ECET 230-001
Professor Hansis

Smart Plant Monitor

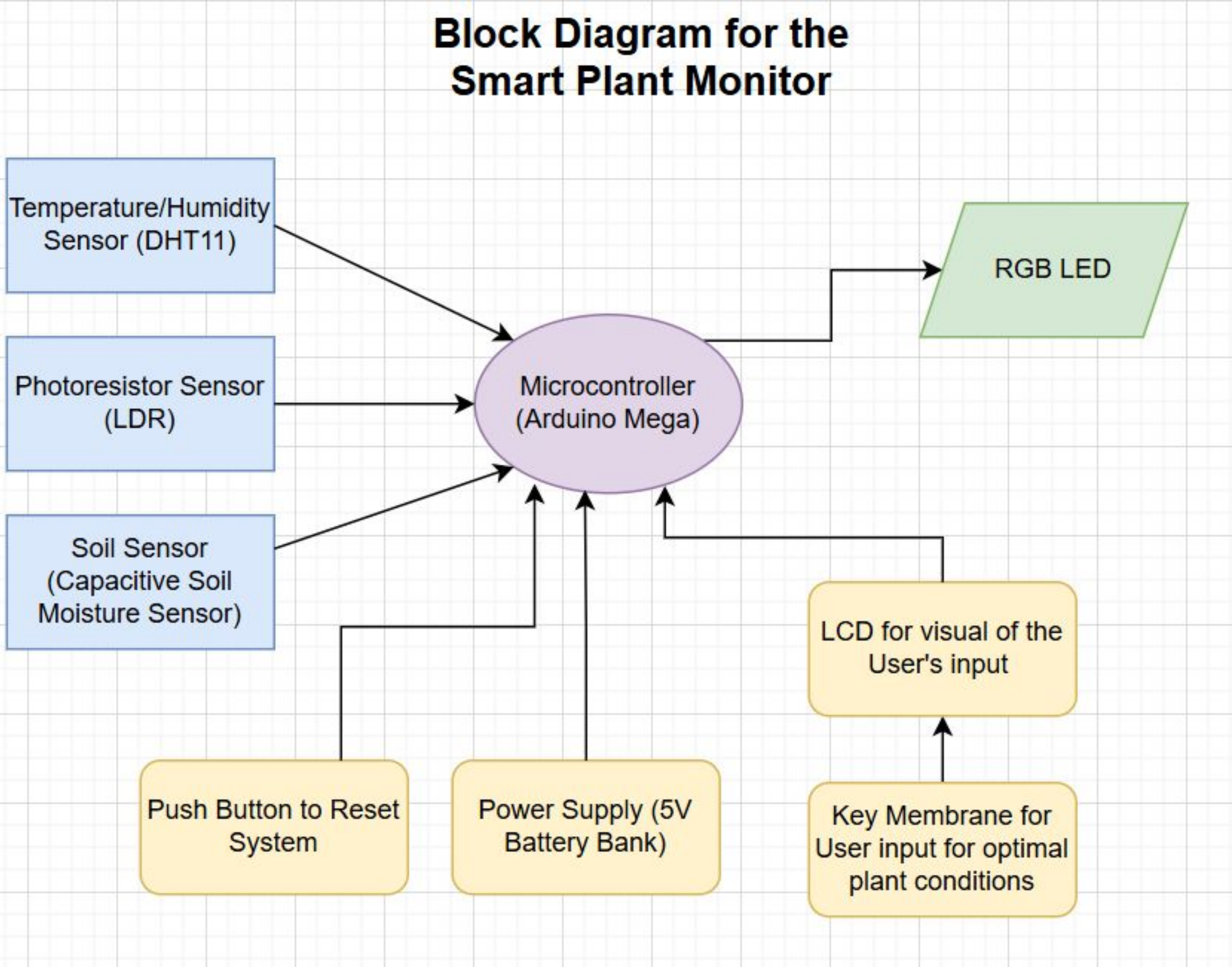
Rachel Romeo
Hailey Horvath
12/19/25

Smart Plant Monitor Overview

What is the Smart Plant Monitor?

- The Smart Plant Monitor will be a simple, portable device that aims to monitor temperature, soil moisture and sunlight levels to keep plants healthy.
- The sensors will collect environmental data and give the user continuous feedback through the use of an RGB LED.
- The use of the project will make it easier to take care of plants.

Block Diagram



Development Process

Planning

Defined the functional requirements of the monitor

Design

Decided on components, software, and constraints.

Created Schematic and PCB drawings to outline all components

Implementation

Used Arduino Mega and C++ code to bring project idea to life.

Testing

Tested the design and made adjustments based on test results

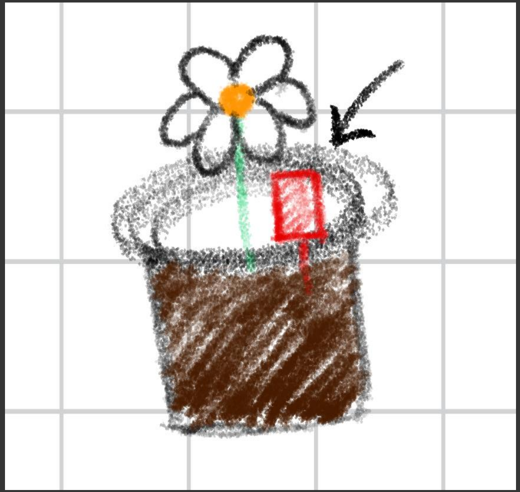
Goal

Created a Working-Prototype for the Smart Plant Monitor ready to be turned into a PCB

Planning

<u>Key Functions:</u>

- Continuous Monitoring
  - Soil, Temperature, Sunlight
- Plant Status Feedback
  - RGB LED
- Low-Maintenance Operation
  - Battery Bank
- Portable
  - Small, no larger than a phone



Planning

- How the RGB LED works:

Everything is in Optimal Range	RGB LED is off
Current Temperature is too hot	RGB LED turns red
Current Temperature is too cold	RGB LED turns blue
Current Soil Moisture is too dry	RGB LED turns yellow
Current Light Level is too dark	RGB LED turns purple

Hardware Design

Arduino Mega 2560:
Plenty of I/O pins for multiple sensors, display, and user interface.
Easy to program and widely supported.

Photoresistor (LDR):
Detects marginal light levels to ensure plants get sufficient light.
Low-cost and easy to integrate.

4×4 Keypad:
Allows user input to set optimal levels and interval readings

DHT11 Temperature & Humidity Sensor:
Cost-effective, simple to use.
Provides accuracy for plant monitoring.

16×2 LCD Display:
Displays sensor readings clearly to the user.
Compact and easy to interface with Arduino.

Reset Button:
Manual reset for the Smart Plant Monitor, resetting the optimal levels and interval readings

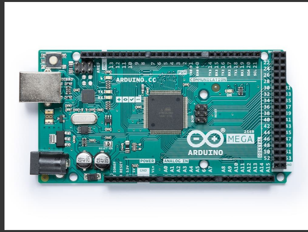
Capacitive Soil Moisture Sensor:
Non-corrosive design, more durable than resistive sensors.
Gives consistent readings of soil moisture.

RGB LED:
Provides visual feedback of plant status.
Adds intuitive, quick-to-read indicators.

USB-C Power Input:
Allows users to connect a Battery Bank to power the Smart Plant Monitor

Hardware Design

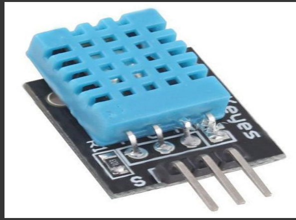
Arduino Mega 2560



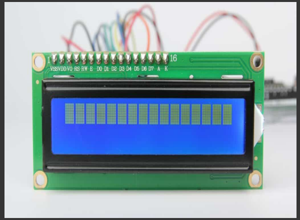
Photoresistor

Keypad

DHT11

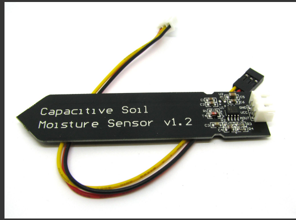


LCD Display

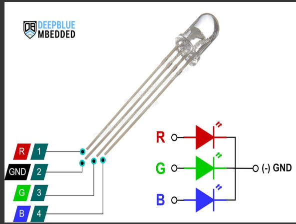


Push Button

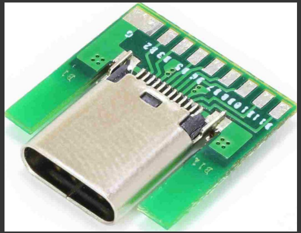
Soil Moisture Sensor

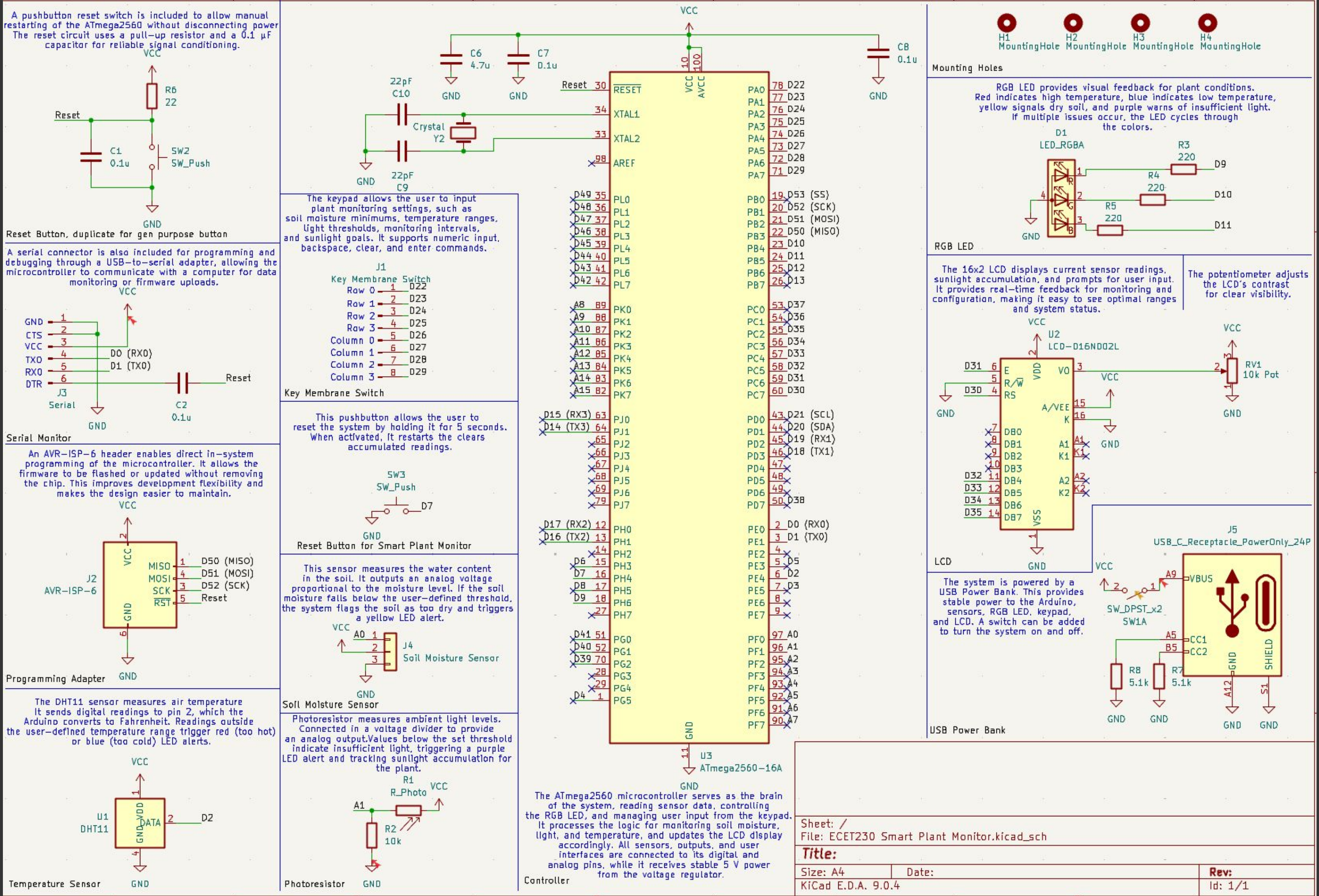


RGB LED



USB-C Input




A pushbutton reset switch is included to allow manual restarting of the ATmega2560 without disconnecting power. The reset circuit uses a pull-up resistor and a 0.1 µF capacitor for reliable signal conditioning.
VCC
R6
22
Reset
C1
0.1u
SW2
SW_Push
GND
Reset Button, duplicate for gen purpose button
A serial connector is also included for programming and debugging through a USB-to-serial adapter, allowing the microcontroller to communicate with a computer for data monitoring or firmware uploads.
GND
CTS
VCC
TXO
RXO
DTR
J3
Serial
D0 (RX0)
D1 (TX0)
Reset
C2
0.1u
Serial Monitor
An AVR-ISP-6 header enables direct in-system programming of the microcontroller. It allows the firmware to be flashed or updated without removing the chip. This improves development flexibility and makes the design easier to maintain.
J2
AVR-ISP-6
MISO
MOSI
SCK
RST
D50 (MISO)
D51 (MOSI)
D52 (SCK)
Reset
Programming Adapter
The DHT11 sensor measures air temperature. It sends digital readings to pin 2, which the Arduino converts to Fahrenheit. Readings outside the user-defined temperature range trigger red (too hot) or blue (too cold) LED alerts.
U1
DHT11
DATA
D2
Temperature Sensor
The keypad allows the user to input plant monitoring settings, such as soil moisture minimums, temperature ranges, light thresholds, monitoring intervals, and sunlight goals. It supports numeric input, backspace, clear, and enter commands.
J1
Key Membrane Switch
Row 0 D22
Row 1 D23
Row 2 D24
Row 3 D25
Column 0 D26
Column 1 D27
Column 2 D28
Column 3 D29
Key Membrane Switch
This pushbutton allows the user to reset the system by holding it for 5 seconds. When activated, it restarts the clears accumulated readings.
SW3
SW_Push
D7
Reset Button for Smart Plant Monitor
This sensor measures the water content in the soil. It outputs an analog voltage proportional to the moisture level. If the soil moisture falls below the user-defined threshold, the system flags the soil as too dry and triggers a yellow LED alert.
J4
Soil Moisture Sensor
Soil Moisture Sensor
Photoresistor measures ambient light levels. Connected in a voltage divider to provide an analog output.Values below the set threshold indicate insufficient light, triggering a purple LED alert and tracking sunlight accumulation for the plant.
R1
R_Photo
R2
10k
A1
Photoresistor
C6
4.7u
C7
0.1u
C8
0.1u
22pF
C10
Crystal
Y2
22pF
C9
RESET
XTAL1
XTAL2
AREF
U3
ATmega2560-16A
The ATmega2560 microcontroller serves as the brain of the system, reading sensor data, controlling the RGB LED, and managing user input from the keypad. It processes the logic for monitoring soil moisture, light, and temperature, and updates the LCD display accordingly. All sensors, outputs, and user interfaces are connected to its digital and analog pins, while it receives stable 5 V power from the voltage regulator.
Controller
H1 MountingHole
H2 MountingHole
H3 MountingHole
H4 MountingHole
Mounting Holes
RGB LED provides visual feedback for plant conditions. Red indicates high temperature, blue indicates low temperature, yellow signals dry soil, and purple warns of insufficient light. If multiple issues occur, the LED cycles through the colors.
D1
LED_RGBA
R3 220 D9
R4 220 D10
R5 220 D11
RGB LED
The 16x2 LCD displays current sensor readings, sunlight accumulation, and prompts for user input. It provides real-time feedback for monitoring and configuration, making it easy to see optimal ranges and system status.
The potentiometer adjusts the LCD's contrast for clear visibility.
U2
LCD-016N002L
RV1
10k Pot
LCD
The system is powered by a USB Power Bank. This provides stable power to the Arduino, sensors, RGB LED, keypad, and LCD. A switch can be added to turn the system on and off.
SW_DPST_x2
SW1A
J5
USB_C_Receptacle_PowerOnly_24P
R8
5.1k
R7
5.1k
USB Power Bank
Sheet: /
File: ECET230 Smart Plant Monitor.kicad_sch
Title:
Size: A4
Date:
Rev:
KiCad E.D.A. 9.0.4
Id: 1/1

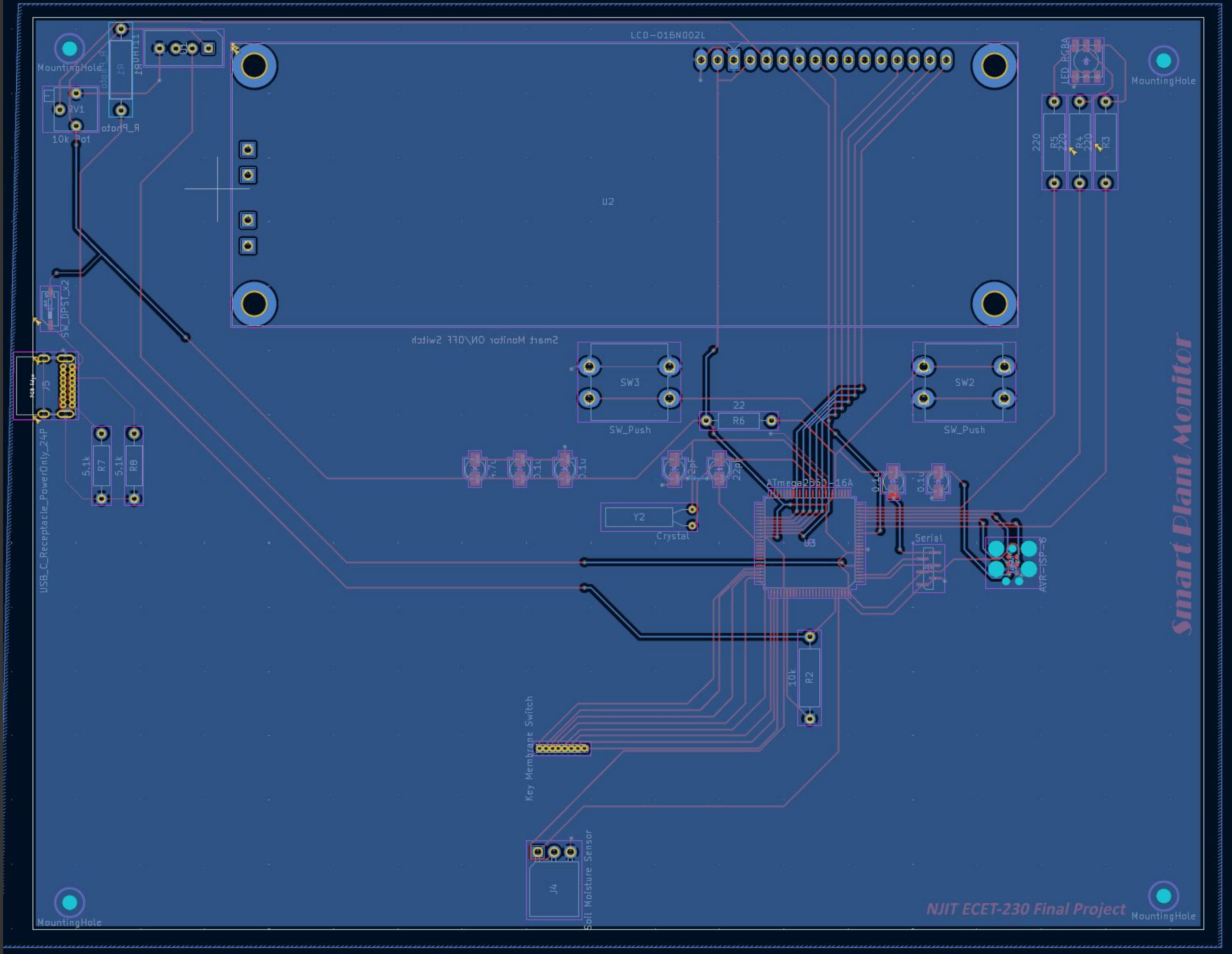
PCB Design

- Dimensions:
  - Height: 142mm → 5.59 inches
  - Width: 182mm → 7.16 inches
  - Weight: 50-300 grams

- Power Management:
  - Powered by a Battery Bank (about 100 hours before charging is needed)

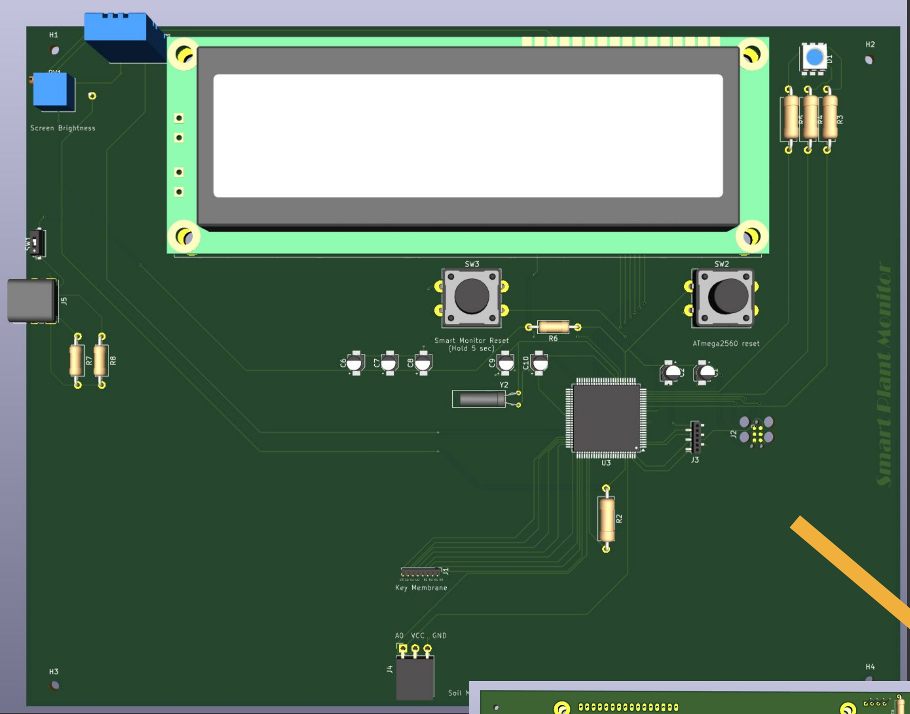
- Component Placement:
  - Spaced out to increase reliability
  - GND Copper Fill to reduce noise and tracks

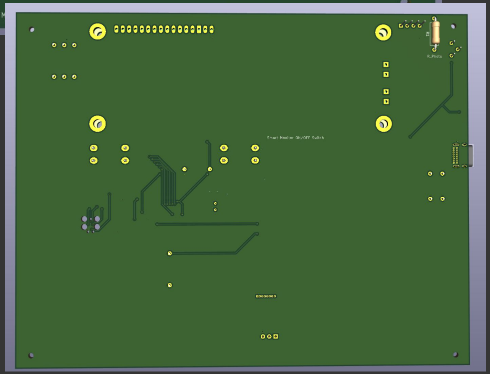
PCB Layout

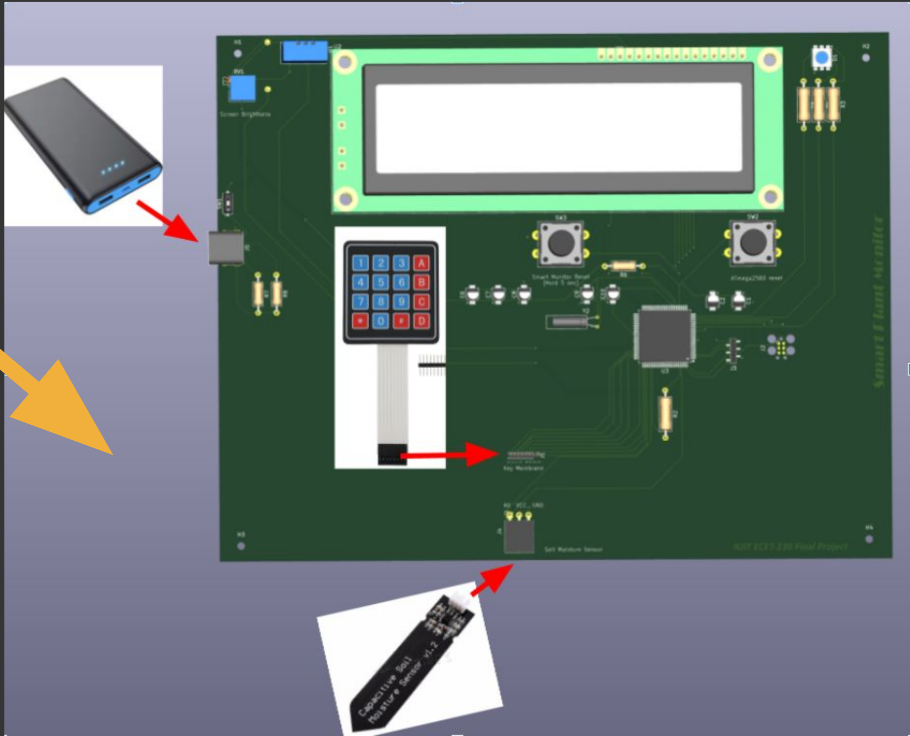


LCD-016N002L
U2
Smart Monitor ON/OFF Switch
SW3
SW2
SW_Push
SW_Push
R6
22
ATmega2560-16A
U3
Y2
Crystal
Serial
AVR-ISP-6
R2
10k
Key Membrane Switch
J4
Soil Moisture Sensor
R7
R8
5.1k
5.1k
USB_C_Receptacle_PowerOnly_24P
J5
SW_DPST_x2
RV1
10k Pot
R_Photo
R5
R4
R3
220
LED_RGBA
MountingHole
MountingHole
MountingHole
MountingHole
Smart Plant Monitor
NJIT ECET-230 Final Project

3D Rendering







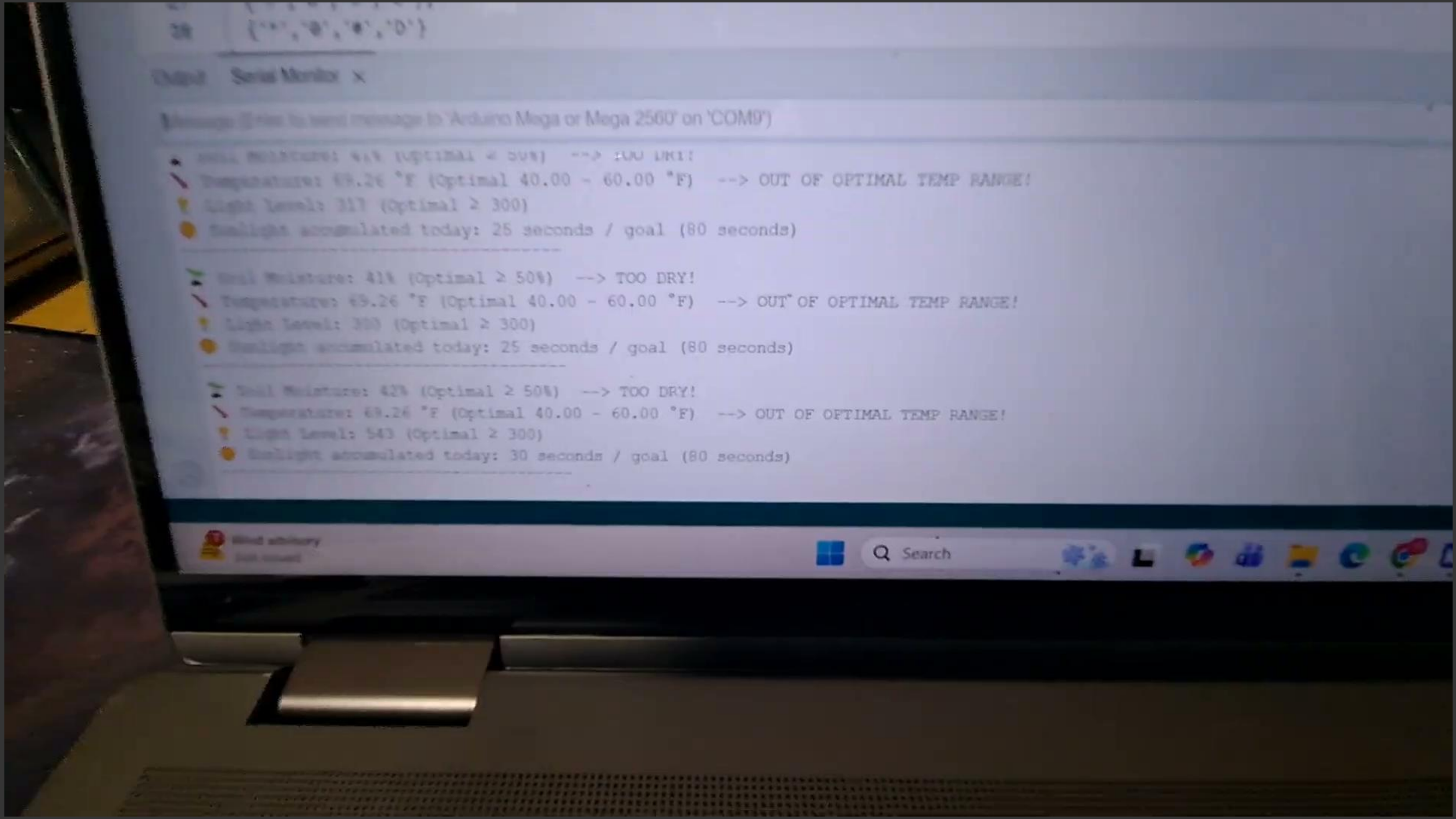
Implementation

- Operation Modes:
  - Real Mode and Test Mode
- Measurement Intervals
  - User defined using key membrane
- How the Monitor Detects “Nighttime”
  - Nighttime is determined in the code when light levels remain below 50 for a continuous period.
    - Test mode: 60 consecutive seconds
    - Real mode: 2 consecutive hours

```
// --- MODE SWITCH ---
#define TEST_MODE          // Uncomment for test mode (seconds instead of hours)
//#define REAL_MODE        // Comment this line for test mode
```

```
// Adjustable night duration
#ifdef TEST_MODE
const unsigned long nightResetSeconds = 60;
#else
const unsigned long nightResetSeconds = 7200;
#endif
```

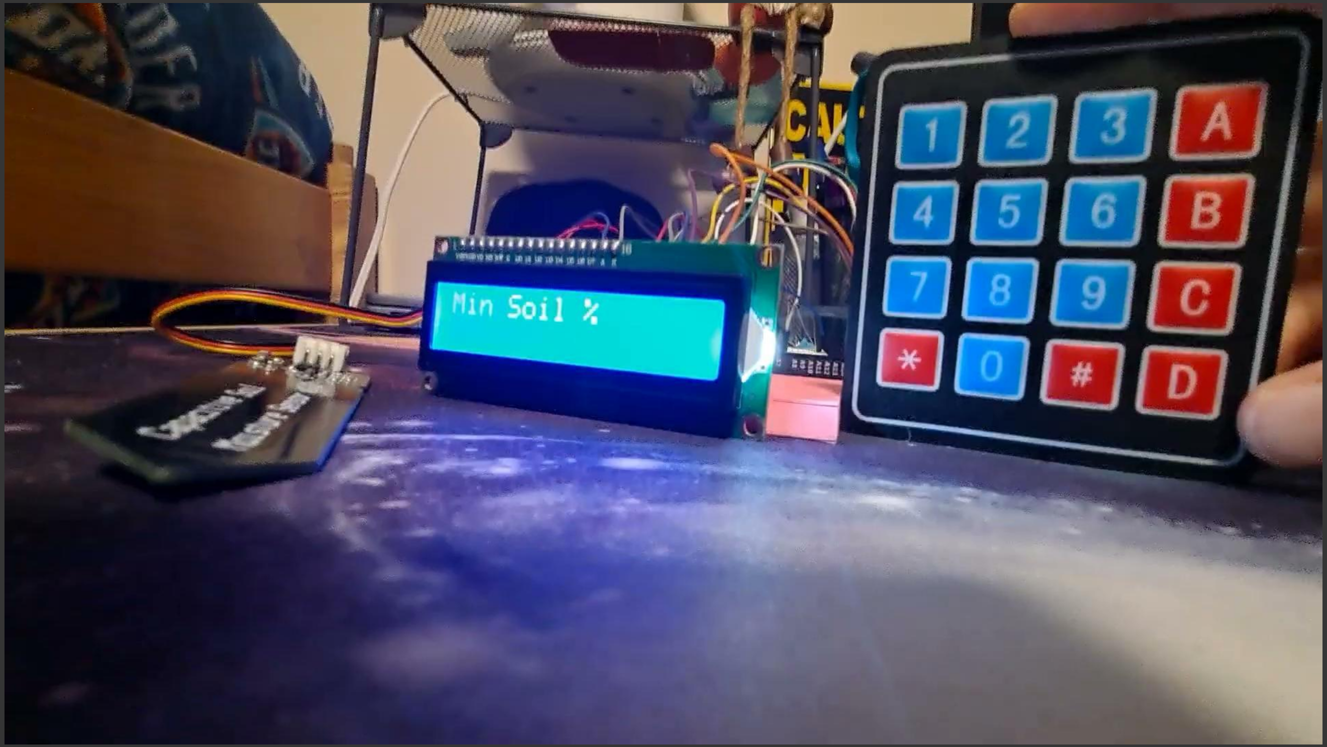
Implementation



Testing

- Before implementing each component in the design was first tested with its own code.
- This allowed troubleshooting, figuring out which components work and which ones didn’t.
- Testing the full code revealed potential issues each time:
  - *What if I input the wrong number into the key membrane?*
  - *What if the number I imputed as the higher temperature bound is actually lower than the lower temperature bound?*

Testing



Functionality of the Product

✔ Requirements Met

- Continuous monitoring: soil moisture, temperature, humidity, light, and daily sunlight
- RGB LED provides plant status feedback (colors + flashing sequence)
- Low-maintenance operation: 5V battery bank (~100 hours)
- LCD display shows sensor readings
- Keypad allows user to set thresholds
- Test mode works for safe simulation

✖ Requirements Not Met

- Prototype size slightly wider than planned
- Battery runtime falls short of 1-week goal
- Solar panel integration not implemented

Challenges & Solutions

Issues	**Solutions**
IR sensor and Remote Not Working	Tried for a few weeks but then the decision was made to switch components
Reset Button not working on Keypad	Added separate push button for reset button.
9V battery would only last 1-2 hours	Switched to a battery bank which increased runtime
Length of night is built into the code, users can not set how long night is.	After research and time constraints, it was better to hardcode a nighttime mode

Future Steps

Solar Power Integration	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.
Waterproof / Weather-Resistant Housing	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.
Wireless Data Transmission	Possible wireless data transmission could be adding a real time clock display that logs data and send it directly to user mobile devices. Could also include an automatic watering system that would respond to the soil moisture sensor.

Lessons Learned

- The importance of reading data sheets for component selection.
- The importance of test codes before implementing components.
- We were able to grow our knowledge of C++.
- The benefits of a Power Budget.
- Group work requires a lot of communication and dedication from all members.

Detailed Specifications:

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃，1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

Any questions?
Ask away!

Thank you