Smart Drip Irrigation System

Team 17: Diego Tolentino (Team Leader), Joshua Mica, Vedant Chopra, Victor Carpio

Project Manager: Dr. Steven Pei

Faculty Advisor: Dr. Leonard Trombetta

Sponsors: IEEE EDS, BioNica, and Universidad Nacional Agraria (UNA)

Date: May 6th , 2021

Problem

Approximately 35% of the Nicaraguan population lives in poverty

Agriculture provides employment for rural population

Farmers cannot afford expensive equipment

Farming as main source of food

Agriculture serves as a primary export

Purpose

Cost Effective System

Maintain a low-cost, fast return-on-investment product

Improve Previous Design

Adapt design to function for multiple crops

Coordinate Relief

Project coordination with BioNica and Universidad Nacional Agraria (UNA)

User Analysis

- Low-income
- Technical inexperience
- Full-time farmers
- Main target is Nicaraguan farmers

Patents

- S. . Bermudez Rodriguez, H. F. . Hamann, L. Klein, and F. J. . Marianno, “Automated Irrigation Control System,” 10 , 241 , 488 B2, 26-Mar-2019.
- Richard W. Parod, C. H. M. (n.d.). “Solar Powered Irrigation Machine”. *Patent No. 8517289B2. 9-28-2007*
- Paul, M. F. (2020). “WATERTIGHT ELECTRICAL COMPARTMENT FOR USE IN IRRIGATION DEVICES AND METHODS OF USE,” 10,965,109, 30-Mar-2021.
- D. Lankford, “Crop-specific Automated Irrigation and Nutrient Management,” 10,512,226 B2, 24-Dec-2019.

Deliverables

- Fully autonomous system that will determine if irrigation is necessary and gives the system and opportunity to open periodically
- Controls system that has the ability to change the set saturation points to allow for use with multiple crops
- Power system that uses solar cells to power and charge a 7 [Ah] battery that can operate the system up to 50 hours without charging
- More sophisticated connections between components by creation of PCB, to avoid damage in shipping
- User Guide and Build Guide to provide to users in Nicaragua

Deliverables: Specs and Features

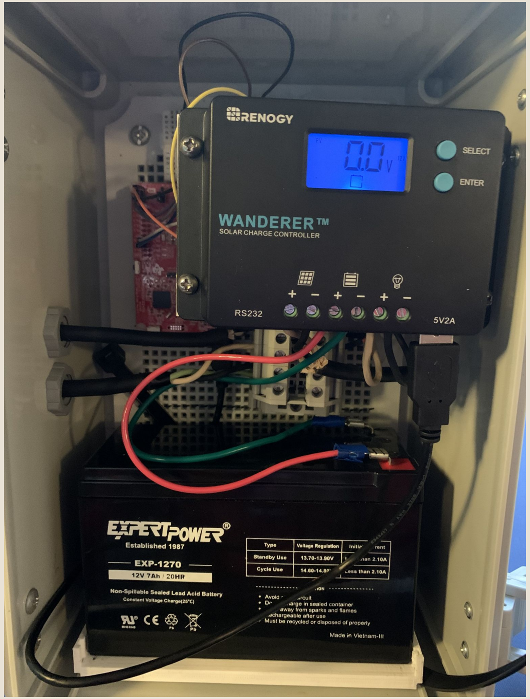
Key Specs:

- Battery: 12 [V], 7[Ah]
- Container: IP67 (14.6"x10.6"x5.9") dustproof, heat and water resistant
- Ability to irrigate 9 [m] x 16 [m]
- System has an opportunity to irrigate every two hours
- Power consumption of approximately 150 [mA]

Features:

- Powered by Solar Panel Array - Outputs up to 20 [V]
- Visual interface to show system info
- Autonomous Operation

Improvements from Previous Group

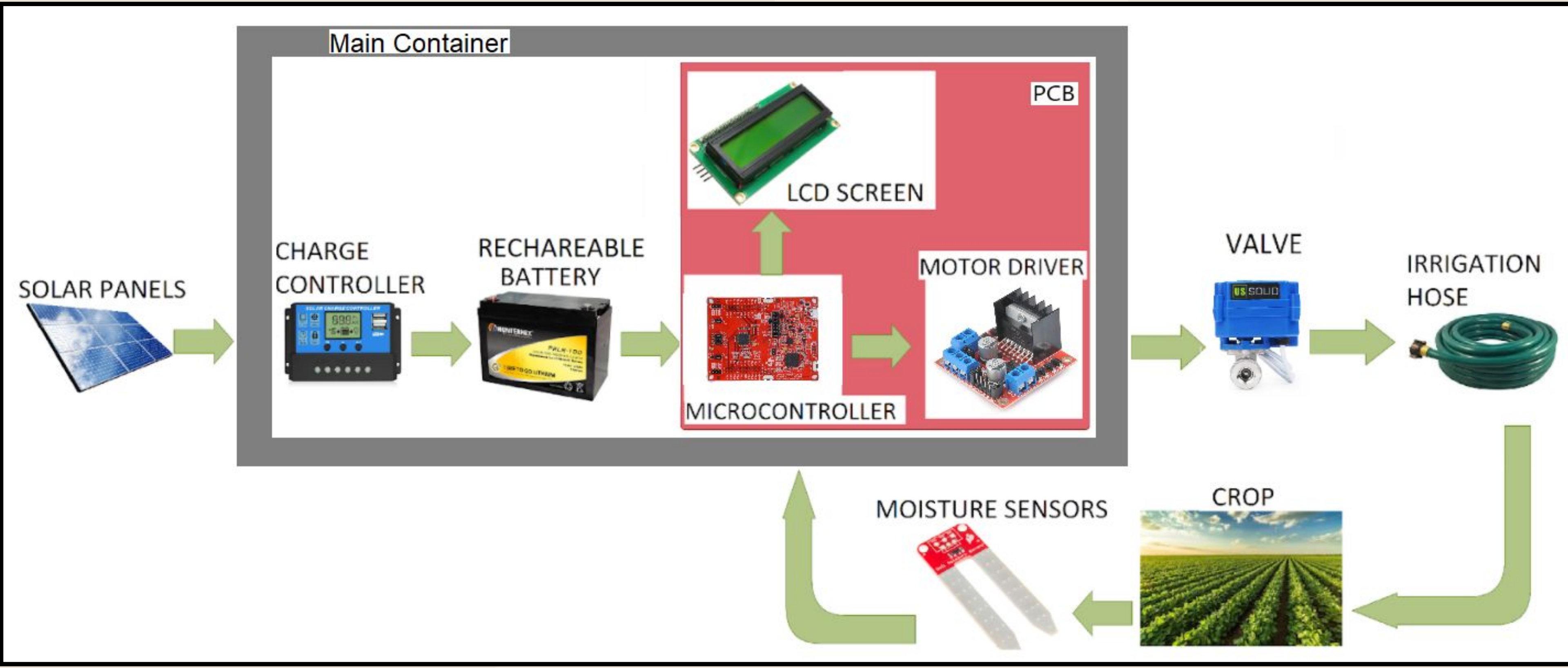


Old Design

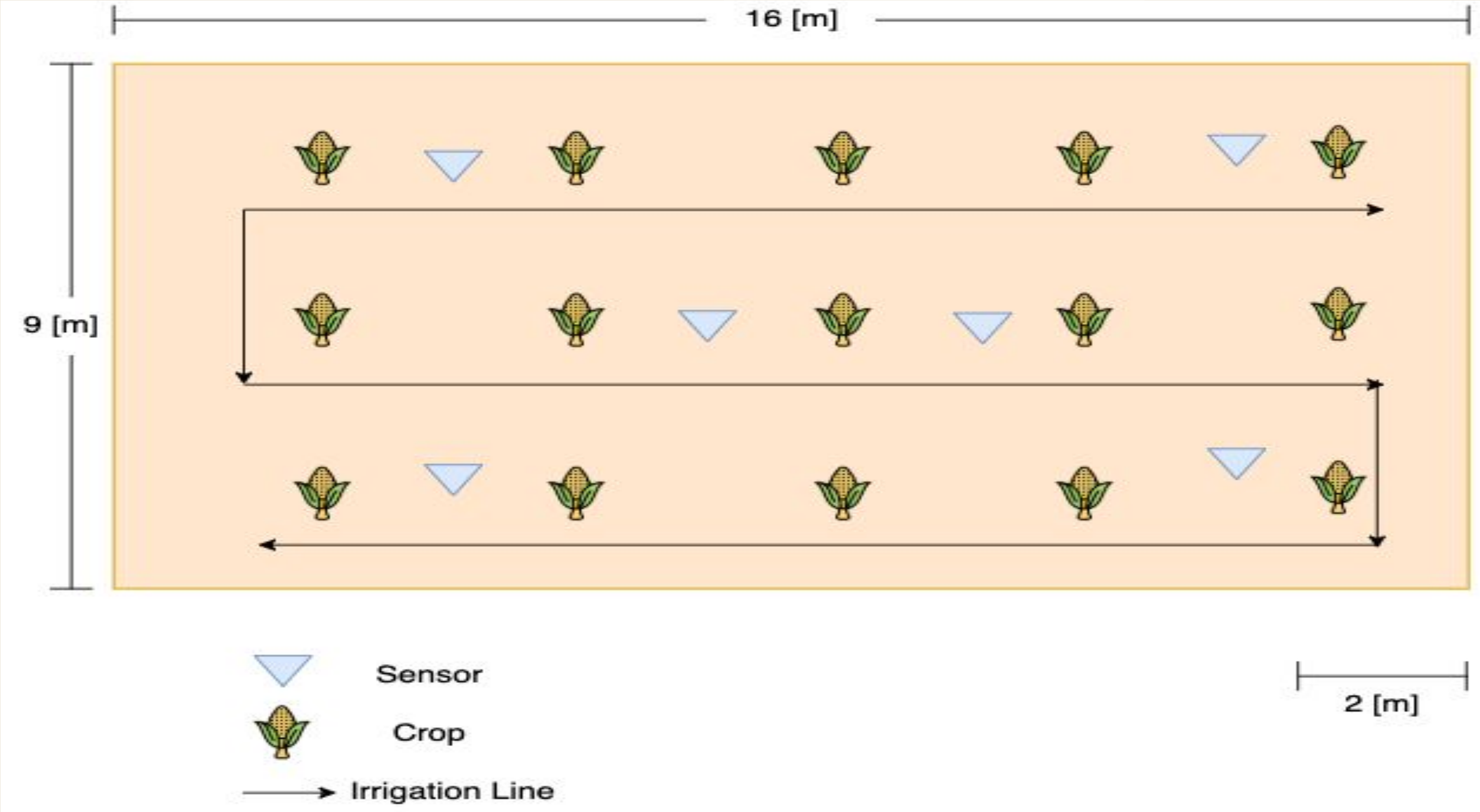
Previous Group	Our Group
Single Crop	Polycrop Design
One Moisture Sensor	Six Moisture Sensors
Breadboard Wiring	Printed Circuit Board
Used LEDs to Communicate	Using LCD Screen to Communicate
3 Solar Panels	4 Solar Panels
IP65 Container	IP67 Container

Improved Design

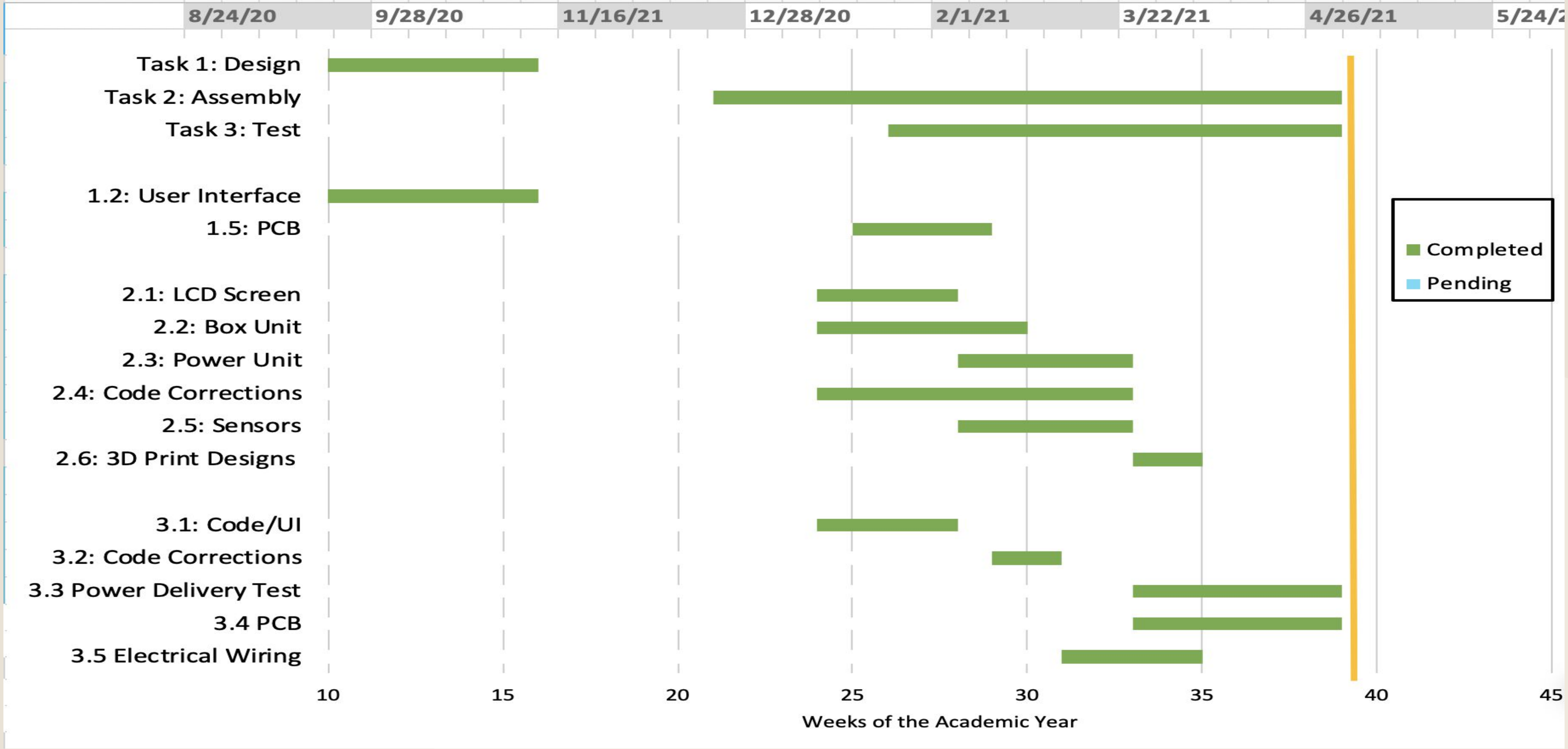
Overview Diagram



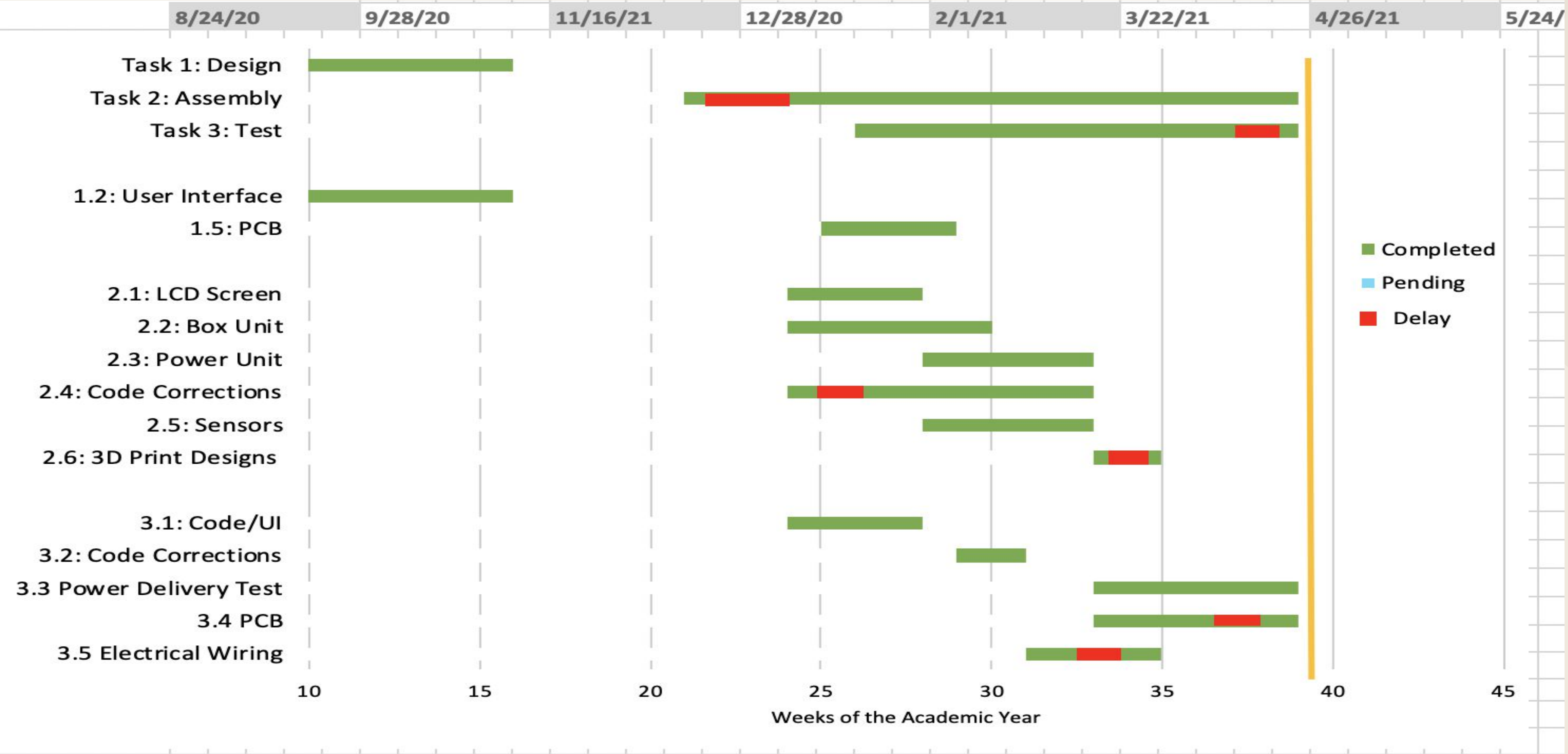
Overview Diagram



Schedule


8/24/20
9/28/20
11/16/21
12/28/20
2/1/21
3/22/21
4/26/21
5/24/2
Task 1: Design
Task 2: Assembly
Task 3: Test
1.2: User Interface
1.5: PCB
2.1: LCD Screen
2.2: Box Unit
2.3: Power Unit
2.4: Code Corrections
2.5: Sensors
2.6: 3D Print Designs
3.1: Code/UI
3.2: Code Corrections
3.3 Power Delivery Test
3.4 PCB
3.5 Electrical Wiring
Completed
Pending
10
15
20
25
30
35
40
45
Weeks of the Academic Year

Schedule



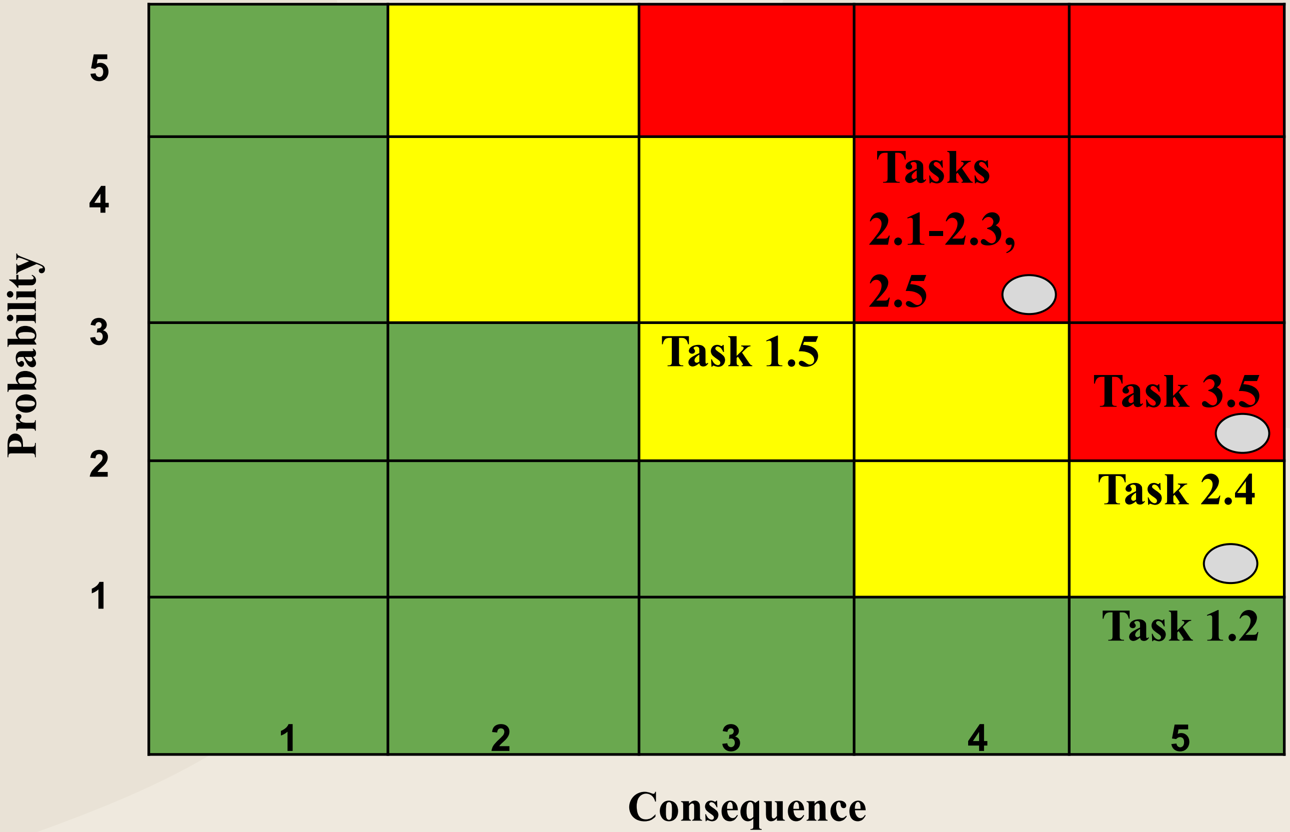
8/24/20
9/28/20
11/16/21
12/28/20
2/1/21
3/22/21
4/26/21
5/24/
Task 1: Design
Task 2: Assembly
Task 3: Test
1.2: User Interface
1.5: PCB
2.1: LCD Screen
2.2: Box Unit
2.3: Power Unit
2.4: Code Corrections
2.5: Sensors
2.6: 3D Print Designs
3.1: Code/UI
3.2: Code Corrections
3.3 Power Delivery Test
3.4 PCB
3.5 Electrical Wiring
Completed
Pending
Delay
10
15
20
25
30
35
40
45
Weeks of the Academic Year

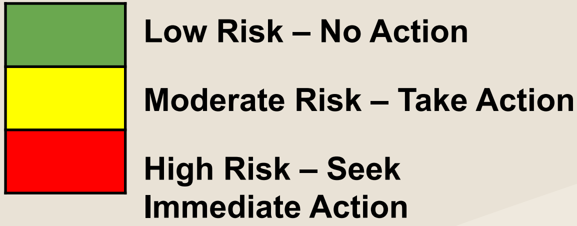
Testing Plan

What We Need to Test	Plan
Task 3.1-3.2: Code/Sensor	Attaching sensor to microcontroller and analyze data
Task 3.4: PCB Connections	Physical test via ohmmeter
Task 3.3: Power Delivery	Connect system and read voltages from charge controller
Task 3: Overall System	Full system test with cups of soil and water

Risk Matrix

- Task 3.5: Electrical Wiring
- Tasks 2.1 - 2.5: System Assembly
- Task 2.4: Original Code Edits



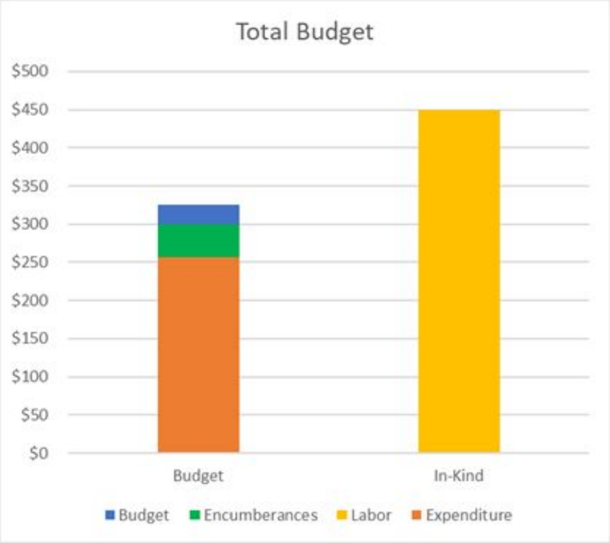


Mitigation Plans

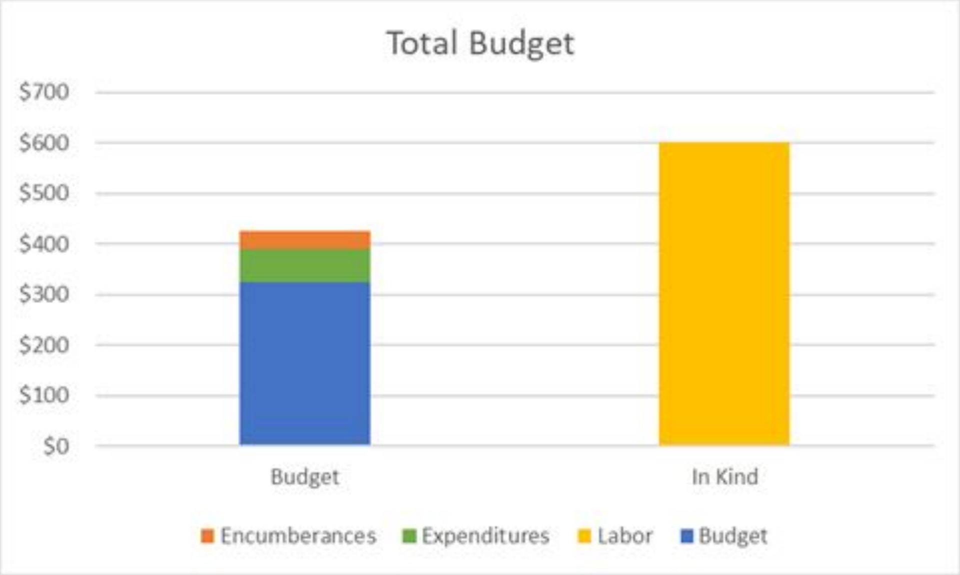
- Task 3.5: Electrical Wiring
  - Follow PCB Schematic
  - Check connections with a multimeter
  - Check soldering connections
- Task 2.4: Original Code edits
  - Troubleshoot the code with fully assembled system
  - Only one team member allowed access to code
- Task 2.2: Assembly
  - Store components inside box
  - Slack wiring

Budget

- Total Spent: $400
- Over Budget

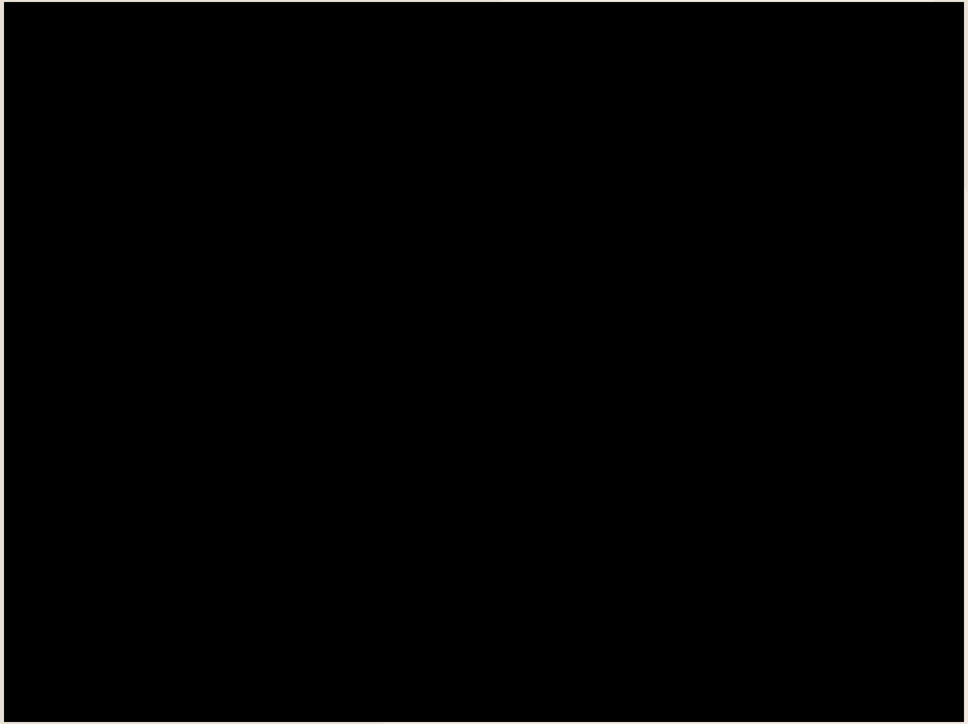


Original Budget



Final budget

System Demo - Full System



Summary/Conclusions

Accomplishments:

Created a fully-functional system, Interactive User Interface, and Improved Wiring with PCB, Provided a Basis for Future Teams

Setbacks:

Communication with Nicaragua, Winter Storm, 3D Print Failures, PCB Failure, and Code Reworks

Lessons Learned:

Effective Teamwork, Time Management, Creativity, and Resilience

Thank you! Any questions?

Bibliography

- “Recommended C Style and Coding Guidelines.” [Online]. Available: http://software-dl.ti.com/hercules/hercules_public_sw/HerculesMCU_C_CodingGuidelines.pdf. [Accessed: 31-Mar-2021].

Future Work

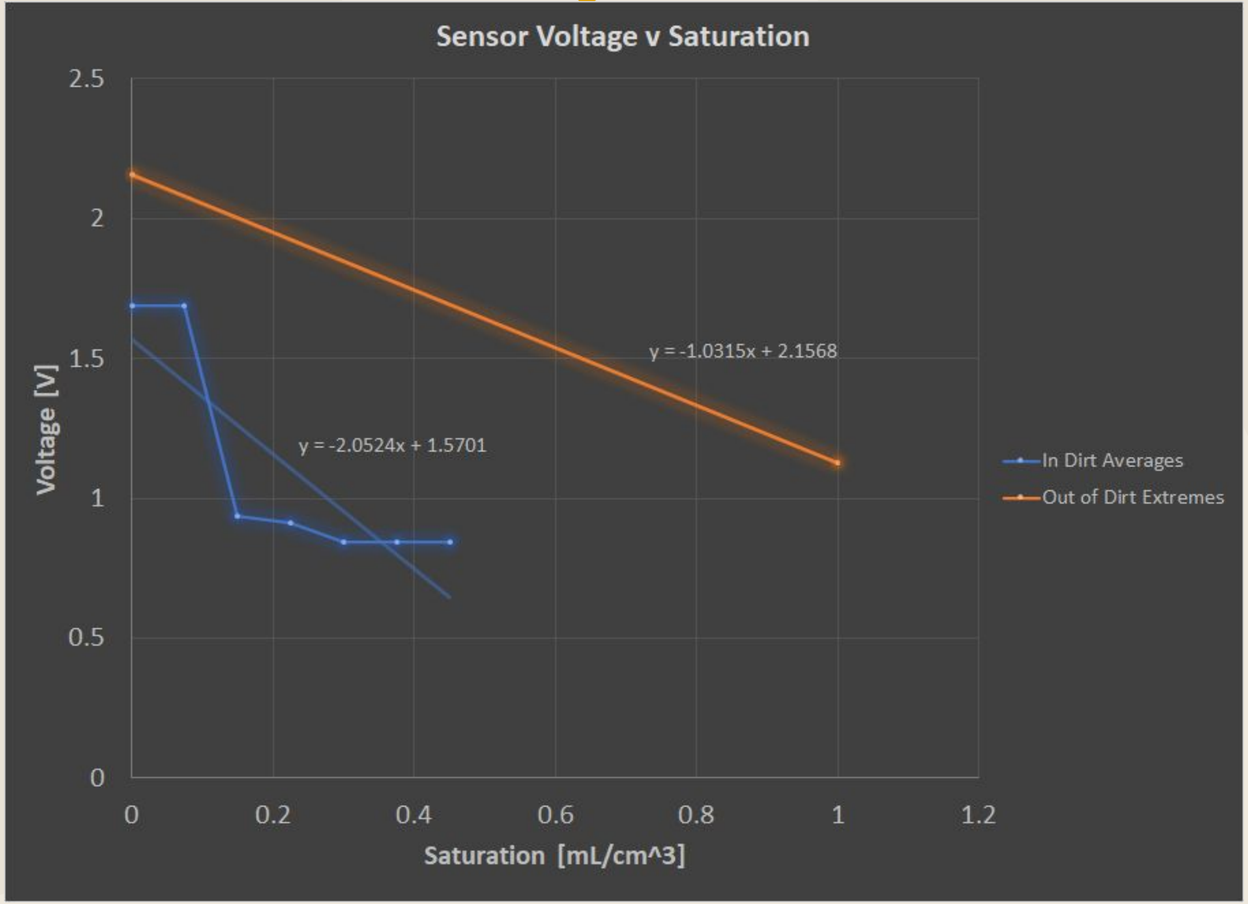
- SDIS with high-accuracy sensors
- Clock system to regulate irrigation
- A SDIS that can work in a plot containing multiple crops
- Implementation of our design in the field

System Demo - User Interface

System Demo - Power Delivery

Task 2.5: Sensor Testing

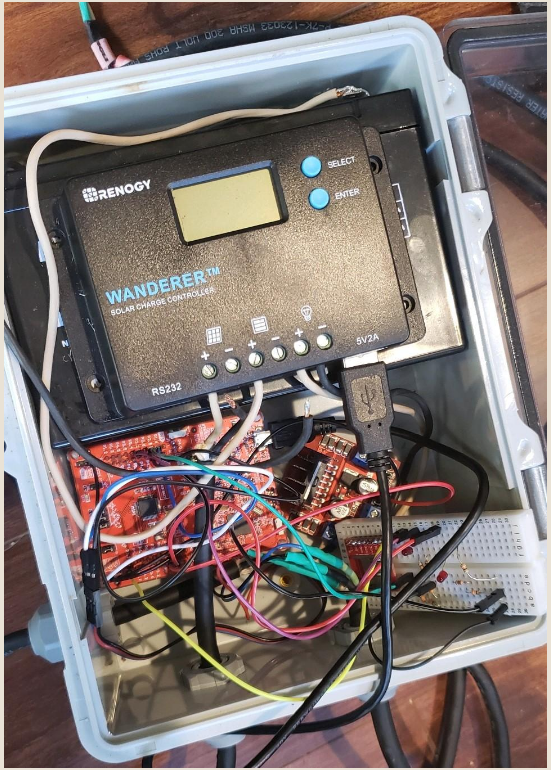
- Ran tests on a sensor to see what reading we get at certain saturations
- The chart displays the voltage captured vs the saturation
- About the same amount of soil was used each run and water was added in 0.5 oz (14.7868 [mL]) steps
- Also show the trend line when the sensor is out of soil



Improvements from Previous Group

Saturation Mode	High	Medium	Low	Manual Trigger
Irrigation Needed Voltage	N/A	1.21 [V]	1.61 [V]	**None**
Satisfied Voltage	N/A	0.97 [V]	1.36 [V]	**None**
Tolerance	+- 0.1 [V]	+- 0.1 [V]	+- 0.1 [V]	**None**

Improvements from Previous Group

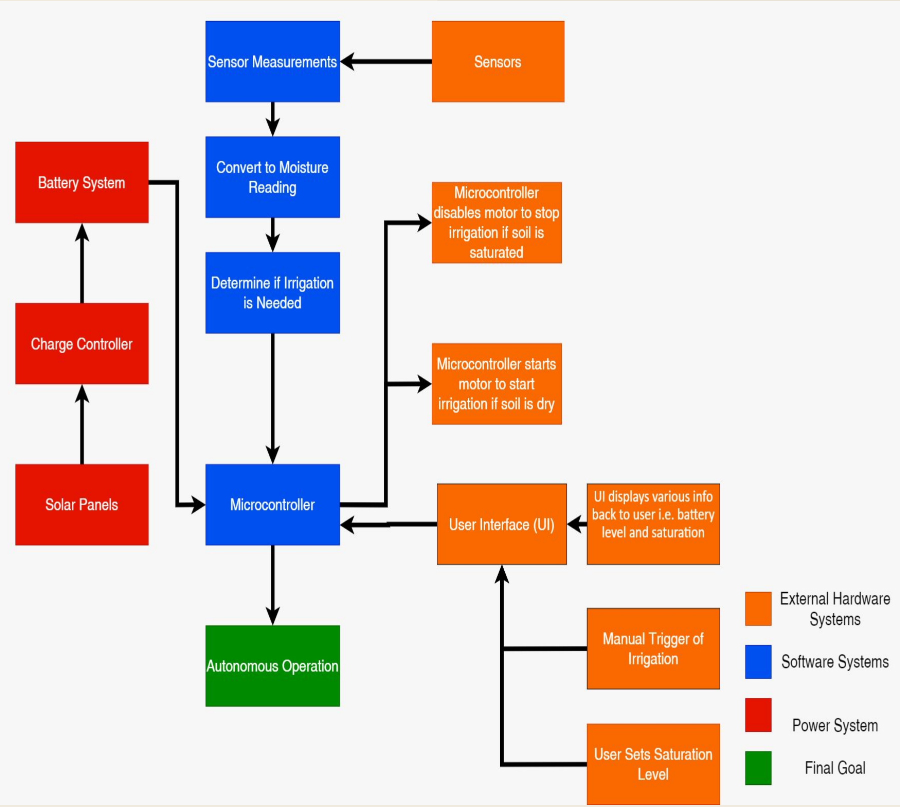


Old Project

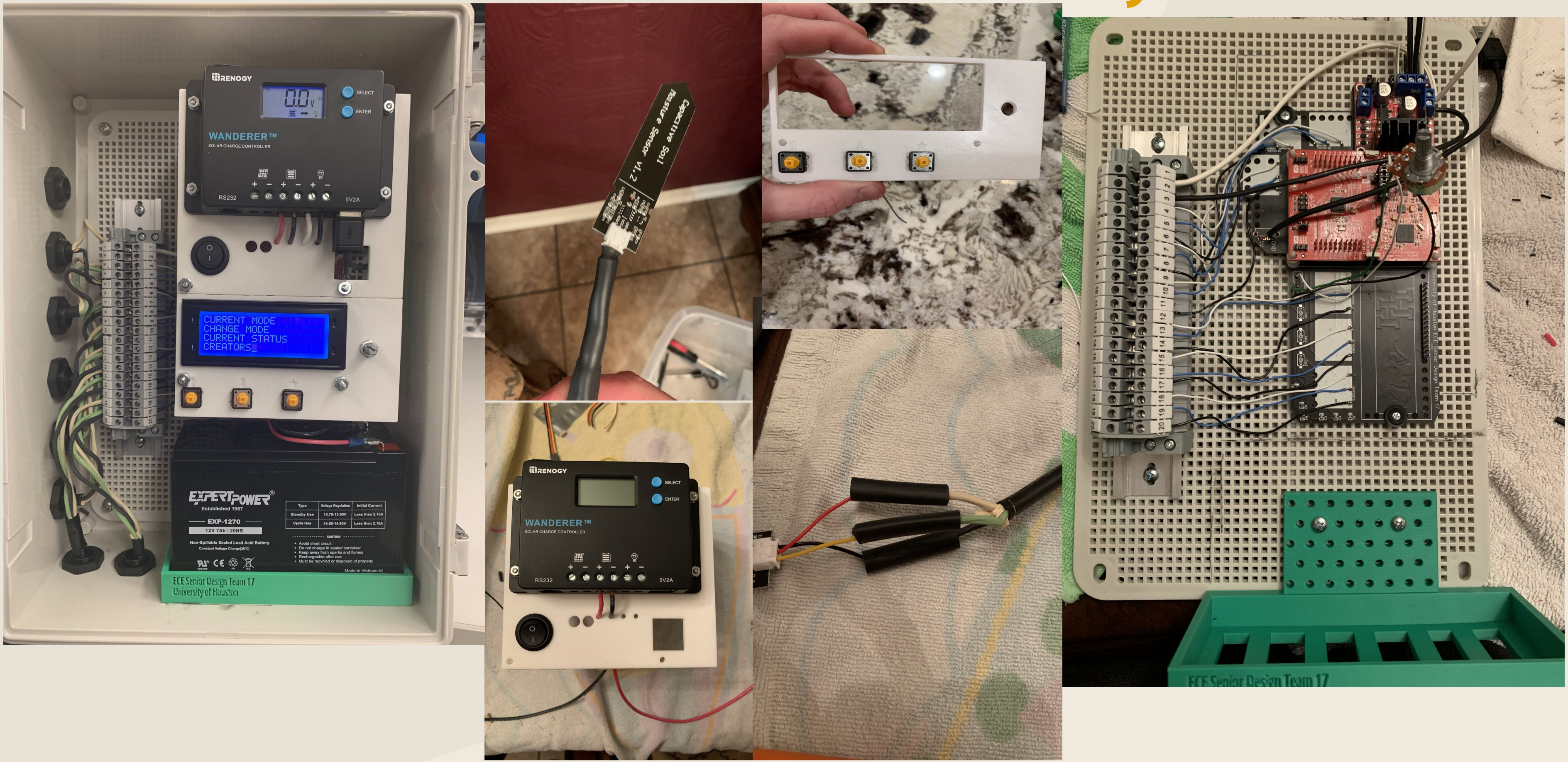
Previous Group	Our Group
Single Crop Design	Polycrop Design
One Moisture Sensor	Six Moisture Sensors
Loose Wiring	Printed Circuit Board
Used LEDs to Communicate	Using LCD Screen to Communicate
Three Solar Panels	4 Solar Panels
IP65 Container	IP67 Container

Goals

- Provide an automated system that irrigates several types of plants
- Keep system's price per unit as low as possible
- Extend the system's lifetime as long as possible



Task 2.2: Box Unit Assembly



Task 2.4: Original Code Edits

- System controls is complete
- System checks if we need to open the valve once every two hours
- Actively queue and dequeue the valve between openings
- Corrected critical code errors from previous team to achieve proper operation

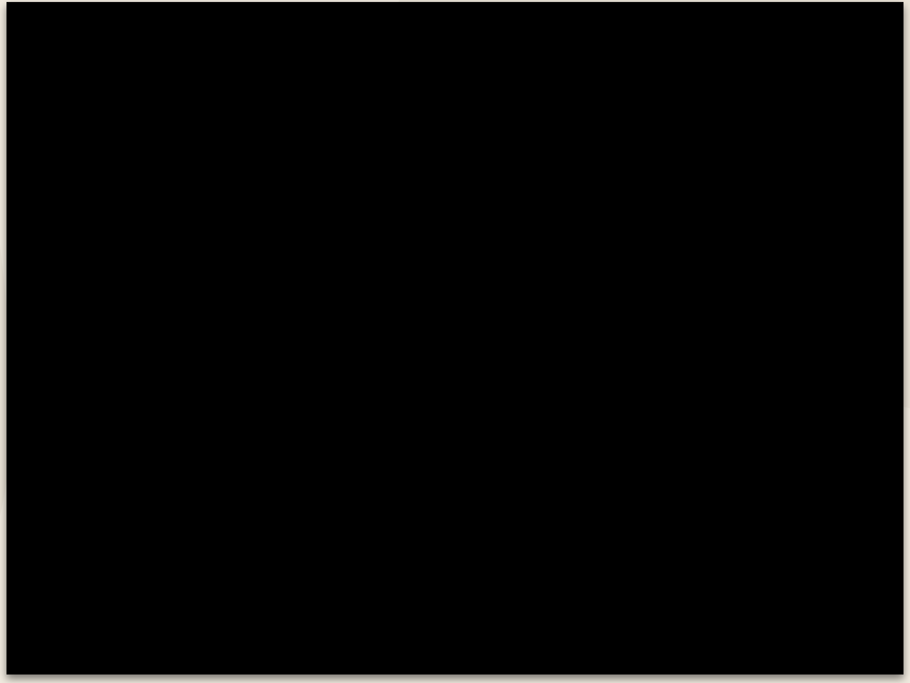
Schedule Setbacks

- Communication with Nicaragua
  - No details on product specs they wanted
- Winter Storm
  - Delayed assembly by a week
- 3D print failures
  - Multiple failures, delayed assembly by a week
- PCB Failure
  - Solder pads melted off, delayed assembly by a day
- Code Reworks
  - System needed code fixed, delayed testing

No longer creating a video manual
Could not perform field test

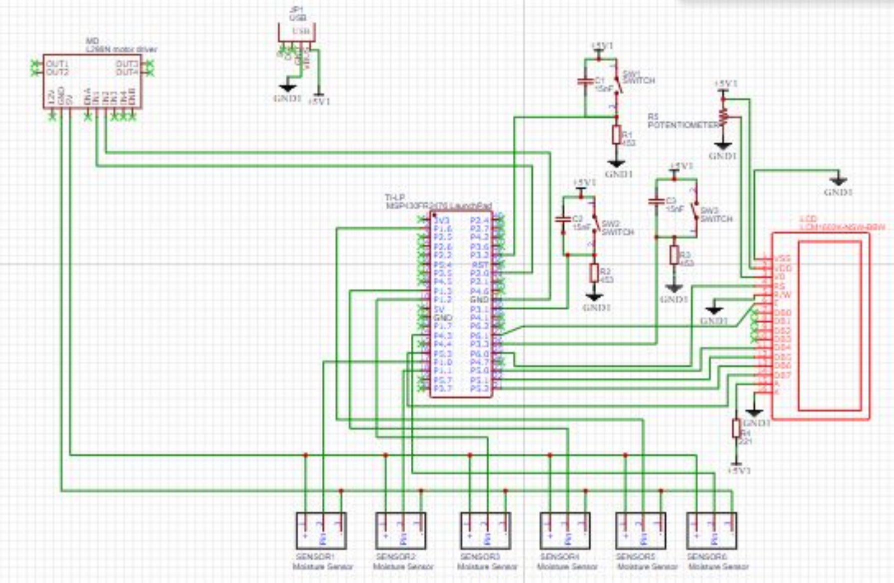
Task 2.1 User Interface Creation Update

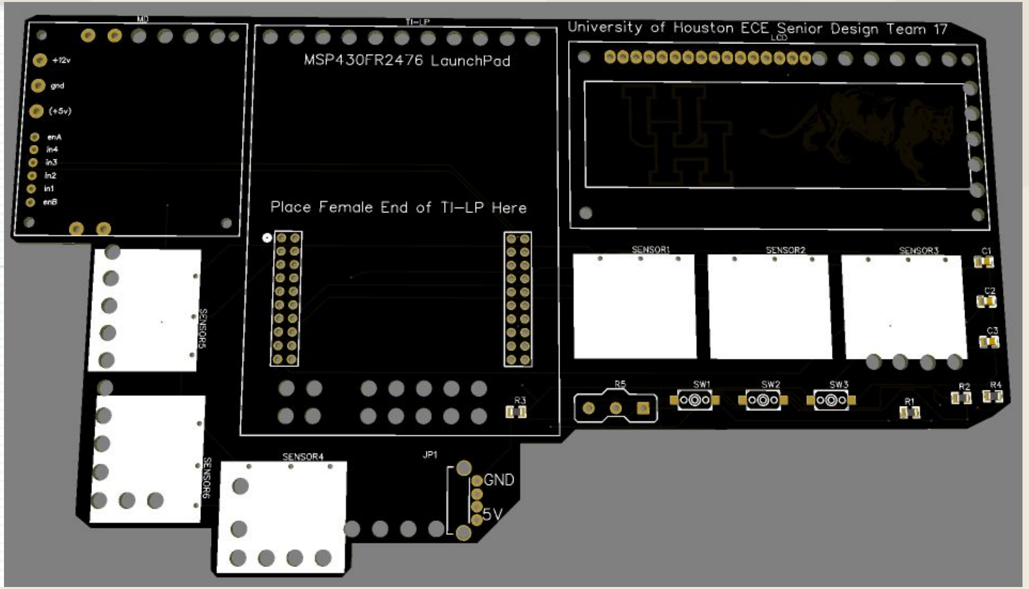
- User interface takes in inputs to set mode
- User interface displays the current mode
- Ability to scroll up and down various options



Task 1.5 Update: PCB

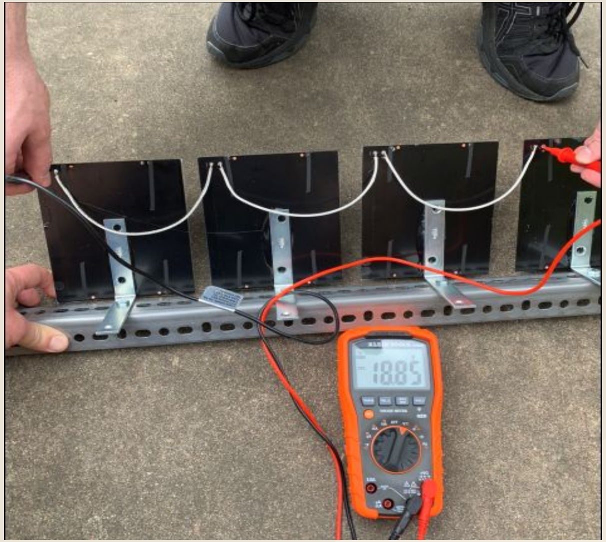
- PCB Schematic: Complete
- PCB Connections: Complete
- PCB Purchase: Complete





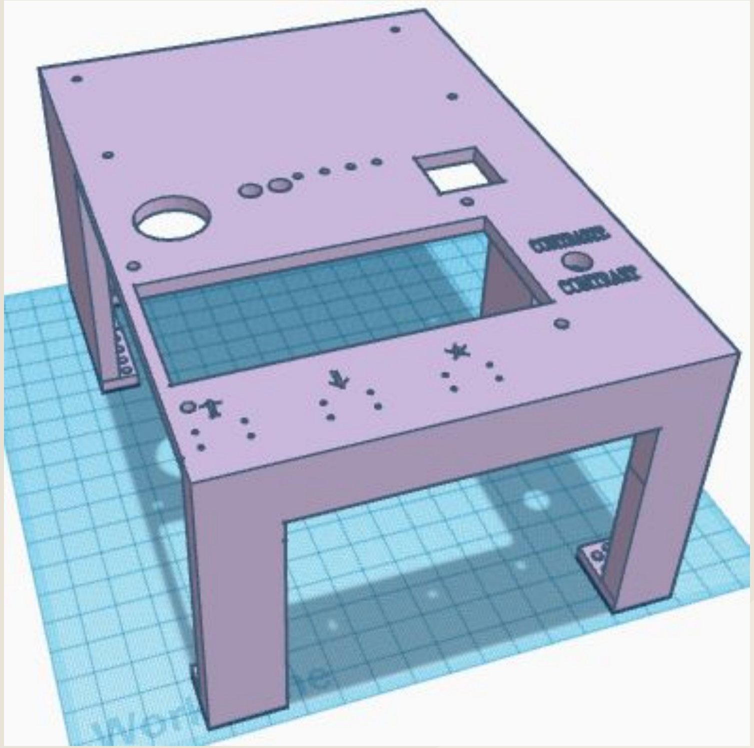
Task 3.3 Update: Power Delivery

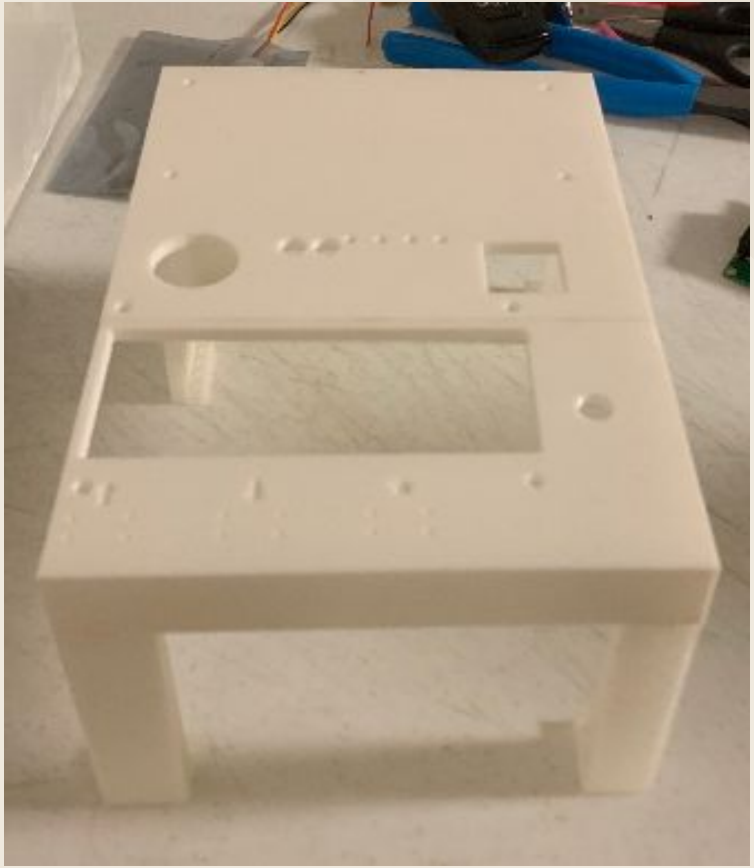
- Power Delivery System Assembled
- Left Picture: Solar Panels on a cloudy day
- Right Picture: Battery, Charge Controller , and Solar Panels Connected Together



Task 2.6: Shield

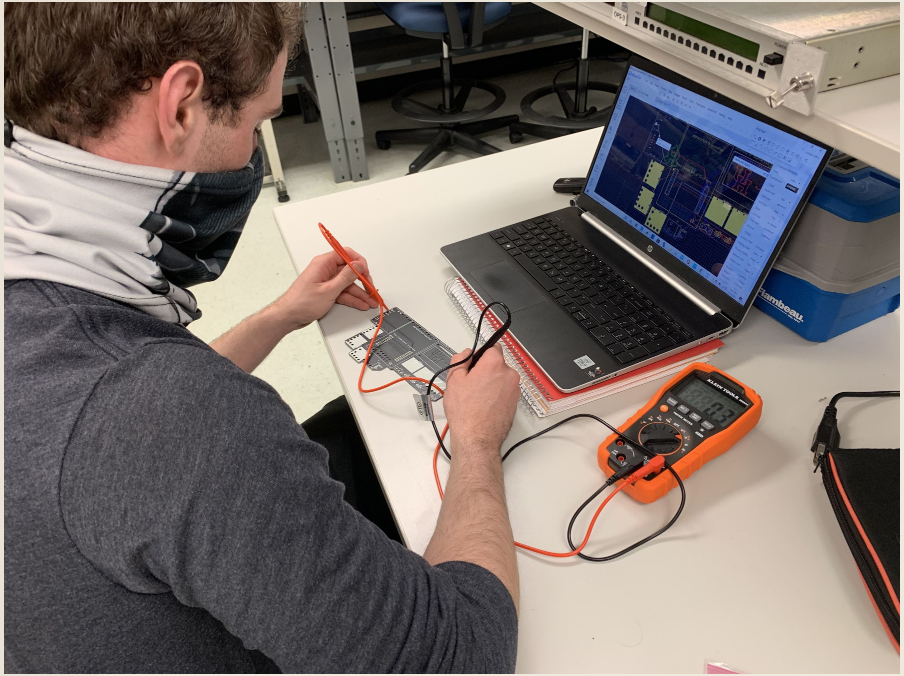
- Designed and Printed Shield
- Performs Properly





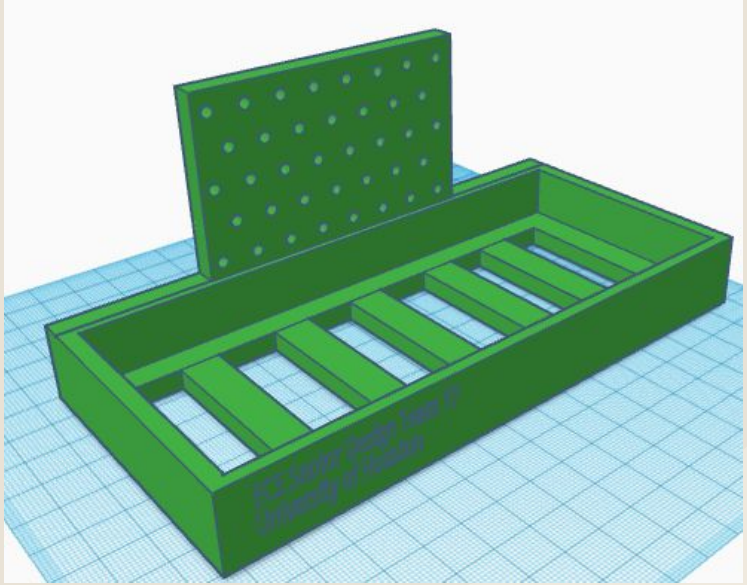
Task 3.4 Testing: PCB

- Tested Terminal Connections
- Everything is Connected Properly



Task 2.6: Battery Platform

- 3D Designed Battery Platform
- 3D Printed Battery Platform
- Performs Correctly



Plot in Nicaragua

Standards

- IEEE Standard for Sensor Performance Parameter Definitions
- IPC J-STD-001, “Requirements for Soldered Electrical and Electronic Assemblies.”
- Recommended C Style and Coding Guidelines
- IPC-2152 —Standard for PCB Trace Width