Proposal Presentation

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C.E.L.P. GARDENS
Smart Plant Monitoring

Problem Overview

Problem Statement/Background

- Gardening for small house plants can be difficult for novices. Regular monitoring of the environment and watering are major factors in a plant's healthy growth.
- Precise measurements such as humidity and soil moisture may be required for a plant's care.
- There are other solutions for plant monitoring. These may be too expensive for a beginner, and none of them feature autonomous operation with sensor integration.

Solution Overview

Goals/Objectives

The C.E.L.P. Gardens module should:

- Provide real-time data on soil moisture and temp/humidity levels for a small potted house plant.
- Feature a self-watering system capable of keeping sufficient water levels for the plant without human intervention.
- Be functional for different size plant containers.
- Store and transmit recorded data to a GUI desktop application.
- Operate independently of a wired power source - use a battery for a set amount of time.

Design Overview

- Capacitive sensors for soil moisture, temperature, and humidity will be used for data collection from the plant environment.
- Data will be fed into the ESP32 development board system.
- Data will be transmitted via Bluetooth to a GUI desktop application to display the plant's conditions to the user.
- Soil moisture data will be used to activate a self-watering system to adjust soil moisture levels according to the user's preferred setting.

Constraints

- Cost
  - Should not exceed $50 in total parts cost
  - Bulk buying will reduce the cost of components

- Availability
  - All components should be able to be ordered or scaled to accommodate mass manufacturing
  -
- Run Time
  - Minimum operation of one week without intervention--this includes battery capacity, reservoir drain, and autonomous sensor data transmission

Constraints

- Size
    - Component housing no larger than 70 x 90 x 28 mm

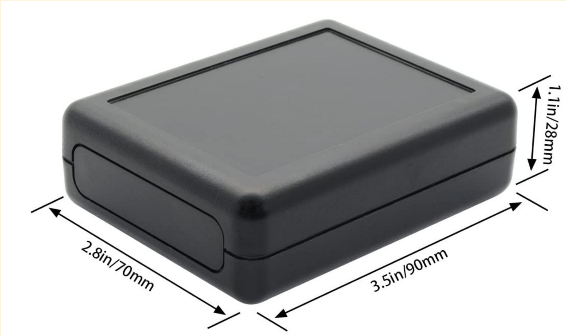
- Aesthetics
    - The device shouldn't stand out excessively or compromise the beauty of the plant. It also shouldn't exceed 40dB under operation.

- Durability
    - Withstand spray of water/humidity, extended exposure to direct sunlight, and ordinary household hazards

Hardware

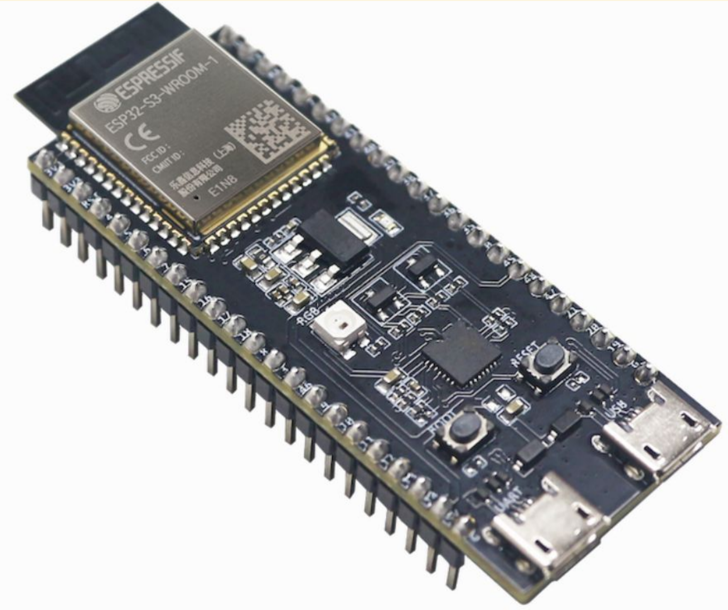
Requirements/Specifications

- Each unit will consist of three main segments: the watering system, main body and moisture sensor.
- The main body segment will fit into a 70 x 90 x 28 mm enclosure.



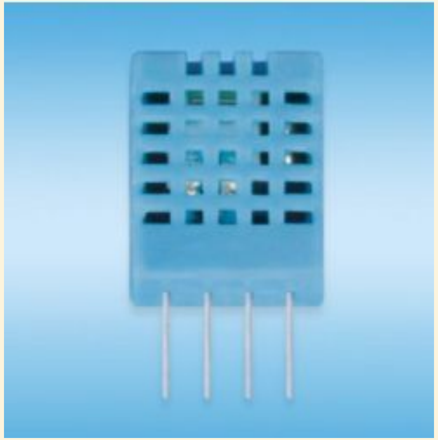
Controller

- ESP32-S3-DevKitC-1 v1.1
- Open-source IDE and resources
- Uses C++ programming language
- 3.3V - 6.5V input
- 45 GPIO, 4x SPI, 3x UART, 2x I2C
- Wi-Fi + Bluetooth® LE MCU
- ESP32 size: 25.4 x 62.74 x 3.2 mm
- 8 MB Flash memory



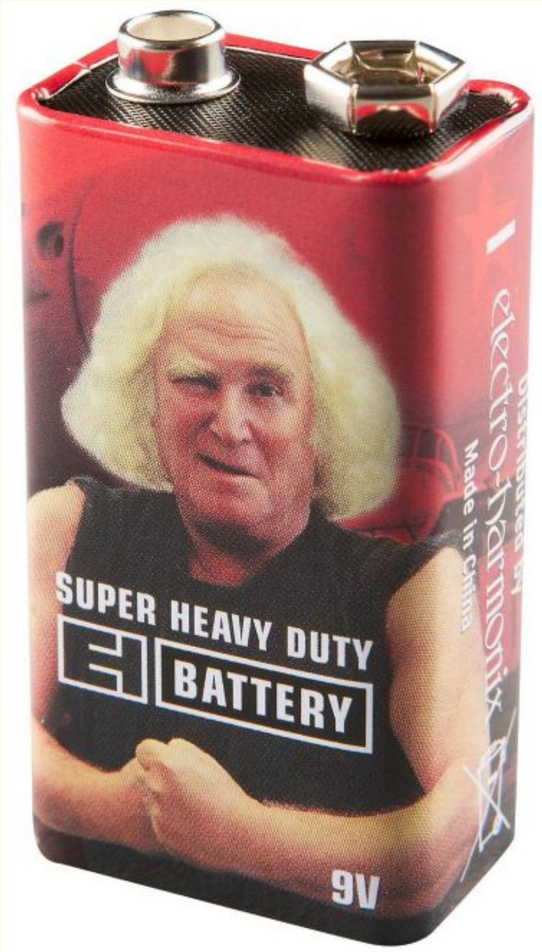
Temperature and Humidity

- Humidity and temperature sensor size: 23.5 x 12 x 5.5 mm
- Power supply: DC 3.5～5.5V
- Supply Current: measurement 0.3mA standby 60μA
- Repeatability: ±1% RH, Accuracy: At 25℃ ±5% RH
- Repeatability: ±0.2℃, Accuracy: At 25℃ ±2℃



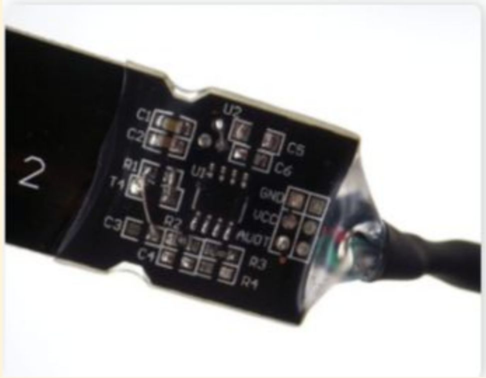
Power

- 2x 9V batteries
- 5.49 Watt Hours each
- Dimensions 48.5 x 26.5 x 17.5mm



Soil Moisture Sensor

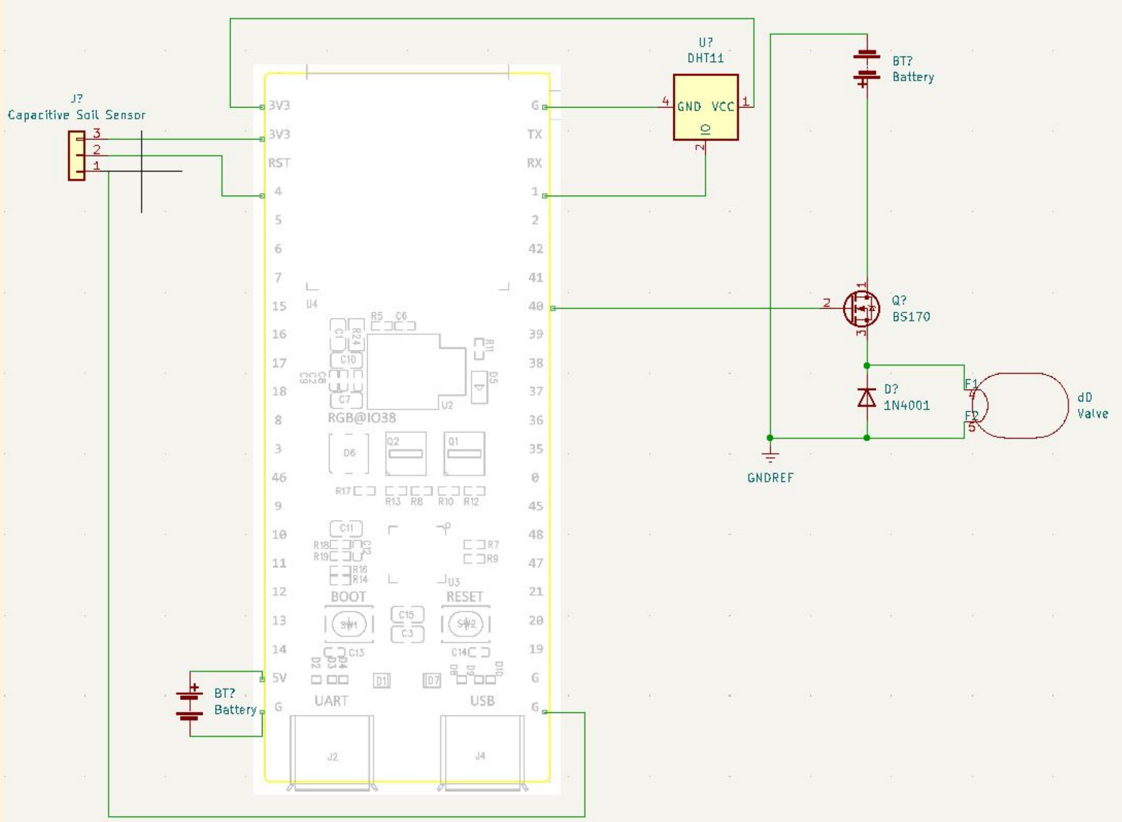
- Size 4.02 x 0.79 in
- Operating voltage: 5V
- Operating current: 7mA
- Resolution: 514 points - moisture levels must be calibrated
- Waterproofing solution: heat shrink and epoxy



Watering System

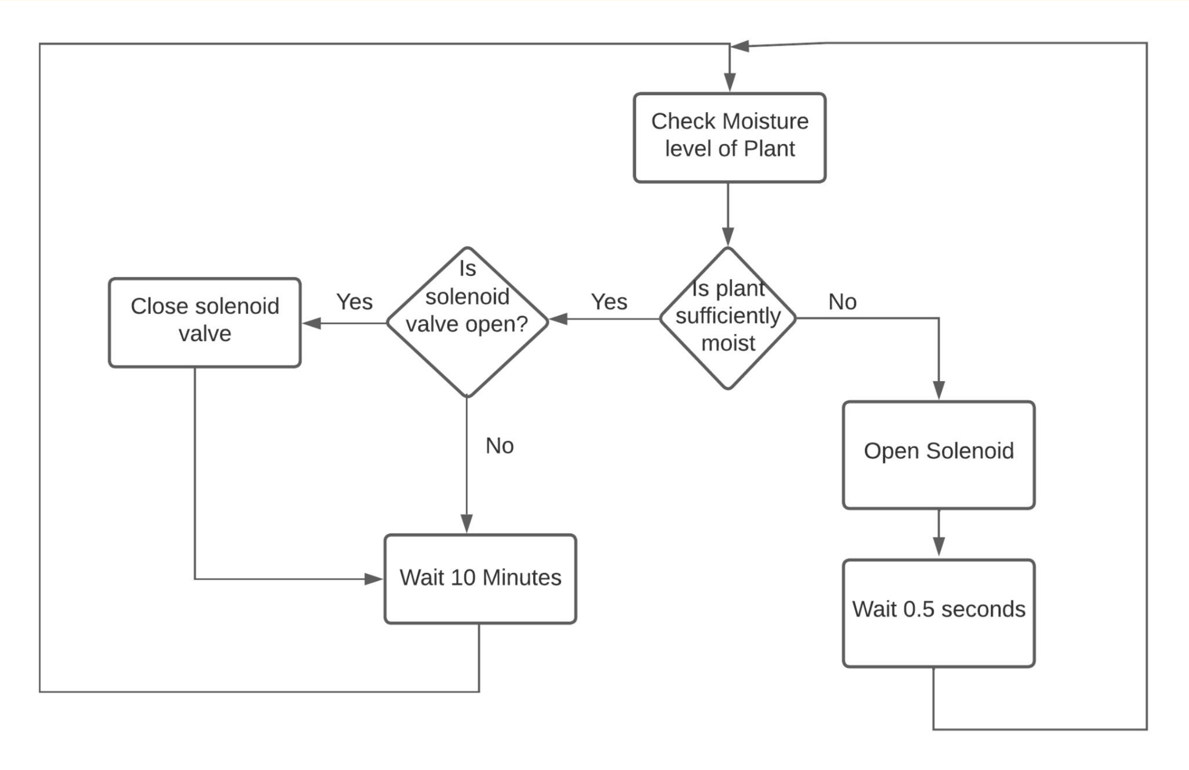
- The final segment will be the solenoid watering valve and water storage, this will be directly attached to the main body.
- Solenoid water valve size : 83.82 x 42.93 x 56.90 mm
- Actuating life: ≥ 50 million cycles
- Working Pressure: 0.02 Mpa - 0.8 Mpa
- ½ in to 38-400 water bottle adaptor (3d model and print)
- ½ in to watering stake (3d model and print)

Circuit Schematic

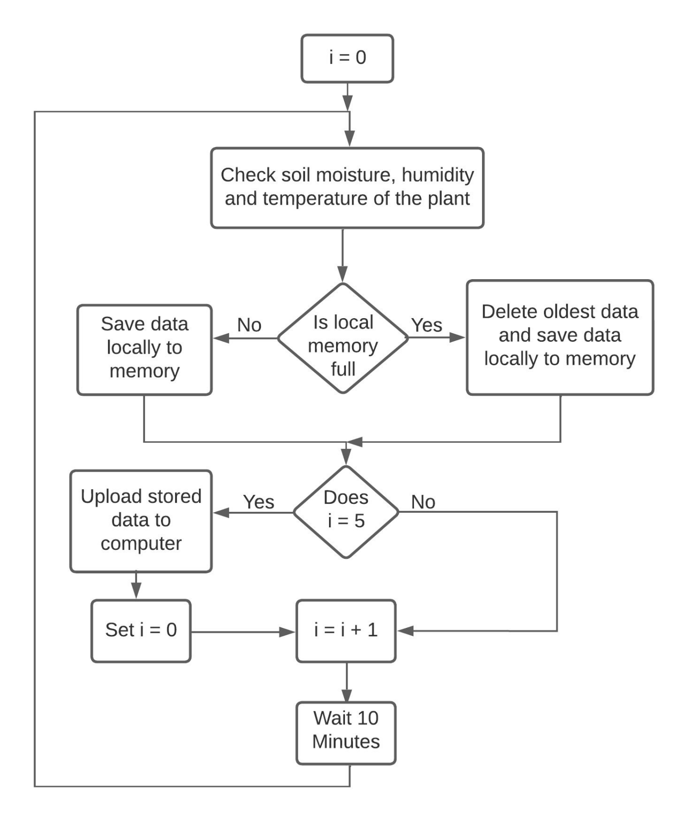


Algorithms

Hardware Feedback System



Software Logic Loop



Debugging

Verification/Testing

- Verify that each sensor is functioning correctly:
  - Check that every sensor powers on and provides an output signal
  - Check for stability of each output signal

- Verify that each sensor is communicating with the microcontroller:
  - Check if the microcontroller can receive the sensors' output signal
  - Check if the microcontroller can control each sensor

- Verify results are within anticipated range:
  - Compare the results of each sensor to expected values

- Verify the total power draw will meet specifications:
  - Check that the power drawn will be low enough for required runtime

Verification/Testing

- Test the auto-watering system
  - Check that the auto-watering system is not over or under watering the plant
  - Check that the auto-watering system functions consistently
  - Check that the moisture sensor is changing in response to the watering system

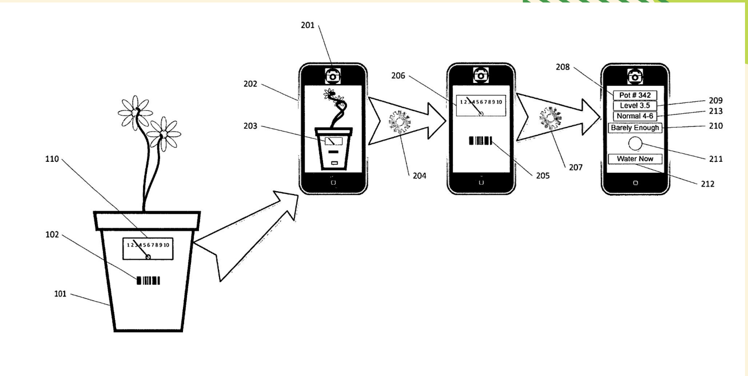
- Test the system for moisture resistance
  - Ensure that the capacitive sensor, and the housing for the other components remains dry under rain like or high humidity conditions

Contingency Plans

- Battery capacity/voltage output is not sufficient:
    - Switch to wall power or find alternative battery supply solution
- Soil moisture sensor is not accurate:
    - Re-calibrate or find alternative brand
- Bluetooth connection to computer is unreliable:
    - Store data locally on microcontroller and have the device plugged into the computer to download data

Research

Patent Research



<u>U.S. Patent US9271454B1 - Intelligent Gardening</u>

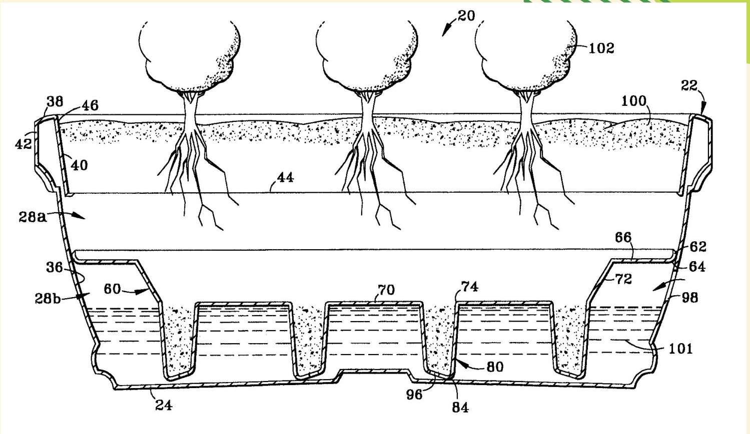
An intelligent gardening system and method for monitoring and analyzing a moisture level in individual gardening pots and/or containers is provided. A system comprises a moisture measuring sensor integrated into a pot/container. A gardener can read moisture-related data using a mobile device, a computer, or a tablet, or directly from built-in display. The gardener can send the moisture level-related data along with other data (such as, a type of a plant, a soil type, size of a pot, a plant size, location, current weather, an air temperature, etc.) to a central server connected to a central gardening database or to a cloud service and receive gardening recommendations. The gardening recommendations can include other recommendations pertaining to a particular plant and gardening conditions.

This patent is similar to our project, but it is missing some facets of the design. The C.E.L.P. Gardens module will include a self-watering system that will rely on the data provided by the moisture sensors. Additionally, it would provide alerts to a device wirelessly when conditions are outside of acceptable limits.

Patent Research cont.

<u>U.S. Patent US6357179B1 - Self-Watering Planter</u>

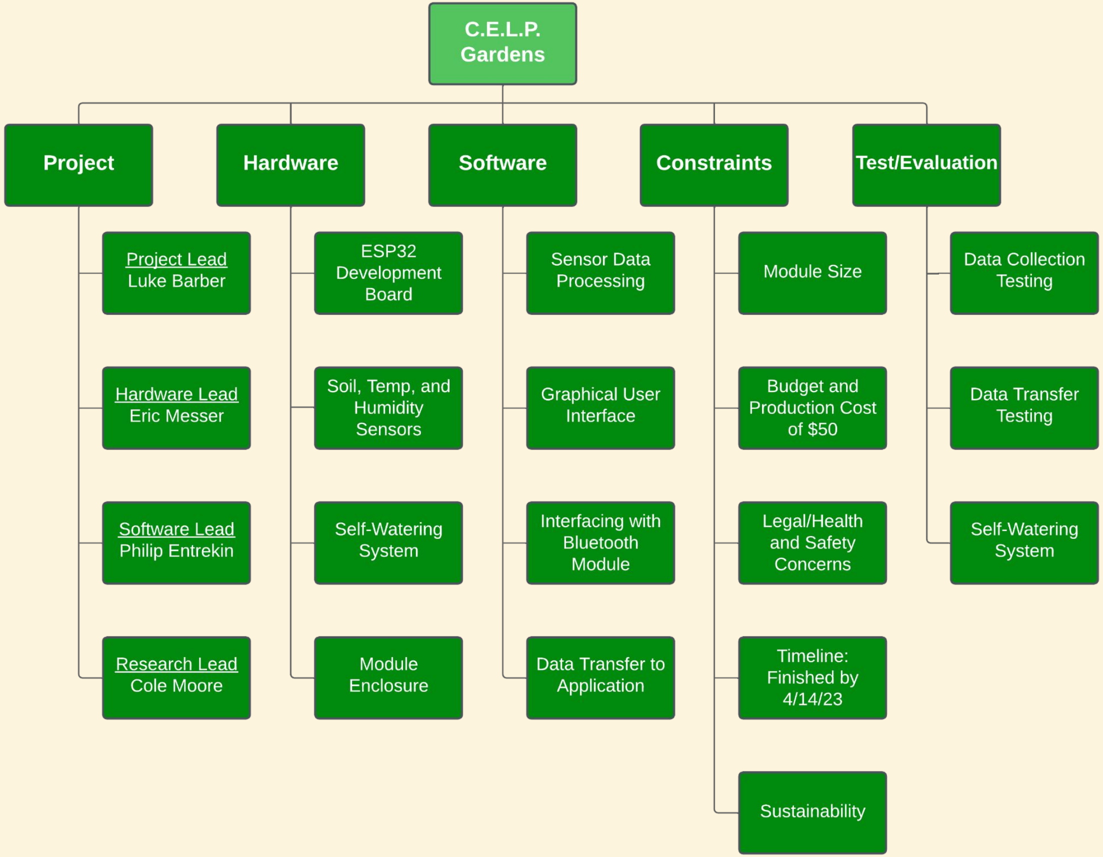
A self-watering planter having a container and a floor structure . The latter includes one or more troughs that extend downwardly from the floor . When manufacture of the planter is complete, a chamber portion for receiving planting medium is provided above the floor. This chamber portion includes interior regions of the troughs. A lower chamber portion is provided beneath the floor structure for receiving water. Openings in bottom ends of troughs permit water in the lower chamber portion to be wicked up into the planting medium in the troughs, which in turn is wicked up into planting medium in upper portions of the upper chamber portion. The planter is designed to be manufactured with a single mold in a single molding operation.



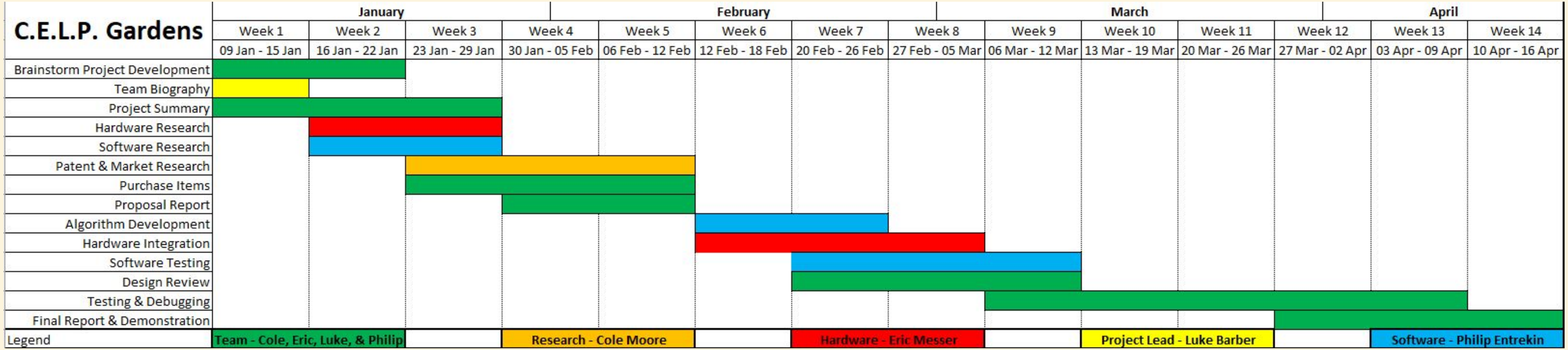
This patent is similar to our idea for a self-watering system, but it fails to include the integration of sensor data with wireless transmission or any kind of notification system/user accessible GUI.

Team Organization

Work Breakdown/Member Roles



Task Schedule



Budget

C.E.L.P. Gardens	Part Number	Part Description	Retail Price	Vendor
Hardware	ESP32-S3-DevKitC-1-N8R8	Microcontroller	$15.00	mouser.com
	DHT11	Temp./Humidity Sensor	$3.15	amazon.com
	B07SYBSHGX	Moisture Sensor	$2.00	amazon.com
	Adafruit-997	Solenoid Valve	$6.95	adafruit.com
	COM-08589	Diode	$0.25	mouser.com
	L7805CV	Voltage Regulator	$0.69	digikey.com
	BS170	MOSFET	$0.44	newark.com
	3D-Printed	Threading Adapter/Spout	$1.70	coreprototyping.xyz
	B07W9H8M3Z	Device Case	$2.20	amazon.com
	Alkaline	2x 9V Batteries	$4.84	amazon.com
Total			**$37.22**	

Questions?