Assignment 10 - Report

Task: Use what you have learned to build a new IoT device using a sensor and actuator or your choice. Send telemetry to an IoT Hub, and use that to control an actuator via serverless code. You can use a sensor and an actuator you have already used in this or the previous project, or if you have other hardware try something new.

I. Purpose

The purpose of this project is to determine the **optimal amount of fertilizer (NPK - Nitrogen, Phosphorus, Potassium), and water** needed. By accurately measuring soil nutrients, farmers can **improve fertilization efficiency, reduce waste, and save time**.

Furthermore, nutrient data will be uploaded to the cloud for analysis. AI-powered predictions will help identify **potential nutrient deficiencies for each crop**, providing farmers with **precise recommendations** on fertilizer application and soil treatment. This approach **optimizes plant growth while minimizing unnecessary costs**, leading to **smarter, more sustainable farming**.

Key Features:

- **IoT Integration:** ESP32-based system connected to **NPK, pH, and moisture sensors**.
- **Cloud Computing:** Data uploaded for **remote access & historical tracking**.
- **AI & Machine Learning (Future Feature):** Models analyze patterns **to cluster land areas with similar nutrient deficiencies** and **recommend the right fertilizer type and quantity** for each group
  therefore
  optimizing fertilization strategies.

- **GPS Mapping (Future feature):** Soil nutrient levels are mapped to **precisely target areas needing treatment**.
- **Cost Efficiency:** Reduces fertilizer waste by applying only what is needed, lowering costs.
- **Sustainability:** Prevents **over-fertilization**, reducing environmental impact.

The system will generate **nutrient maps** that visually indicate **areas of deficiency**, allowing farmers to take **immediate action**. Over time, the AI model will **continuously improve** based on collected data, making predictions even more accurate.

II. Progress Report

- LCD display has been successfully create using function from library below and show the NPK level in mg/Kg

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adafruit/Adafruit SSD1306 @ ^2.5.9
  adafruit/Adafruit GFX Library @ ^1.11.9
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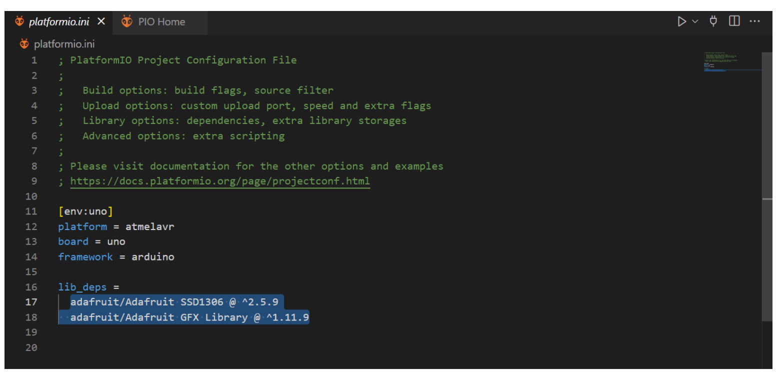
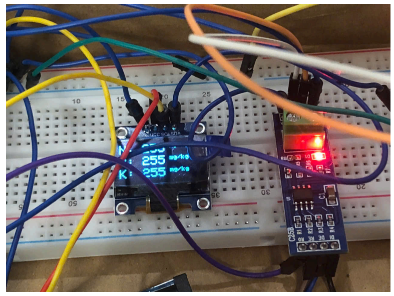
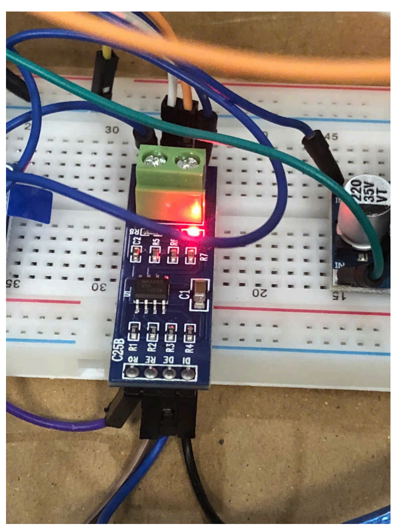
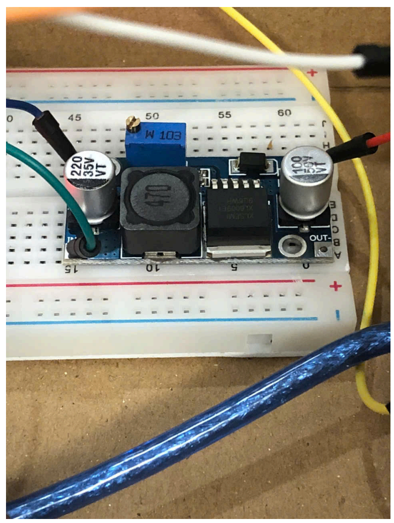




- The **MAX485** is an **RS-485 to TTL (Transistor-Transistor Logic)** converter. It acts as a **bridge between your ESP32 (which uses TTL serial communication)** and the **soil NPK sensor (which uses RS-485 communication)**.
    - **ESP32 UART Pins (TX/RX)** connect to the **MAX485's DI/RO**.
    - The **MAX485 A/B pins** connect to the **RS485 data line of your NPK sensor**.
    - The **DE/RE (Driver Enable/Receiver Enable)** pins control whether you're sending or receiving:
        - Set **DE = HIGH and RE = LOW** to send data (write).
        - Set **DE = LOW and RE = HIGH** to receive data (read).

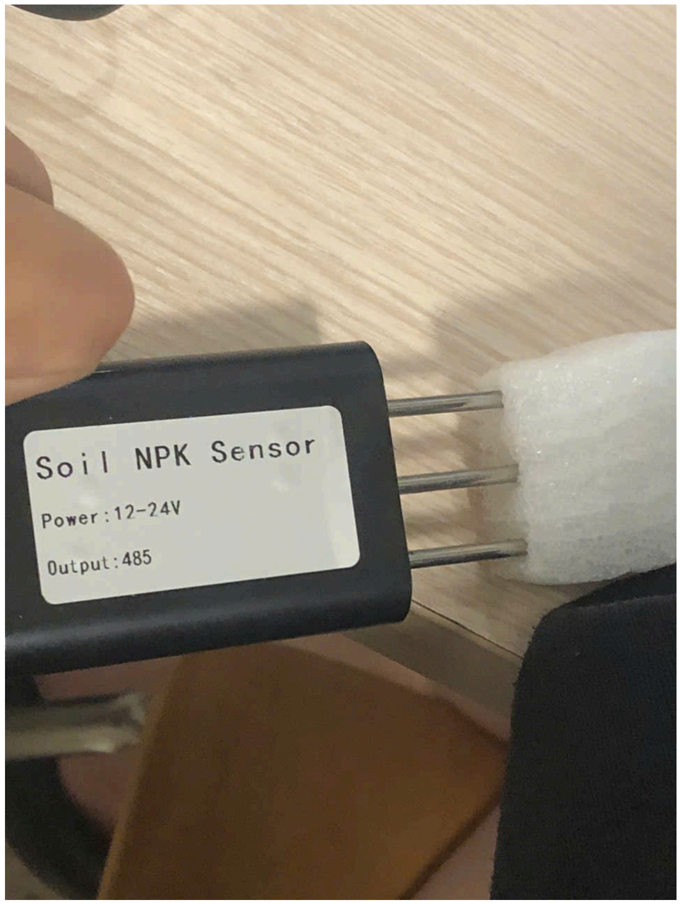


- Voltage Booster from 5 volt to the range of sensor (12 - 24 volts):
  - The voltage booster (also called a **DC-DC step-up converter**) **increases the 5V power supply** from your ESP32 system or USB power source to the **required 12V–24V** to **power the RS485 NPK sensor**.



- The soil NPK sensor is a digital sensor designed to measure the concentration of **Nitrogen (N), Phosphorus (P), and Potassium (K)** — three critical macronutrients in soil fertility. It helps farmers and researchers optimize fertilization, improving crop yield and soil health.
  - **Communication Protocol**: RS485 (Modbus RTU)
  - **Operating Voltage**: 12V–24V DC
  - **Output**: Digital data (N, P, K values in mg/kg or ppm)
  - **Measurement Range**:
    - Nitrogen: 0–1999 mg/kg
    - Phosphorus: 0–1999 mg/kg

        - Potassium: 0–1999 mg/kg
    - The sensor is powered using a **DC-DC Voltage Booster** that steps up **5V to 12V–24V**, supplying the sensor with the required operating voltage.



3. Working Flow

1. ESP32 sends the correct Modbus request via the **MAX485**.
2. The sensor responds with a data packet including the requested value (e.g., Nitrogen).
3. ESP32 parses the response and extracts the numeric nutrient value.
4. The data is sent over Wi-Fi using **MQTT or HTTP** to the **Azure IoT Hub** (`soil-sensor-Deuna`).
5. Azure Function Apps or Stream Analytics can process, visualize, or store this data.

4. Final Product

attachment:fa946f64-05a4-44b1-b635-a03f9494c612:6489562041545.mp4