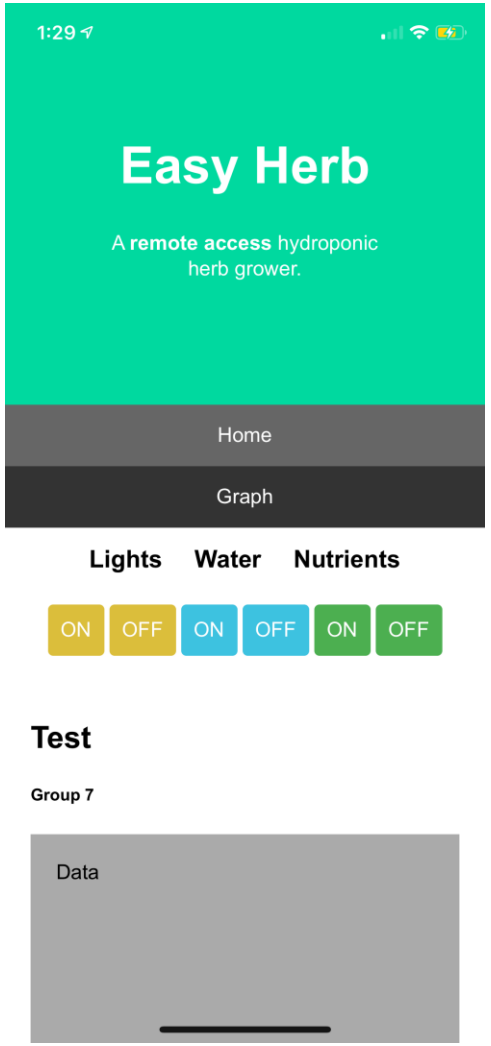
- The system can be accessed remotely using the wi-fi module.
- After connecting to any local network, the device is then able to communicate with the non-local EasyHerb web server.
- This will allow the user to access their system data as well as make state changes remotely.



EasyHerb App

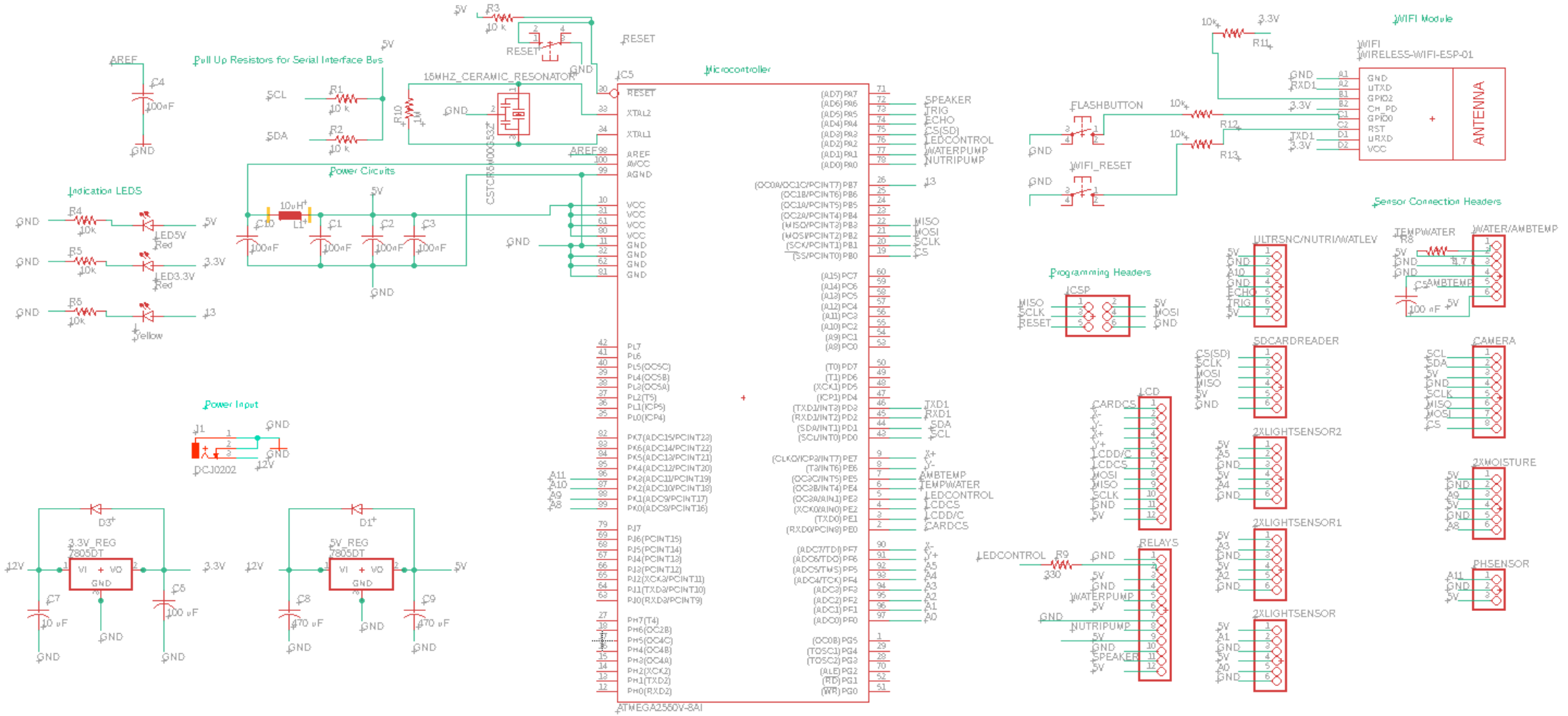

KM

- A phone app for EasyHerb was created to enhance the accessibility to the device as well as user experience.
- The user can access the remote features on the app as well as display the current statistics of the device.
- The app runs on the EasyHerb web server backend. A user can access the same features remotely through a web browser if they do not have access to the app.



PCB Schematic

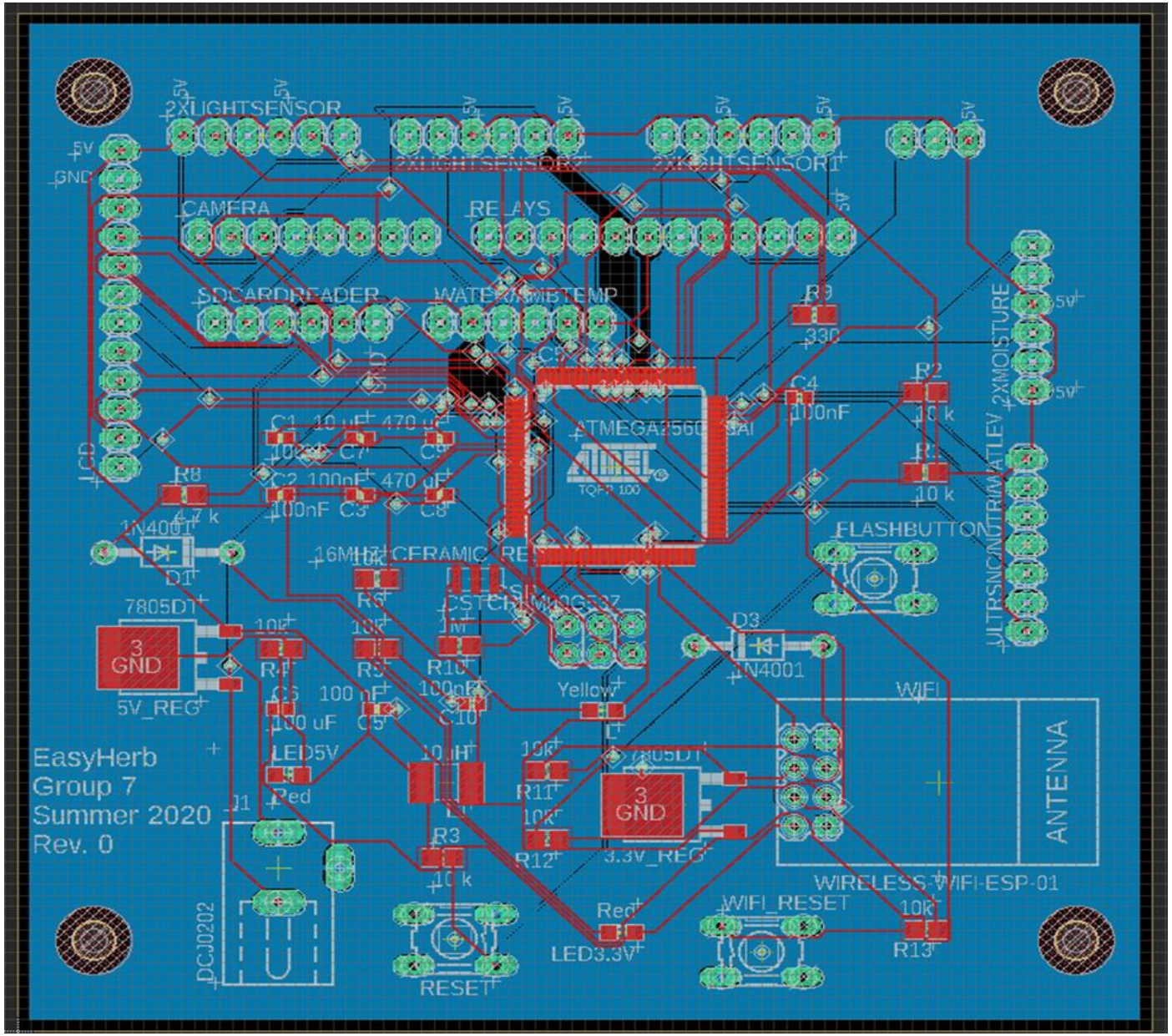
LV



PCB Layout

- 2 Layers
- 90mm x 90mm
- 12V input stepped down to 5V for majority of the system and 3.3V for the WiFi module
- LEDs for troubleshooting
- Push buttons for reset
- Additional protection circuits
- 4 mounting holes

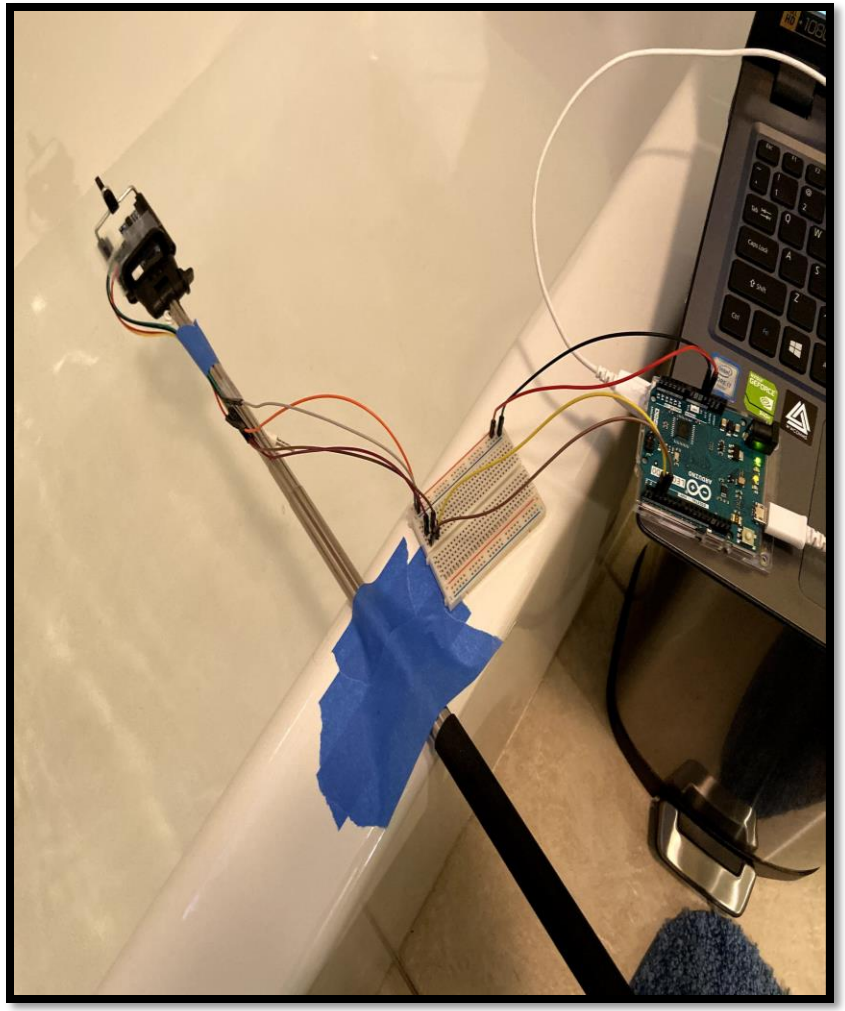
LV



Prototyping

LF

- Each sensor was tested individually for functionality, and data was gathered when necessary
- All sensors, pumps, lights, speakers, and the screen worked as needed
- Relays effectively connect the pumps with 12 V power, allowing them to easily be run when needed
- Ultrasonic distance sensor is able to measure the distance to the surface of water without the need for a bobber

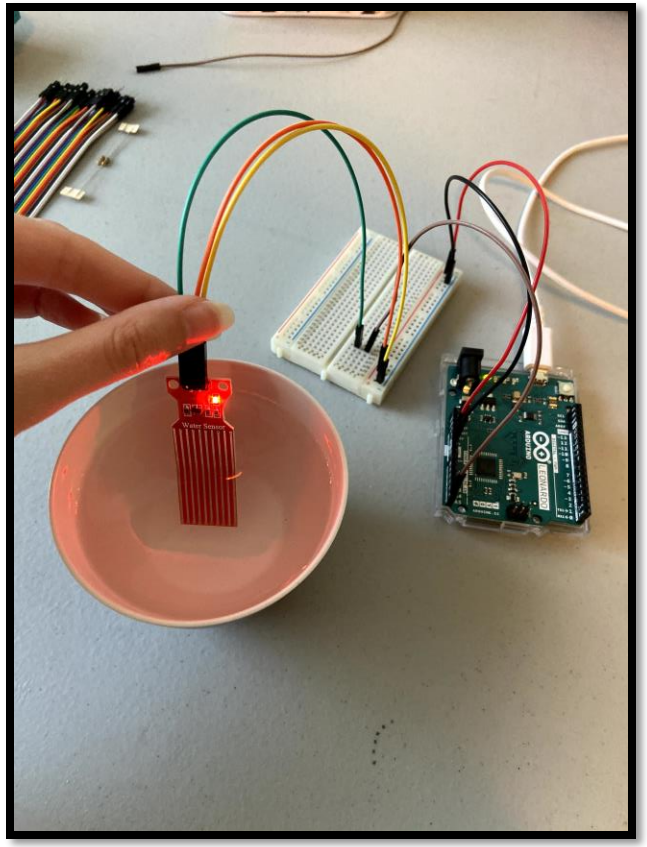


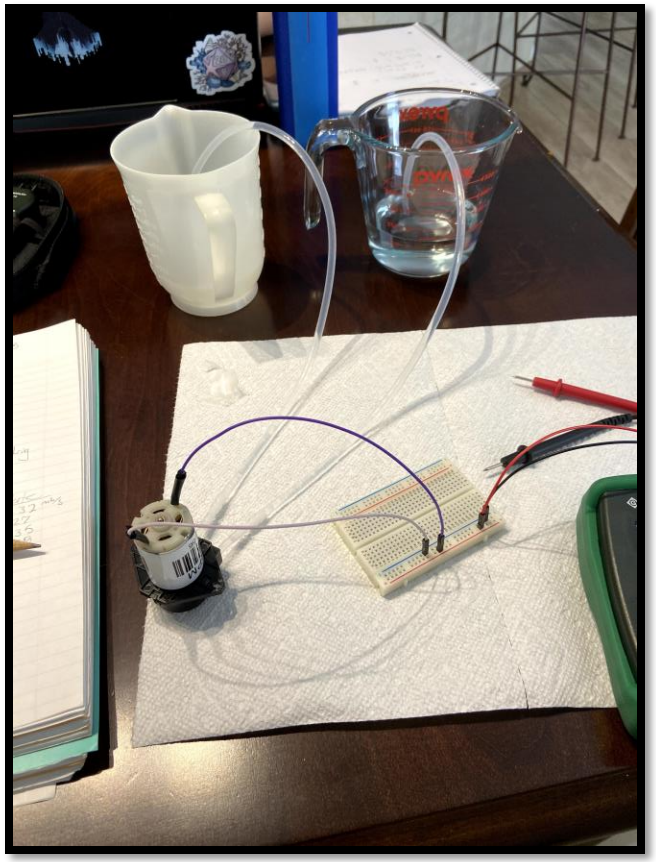
Prototyping Data Collected

- Liquid level sensor: resistivity value measured at certain percentages was observed, from 0-750, with 0% at 0 and 100% at 750

- Peristaltic Pump: flowrate measured to be 1.34 mL/s

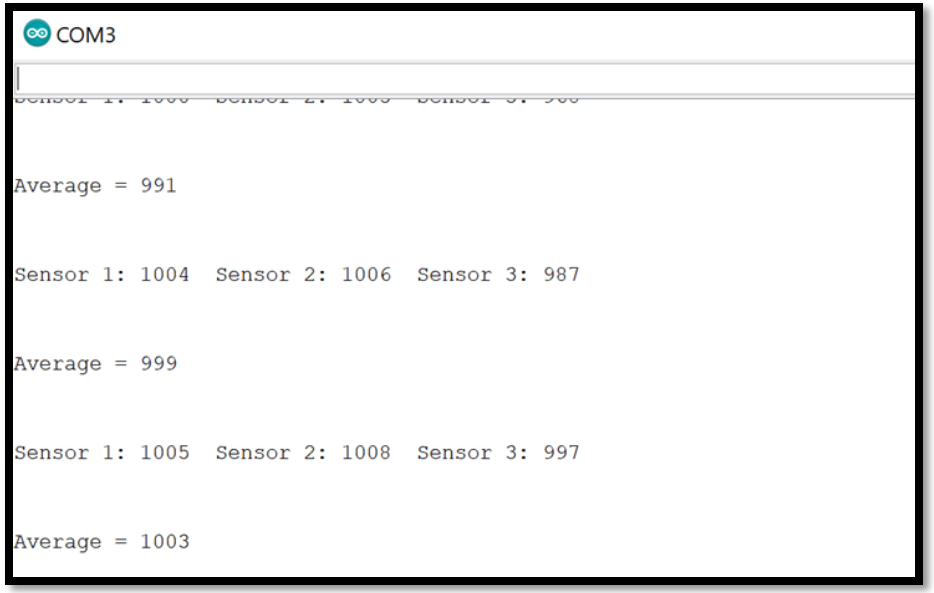
LF



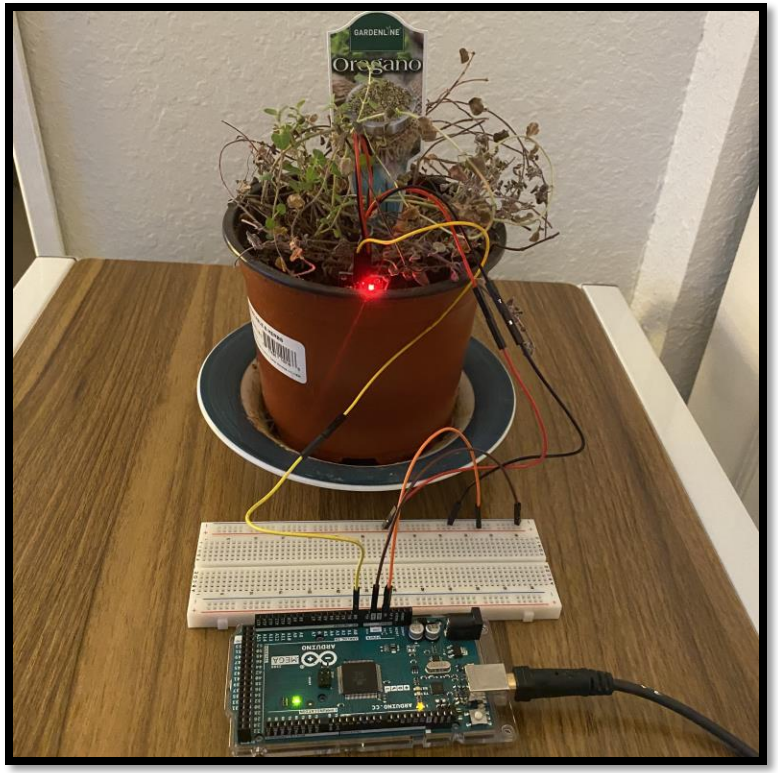


Prototyping light sensor/moisture sensor

- Light sensors used to determine brightness that will in turn determine if the grow lights should turn on or off
- Determined that a higher integer value read means less light while a smaller number indicates high brightness
- Dark ≈ 1000
- Very Bright ≈ 10-20
- Using multiple sensors developed a method to find an average brightness
- These sensors can be arranged in different locations to get a better idea of the environment brightness
- Moisture sensors will work using a similar method to determine if the plants should be watered
- Completely Dry ≈ 0
- Completely Wet ≈ 3900



LV



Difficulties/Challenges for each subsystem

CH

- PCB took two iterations and unable to get PCB professionally assembled
- Ensuring all systems were able to successfully connect through the pipes
- Uploading certain data (e.g. image files) to the server was difficult due to some port forwarding security protocols set by the ISP that the server runs on

Administrative Content

Project Budget Projections

- Breakdown of initial estimated costs for the entire system
- This is the guideline of the budget in place for the final product

KM

Item	Cost
Microcontroller	$40
Wireless Modules	$55
Water Level Sensor	$4
pH Sensor	$30
Nutrient Pump	$25
Nutrient Level Sensor	$6
Temperature Sensors	$3
Camera	$31
Camera SD Reader and SD	$8
Water Pump	$11
Emitters	$4
Moisture Sensor	$5
Touchscreen Display Screen	$35
Grow Lights	$25
Light Sensors	$5
Construction Materials	$60
PCB / Power	$70
Total	$418

Final Budget

Component	Cost
ATmega2560	$11.85
Water Level Sensor	$3.95
Photoelectric Sensor	$5.99
Peristaltic Liquid Pump	$24.95
PH Sensor	$33.99
WS2812b LED Strip	$22.88
Water Temperature Sensor	$2.60
Temperature/Humidity Sensor	$10
Moisture Sensor	$4.99
Water Pump	$10
Camera	$30.99
LCD Screen	$17.80
Wi-Fi Module	$6.49
Speakers	$20
PCB	$ 30
Construction Materials	$110
Relays	$10
Relays	$10

LF

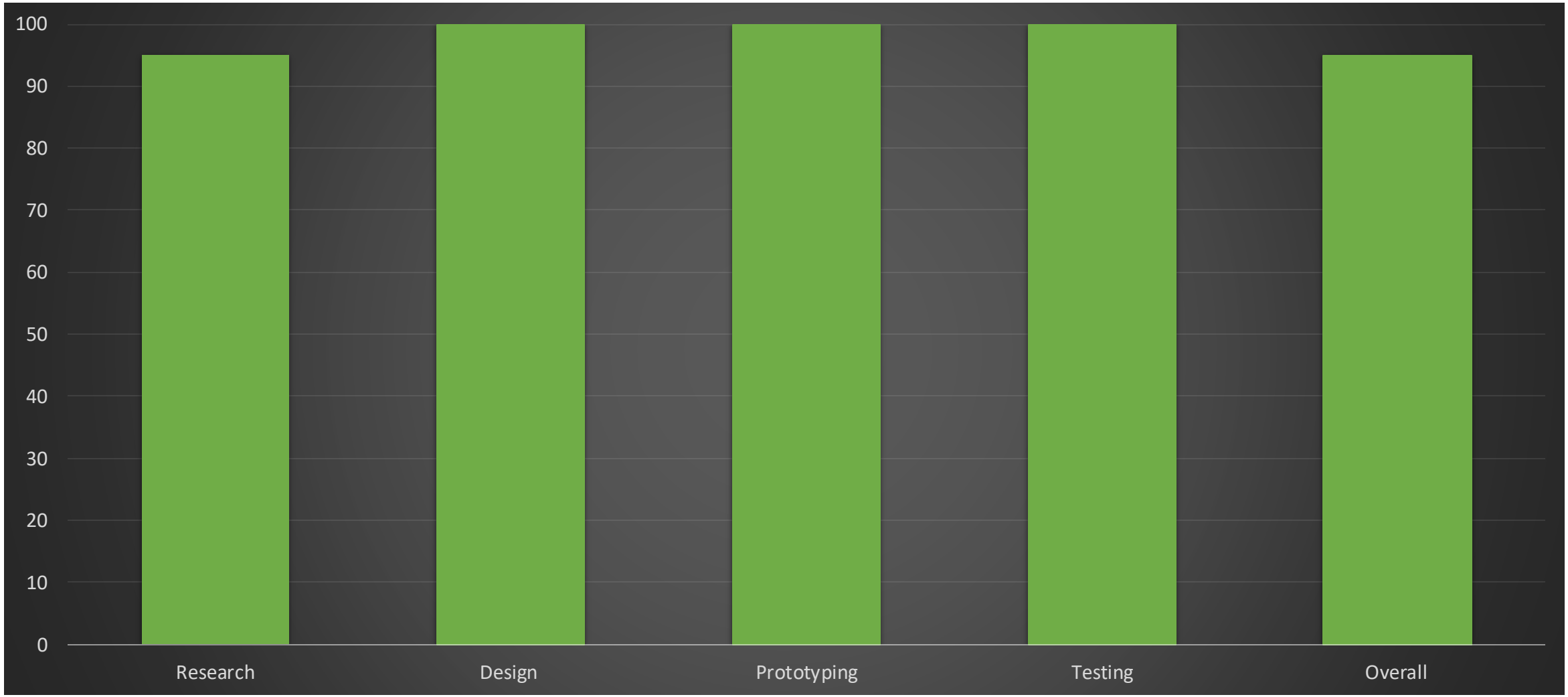
Work Distribution


LV

	Luna Vazquez	Lindsey Feldman	Chris Hernandez	Kyle Patrick Magboo
Nutrient System		P	S	
Water System	S		P	
MCU	S			P
PCB	P			
Lighting System	S	P		
Power Supply	P		S	
Soil Moisture Sensor	P	S		
Communications				P
Software	S			P
System Enclosure			P	S
Camera	P			S
LCD Interface	S			P
pH sensor		P	S	
Water Temperature Sensor		S	P	
Liquid Level Sensor		P	S	
Water Level Sensor		P	S	
Ambient Temp/Humidity Sensor			P	S

Progress Made (% done by category)

CH



Future Upgrades

CH

- Maximize space to minimize total size
- Potential to add a third plant in the system
- Incorporate an automatic pH balancing system