ECET x30 - Design Decisions

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Smart Plant Monitor Overview

The objective of the Smart Plant Health Monitor is to provide plant owners with a simple and reliable way to track the overall well-being of their plants. The device measures key environmental factors, including soil moisture, soil temperature, ambient temperature, humidity, and light levels, providing users with a comprehensive understanding of the conditions that impact plant health.

To make the data easy to understand, the monitor uses an RGB LED indicator to communicate status at a glance. When all conditions fall within the user-defined optimal ranges, the LED remains off, signaling that the plant is healthy. If the temperature rises too high, the LED turns red; if it becomes too cold, it turns blue. A yellow light alerts the user when soil moisture drops below the ideal threshold, indicating that the plant needs watering. An orange LED indicates the plant needs to be exposed to more sunlight. When multiple conditions are outside the optimal range, the RGB LED flashes the corresponding colors in sequence, for example, if the temperature is too low and the soil moisture is too low, the LED alternates between blue and yellow.

The smart monitor is powered by a rechargeable battery with integrated solar charging capabilities, allowing it to operate outdoors for extended periods with minimal user intervention. This makes it both practical and low-maintenance, ensuring that users can keep their plants healthy without needing constant monitoring.

Figure 1 below is an example sketch of what the smart plant monitor could

look like when placed in a plant pot:

Figure 1

Figure 2 below is the block diagram for the smart plant monitor. Blue blocks represent the input sensors, green are the outputs, purple is the microcontroller, and the yellow is external components such as the battery and user input.

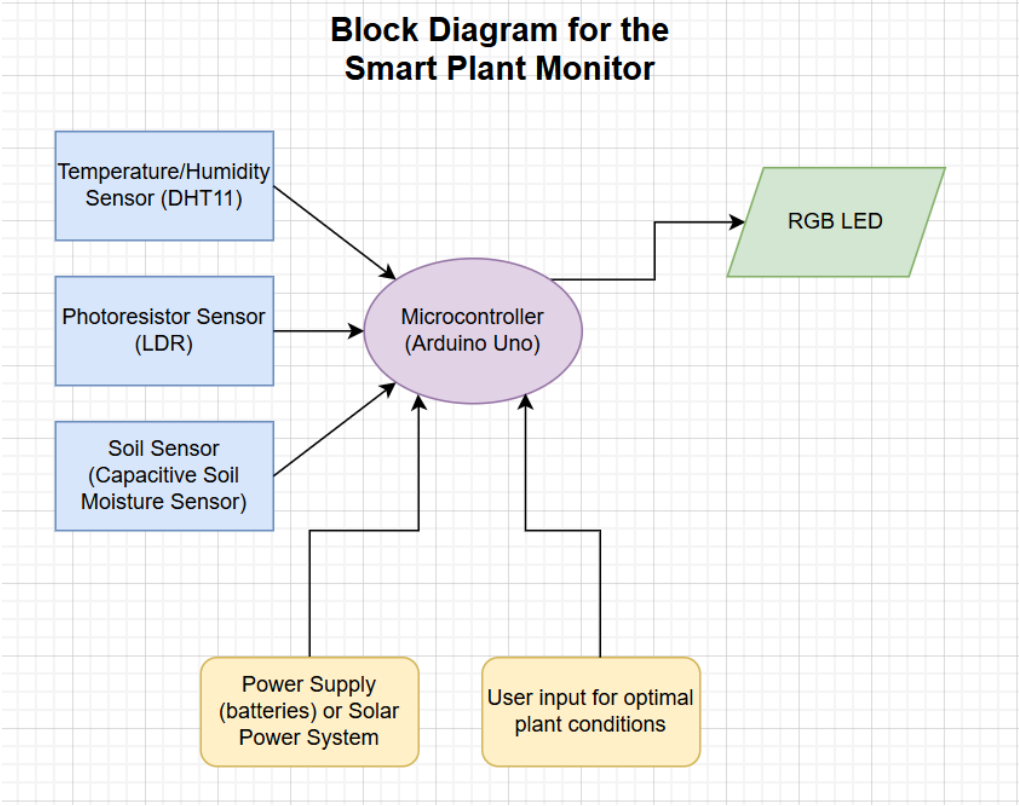

Figure 2

Figure 3 below shows the advanced block diagram of the Smart Plant Monitor, highlighting the function of each sensor and the system's response under different conditions. The monitor is powered by a battery. Once powered, the user can input the optimal temperature range for the specific plant being monitored. The microcontroller stores this data, and the sensors begin monitoring.

Each sensor measures temperature, soil moisture, or sunlight at one-minute intervals. This intermittent monitoring helps conserve battery life, as continuous monitoring would drain the battery more quickly. After collecting the data, the microcontroller evaluates whether the current conditions fall within the user-defined optimal range.

If the temperature is too high, the RGB LED turns red; if it is too low, the LED turns blue. If sunlight is insufficient, the LED turns orange, and if soil moisture is too low, the LED turns yellow. When multiple conditions are outside the optimal range, the RGB LED flashes the corresponding colors in sequence, for example, if the temperature is too low and the soil moisture is too low, the LED alternates between blue and yellow. When all conditions are within the optimal range, the RGB LED remains off.

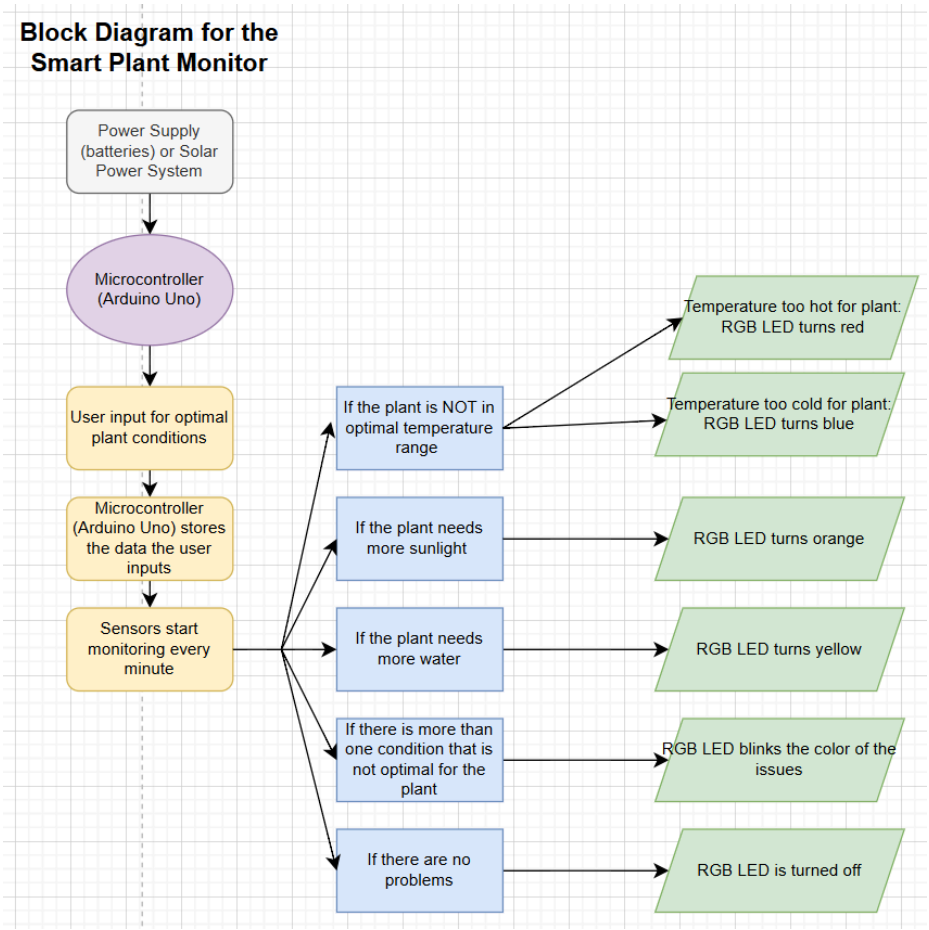

Figure 3

Electronic Design Section

- Microcontroller: Arduino Uno
    - Reads all sensors, controls the RGB LED, and processes sensor data.
    - Use Arduino 5V and GND rails to power sensors and the LED
    - Digital and analog pins connected to sensors and RGB LED
- Temperature & Humidity Sensor: DHT11
    - Measures ambient temperature and humidity.
    - Uses VCC, GND, and Digital Pin.
- Soil Moisture Sensor: Capacitive Soil Moisture Sensor Module Corrosion-Resistant Moisture Detection Garden Watering for Arduino
    - Detects if the soil is too dry.
    - Uses Analong Output, Digital Output, VCC, and GND
- Light Sensor: Photoresistor
    - Measures sunlight intensity
    - Uses Analog LDR
- RGB LED
    - Shows plant health based on sensor readings.
    - Uses resistors to limit the current going through to the LED
    - Uses GND, digital Pins
- Power Supply
    - Powers Arduino and sensors reliably.
    - 5V Regulated battery
    - A small solar panel will be used to recharge the battery connected through a 5V regulator.
- User Input: Rotary Encoder
    - Allows the user to input the plant's optimal temperature range.
    - Provides precise adjustments with rotational steps and a push button for selection.
    - Uses digital pins for CLK, DT, and SW, along with VCC and GND.

<u>Prototyping on a Breadboard:</u>

To prototype the Smart Plant Monitor on a breadboard, we can connect each sensor and component to the Arduino using jumper wires. The soil moisture sensor plugs into an analog pin, the photoresistor connects as a simple analog input, and the RGB LED is wired with resistors to digital pins. The rotary encoder goes to digital pins for its signals and power rails for VCC

and GND. Power is supplied to the Arduino and shared across the breadboard, so all components run together.

Conclusive Explanation of Design Choices:

The Arduino Uno was chosen as the central controller because it is breadboard-friendly, reliable, and has sufficient analog and digital inputs to interface with all sensors. Its PWM-capable pins allow smooth control of the RGB LED, and it is fully compatible with widely available libraries for sensors like the DHT11. Using the Arduino also allows the design to be easy to prototype, while still allowing future expansion with additional sensors or outputs.

The user can input their plants' optimal ranges for temperature using the rotary encoder. This provides a user-friendly way to adjust values directly on the Smart Plant Monitor without needing a computer or external interface. The encoder allows the user to scroll through temperature settings and select the desired range, giving flexibility for different plant types. It’s also compact, reliable, and integrates easily with the microcontroller, making it an ideal input method for our portable design.

The DHT11 temperature and humidity sensor was selected for its simplicity, low power consumption, and direct compatibility with Arduino digital pins. It provides adequate accuracy for monitoring environmental conditions that affect plant health, and the well-supported DHT library allows easy reading and integration into the system.

For soil moisture monitoring, the capacitive soil moisture sensor was chosen since it is more durable and reliable than traditional resistive sensors. Unlike resistive types, it does not have exposed electrodes that corrode over time, making it better for long-term monitoring in soil. It provides more stable and accurate readings of soil moisture and integrates easily with our Arduino-based Smart Plant Monitor, ensuring consistent performance for automatic plant care.

The light sensor is implemented using a simple LDR (photoresistor) providing an analog signal that Arduino can read. This allows the system to measure sunlight exposure and alert the user when light levels are insufficient. This approach integrates seamlessly with the Arduino’s analog inputs.

The RGB LED was chosen as the visual status indicator because it provides a clear, intuitive way for users to understand plant conditions at a glance. Using PWM pins and current-limiting resistors ensures that each LED

color can be safely controlled without damaging the Arduino or the LED.

The system's power supply was designed for outdoor, low-maintenance operation. A rechargeable battery powers the Arduino and sensors, while a small solar panel can maintain a charge over time, extending the monitor's operational life and reducing the need for frequent human intervention.

Design Decision Table

Choice of Microcontroller	Arduino Uno	Widely Used Board that can support all sensors and outputs for this project
Sensors	DTH11	Selected for measuring environmental conditions around the plant. Needs to monitor the temperature every few minutes.
	Capacitive Soil Moisture Sensor	More durable and reliable than traditional resistive sensors.
	Photoresistor (Photocell)	Measure light intensity
Input	Rotary Encoder	Allows users to scroll through temperature settings and select the desired range for the plant
Output	RGB LED	Provides a quick, color-coded indicator of plant status
Power	9V Battery	
Size	No more than 6.5 inches in height, no more than 3 inches wide.	The monitor should be portable, allowing it to be moved easily between different plants. It must be compact enough not to interfere with plant growth

		and designed to fit inside the plant pot.