**Project Title:**

**IoT-Based Real-Time Soil Moisture, Temperature, and Humidity Monitoring System using ESP32 and Blynk**

**Objective:**

To build an **intelligent monitoring system** for agriculture that can:

* Detect soil moisture condition,
* Measure air temperature and humidity,
* Send real-time updates to a **mobile app**,
* Trigger **local alerts** when soil gets too dry.

The aim is to help **farmers, gardeners, and greenhouse owners** make smart irrigation decisions and improve crop health by monitoring environmental factors remotely.

**Hardware Components:**

| **Component** | **Purpose** |
| --- | --- |
| ESP32 | Main microcontroller with built-in Wi-Fi |
| DHT11 / DHT22 | Senses temperature and humidity |
| Soil Moisture Sensor | Measures soil moisture level |
| OLED Display (Optional) | Shows readings on-site |
| Buzzer / LED (Optional) | Alerts when soil is too dry |
| Wi-Fi Router | Sends data from ESP32 to the internet |
| Smartphone with Blynk App | To view real-time data remotely |

**How the System Works — In Detail**

**Sensing Environment:**

* The **DHT11 or DHT22 sensor** measures:
  + **Temperature** (°C)
  + **Humidity** (% relative humidity)
* The **capacitive soil moisture sensor** gives an **analog voltage** that changes with the water content in the soil:
  + Wet soil → low voltage
  + Dry soil → high voltage

**ESP32 Reads the Data:**

* The **ESP32** collects:
  + Analog value from the **soil sensor**
  + Digital values from the **DHT sensor**
* It then:
  + Converts the analog soil value into a **percentage moisture level**
  + Stores and sends all readings

**Local Processing + Display:**

* Optionally displays all values on an **OLED screen**
* If moisture level < threshold (e.g. 30%), it activates:
  + A **buzzer**
  + An **LED indicator**

This helps a farmer in the field know instantly when the plant needs water.

**Sending to Cloud (Blynk IoT App):**

* ESP32 connects to Wi-Fi
* Sends:
  + Soil Moisture % → V2
  + Temperature → V0
  + Humidity → V1
* **Blynk app** receives this data using **virtual pins**
* The app displays live values using:
  + Gauges
  + Labels
  + Charts (optional)

**Remote Monitoring via Smartphone:**

* A farmer can check values from anywhere in the world.
* No need to physically inspect the field every time.
* Can help trigger **automated irrigation** (in future expansions).

**Real-Time Workflow:**

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[Soil/DHT Sensors]

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ESP32 (Reads data every 5 sec)

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1. Sends data to Blynk Cloud (via Wi-Fi)

2. Activates Buzzer if soil is dry

3. Optional OLED Display output

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[Blynk App → Farmer's Phone]

**Optional Add-ons (Advanced Version):**

* Firebase cloud dashboard for web monitoring
* Auto-irrigation with water pump relay
* Solar-powered deployment
* SD card logging of sensor history
* GSM for non-Wi-Fi locations

**Real-World Applications:**

* Home and rooftop gardens
* Greenhouses and nurseries
* Agricultural farms
* Precision farming systems
* Soil research labs