Divide & Conquer Document

Department of Electrical Engineering and Computer Science

EEL 4914: Senior Design I – Summer 2024

UNIVERSITY OF CENTRAL FLORIDA

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[Project name]

Group 11

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Reviewers

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1. Project Narrative Description

1.1 Motivation

When we think about plants, we think about life since they help us in various ways, including providing food, medicine, reducing stress, producing oxygen, and eliminating air pollutants. Plants play an integral role in maintaining the balance of our ecosystem and improving our quality of life. Recently, millennials have become increasingly obsessed with houseplants. Why is this? Most seek houseplants primarily for air quality improvement and the encouragement of self-care. The presence of greenery in living spaces has been shown to enhance mood, boost creativity, and reduce stress.

Having a houseplant comes with the responsibility of taking care of it and ensuring it thrives. This involves regular watering, and appropriate sunlight exposure. Proper plant care is essential to maintaining their health and longevity. However, the majority of people are busy or travel frequently, making it difficult to leave their plants with someone who may not have the knowledge to care for them properly. This can lead to issues such as overwatering or underwatering, both of which can be detrimental to plant health. Overwatering, in particular, can cause root rot, while underwatering can lead to wilting and eventual plant death. Additionally, inconsistent care routines can stress plants, making them more susceptible to diseases and pests.

To address these concerns, we have developed an ideal solution for those who worry about their houseplants. Our solution involves a smart watering system that monitors the moisture levels of the soil and automatically waters the plant as needed. This system ensures that the plant receives the right amount of water at the right time, preventing both overwatering and underwatering. The smart watering system is equipped with sensors that continuously track soil moisture levels, temperature, and humidity, providing real-time data to optimize plant care. The system is designed to be user-friendly and can be controlled via a mobile app, allowing users to manage their plants even when they are away from home. The app provides a comprehensive interface where users can set watering schedules, monitor plant health, and receive notifications when the system detects any issues. Additionally, the app offers reminders for other plant care tasks such as ensuring a holistic approach to plant maintenance. For those who travel frequently, the app includes a live-stream feature, enabling users to check on their plants remotely and ensure they are thriving. This innovation aims to bring peace of mind to plant owners and ensure that their plants continue to enhance their living spaces, regardless of their busy schedules or travel plans. By integrating technology with plant care, our smart watering system not only simplifies the process but also fosters a deeper connection between individuals and their houseplants. This project represents a step forward in sustainable living and personal well-being, making it easier for everyone to enjoy the benefits of having healthy, vibrant plants in their homes.

1.2 Stretch Goals

- **Utilize the Camera for Plant Health Monitoring:** Enhance the camera system to analyze plant health, detecting signs of disease, pests, or nutrient deficiencies. This feature will help users take proactive measures to maintain plant health and vitality.

- **Weed Detection:** Develop an algorithm to identify and alert users to the presence of weeds. By utilizing image recognition technology, the system can distinguish between desired plants and weeds, helping maintain a clean and productive garden space.

- **Plant Type Detection:** Integrate plant type detection capabilities into the camera system. This feature will allow the system to recognize different plant species and provide tailored care recommendations based on the specific needs of each plant type.

By focusing on these goals and objectives, we aim to create a comprehensive and innovative smart water planter that addresses the challenges of modern gardening. Our main goals will establish a strong foundation for efficient plant care, while our stretch goals will add advanced features that further enhance the user experience and plant health monitoring capabilities.

1.3 Objectives

Our goal is to develop a smart water planter that modernizes plant care, enhances the user experience, increases productivity, and implements data-driven decision-making features. By achieving the following goals, we aim to make indoor gardening more accessible and efficient, particularly for urban dwellers, busy individuals, and gardening enthusiasts**.**

- **Implement a Temperature Sensor:** Integrate a temperature sensor to monitor and maintain optimal growing conditions for plants. This will help ensure that plants are not exposed to harmful temperature extremes that could hinder their growth and health.

- **Install a Water Level Sensor:** Incorporate a water level sensor to monitor the water reservoir. This will prevent the water pump from running dry and ensure that the planter always has an adequate water supply, promoting consistent and healthy plant hydration.

- **Integrate a Camera System: Equip** the planter with a camera to provide real-time visuals of the plants. This feature allows users to remotely monitor plant health and growth, offering peace of mind and the ability to quickly address any issues that arise.

- **Develop a Mobile Application:** Create a user-friendly mobile app that allows users to control and monitor the smart planter. The app will provide real-time data from the sensors, control the water pump and lighting, and send notifications about the planter's status.
- **Ensure Functional Water Pump:** Install and configure a reliable water pump to automate the watering process. The pump will be controlled by the moisture and water level sensors to deliver precise amounts of water to the plants as needed.
- **Activate Optimal Lighting:** Implement an advanced lighting system that provides the correct light spectrum and intensity for various plants. The lighting will be adjustable through the mobile app, ensuring that plants receive the best possible conditions for growth.

2. Requirement Specifications

2.1 Specifications & Eng. Requirements

Attributes	Description	Specifications
Size of the box	Maximum dimensions of the system as a whole excluding any power cables.	1 meter x 1 meter x 1 meter
Power usage	Power of the entire system excluding any external servers.	200w
Weight	Weight of the system not including the plant or water.	10 pounds
Data refresh rate	How often the data is refreshed on the website.	10 minutes
PH sensor accuracy	Sensor measurement accuracy. (pH)	90%

Moisture sensor accuracy	Sensor measurement accuracy. (VWC)	90%
Temp sensor accuracy	Sensor measurement accuracy. (Degrees)	90%
Water pump control	System will water the plant.	Within 5s
Light control	System will toggle the light.	Within 5s
Camera data	Captures the real time image of the plant.	Every 10s

Table 1: Eng. Requirements table

2.2 Demonstrable Requirements

Attribute	Description	Specifications
Water pump Control	Be able to remotely activate water pump.	
Light Control	Be able to remotely toggle grow lamp.	
Camera data	Be able to see an image of the plant in the app.	

Table 2: Demonstrable requirements table

2.3 Constraints

Constraints	Description
Indoor only	This system will only work inside and will not be weather proofed for outdoor weather.
Must be made in 7 months	Reduced time compared to normal senior design due to starting in the summer.

TI product availability	Due to TI moving facilities chips we would potentially use could be out of stock.
Expenses	Not funded by sponsor so on student budget.

Table 3: Constraints table

3. Project Block Diagrams

For our block diagrams, we have strategically allocated responsibilities to each team member to ensure a seamless and efficient project workflow. The entire system will be controlled by the MCU, highlighted in orange, with Steven overseeing its implementation and functionality. Our inputs, highlighted in blue, comprise a variety of sensors including pH, temperature, water level, and a camera, all managed by Luz. These sensors are crucial for gathering real-time data to optimize our smart irrigation system.

On the output side, highlighted on black, we have the water pump and lighting components, which Keven will handle. These outputs are essential for delivering the precise amount of water and light required by the plants, based on the input data received.

Additionally, the system's monitoring and control will be facilitated through a user-friendly app, highlighted in green, as depicted in our software block diagram. Tony will lead this aspect, ensuring the app provides an intuitive interface for users to interact with the irrigation system, monitor sensor data, and adjust settings as needed.

By clearly defining and distributing these roles, we aim to leverage our collective expertise and ensure each component of the project is developed with the highest level of precision and integration.

Hardware Block Diagram:

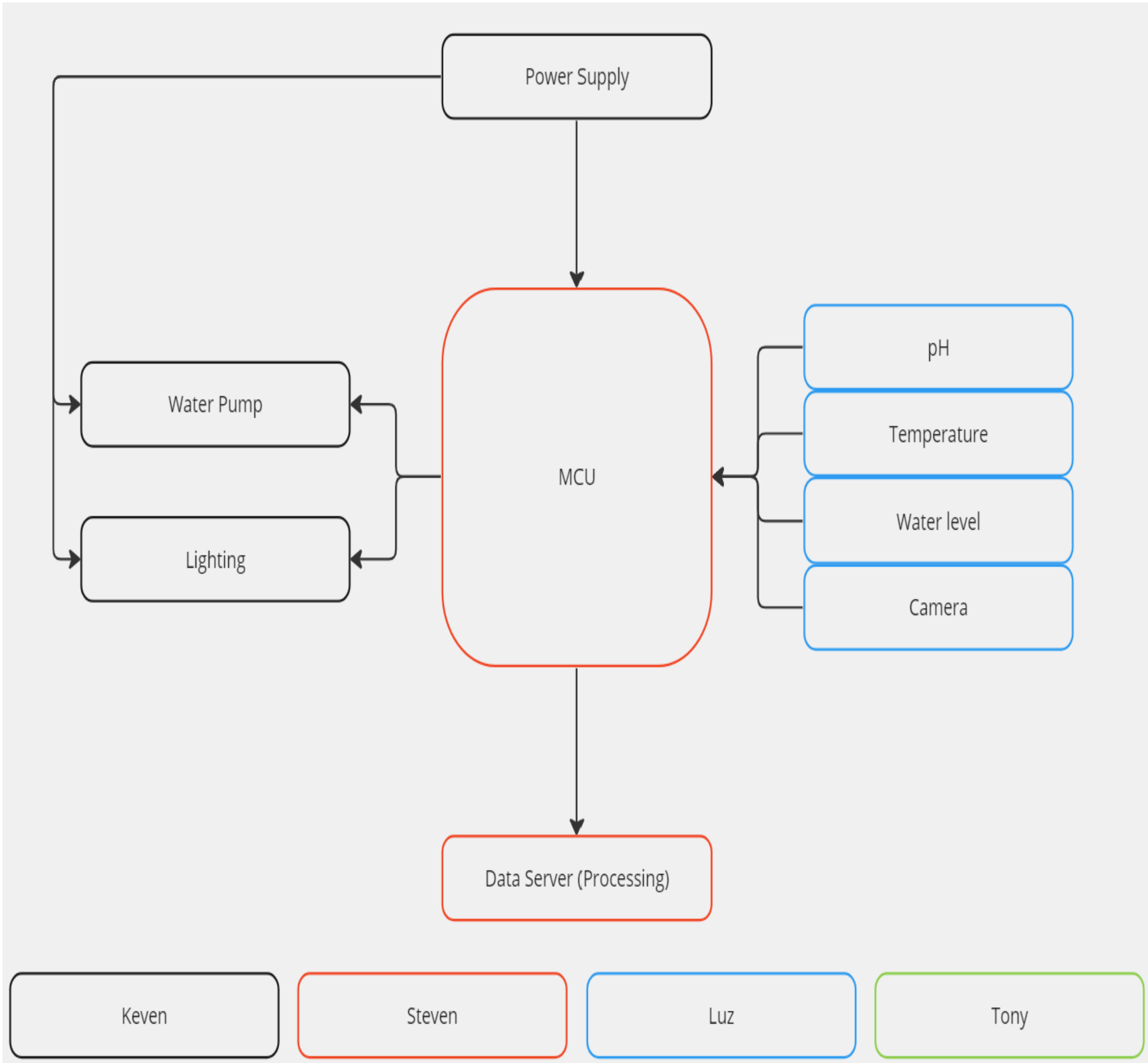


Figure 1: Hardware Diagram

Software Block Diagram:

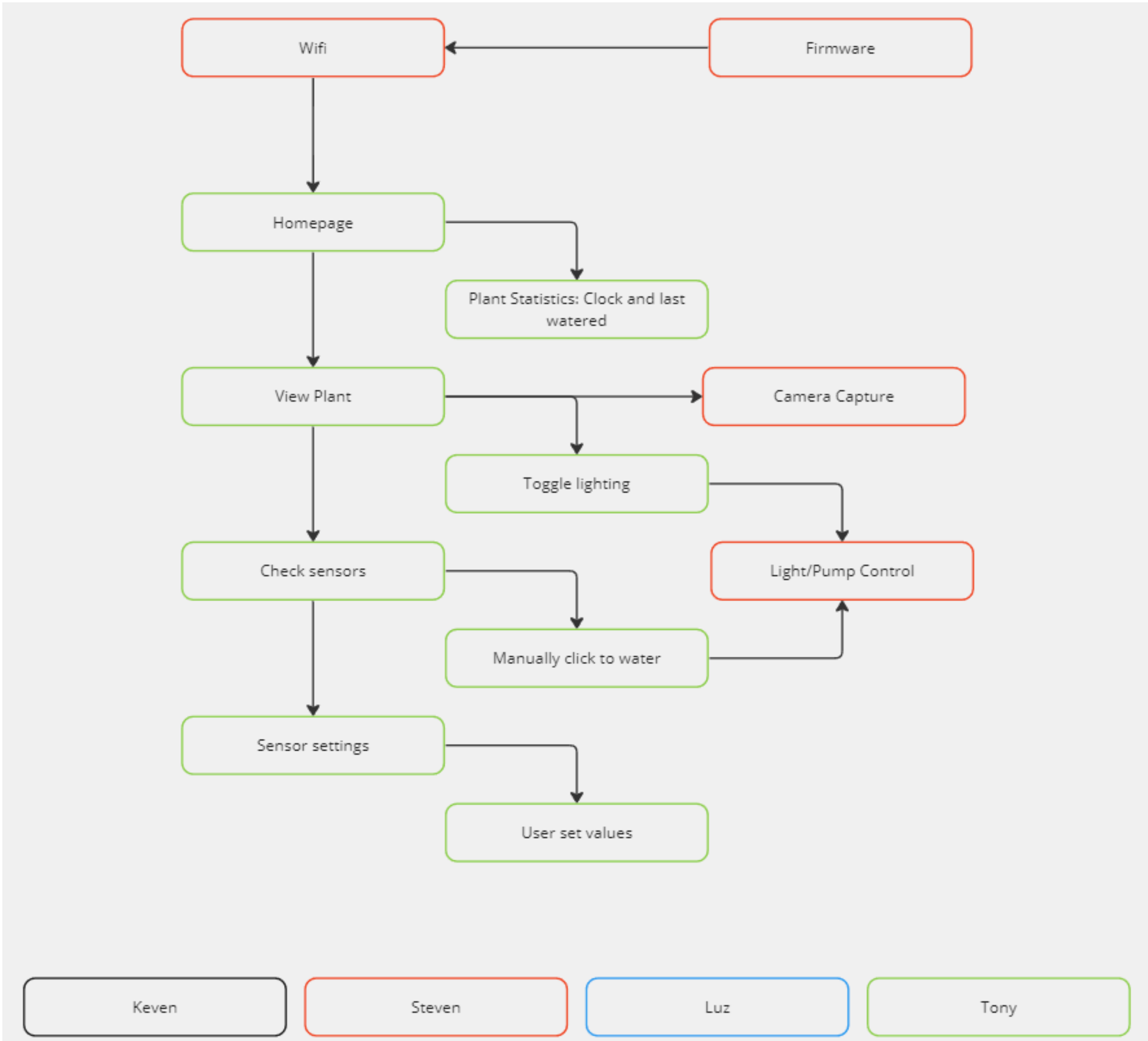


Figure 2: Software Diagram

4. Project Budget and Financing

During our research, we meticulously sought out the most cost-effective items that would enable us to achieve our project goals without compromising on quality. Our goal is to design an efficient and reliable smart system that ensures optimal care for plant health. To manage our resources effectively, we have set a budget limit of $400.00. This budget will cover essential components such as sensors, microcontroller, water pump, power supplies, and any additional hardware required for system integration. The table below provides a detailed estimate of the expenses we anticipate for the necessary components identified thus far, ensuring transparency and careful financial planning throughout the project's development.

Estimated Cost of Materials

DC Water Pump	$13
MCU (ESP32)	$10
Relay Module	$10
ph Sensor	$35
Temperature Sensor	$15
Water Level Sensor	$9
Moisture Sensor	$12

Table 4: Budget Table

5. Initial Project Milestone

Task	Duration	Status
Senior Design 1	5/13 – 8/02	Current
Brainstorming/Project selection/Group Formation	5/14 – 5/21	Done
Divide and Conquer 10-page Document	5/21 – 5/31	Current
Research	5/30 - 6/6	Current
Materials research	5/30 – 6/6	Current
Paper (25 pages)	6/3 – 6/20	To be completed
Paper (40 pages)	6/20 – 6/27	To be completed

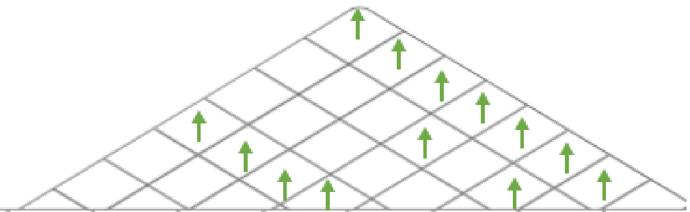
Paper (60 pages)	6/27 – 7/5	To be completed
Demo	7/5 – 7/12	To be completed
90 Page Final Document/Demo	7/12-7/23	To be completed
Order Parts and PCB	Early August	TBD
Senior Design 2	8/19 – 12/07	TBD
PCB Assembly	Late August	TBD
Testing and Redesign	September	TBD
PCB Assembly	October	TBD
Testing	November	TBD
Final Presentation	November	TBD

Table 5: Senior Design I & II Schedule Table

6. House of Quality Table

The House of Quality (HoQ) is a crucial tool in the development of our project as it helps translate customer needs into specific technical requirements. By using HoQ, we can systematically identify and prioritize customer desires such as ease of use, reliability, and water efficiency, and then align these with design specifications like sensor accuracy, battery life, and material durability. This structured approach ensures that the final product not only meets but exceeds user expectations, thereby enhancing customer satisfaction and market competitiveness. Additionally, the HoQ facilitates cross-functional collaboration, ensuring that every team member is focused on the critical features that will drive the project's success.

Interrelationship matrix



Engineering Requirements / Customer Requirements	TEMPERATURE ACCURACY #1	MOISTURE ACCURACY #2	pH ACCURATURE #3	POWER #4	DATA UPDATE #5	HEIGHT #6	SIZE #7	COST #8
Easy of use				↓	↑	↓	↓	
Maintenance reliability	↑↑	↑↑	↑↑	↓				↑
Easy to install				↓		↓↓	↓↓	
Cost	↑	↑	↑	↑↑	↑	↑↑	↑	
Organizational	90%	90%	90%	200W	10 mins	10 pounds	1m x 1m x 1m	$400

Table 6: House of Quality Table

Symbol	Description
↑	Positive Correlation
↑↑	Strong Positive Correlation
↓	Negative Correlation
↓↓	Strong Negative Correlation
+	Positive Polarity
-	Negative Polarity

Table 7: Description of House of Quality