ECET x30 - Project Definition Template

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High Level Description

A battery-powered smart plant monitor is designed to be inserted into the soil to measure moisture, temperature, humidity, and light levels. Users can configure optimal ranges for each parameter, and the device provides real-time feedback through an RGB LED indicator. A green light means all conditions are optimal, red signals temperatures that are too high, blue indicates temperatures that are too low, yellow warns that the plant needs water, and orange indicates that the plant needs more sunlight. When multiple conditions are outside the optimal range, the RGB LED flashes the corresponding colors in sequence. The monitor runs on rechargeable batteries that are kept charged by a small solar panel, allowing for extended outdoor operation without frequent maintenance.

Purpose

The Smart Plant Health Monitor helps users track and maintain their plants' well-being by monitoring environmental conditions and providing clear feedback.

Key components of the Smart Plant Health Monitor are:

- Continuous Monitoring: Measures soil moisture, temperature, humidity, and light to ensure conditions remain within user-defined optimal ranges.
- Provides a plant status
  - LED off when optimal
  - Red = too hot
  - Blue = too cold
  - Yellow = needs more water
  - Orange = more sunlight
  - Flashing = multiple conditions are outside the optimal range

- Low Maintenance: Minimizes user intervention with rechargeable batteries supported by solar charging for extended outdoor use.

Client

• contact information
• roles
• budget

Communication

For the Smart Plant Monitor, all the documents and diagrams can be found on the GitHub Repository: https://github.com/hgh-29/Smart-Plant-Monitor
The Logbook for this project is the following table:

Objectives

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 such as soil moisture, soil temperature, ambient temperature, humidity, and light levels, giving users a complete picture of the conditions that affect 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 monitor is powered by a rechargeable battery with integrated solar charging support, which allows 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.

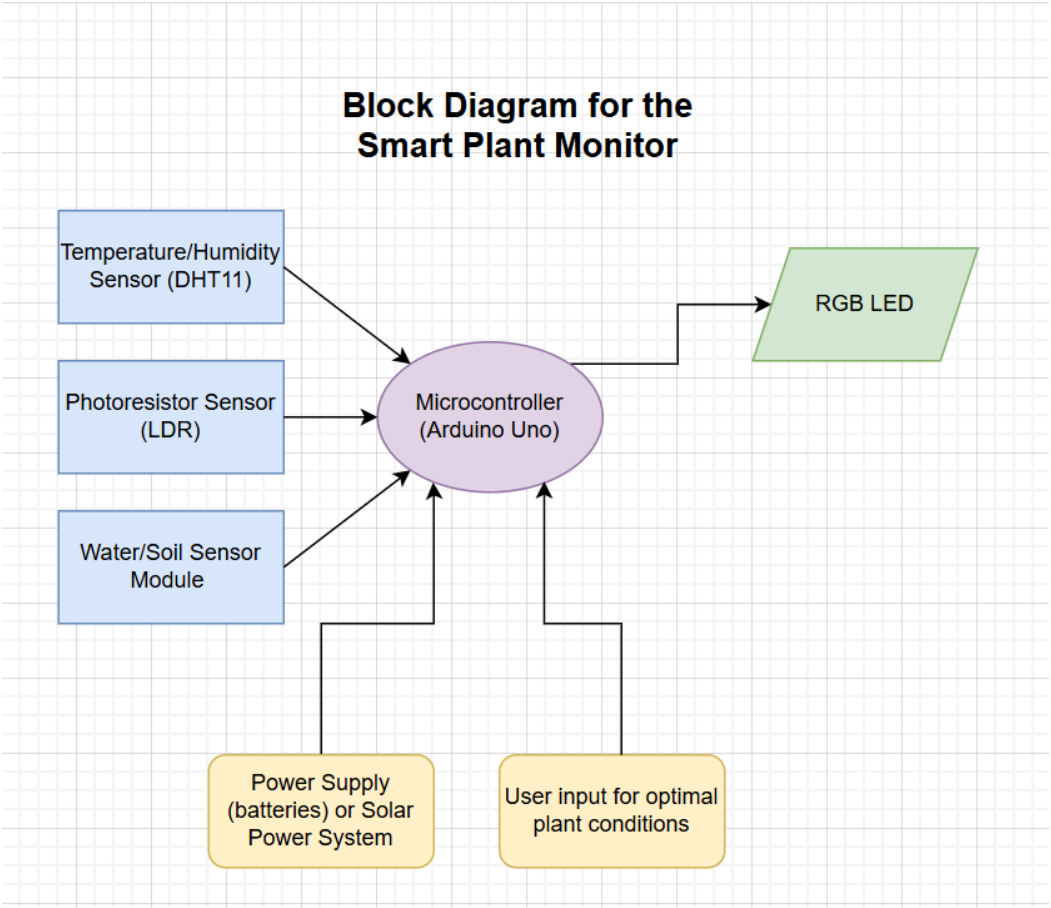


Figure 2

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.

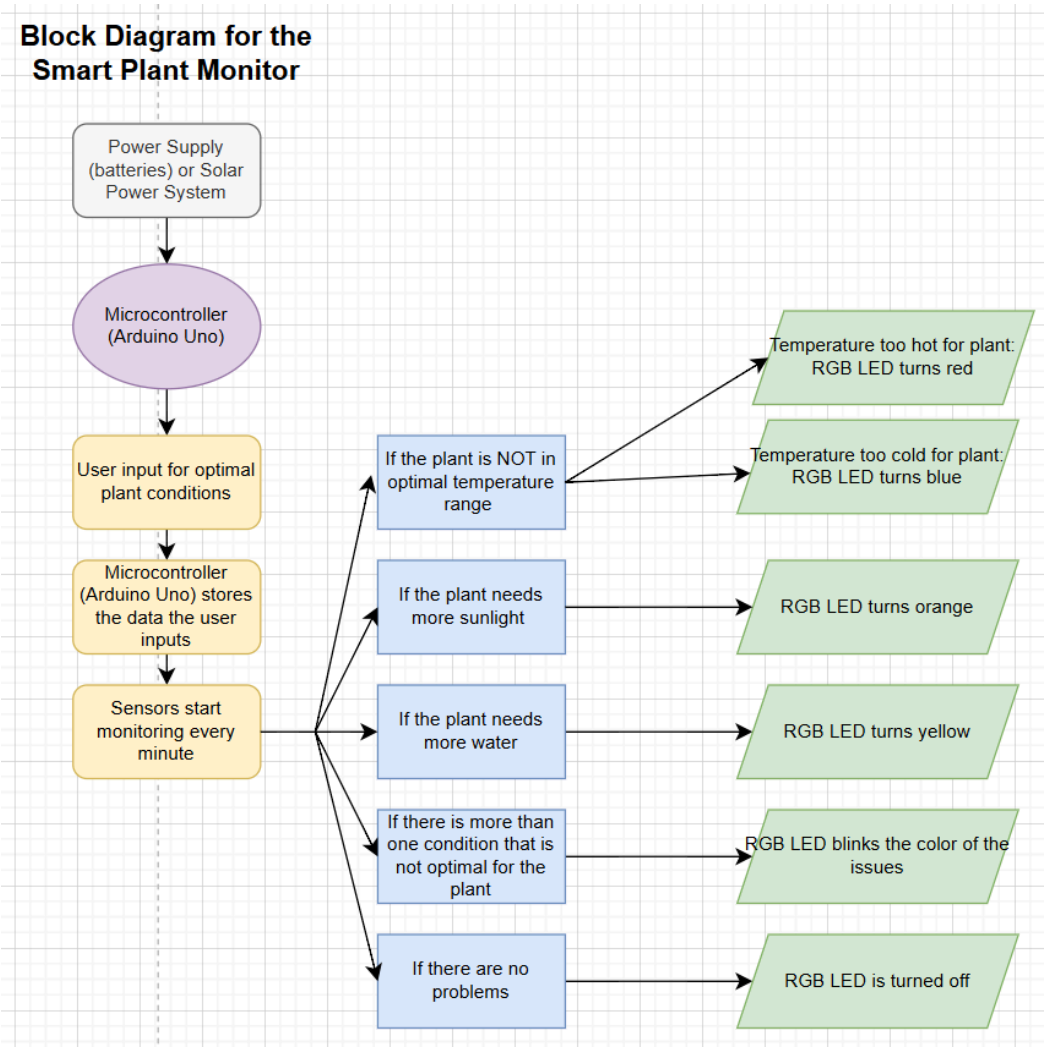


Figure 3

<u>Electronic section:</u>

- Microcontroller: Arduino Uno
  - Reads all sensors, controls the RGB LED, and processes sensor data.
  - Use Arduino 5V and GND rails to power sensors and 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:
  - 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.
  -

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.....

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.....sensor was chosen.

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.

Scenario

User Interaction Stories

• unboxing
• configuring
• using
• troubleshooting
• passive/active interaction
• servicing

User Interface

The Smart Plant Health Monitor provides feedback to the user primarily through an RGB LED indicator, giving a clear, at-a-glance understanding of plant conditions.

LED Indicators:

- Off: Plant is healthy and in its ideal conditions
- Red: Plant is too hot
- Blue: Plant is too cold
- Yellow: Plant needs to be watered
- Orange: Needs more sunlight

Sensors:

- Soil Moisture Sensor: Measures soil moisture levels and alerts the user via the LED when the soil is too dry.
- Temperature and Humidity Sensor (DHT11): Monitors ambient temperature and humidity around the plant to ensure conditions remain within the ideal range.
- Light Sensor (Photoresistor): Measures sunlight exposure to determine if the plant is receiving sufficient light.

User Input:

The monitors will read all sensor data and updates the LED status in real time, allowing users to quickly assess the health of their plants. By providing clear visual feedback and minimizing user intervention, the system simplifies plant care and helps maintain optimal growing conditions.

User Acceptance

Given–When–Then Criteria:

- Soil Moisture Feedback:
  - Given: the plant is in the soil with the monitor inserted
  - When: the soil moisture drops below the user-defined threshold
  - Then: the yellow LED turns on to alert the user

- Temperature Monitoring
    - Given: the monitor is measuring ambient temperature
    - When: the temperature rises above the optimal range
    - Then: the red LED illuminates; if it falls below the optimal range, the blue LED illuminates
- Light Monitoring
    - Given: the monitor is measuring sunlight exposure
    - When: the light level falls below the user-defined threshold
    - Then: the yellow LED lights up to indicate insufficient light
- Power Operation
    - Given the monitor is powered by the battery and solar panel
    - When the device is deployed outdoors for 24 hours
    - Then it continues operating without requiring manual charging

Quantifiable Goals:

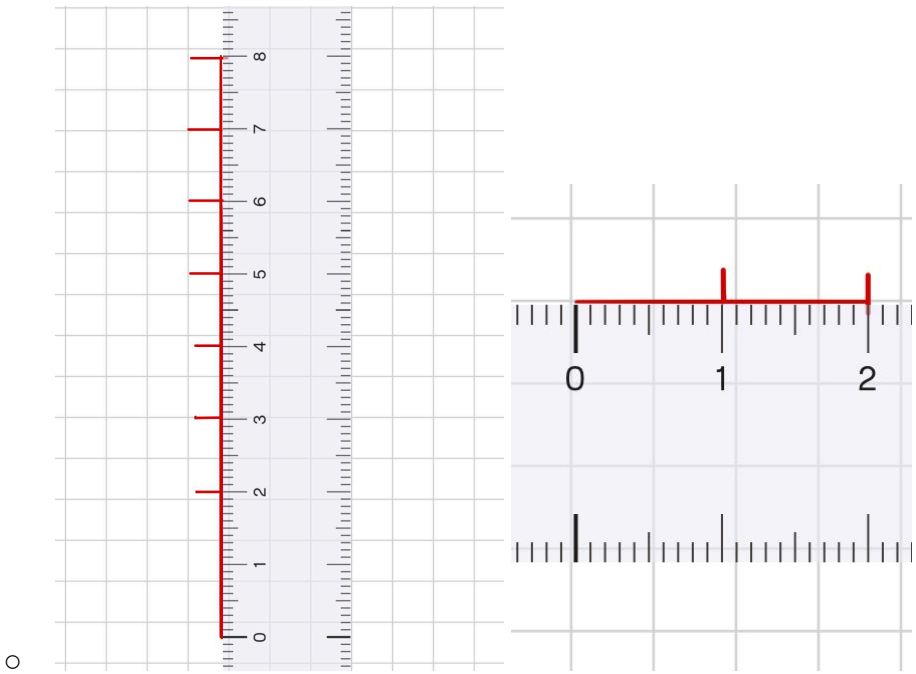
- LED status update response time ≤ 5 seconds after a sensor reading change
- Continuous operation for at least 7 days on a fully charged battery under typical sunlight conditions

Parameters

Technical

This project must be small enough that it can be placed in the pot/soil of a plant. The dimensions can not be larger than 8 inches. The project must be somewhat waterproof or water-resistant since it will be located in the plant pot/soil. This project should be able to read the current temperature, humidity, moisture, and light level.

- Dimensions
    - Height: No larger than 8 inches tall, no smaller than 2 inches tall
    - Width: No larger than 2 inches wide, no smaller than 1 inch wide
    - Weight: 50-300 grams
- Electromagnetic Compatibility (EMC) & Electromagnetic Interference (EMI) Protection
    - Add small capacitors near the sensors and microcontroller to keep signals clean
    - Add a diode or filter to protect against noise from the servo or pump
    - Make sure the solar panel and battery connections are protected against surges or wrong wiring



Functions

The Smart Plant Health Monitor performs several core functions to help users maintain optimal plant conditions.

- Soil Moisture Monitoring: The device measures the moisture level in the soil and alerts the user via the LED when the soil is too dry.
- Temperature and Humidity Monitoring: A DHT11 sensor measures the air temperature and humidity around the plant. If conditions become too hot or too cold, the LED changes color to warn the user.
- Light Monitoring: A light sensor measures sunlight exposure. When the plant is not receiving enough light, an orange LED illuminates to indicate this.
- Power Management: The system is powered by a rechargeable battery and supported by a small solar panel, allowing the monitor to operate outdoors for extended periods with minimal user intervention.
- User Input:

Integration

• interfaces
• protocols

Operational

• restrictions
• duty cycle

Regulatory

- laws
- regulations
- policies

Life Cycle

- manufacturing
- programming
- tracking
- service
- associated services

Environment

- temperatures
- hazards
- ingress
- power

Starting Point

- existing IP
- existing prototypes

Key Concerns

- most important
- set-in-stone parameters

Future

- plans
- ideas

Glossary

- common vocabulary
- project specific terms

Open Questions

to be discussed with team/client