EEL 4914C
Senior Design 1

Modular Hydroponic System

Initial Project and Group Identification Document Divide and Conquer

Group 7 Members:
Adam Loree | Computer Engineering
Don Ellington | Computer Engineering
Brandon Mitchell | Computer Engineering
Jonathan Rodriguez | Electrical Engineering




1.0 Potential Customers

- DIY Enthusiasts
- Terrace/Small Farmers
- Harsh Terrain Environment Farmers
- Environmental Teachers
- Sustainability Advocates
- Doomsday Bunker Builders

2.0 Project Narrative Description

2.1 Introduction

The world today is constantly competing for control over the dwindling resources that are becoming harder to obtain. Rural agriculture for thousands of years relied on land and soil to grow and maintain crops to make food and support civilizations. This same technique is being implemented today, however there is a scarcity of arable land due to climate change, expanding populations, and pollution. Within the past few hundreds of years scientists have been experimenting and improving upon the idea of hydroponics.

Hydroponics combines the english words *hydro*, meaning water, and the greek word *ponos,* meaning labor, to describe this process of farming. This farming technique relies mainly on water to conduct the sustaining and maintaining of plants without the need for soil. However, this definition applies to plants that can be supported with gravel and other materials to provide structure.

In the current times, hydroponics is a common investment for people to provide fresh food for themselves. The advantage of hydroponics is the reduction in water and space needed to grow plants. However, the disadvantage of hydroponics is the upfront cost, installation, and constant attention required.

2.2 Motivation

Our group saw that shifting the production of food from soil to a system that could be implemented anywhere would be impactful and we wanted to improve upon it.

Besides the increased water efficiency of hydroponics and flexibility of growing location, hydro farming can also increase the supply and variety of food in diets that may lead to an overall increase of health and happiness for people.

We are determined to create a more modular and flexible system than the typical hydroponics setup that can be scaled and shaped to the users needs while still providing sufficient food output.

2.3 Goals and Objectives

Our goal is to design a modular automatic hydroponic system. This system should be small enough to be stored in a room of a house, but also be scalable and modular for flexibility of the space required. Also, it will be able to grow plants with minimal human interaction and resource costs.

2.4 Project Functionality

The hydroponics system will have multiple sensors to measure, light, water, pH, power usage, and humidity levels. The power will come from a normal power outlet found in a household. To push the fluids through the system and maintain the plant growth a pump will be implemented that receives inputs from a control unit. The sensors will gather data to make decisions for a control unit to control the resource distribution within the system. The control unit is the central part of the system that processes the sensor data and maintains plant health for farming.

Software will be developed to allow monitoring and management of the hydroponics system through a website and app. The app and website will also record data from the sensors that can be accessed and controlled by the user.

3.1 Project requirements

- The system must moderate PH and nutrient levels
- The system must be able to change PH and nutrient levels
- The system should supply the proper units with correctly balanced water
- The system must treat small segments of water to send to units
- The system shall be able to communicate with a device for controls and data
- The system will control the flow of water to the units
- The system will be able to monitor the quantity of water in the reservoir
- The system will be able to measure ambient light
- The units will be able to detect PH and nutrient levels
- The units will be able to communicate information back to the system
- The units will have the ability to drain the reservoir and accept new water
- The unit will be able to control ambient light on the plants
- The unit will be able to monitor the amount of water in its reservoir

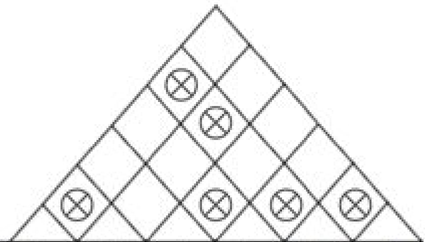
- The unit must not leak into surrounding electronics
- The software will be able to control the system remotely
- The software will display necessary data

3.2 Project constraints

Since this is our first iteration of a design document the constraints we face are not very palpable. The ones that we were able to brainstorm follow the constraints of any group project: time management, cost, research… etc. We expect that our constraints will lie in creating a suitable management system for our treated water to be given to each unit. This must be done properly and without leaks. Since the electronics are in such close proximity this could be detrimental.

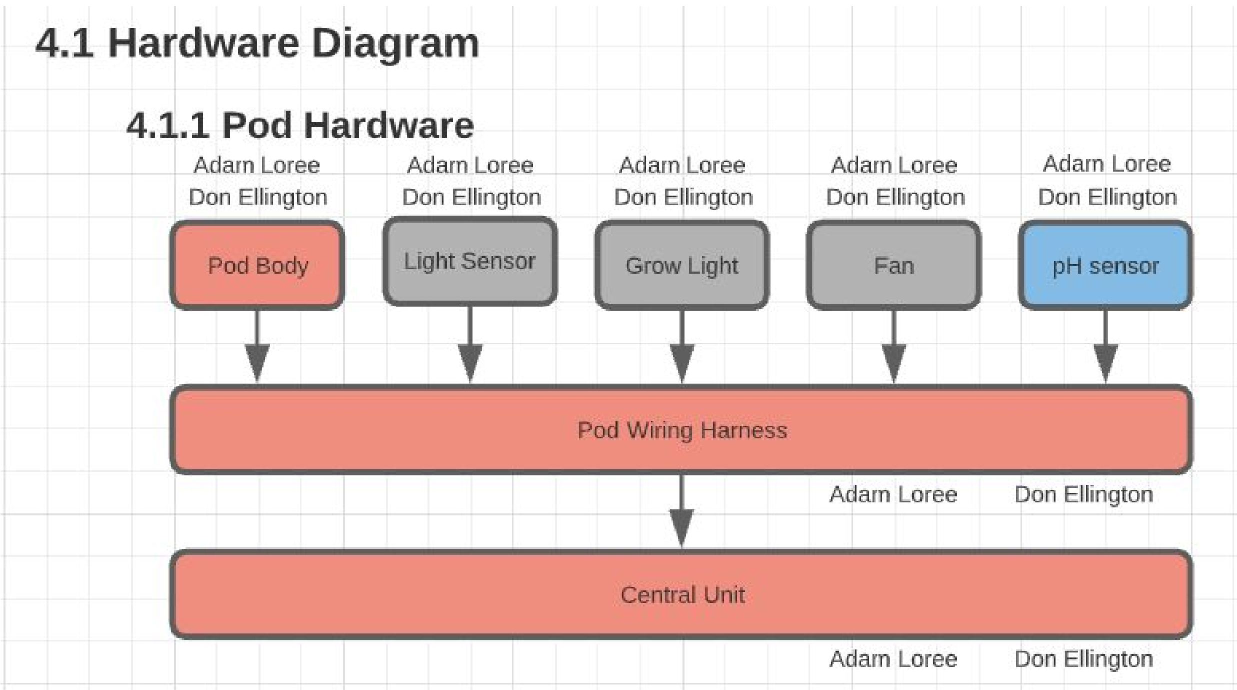
3.2 House of Quality

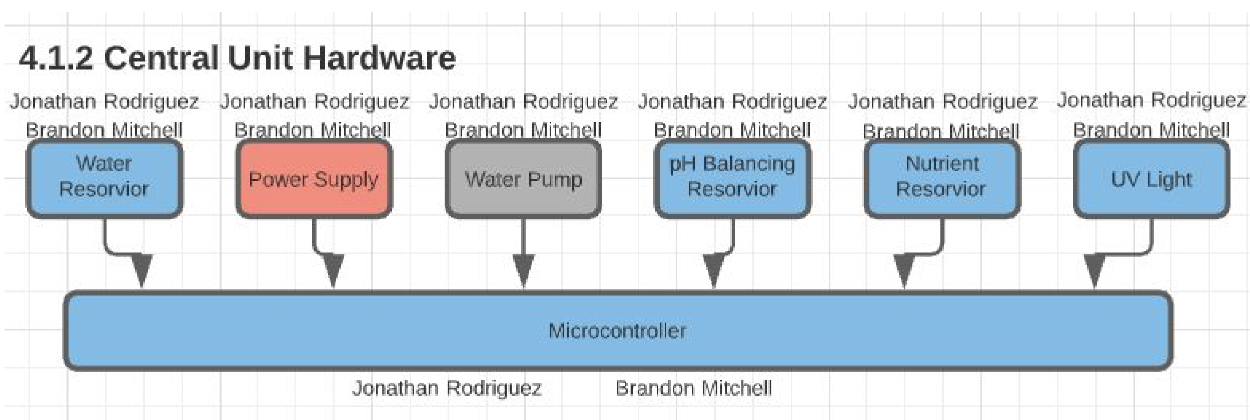
Legend		
⊙	Strong Relationship	9
○	Moderate Relationship	3
▲	Weak Relationship	1

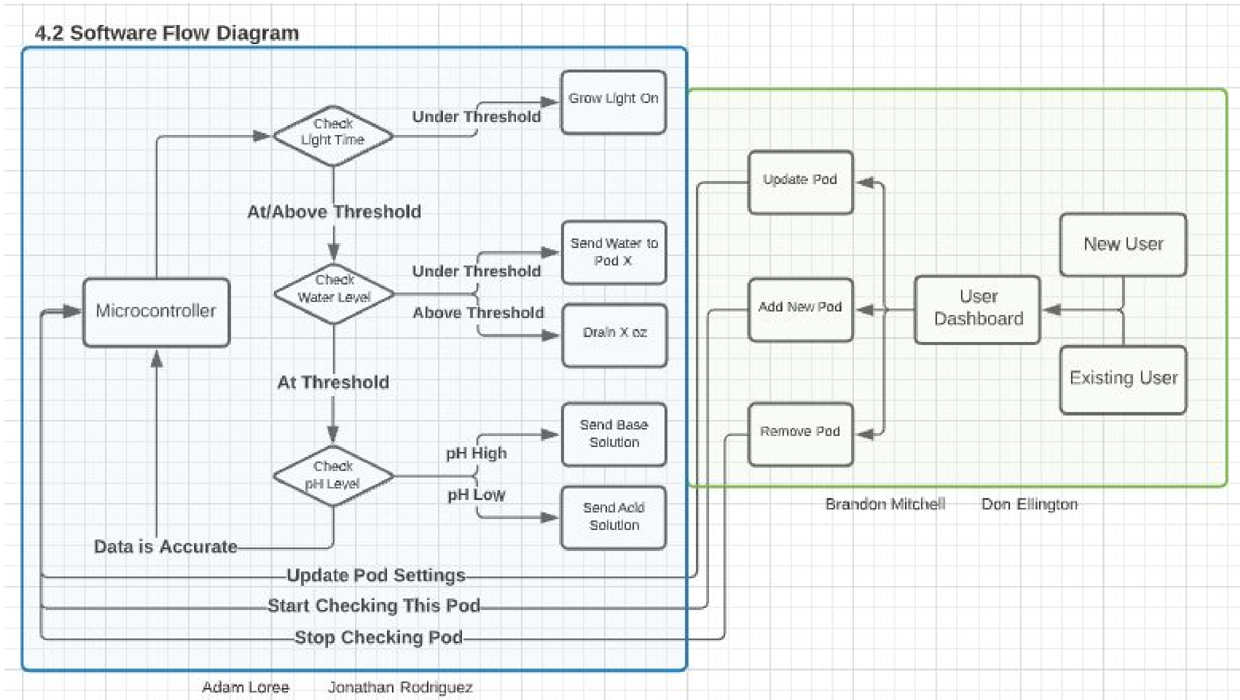


Row #	Max Relationship Value in Row	Relative Weight	Weight / Importance	Column #	1	2	3	4	5	6
				Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)						
				Quality Characteristics (a.k.a. "Functional Requirements" or "Hows") / Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Size	Weight	Required chemical balancing	Effectiveness	Cost	Manufactering Time
1	9			Cost	○	⊙	▲		⊙	○
2	9			Size	⊙	○				
3	9			Asthetic	⊙	○			▲	⊙
4	9			Usability				⊙	○	○
5	9			Growth rate				⊙		
6	9			Stable			○	⊙		⊙
				Target or Limit Value	5 ft	25lbs (with water)	12 fl oz bottles	> avg. growth	< 100 p/person	< 8 weeks
				Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)						
				Max Relationship Value in Column	9	9	3	9	9	9
				Weight / Importance						
				Relative Weight						


Chart Key:
To be acquired - Grey
Acquired - Orange
Investigate - Blue
Design - Red
Prototype - Yellow
Completed - Green


4.1 Hardware Diagram
4.1.1 Pod Hardware
Adam Loree
Don Ellington
Pod Body
Adam Loree
Don Ellington
Light Sensor
Adam Loree
Don Ellington
Grow Light
Adam Loree
Don Ellington
Fan
Adam Loree
Don Ellington
pH sensor
Pod Wiring Harness
Adam Loree
Don Ellington
Central Unit
Adam Loree
Don Ellington


4.1.2 Central Unit Hardware
Jonathan Rodriguez
Brandon Mitchell
Water Resorvior
Jonathan Rodriguez
Brandon Mitchell
Power Supply
Jonathan Rodriguez
Brandon Mitchell
Water Pump
Jonathan Rodriguez
Brandon Mitchell
pH Balancing Resorvior
Jonathan Rodriguez
Brandon Mitchell
Nutrient Resorvior
Jonathan Rodriguez
Brandon Mitchell
UV Light
Microcontroller
Jonathan Rodriguez
Brandon Mitchell


4.2 Software Flow Diagram
Check Light Time
Under Threshold
Grow Light On
At/Above Threshold
Check Water Level
Under Threshold
Send Water to Pod X
Above Threshold
Drain X oz
Microcontroller
At Threshold
Check pH Level
pH High
Send Base Solution
pH Low
Send Acid Solution
Data is Accurate
Update Pod Settings
Start Checking This Pod
Stop Checking Pod
Adam Loree
Jonathan Rodriguez
Update Pod
Add New Pod
Remove Pod
User Dashboard
New User
Existing User
Brandon Mitchell
Don Ellington

5.1 Project Budget Estimate

Pod		
Part	Quantity/Pod	Estimated cost/unit
Photo sensor resistor	4	$2 - $4
Led Grow lights	1	$5 -10
Humidity/ Temperature sensor	1	$2 - $11
Liquid Ph Sensor	1	$20 - $50
Capsule w/ water tank (3D printed)	1	$40 - $50
Water level sensor	1	$5 - $15
Solenoid Valve	1	$17 -$20
Wireless Module	1	$10 - $20
Total		~$100 - $180

*Given the modular nature of the project, the cost estimate will be listed per unit

Central Unit		
Part	Quantity/unit	Estimated cost
Liquid Ph Sensor	1	$20 - $50
Water Pump	1	$30 - $50
Small water pump	3	$5 - $15
Tubing	1	$15 - $20
UV light	1	$20 - $25
Microcontroller	1	$10 - $15
Pod Capsule w/ water tank (3D printed)	1	$40 - $50
**Miscellaneous materials	N/A	$50 - $70
Total		~$190 - $295

**Horticultural materials, electrical components, minor parts, etc.

6.1 Initial Project Milestones

#	Milestone	Planned Completion Week
1	Finish divide and conquer 1	3
2	Finalize design and get all team members on the same page	4
3	Create CAD designs	6
4	Finalize research on hydroponics and plants that we want	7
5	Design balancing system in base	8
6	Design feed system to units	9
7	Design units reservoir and electronics	12
8	Design electronics for base complete with access to networks	14
9	Design electronics for unit	15
10	Integrate unit and base to communicate with each other	16
11	Design PCB	17
12	Build system with finished electronics and printed parts	18
13	Testing and debugging	19

14	Finalize report	END