



ACE6263

EMBEDDED IoT SYSTEMS & APP

Assignment

Submission date :20-6-2025

No	Name	Student ID	Major
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3	MAHENDRAN A/L SURESH	1191101755	TE

Smart Soil Moisture Monitoring System

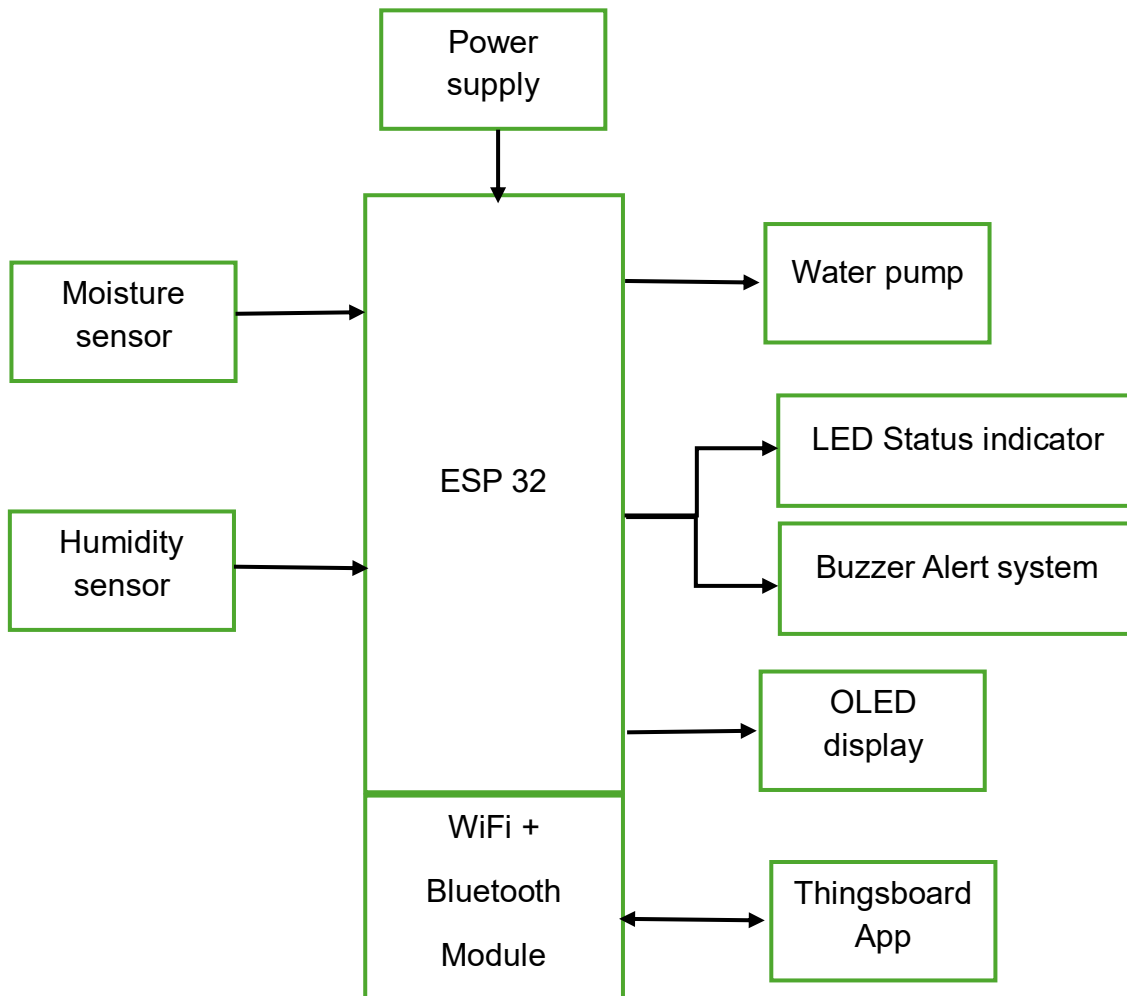
Introduction:

The Embedded IoT-based Smart Soil Moisture Monitoring System is a project aimed at automating plant care through real-time monitoring of environmental and soil conditions. This system seeks to enhance farming productivity and decrease manual work by ensuring that plants are given sufficient water according to real soil moisture conditions. It is especially beneficial for home gardening, greenhouse management, and small-scale agricultural uses.

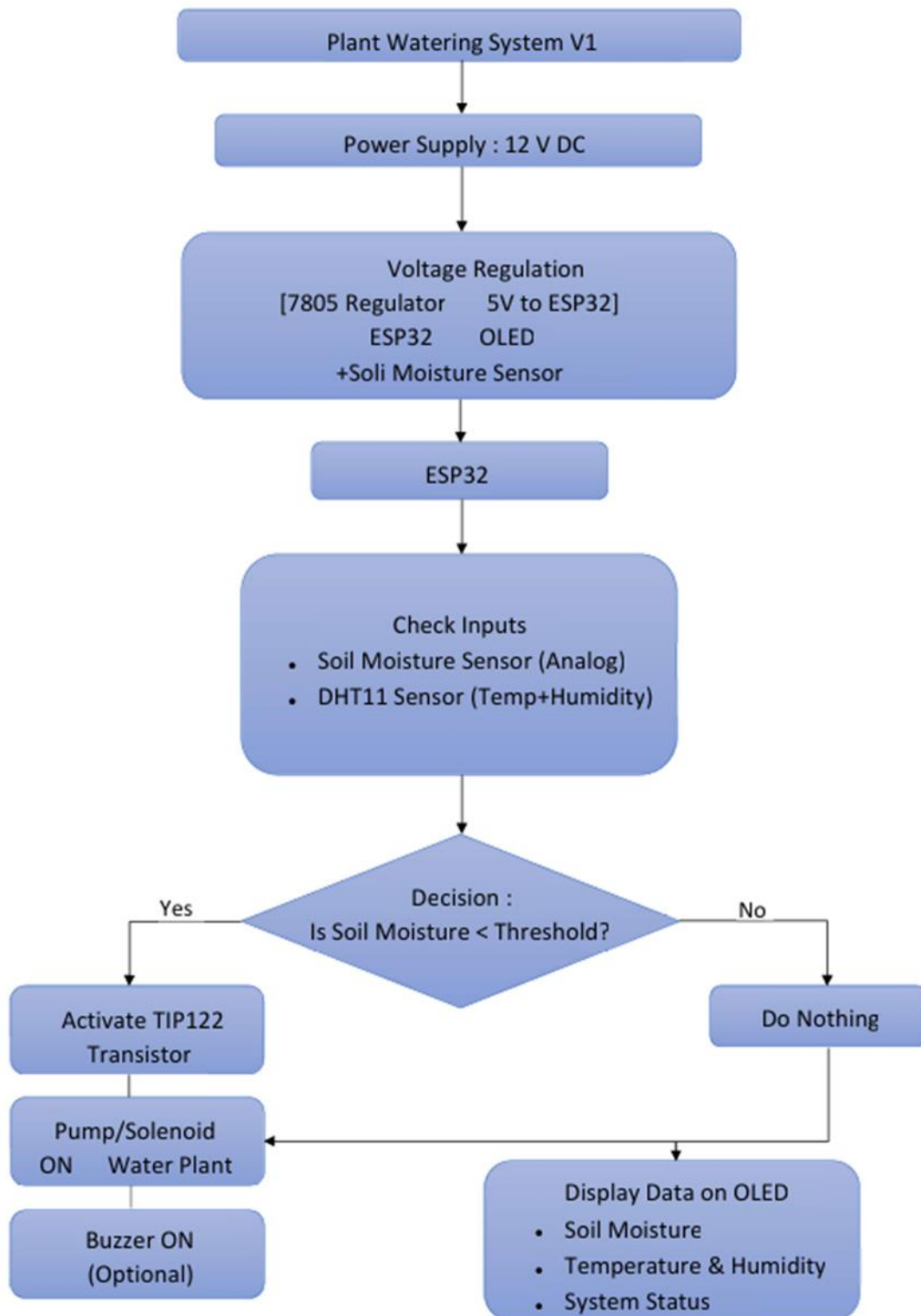
At the heart of this project is the ESP32-WROOM-32 microcontroller, offering processing capabilities and wireless communication. A soil moisture sensor measures the amount of water in the soil, whereas a DHT11 sensor tracks the surrounding temperature and humidity. When the ground gets too arid, the system automatically triggers a small water pump to water the plant. Visual information is displayed on a 0.96" OLED screen that presents real-time sensor data. Moreover, an LED and a buzzer serve to offer visual and auditory notifications for low moisture levels or system operations.

By combining these elements, the system delivers an effective, immediate solution for intelligent irrigation, assisting in water conservation and encouraging healthier plant development. This project showcases the real-world use of embedded systems and IoT in precision agriculture

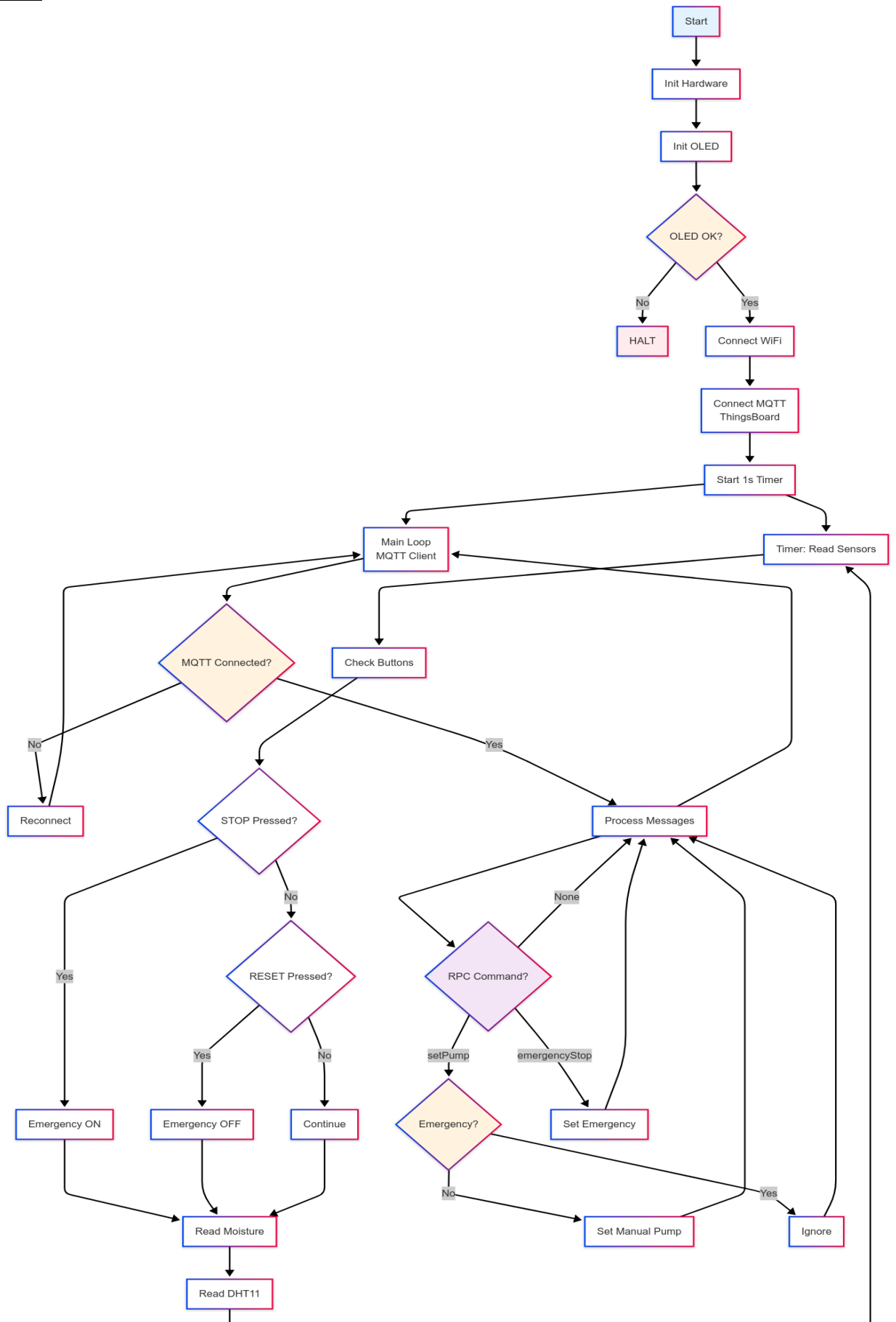
Block diagram:

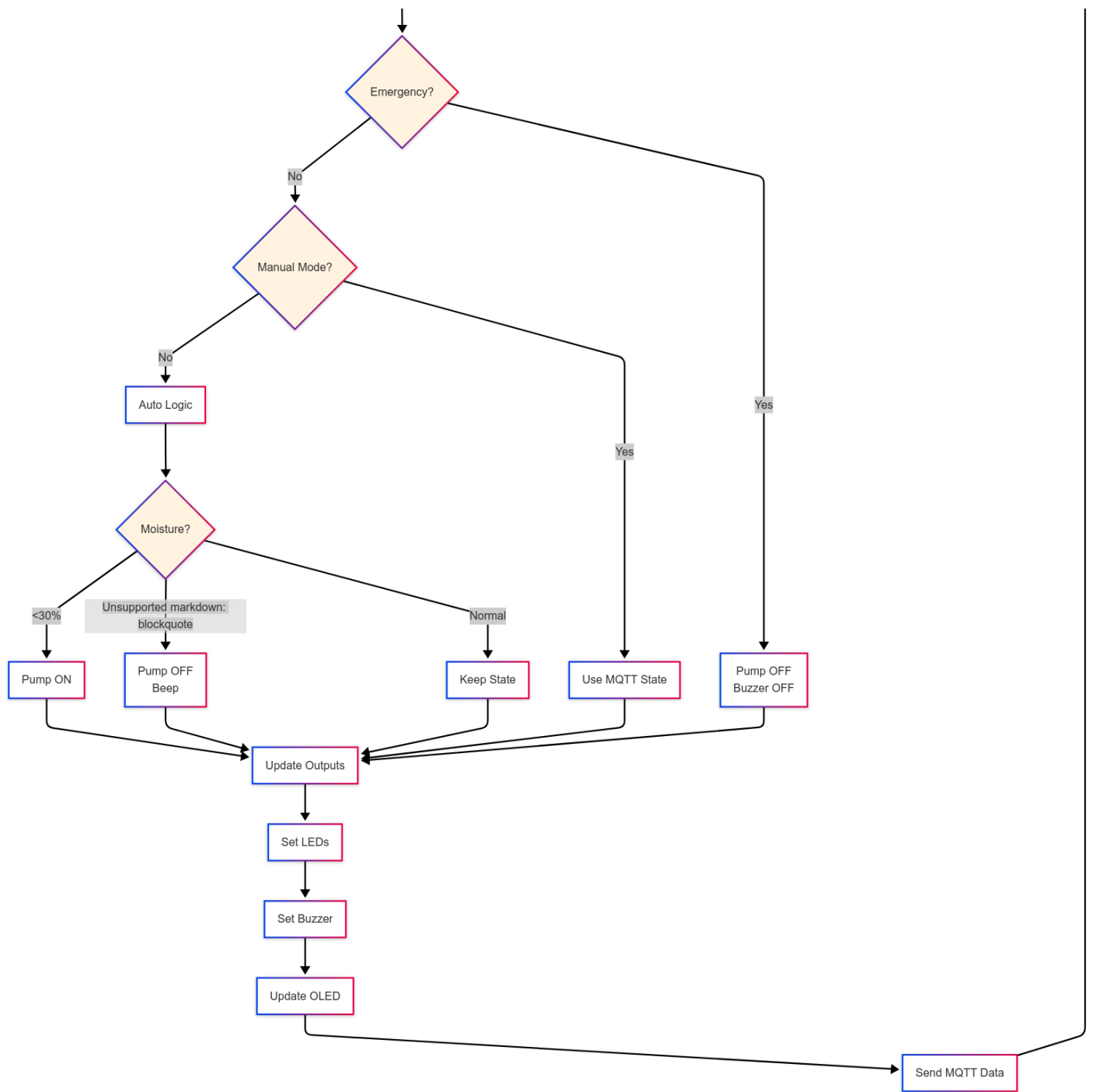


Flowchart



Flowchart





Results

System Overview and Behavior

The Smart Soil Moisture Monitoring System was assembled and tested using the ESP32-WROOM-32 microcontroller. It successfully collected data from the DHT11 sensor (temperature and humidity) and the soil moisture sensor. Real-time values were displayed on the 0.96" OLED screen. When the soil was dry, the system automatically activated the mini water pump, confirming that the moisture threshold logic worked as intended. The LED and buzzer also functioned correctly, providing visual and auditory alerts.

Test Case 1: Dry Soil Condition

- **Initial Conditions:**
 - Soil moisture: below threshold (dry < 30)
 - Temperature: 30°C
 - Humidity: 45%
- **System Response:**
 - OLED showed live readings
 - Pump activated automatically
 - Red LED turned ON and white LED turn OFF
 - Buzzer buzzed briefly
- **Result:** All components responded correctly to the dry condition.

Test Case 2: Moist Soil Condition

- **Initial Conditions:**
 - Soil moisture: above threshold (wet > 70)
 - Temperature: 29°C
 - Humidity: 50%
- **System Response:**
 - OLED updated values
 - Pump remained OFF
 - White LED turn ON and red LED turn OFF
 - No buzzer sound
- **Result:** The system conserved water and correctly identified no need for irrigation.

Test Case 3: Continuous Monitoring

- **Setup:** System left running for 3 hours in a plant pot.
- **Observed Behavior:**
 - Periodic updates on OLED
 - Pump triggered 3 times based on soil dryness
 - Data sent to ThingsBoard (if configured)
- **Result:** Demonstrated long-term monitoring and autonomous decision-making.

Display Output

- The OLED clearly displayed:
 - "Soil Moisture: XX%"
 - "Temp: XX°C | Humidity: XX%"
 - "Status: Pump ON/OFF"
- Display was readable under indoor lighting and updated every few seconds.

Reliability & Responsiveness

- **System Delay:** < 1 second between detection and actuation
- **Wi-Fi Connectivity:** Stable with minimal lag
- **Power Supply:** 5V via USB or regulated adapter; system ran continuously without failure.

Conclusion

The Smart Soil Moisture Monitoring System effectively accomplished its objective of automating irrigation according to current environmental conditions. The system integrated essential sensors and actuators with the ESP32-WROOM-32, allowing it to accurately detect soil moisture, monitor temperature and humidity, and activate the mini water pump as needed to respond appropriately.

The incorporation of a 0.96" OLED display enhanced system engagement, enabling users to access live data easily. The addition of an LED and buzzer enhanced reliability with visual and audio notifications. Throughout the testing phase, the system reliably reacted to varying soil conditions and showcased the effectiveness of integrated IoT in precision farming.

In summary, this project emphasizes that cost-effective parts and basic logic can produce an effective and expandable smart agriculture system. It encourages water-saving practices, decreases physical work, and establishes the groundwork for more sophisticated IoT-driven farming systems. Upcoming enhancements might feature a mobile app interface, automated scheduling, or solar-powered functionality to improve system sustainability and user-friendliness.

BILL:

Bill To
Cash Sale

Invoice Details
Invoice No. : 21424
Date : 29-04-2025

#	Item name	Item Code	Quantity	Unit	Price/ Unit	Amount
1	RESISTOR 0.25W 5% MIX		3	Pcs	RM 0.10	RM 0.30
2	BREADBOARD 400HOLE 8.3*5.5CM	BB-400	1	Pcs	RM 4.50	RM 4.50
3	ML CAP 104 50V 0.1UF		2	Pcs	RM 0.20	RM 0.40
4	BATTERY SNAP 9V	BS9V	1	Pcs	RM 0.60	RM 0.60
5	WIFI + BLUETOOTH MODULE	ESP32	1	Pcs	RM 35.00	RM 35.00
6	TACT SWITCH 6*6*5MM 4PIN	TS-060605	1	Pcs	RM 0.40	RM 0.40
7	CH-2 TERMINAL BLOCK 2WAY	CH-2	5	Pcs	RM 0.30	RM 1.50
8	TIP122 TRANSISTOR TO-220	TIP122	1	Pcs	RM 2.00	RM 2.00
9	JUMPER WIRE 10WAY		6	Pcs	RM 2.00	RM 12.00
Total			21			RM 56.70

Invoice Amount In Words

Fifty Six decimal Seven only

Terms and Conditions

GOODS SOLD AND DELIVERED ARE NOT RETURNABLE OR
EXCHANGEABLE.
THANKS FOR DOING BUSINEES WITH US!

Sub Total RM 56.70

Total RM 56.70

Received RM 56.70

Balance RM 0.00

Payment mode EWALLET

AISZZY ELECTRONICS
 SAG377756-H
 13A JALAN KRISTAL 17/L SEKSYEN 7
 40000 SHAH ALAM SELANGOR
 TEL : 03-55244213
 INQUIRY : AISZZYELECTRONIC@GMAIL.COM

SALE INVOICE

WALK-IN

RECEIPT # CS00017874 DATE 27/04/2025
 SALESPERSON TIME 13 58 00
 CASHIER: USER

ITEM	QTY	U/P	AMOUNT
SEN-MOD-0079 TEMPERATURE & HUMIDITY MODULE DHT11	1	10.00	10.00
REL-MOD-0004 RELAY MODULE 2 CHANNEL 5V LOW TRIGGER	1	10.50	10.50
RES-1/4W-1010 RES 1K	4	0.10	0.40
RES-1/4W-2003 RES 200	2	0.10	0.20
LED-RD-0003 RED LED DIFFUSED 5MM	4	0.35	1.40
CAP-EL-0003 ELECTROLYTIC 100UF 16V	2	0.50	1.00
TRAN-0017 TIP 120 TO-220 NPN 80V 5A	1	2.00	2.00
IC-0056 LM 7805 TO-220	1	3.00	3.00
SWH-0021 SELF PUSH RESET SWITCH 2 PIN 12MM PBS-11A	1	2.50	2.50
TRAN-0007 BC 547 NPN TO-92	1	0.50	0.50
DIO-0005 1N4007	1	0.30	0.30
JMW-10-0001 10CM FEMALE TO FEMALE 10PCS	1	2.30	2.30
JMW-10-0002 10CM MALE TO FEMALE 10PCS	1	2.30	2.30
JMW-10-0003 10CM MALE TO MALE 10PCS	1	2.30	2.30
JMW-30-0003 30CM MALE TO MALE 10PCS	2	2.80	5.60
JMW-30-0001 30CM FEMALE TO FEMALE 10PCS	2	2.80	5.60
JMW-20-0001 20CM FEMALE TO FEMALE 10PCS	1	2.50	2.50
JMW-20-0002 20CM MALE TO FEMALE 10PCS	1	2.50	2.50
JMW-20-0003 20CM MALE TO MALE 10PCS	1	2.50	2.50

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WALK-IN

RECEIPT # CS00017874 DATE 27/04/2025
 SALESPERSON TIME 13 58 00
 CASHIER: USER

ITEM	QTY	U/P	AMOUNT
JMW-30-0002 30CM MALE TO FEMALE 10PCS	2	2.80	5.60
TOTAL QTY:	32		
SUB-TOTAL :			79.00
DISC :			0.00
TAX :			0.00
ROUNDING :			0.00
TOTAL :			79.00
CASH :			100.00
CHANGE :			21.00

GOODS SOLD ARE NOT RETURNABLE
 / REFUNDABLE. THANK YOU.

Tang chin wen (1191201278)

I am Tang Chin Wen; I am the leader of Group 4. The project we are working on is a smart watering system. In this project, I am responsible for the soil moisture sensor and the code of the humidity sensor. I understand that the humidity of the air will affect the humidity of the soil. The lowest soil humidity of plants is (20-30%) and the highest soil humidity of plants is (70-80%). So I set the soil humidity code of our soil humidity sensor to (30-70%). If the soil humidity is lower than 30%, the red LED will light up as a reminder. If the soil humidity is higher than 70%, the white LED will light up as a reminder. I also set up two button systems in this project. The first is an emergency button system to prevent the water pump from continuing to discharge water when the soil humidity is higher than 70%. Currently, the emergency button is needed. After the pump is repaired, we can press the reset button to resume the operation of the pump.

Because of this project, I had the opportunity to use thingsboard. This was my first time using thingsboard and I was not very familiar with it, so I gave it to my teammate Thanesh to write the code to connect to thingsboard. Since it was not his first time using thingsboard, I learned from him how to use esp32 to connect to Wi-Fi or Bluetooth and then connect to thingsboard to check the moisture of our soil directly from the phone or computer. Although I did not write the code, I was also responsible for designing the dashboard because I wrote the codes for soil moisture sensor, humidity sensor, emergency button and reset, so I knew what widgets were needed in the dashboard.

In this project, I also learned how to be a good leader. Aside from the usual tasks like assigning works to the members and leading them during the progress, I also learned how to be patient in communicating with teammates. Even though it started unpleasantly, everyone was cooperative in doing the circuit all together. The most difficult part of the circuit is the water pump part because our water pump is 5 voltages but the supply voltage of our entire circuit is higher than 5V. The voltage supplied by our entire circuit is 12V, so we discussed using npn transistors to step down the voltage to protect all components.

THANESHWARAN A/L RAVICHANDRAN (1201101420)

In the Smart Soil Moisture Monitoring System project, my main task was to guarantee the effective deployment of the Wi-Fi communication system with the ESP32-WROOM-32 microcontroller and to establish the cloud-based monitoring interface via the ThingsBoard platform. This position was essential for facilitating the immediate transmission and display of soil moisture data gathered by our sensor system. Initially, I was responsible for coding the ESP32 to establish a connection to a Wi-Fi network. This task required creating and adjusting Arduino code that enabled the ESP32 to connect to our local Wi-Fi using designated SSID and password details.

Simultaneously with the microcontroller configuration, I focused on the ThingsBoard platform to display the gathered data. I established a new device on ThingsBoard and produced an access token to connect the ESP32 securely. After establishing communication, I created a dashboard featuring digital widgets like gauges and time-series graphs that refreshed in real time. These visual aids were created to show the soil moisture level in a clear and intuitive manner. I also set up fundamental alert functions like emergency stop to activate a warning whenever the soil moisture fell below a specified limit, mimicking how automated irrigation systems can operate based on real-time data

During this journey, I faced numerous technical difficulties, especially in ensuring the ESP32 reliably communicated with ThingsBoard. These experiences greatly improved my problem-solving abilities and highlighted the significance of thorough testing in embedded systems. his project provided me with hands-on experience in implementing agricultural solutions based on IoT technology. I discovered how microcontrollers with Wi-Fi capabilities function in a cloud-connected environment, and I gained knowledge of cloud platforms such as ThingsBoard, commonly used for data visualization in intelligent applications.

in summary, my involvement in creating the Wi-Fi and ThingsBoard elements of the Smart Soil Moisture Monitoring System was equally demanding and fulfilling. It enhanced my technical base in IoT systems and provided me with a greater appreciation for collaboration and system integration.

MAHENDRAN A/L SURESH (1191101755)

For this project, I helped put together a live alert-and-monitoring setup with an ESP32, a small buzzer, and a handy OLED screen. I wired the buzzer to GPIO 26 and wrote code for three main alerts: (1) a constant 1000-Hz tone when soil moisture drops under 30%, (2) two brief 2000-Hz beeps when the pump shuts off after the soil hits 70%, and (3) a `noTone()` command that cuts the sound during an emergency stop, whether I trigger it by hand or through a ThingsBoard RPC. At the same time, I set up an SSD1306 display on the same I2C bus (address 0x3C); it refreshes every second and shows the soil moisture level, temperature, humidity, pump status (ON/OFF), soil condition (DRY, NORMAL, WET), and a big red warning-!! EMERGENCY !!-whenever the buzzer goes into crisis mode.

While putting both systems to work, a few bumps cropped up along the way:

Synchronization Issues: I had to make sure the buzzer and OLED talked at the same time and didn't step on rapid sensor updates.

Display Flickering: At first, the screen flashed because I wiped the whole buffer every second; switching to partial redraws stopped the jumpiness.

Timing Conflicts: The blocking `delay()` calls made behavior erratic, so I rewrote the timing with `millis()` and kept everything responsive.

Tone Overlap: I also needed the buzzer to cut out the instant emergency mode fired, so I tracked state carefully and dropped `noTone()` everywhere it mattered.

I2C Communication Lag: Because the OLED runs over I2C, its updates added tiny delays that threw off the buzzer, so I lined the displays refresh with quieter moments.