ECET 230 - Project Definition Template

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2025-12-20

Table of Contents

High-Level Description

The smart plant monitoring system measures soil moisture, temperature, humidity, light level, and accumulated daily sunlight, with all optimal thresholds and timing intervals fully configurable through a 4×4 keypad and displayed on a 16×2 LCD. The device utilizes a DHT11 sensor, a soil moisture probe, and a light sensor, tracking sunlight accumulation throughout the day and automatically resetting the daily sunlight counter after an extended nighttime period. A reset button can be held for five seconds to restart the entire system. Based on the measured values, the RGB LED provides real-time alerts: red for high temperature, blue for low temperature, yellow for dry soil, and purple for insufficient light when it is not nighttime and the sunlight goal has not been met. If only one issue is active, the LED displays a solid color, but if multiple issues occur, the LED cycles through each condition's color in sequence. When no issues are detected, the LED remains off. All sensing and alert logic updates according to the user-defined monitoring interval, ensuring accurate, continuous, and power-efficient operation.

Purpose

The Smart Plant Health Monitor is designed to help users maintain their plants' well-being by continuously tracking key environmental conditions and providing clear, immediate feedback. By comparing real-time sensor readings against user-defined optimal ranges, the device alerts the user when conditions fall outside the desired thresholds, making plant care simpler and more effective.

Key Functions:

- Continuous Monitoring:
  - Measures soil moisture, temperature, humidity, light levels, and accumulated daily sunlight to ensure the plant's environment remains within the user-set optimal range.
- Plant Status Feedback (RGB LED):
  - LED Off: Conditions are optimal
  - Red: Temperature too high
  - Blue: Temperature too low
  - Yellow: Soil is too dry
  - Purple: Plant needs more sunlight
  - Flashing Sequence: Multiple conditions are outside the optimal range (cycles through each issue's color)
- Low Maintenance Operation:
  - Designed for extended outdoor use with minimal user intervention, powered by a 5V battery power bank, which allows for a runtime of up to 100 hours. Depending on the battery bank, the runtime hours can vary.

Client

Target Audience

- Plant owners who want an easy way to monitor the health of their plants
- Gardeners looking for a low-maintenance, portable monitoring system
- Hobbyists or students interested in learning about electronics and plant care

Roles

- Provide a way for users to track key environmental factors (soil moisture, temperature, humidity, light)
- Offer real-time feedback on plant conditions using the RGB LED
- Serve as an educational tool for understanding sensor-based monitoring systems
- Help users maintain healthier plants with minimal effort

Budget Considerations

- Designed to be affordable and accessible for hobbyists and small-scale users
- Estimated cost of components for the PCB Prototype: $76.24
- Optional enhancements (solar panel, wireless connectivity, automatic watering) may increase cost
- Below is the full Bill of Materials Table:

Bill of Materials					
Id	Designator	Footprint	Quantity	Designation	Price Total (Dollars)
1	SW1	SW_DIP_SPSTx01_Slide_Copal_CHS-01A_W5.08mm_P1.27mm_JPin	1	SW_DPST_x2	1.25
2	R8,R7	R_Axial_DIN0207_L6.3mm_D2.5mm_P10.16mm_Horizontal	2	5.1k	0.10
3	J5	USB_C_Receptacle_GCT_USB4085	1	USB_C_Receptacle_PowerOnly_24P	3.00
4	D1	LED_RGB_5050-6	1	LED_RGBA	1.50
5	J2	Tag-Connect_TC2030-IDC-FP_2x03_P1.27mm_Vertical	1	AVR-ISP-6	4.50
6	U2	LCD-016N002L	1	LCD-016N002L	4.99
7	J4	PinSocket_1x03_P2.54mm_Horizontal	1	Soil Moisture Sensor	0.50

8	U1	Aosong_DHT11_5.5x12.0_P2.54mm	1	DHT11	2.00
9	R3,R5,R4	R_Axial_DIN0309_L9.0mm_D3.2mm_P12.70mm_Horizontal	3	220	0.15
10	C2,C1,C7,C8	CP_Elec_3x5.3	4	0.1u	0.40
11	C9,C10	CP_Elec_3x5.3	2	22pF	0.10
12	Y2	Crystal_AT310_D3.0mm_L10.0mm_Horizontal	1	Crystal	0.50
13	SW2,SW3	SW_PUSH-12mm_Wuerth-430476085716	2	SW_Push	0.40
14	U3	TQFP-100_14x14mm_P0.5mm	1	ATmega2560-16A	15.00
15	J3	PinSocket_1x06_P1.00mm_Vertical_SMD_Pin1Right	1	Serial	0.50
16	R2	R_Axial_DIN0309_L9.0mm_D3.2mm_P12.70mm_Horizontal	1	10k	0.05
17	C6	CP_Elec_3x5.3	1	4.7u	0.20
18	J1	PinHeader_1x08_P1.00mm_Vertical	1	Key Membrane Switch	0.50
19	R6	R_Axial_DIN0207_L6.3mm_D2.5mm_P10.16mm_Horizontal	1	22	0.05
20	RV1	Potentiometer_Bourns_3266P_Horizontal	1	10k Pot	1.50
21	R1	R_Axial_DIN0309_L9.0mm_D3.2mm_P12.70mm_Horizontal	1	R_Photo	0.05
			1	Capacitive Soil Moisture Sensor Module	5.00
			1	Battery Bank	30.00
			1	4×4 Keypad	4.00
Total Cost:					76.24

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:

Project Logbook					
Week	Date	Options/Evaluations/ Decisions	More details	Issues	Lessons Learned
1	9/1-9/6	Came up with project ideas			
2	9/7-9/13	Picked Project Groups and Project Idea: Smart Plant Monitor. Created a Block Diagram and Project Definition Template			
3	9/14-9/20	Brainstormed Parts for Project	UC: Arduino Uno Sensors: DHT11, Photoresistor, Soil Sensor Output: RGB LED Picked these components since we have all used them (other than the Soil Sensor), they are easy to code, and they are reliable	Need to figure out which soil sensor to use and a way for users to input plant data.	Reading Data sheets is important to figure out which components will best suit the project
4	9/21-9/27	Picked the Capacitive Soil Moisture Sensor	Picked the Capacitive Soil Sensor since it is more durable and reliable		
5	9/28-10/4	Make test codes for each component	Found the libraries and data sheet for each component that is currently being used. The test codes for each component worked, based on the test codes.	Some of the aspects for the test codes will be implemented into the code; other aspects need to be altered to carry out what the Smart Plant Monitor is supposed to do	Test codes are very important to figure out which components work before implementing them in the project. If there is an issue with the component, it will be easy to troubleshoot since the component is

					isolated.
6	10/5-10/11	Start coding the project to make a proof of concept midterm, and create the presentation	The Soil Sensor, Photoresistor, and Temperature Sensor are all working	Instead of an orange LED for not enough sunlight, it will be purple since orange did not look good, too similar to yellow. Need a way to not make the light sensor go off at night	Getting an orange color in an RGB LED is challenging. Came across an issue with the light sensor and what happens when it is nighttime. Having the light sensor detect that it is night will save some battery of the Smart Plant Monitor.
7	10/12-10/18	Make changes to the presentation and review it before the proof of concept presentation midterm			
8	10/19-10/25	Added the nighttime clock. Attempted to add an IR sensor with a remote	The nighttime clock allows users to define how long the night is and what light level.	Length of night is built into the code; users can not set how long night is. Night level is used to reset the sunlight intake daily. Could not get the IR sensor to work, opted to try different components	Figuring out how to create a "Nighttime clock" was challenging. After research and time constraints, it was better to hardcode a nighttime mode
9	10/26-11/1	Added Key Membrane and switched to Arduino Mega	Switched to Arduino Mega to add the key membrane for more pins Users enter optimal values using the key membrane		Sometimes, not all components work. The IR sensor + remote was not working properly; it was easy to determine this issue by testing the component with the test code. After a few weeks of failures, the decision was made to switch components

10	11/2-11/8	Added Push Button	Users can reset the system by holding down for about 5 seconds	Could not get a reset button to work on the key membrane, mostly due to coding problems, added a separate component for the reset aspect	Steep learning curve with coding. If our knowledge of C++ were a little better, then there should have been no issue with getting the reset button to work on the key membrane
11	11/9-11/15	Added LCD Users can input how frequently the sensors monitor	LCD helps users see what values they are inputting		The display will help users see what they input, just in case they it the wrong numbers. This was helpful when testing
12	11/16-11/22	Work on updating the schematic, report documents			
13	11/23-11/29	Work on Updating PCB Layout			
14	11/30-12/6	Work on updating PCB Layout, updating report documents, and design files			
15	12/7-12/13	Created a Power Budget, worked on report documents, fixed the schematic, and created the final project presentation	Switched the 9V battery with a USB battery pack so that the run time for the smart plant monitor can last a week	Created a Power Budget and realized that the 9V battery would only last 1-2 hours	Power Budget showed the flaws with the 9V battery. The design was made to switch to a battery bank for more runtime
16	12/14-12/19	Finishing touches on Final Project Presentation	Practiced presentation	Timing conflicts with finals and work	Working on a group project all semester relies heavily on communication and dedication.

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.

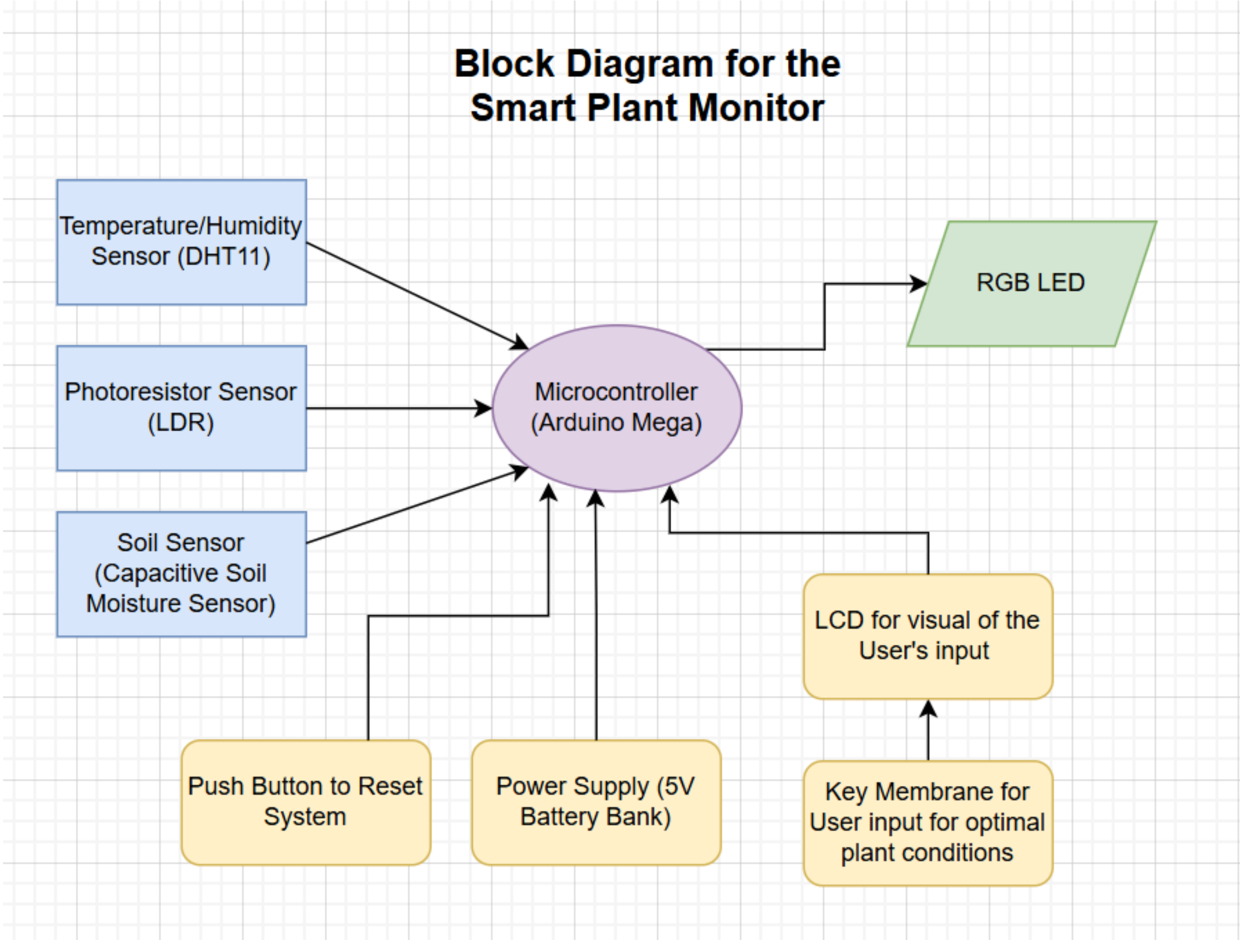
To make the data easy to understand, the monitor uses an RGB LED indicator to communicate status at a glance. When all conditions fall within the user-defined optimal ranges, the LED remains off, signaling that the plant is healthy. If the temperature rises too high, the LED turns red; if it becomes 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. A purple 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 battery bank that allows it to operate outdoors for extended periods before being recharged. This makes it both practical and low-maintenance, ensuring that users can keep their plants healthy without needing to be monitored every day.

Figure 1 below is an example sketch of what the smart plant monitor could look like when placed in a plant pot:

Figure 1: Example Sketch of Smart Plant Monitor

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 bank and user input.



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

Figure 2: Block Diagram

Schematic

This schematic shows the full design of a Smart Plant Monitor built around the ATmega2560 microcontroller. Power is supplied through a USB-C port, allowing the system to run from a standard USB power bank. The 5V line from the USB-C connector feeds the entire circuit and can be switched on or off with the onboard power switch. Supporting components like the crystal oscillator and decoupling capacitors ensure that the microcontroller operates with a stable clock and clean power.

Not featured on the schematic are the following components:

- 4×4 Keypad
- Capacitive Soil Moisture Sensor Module
- 5V Battery Bank (At least 10000 mAh)

These must be externally connected via their respective pin headers or USB port.

Below is the schematic for the PCB Prototype:

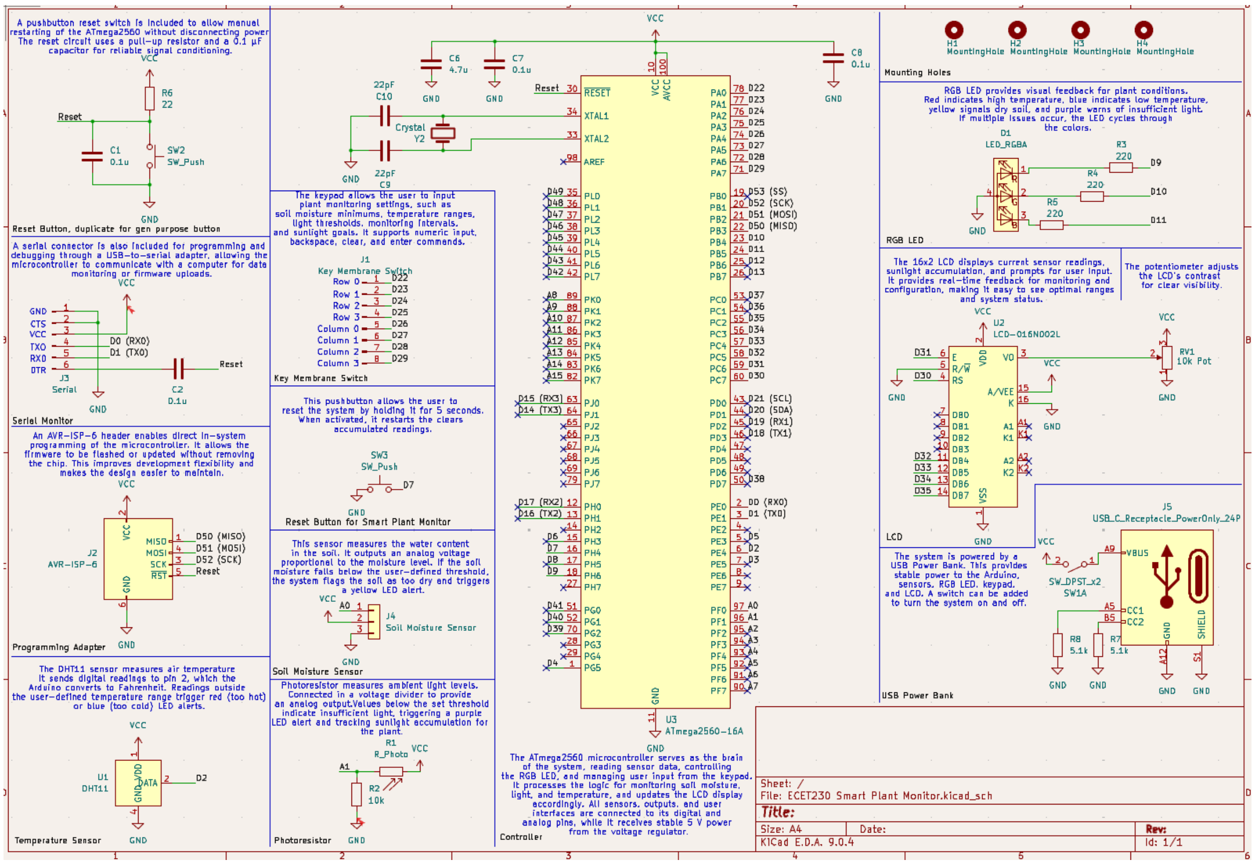


Figure 3: Schematic

PCB 3D Board Rendering

The PCB for the Smart Plant Monitor is a two-layer design with most signal routing on the top layer and a nearly full ground plane on the bottom layer. In the 3D rendering, the blue areas represent the bottom copper layer, which is poured and tied to GND. Using a large ground plane helps reduce electrical noise, improves analog sensor accuracy, and provides a stable reference for the entire system.

User-interface components like the RGB LED, pushbuttons, and LCD header are arranged for simple routing and a clean layout, while analog sensors such as the photoresistor and soil moisture header have short, direct traces to minimize interference. Mounting holes are placed around the board so it can be secured in a housing or project enclosure.

Overall, the PCB layout is organized, easy to assemble, and electrically robust. The top layer handles most signals, while the bottom ground plane ensures stability and reduces noise across the system.

Below is the sketch for the PCB:

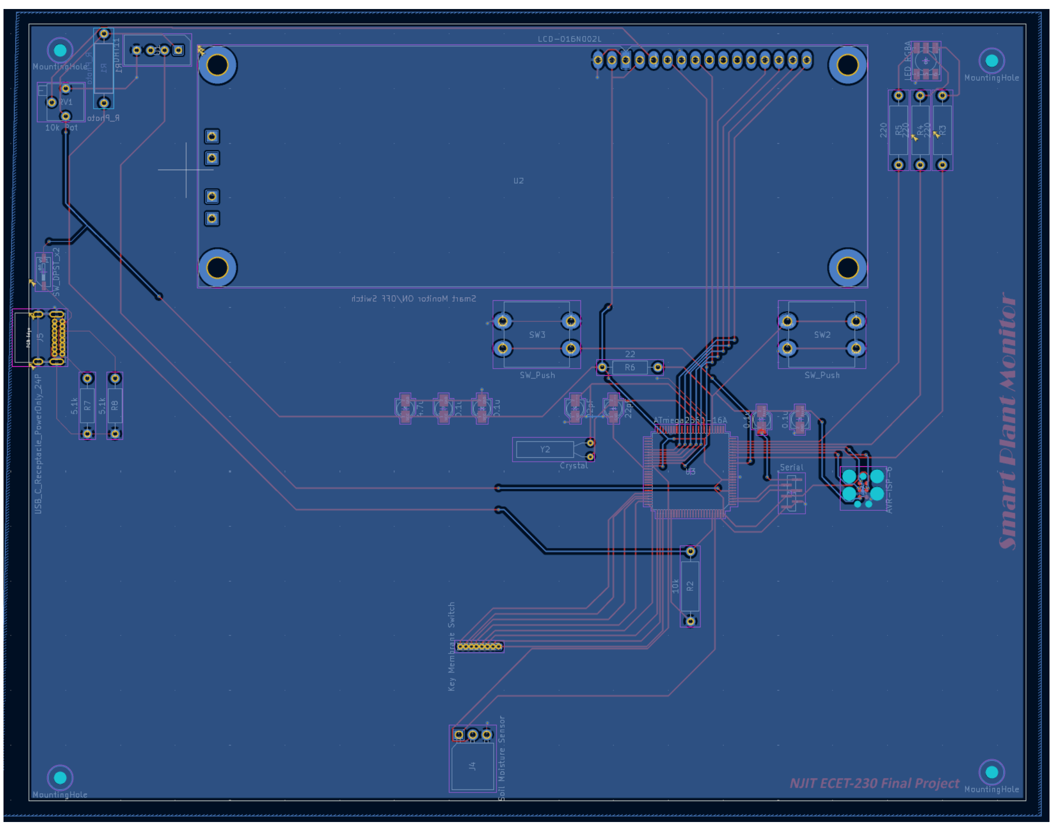


Figure 4: PCB

The figure below (Figures 5 and 6) shows the PCB 3D rendering. This figure shows how the PCB will physically look:

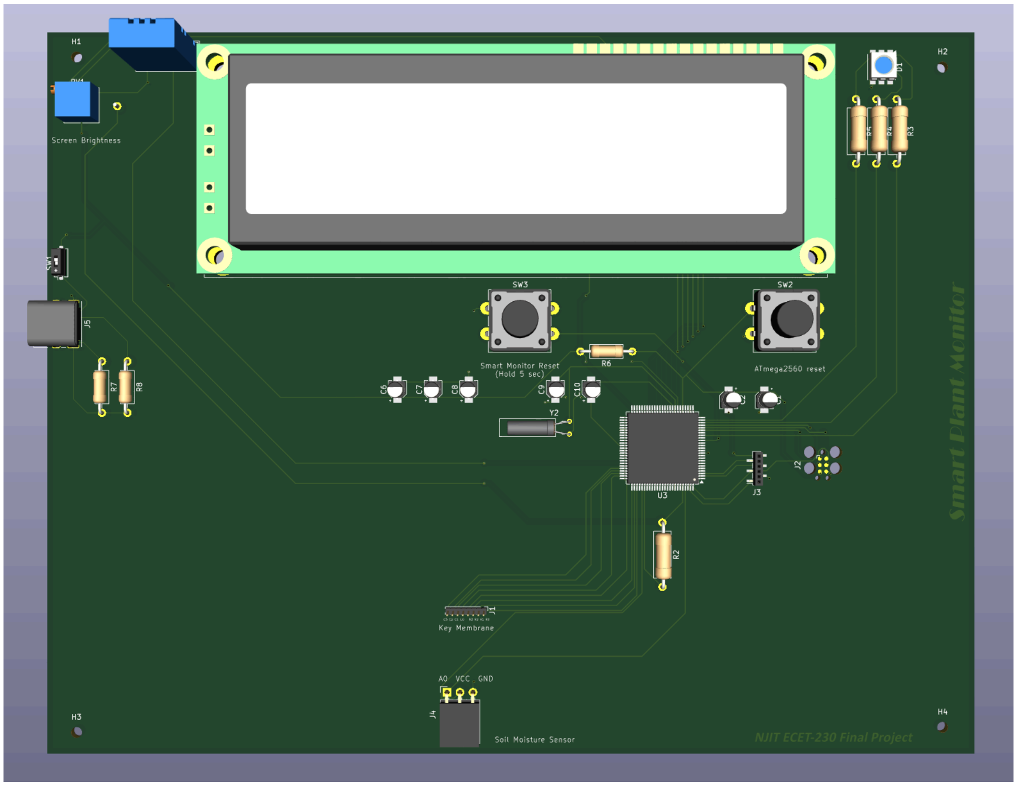


Figure 5: Front of PCB 3D Rendering

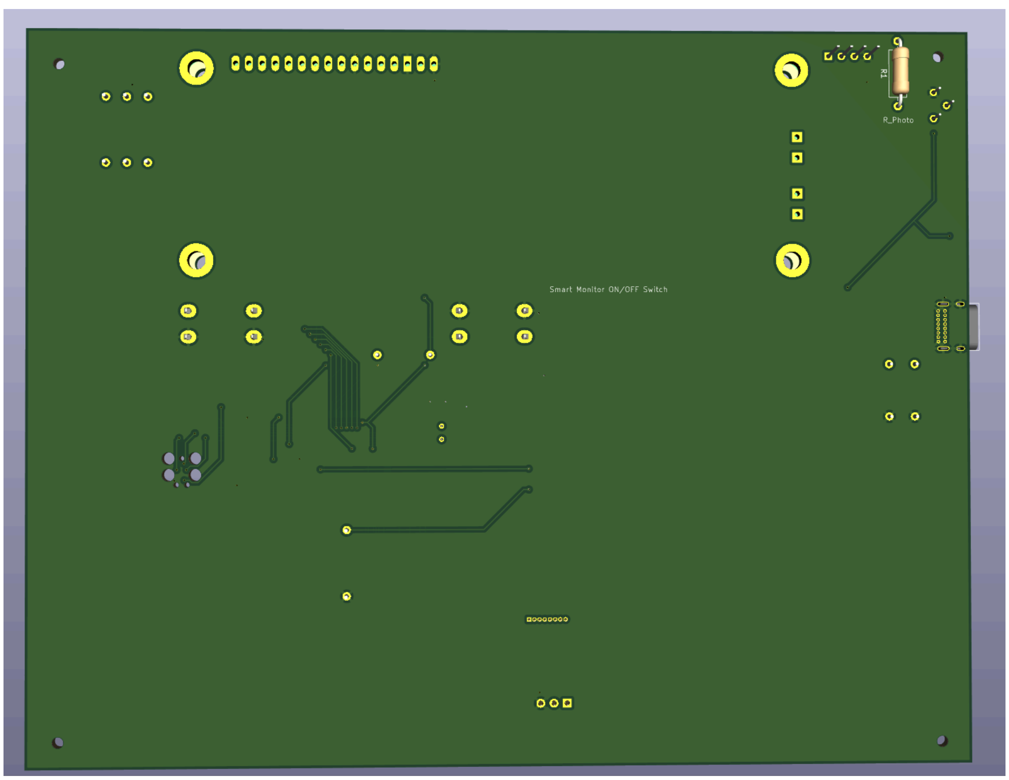


Figure 6: Back of PCB 3D Rendering

In the PCB 3D renderings, a few components are missing. Those are the key membrane, soil moisture sensor, and the 5V battery bank. These components must be connected to the board via their respective pin headers or USB port.

The figure below highlights where these components will be when connected to the PCB:

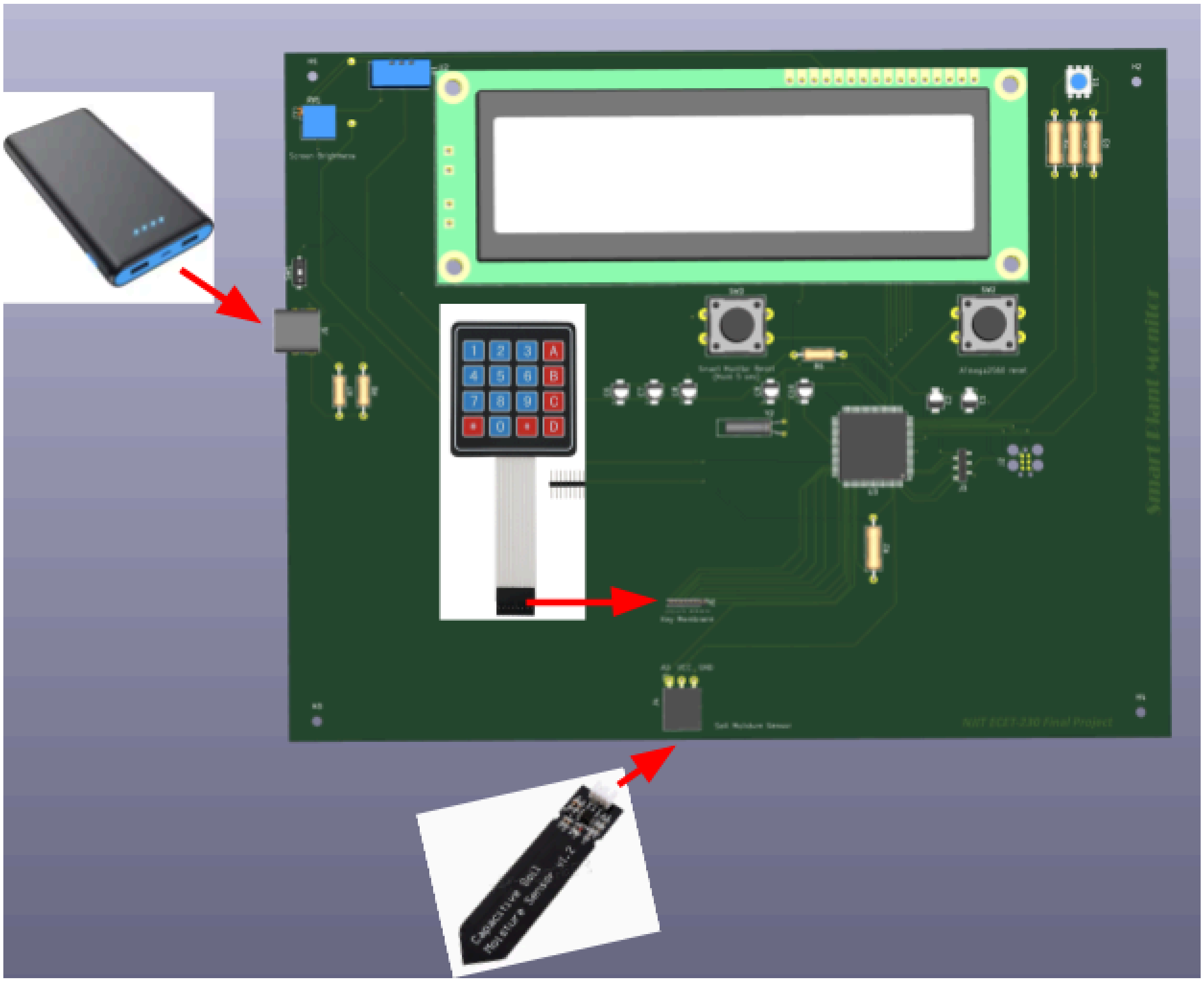


Figure 7: PCB 3D Rendering with External Components

Scenario

User Interaction Stories

When a user first receives the Smart Plant Monitor, they open the package and check that all the components are included, such as the monitor, sensors, battery, and instructions. The setup is simple and doesn't require any special tools.

To configure the monitor, the user connects a battery bank (not included) to the PCB. If the power switch is on, the Smart Plant Monitor powers on and uses the keypad to set the optimal temperature range for their plant. Soil moisture and light thresholds can also be adjusted if needed. These settings are saved so the device can monitor the plant automatically.

During normal use, the monitor measures soil moisture, temperature, humidity, and light levels. The RGB LED gives an easy-to-read visual status: LED off means the plant is in optimal levels, red indicates high temperature, blue shows low temperature, yellow warns that the soil is dry, and purple signals low light. The LED can also flash multiple colors if more than one condition is outside the optimal range.

If the device doesn't seem to work correctly, troubleshooting is straightforward. Users can check the battery bank, ensure the sensors are properly connected, and adjust thresholds as necessary.

The monitor allows both passive and active interaction. Passively, it continuously tracks plant conditions and displays status via the LED. Actively, the user can change settings, check readings, or use optional features such as data logging or connecting to a display.

Finally, the device is designed for easy servicing. The battery bank can be recharged or replaced, and sensors can be cleaned or swapped out if needed. This ensures the monitor remains reliable over time with minimal effort from the user.

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
- Purple: Needs more sunlight

Sensors:

- Soil Moisture Sensor (Capacitive 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:

- Keypad: The user can input their plants' optimal ranges for temperature using the keypad.
- Reset Button: The User can reset all plant data and re-enter values.

The monitors will read all sensor data and update 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 that the monitor is powered by the battery bank
  - When the device is deployed outdoors for less than 100 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 bank under typical sunlight conditions.

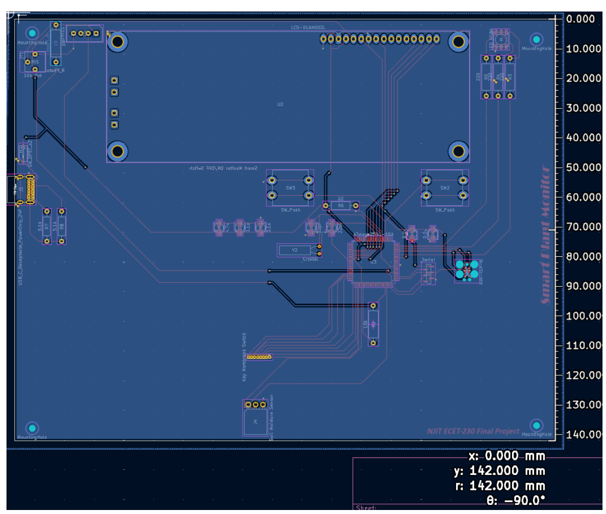
Parameters

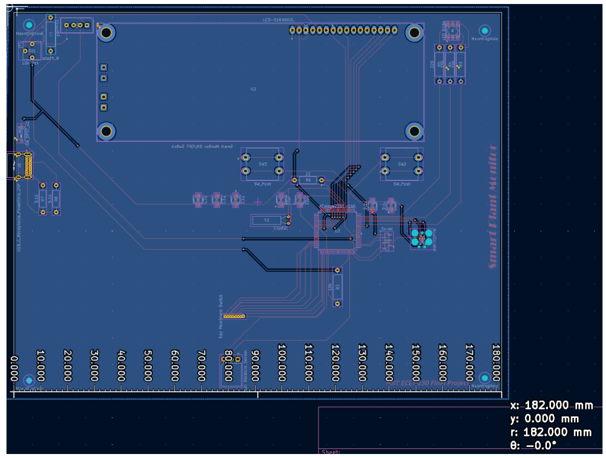
Technical

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: 142mm → 5.59 inches
    - Width: 182mm → 7.16 inches
    - 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

Below are the true dimensions of the PCB for the Smart Plant Monitor:

<table>
<tr>
<td>Height:
142mm</td>
<td>
</td>
</tr>
</table>

Width: 182mm	

Functions

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

- Soil Moisture Monitoring: The Capacitive Soil Moisture Sensor 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, a purple LED illuminates to indicate this.
- Power Management: The system is powered by a battery bank (10,000 mAh at least). This allows the system to operate for at most 100 hours before user intervention.
- User Input: The user can input their plants' optimal ranges for temperature using the 4x4 keypad.

Integration

The Smart Plant Monitor uses standard analog and digital interfaces to connect its components. Sensors such as the soil moisture sensor and LDR provide analog signals that the Arduino reads through its analog pins. The RGB LED is connected to digital PWM pins for color control. The keypad also sends signals to the microcontroller through digital pins. Power is supplied via 5V and GND rails, shared across the sensors, LED, and encoder.

The system uses basic Arduino I/O protocols to read sensor data and control outputs. No advanced communication protocols are required for this version. The DHT11 temperature and humidity sensor communicates through a simple digital protocol supported by the Arduino DHT library. The keypad uses electrical switching signals to react when keys are pressed. Overall, the Smart Plant Monitor relies on direct pin-level communication between the microcontroller and each component, keeping the integration simple and reliable.

Operational

The Smart Plant Monitor is designed for indoor and outdoor use, but it has some limitations. It should not be exposed to extreme weather conditions such as heavy rain, flooding, or extremely high temperatures beyond the sensor specifications. The device is intended for use with small to medium-sized potted plants and may not provide accurate readings for very large planters or outdoor garden beds.

The monitor operates on a low-duty cycle to conserve battery life. Sensors take readings for a user-specified interval, rather than continuously, which reduces power consumption and extends the life of the battery. The RGB LED only activates when a condition is outside the optimal range, further conserving energy. This intermittent monitoring ensures reliable operation over long periods with minimal maintenance.

Regulatory

The Smart Plant Monitor is designed to comply with general safety laws regarding small electronic devices. It operates at low voltages (5V from battery bank), which is below thresholds requiring special electrical certifications.

The device adheres to electrical and electronic component regulations, ensuring that all sensors, LEDs, and microcontrollers are used within their rated voltage and current limits. Any wireless or battery-powered components would comply with local FCC or CE requirements if included in future versions.

The Smart Plant Monitor is intended for educational and personal use, not commercial sale in its current form. Users should follow manufacturer guidelines for battery handling, sensor care, and safe disposal of electronic components to meet environmental and safety policies.

Life Cycle

The Smart Plant Monitor is designed for small-scale assembly using widely available components. The Arduino, sensors, RGB LED, keypad, and battery are sourced from standard suppliers. Components are mounted on a breadboard for prototyping or a simple PCB for future production. The assembly process is straightforward, allowing easy replication or modification.

The device is programmed using the Arduino IDE with C/C++ code. The program reads sensor data, processes it according to user-defined thresholds, and controls the RGB LED output. The keypad allows users to input settings, which are stored in memory for ongoing operation. Programming is modular, enabling updates or additional features to be integrated easily.

During use, the Smart Plant Monitor tracks environmental conditions such as soil moisture, temperature, humidity, and light levels. Data can be logged or monitored in real-time via the LED indicators. In future versions, tracking could include recording readings for analysis or remote monitoring, providing insight into plant health trends over time.

The runtime of the Smart Plant Monitor depends on the battery capacity of a battery bank. The minimum battery capacity that the bank should be rated for is 10000mAh. This allows for the monitor to run a maximum of roughly 100 hours before the battery runs low. Below are the following calculations for the battery runtime based on a battery capacity of 10000mAh and battery efficiency of 90%, 85% and 80%:

Runtime Calculation			
Battery Capacity (mAh)	10000		
Efficiency (3 different %)	0.9	0.85	0.8
Effective Current (mA)	97.47	103.20	109.66
Runtime (Hours)	102.59	96.89	91.20

Environment

The Smart Plant Monitor is designed to operate within typical indoor and outdoor temperature ranges. Extreme heat or cold outside the sensor or Arduino specifications may affect performance or accuracy.

The device should be kept away from water spills, flooding, or corrosive substances. While it monitors soil and environmental conditions, it is not fully waterproof, and exposure to liquids may damage electronic components.

The monitor is intended for potted plants, not direct exposure to rain or heavy outdoor elements. An optional enclosure for the system should prevent dust and soil from entering sensitive electronics, but full waterproofing is not implemented in this prototype.

The device runs on a 5V battery bank, which allows for extended outdoor use. Low-voltage operation reduces safety risks, and the power system is designed to ensure reliable operation of all sensors and the LED.

Starting Point

The Smart Plant Monitor builds on widely available open-source hardware and software. The Arduino platform provides a flexible microcontroller environment, and common sensors like the DHT11, capacitive soil moisture sensors, and LDRs have established libraries and code examples. This existing intellectual property allows the project to focus on integration and user-friendly design rather than developing components from scratch.

During the project, one of the objectives is to create a breadboard prototype to test sensor connections, RGB LED indicators, and keypad input. This prototype will help refine wiring, power management, and software logic. Insights gained during prototyping will guide the development of the final device, ensuring it is reliable, portable, and easy for users to operate.

Key Concerns

The primary concern for the Smart Plant Monitor is accurate and reliable monitoring of plant health. Ensuring that sensors correctly measure soil moisture, temperature, humidity, and light is critical, as incorrect readings could mislead the user and negatively affect plant care. Battery life and low-power operation are also major concerns, especially for outdoor use.

Certain design parameters are fixed to ensure functionality and usability:

- Sensor types: DHT11 for temperature/humidity, capacitive soil moisture sensor, LDR for light

- Microcontroller: Arduino Mega
- Power supply: 5V battery bank (at least 10000mAh)
- RGB LED output: Must indicate plant status clearly using color codes (green, red, blue, yellow, purple)
- Size constraints: Maximum height 8 inches, maximum width 8 inches, for portability and fit in a plant pot

These parameters provide clear boundaries for the design while allowing flexibility in other areas, such as enclosure design or additional features.

Future

After the Smart Plant Monitor project is complete, future work could focus on enhancing functionality and user experience. Potential improvements include adding a small display to show real-time sensor readings, integrating wireless connectivity to log data or send notifications to a smartphone, and developing an automatic watering system that responds directly to soil moisture levels.

Other ideas include expanding compatibility with different plant types, allowing users to customize thresholds for light, temperature, and moisture, and refining the enclosure for better durability and weather resistance. These future enhancements would make the Smart Plant Monitor more versatile, user-friendly, and suitable for a wider range of plant care applications.

One of our initial ideas for the products was for them to be solar-powered. As it currently stands, our product is powered by a 5V battery bank. In the future, adding a panel battery would be beneficial. This would allow the product to be self-sustaining (if the automatic watering system is also designed), and it is environmentally friendly. This would work, being that plants need sunlight to survive. A solar panel battery would store energy for the moments where there is no sunlight available (nighttime or cloudy days).

A self-sustainable product limits user interaction, improving the convenience of our product and making it more user-friendly. The importance of designing an environmentally friendly plant monitoring system is that it will have less of a negative impact on the planet. Many companies have started to turn to renewable and clean energy sources to improve long-term sustainability, be more responsible, and appeal more to the consumer.

The final addition that is possible for the future of the product is an enclosure for the PCB. An enclosure would limit the risk of physical damage done to the product as well as issues such as overheating, corrosion, or weather damage. Having a PCB in an enclosure also improves the reliability of the PCB by reducing any interference from EMI and RFI. PCB shields are often used for this reason. On a simpler note, having an encore would improve the visual aesthetics of the product by making it look cleaner and more compact.

Glossary

- Sensor: A device that detects and measures physical properties such as temperature, light, or moisture.
- Microcontroller: A small computer on a single integrated circuit that controls devices and processes data.
- RGB LED: A light-emitting diode that can display red, green, and blue colors to indicate different statuses.
- Battery: A portable power source that supplies electricity to the device.
- Prototype: An early version of a device used to test and refine design and functionality.
- Soil Moisture Sensor: Measures the water content of soil to determine if a plant needs watering.
- 4x4 Keypad: Matrix-style input device for embedded systems.
- DHT11 Sensor: Measures ambient temperature and humidity.
- LDR (Light Dependent Resistor): A sensor that changes its resistance based on the amount of light, used to measure sunlight intensity.
- Duty Cycle: The frequency or interval at which sensors take readings to conserve power.

Open Questions

- What is the optimal sampling interval for each sensor to balance accuracy and battery life?
- What is the final enclosure design, and how will it protect the device from dust, moisture, or accidental spills?
- Should data logging or wireless communication be implemented now, or reserved for future versions?