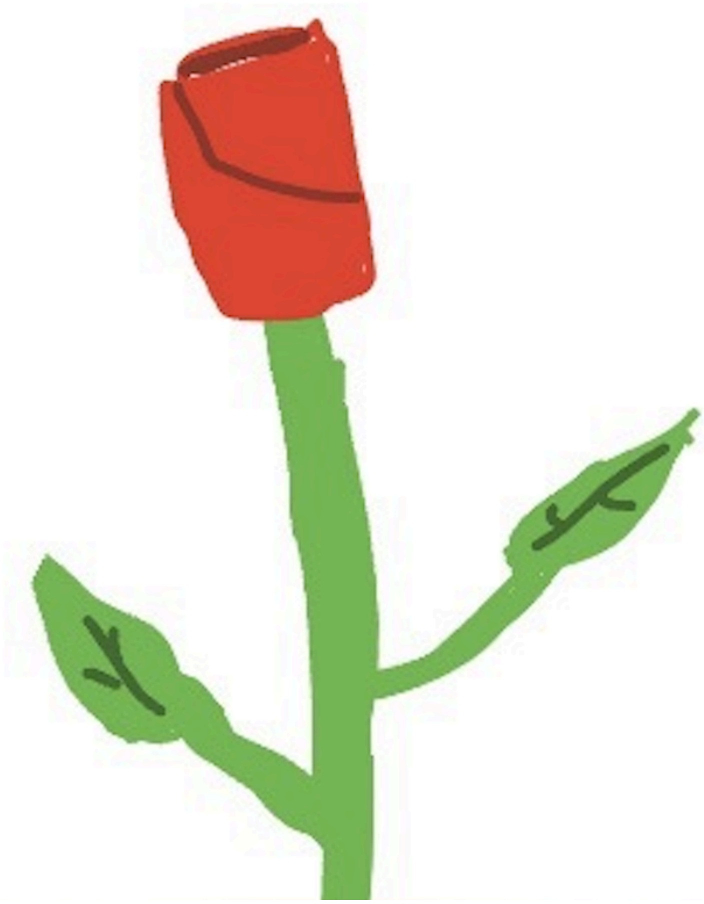
P.L.A.N.T.



EE 41430: High Level Design Document

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1. Introduction

As everyday life continues to be automated further and further with new gadgets, inventions, and applications, there are some facets that have been ignored or made out to be "good enough" just as they are. One such common part of life that has been left behind in this age of automation for many Americans is that of home plant care and gardening, which has remained predominantly manual. The significance of nurturing plants goes beyond merely the aesthetics of the plant, but affects its health, longevity, and food production. Plant health is not a "one-size-fits-all" category, and treating plant care in such a way leads to suboptimal conditions for them to flourish.

For example, watering plants is a critical aspect of plant care for which precision is paramount. Different plant species have different water requirements, and misjudging the amount of water can have severe consequences regarding root health, nutrient absorption, and overall vitality of the plant. Furthermore, sunlight exposure is not as simple as placing a plant in the general vicinity of sunlight. Just as different plant species require different amounts of water, the same is true for sunlight and is essential for healthy plant growth. Similarly, the quality of the soil, namely its moisture level, is a fundamental determinant of a plant's well-being and is not something that can be overlooked.

These are some of the crucial factors that are often overlooked and are essential for the ideal care of a plant. The disconnect between plant caretakers and these complicated, and the important details of plant care must be dealt with. This would ensure the good health and longevity of the individual plants and that they are receiving the best possible care to be able to flourish.

2. Problem Statement and Proposed Solution

The average plant owner doesn't know much about how to care for their plants. Are they getting enough sunlight? Are they being watered enough? Are they being over-watered? Is the ambient temperature correct? An inadequate environment often leads to a short lifespan and eventually the death of the plant, as well as cosmetic or other health issues throughout its lifespan. It can affect all kinds of plants, whether for food, aesthetics, or for pleasure, and can hinder its growth, health, and longevity.

Plant owners need a way to take care of their plants and make sure that the environment is adequate for the type of plant they have, since they do not all share the same requirements. There is often a lack of knowledge regarding the ideal environment for plants to maximize their health. Many plant owners forget to water them, and do not have the time to research factors that make up an ideal environment for the plant and struggle with maintaining the health of their plants with only the basic knowledge that skims the surface of plant care.

Our solution to this problem is an all-in-one device that makes caring for household plants easy and stress free. Our database consists of the living requirements (soil moisture, amount of sunlight exposure, ambient temperature) of the most relevant and common household plants. Our device is equipped with temperature and sunlight sensors to make sure that the environment is adequate for the specific plant and notifies them in case of extended inadequacy. In addition to the consistent monitoring, in the case of a detected unideal level, our device will suggest a fix that will better the plant's overall health. The device is also equipped with a soil moisture sensor and water pump, that in case of low moisture automatically drips water to the plant before stopping when it detects a corrected level. The reservoir is also equipped with a water level sensor that prompts the user to refill the container with water, if it is getting low. Simply place our sensors in the pot of your newest plant and let it talk to you!

3. System Requirements

Features

1) Soil Moisture Tracking
2) Sunlight Tracking
3) Temperature Tracking
4) Automatic Plant Watering
5) Reservoir Level Tracking and Notification
6) User-friendly interface with a plant data-base to choose from
7) Automatic email distress signal with solution

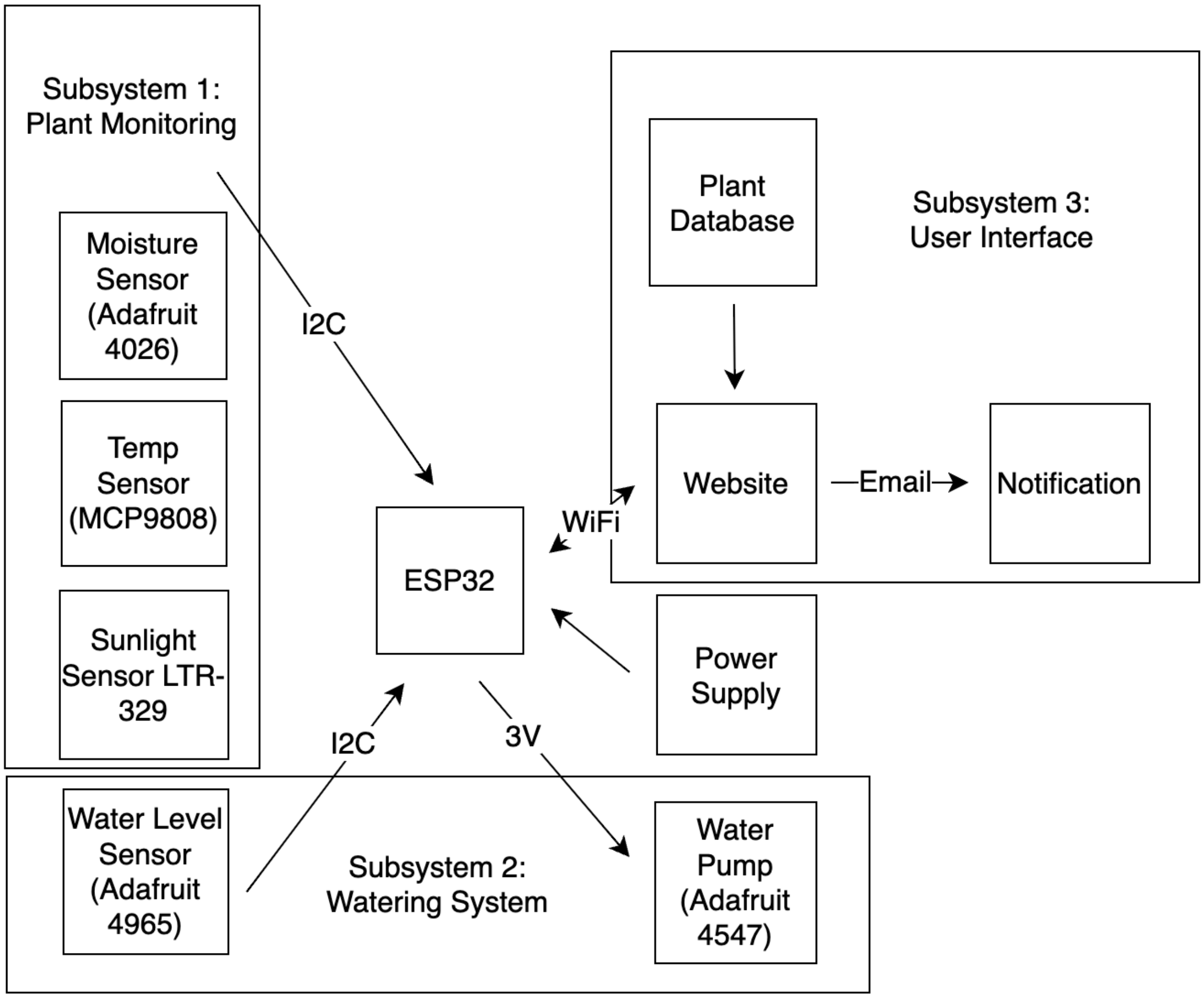
Directions

The device will be placed within the plant pot. The soil moisture sensor will be driven down within the soil and the sunlight and temperature sensors will sit at the soil's surface. Our water-tank with embedded pump and water-level sensor will have a sleek design and can be placed outside of the pot to enable an easy refill. Once the components are placed, flip the switch on and visit the user-interface website to select your type of plant, assign it a name or number, and enter your email address to receive health notifications and updates.

Safety

The main concern here is that not all the parts of the board will be waterproof. Therefore, only the soil moisture sensor will be placed in the soil, with the rest of the board and components being placed above or outside the soil and out of reach of the water pump in order to reduce the risk of a short. Please note, when self watering the plant, avoid spilling water on and around the main components of the device.

4. System Block Diagram



4.1 Overall System

Our overall system collects data from a temperature, moisture, and sunlight sensor attached to a plant and sends it to our ESP32 chip. From here, this data is sent to our user interface website. This website is connected to a database that contains different plants and the specific levels of each measured metric stated earlier. Once a type of plant is chosen, these metrics are monitored and if the sunlight or temperature parameters are incorrect, an email notification is sent to the user, describing the problem. Furthermore, if the soil moisture level is incorrect, the ESP32 contacts the water pump to drip water to the plant. Finally, there is also a water level sensor in the water tank, and again, if this level is too low, the user will receive an email.

4.2 Subsystem 1: Plant Monitoring System

This subsystem contains three of our sensors. These include the temperature, moisture, and sunlight sensors. Each of these sensors are connected to the ESP32 chip via I2C. Each sensor acts independently of each other and collects data to send to the ESP32. This data is transmitted and checked against the specific levels each plant needs from the user setting.

4.3 Subsystem 2: Watering System

The watering system has two components: the water level sensor and the water pump. The water level sensor is in the container and sends data to the ESP32. Just as with the temperature and sunlight sensors, an email will be sent to the user when the water level is low. Next, when the moisture level in the soil has gone too low, the ESP32 requests to turn on the water pump and water the plant. Further, the database will have a certain moisture level for each selected plant.

4.3 Subsystem 3: User Interface System

This is the final subsystem of our project and contains the website, plant database, and notification system. This is where we get our reference values from. On the website, the user will be able to select what plant they have in the pot and then it will set standards for sunlight, soil moisture, and temperature. When these are measured to be out of line from our other subsystems, the website will email the user and warn them. They will also be emailed if their water tank is low. The only way to turn the water pump on is if the soil moisture level is out of range.

4.4 Future Enhancement

In the future, if time permits, we would like to have our device use a battery. This will be hard as the water pump requires so much voltage. We also think the addition of an OLED Display to view biometrics at a glance can add to the user experience.

5. High Level Design Decisions

Plant Monitoring System

- Temperature sensing - will be used to read the temperature and report back to the processor for data interpretation
    - Data interpretation - uses I2C to communicate
- Moisture sensing - will be used to read the solid moisture and report back to the processor for data interpretation
    - Data interpretation - uses I2C to communicate
- Light sensing - will be used to read the soil moisture content and report back to the processor for data interpretation
    - Data interpretation - uses I2C to communicate

Watering System

- Water tank sensing - will be used to read the water level in the water tank
    - Data interpretation - uses I2C to communicate
- Water Pump - will be used to drip water into the plant soil
    - Data interpretation - uses I2C to communicate

User Interface System

- Website/Application - this will use wifi to allow the user to connect to an application or website that allows them to choose which plant they would like to track. This decision will set the parameters for temperature, moisture, and light that are to be read by the sensors.
- Notification to email - will need to connect to the Wi-fi
    - Simple Mail Transfer Protocol to send the email notification.
- Potential for an OLED Display - will need a I2C connection

Power Supply

- Power Supply - the power supply (or alternate battery option) will be used to power the main chip device

All sensors will be connected to VDD from our ESP32 chip of choice
Sensor CLK will have to depend on settings, and will be dealt with at time of purchase
Only the main chip will be connected to WiFi

6. Open Questions

1) How to design the soil moisture sensor's connection to the main board
2) How to determine the best way to power our device
3) How to design our device to be as waterproof as can be
4) How to send email notifications to the user
5) What factors to consider when designing a sleek user interface

7. Major Component Costs

- Soil Moisture Sensor (Adafruit 4026): $7.50
- Water Pump (Adafruit 4547): $2.95
- Water Level Sensor (Adafruit 4965): $1.95
- Temperature Sensor (MCP9808): $4.95
- Sunlight Sensor (LTR-329): $4.50
- ESP32 with Type C connector: $19.95
- LiPo Battery: $11.90
- OLED Display (SSD1306) $11.99
- Board manufacturing: ~$50

Estimated Price: $103.70

This leaves us with space in our budget to get multiple of each sensor for purposes of prototypes and possible defunct devices. Furthermore, this leaves space for possible other additions as the project continues. There are also multiple versions of each type of sensor, but we chose the most cost-effective one that satisfied all of our capabilities.

8. Conclusions

The smart P.L.A.N.T is designed to revolutionize the way in which individuals are able to care for their plants. By incorporating technology and automation, the major subsystems work together to create a solution catered to the specific needs of each plant and provides the user an easy-to-use, efficient home gardening tool. The Power System (featuring a possible battery) serves as the backbone of the device, providing uninterrupted, up-to-date power to the device. The User Interface System allows the user to interact with the device, effortlessly monitor their plant's conditions and sends them an email if the plant needs attending to. The Plant Monitoring Subsystem monitors crucial data necessary for the health of the plant and utilizes I2C for seamless communication with the data interpretation system. The Watering System keeps track of water in the reservoir and handles providing water to the soil when needed. Finally, the user is notified of any needed changes via email.

The P.L.A.N.T. represents a significant step forward in home gardening and natural decoration. By providing users with real-time insights into their plant's well-being and taking charge of essential plant care processes, our system not only fosters healthier plants but also encourages a more sustainable and connected approach to home gardening. As the gap between technological innovation and the natural environment, this system exemplifies the potential for creating harmonious and intelligent solutions that benefit both the user and the plant.

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