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ECE3502-IoT DOMAIN ANALYST

Smart Soil Monitoring System

J Component Report

Programme : **Integrated M.Tech CSE (Business Analytics)**

Course Title : **IoT Domain Analyst**

Course Code : **ECE3502**

Slot : **G1 Slot**

Title : **Smart Soil Monitoring System**

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Signature:

ABSTRACT:

The Smart Soil Moisture Monitoring System using AWS IoT and Raspberry Pi is an innovative project aimed at helping farmers and cultivators monitor their soil's moisture level in real-time. The system combines hardware and software components to gather and analyze data on soil moisture levels, which can be used to make decisions about irrigation and plant health. The Raspberry Pi serves as the primary hub for data gathering and analysis, while the moisture sensor buried in the ground collects information about the moisture content.

Utilizing Amazon Web Services (AWS) IoT, the data is transmitted to the cloud, where it can be stored, processed, and displayed. This system enables users to remotely monitor soil moisture levels and receive alerts when the levels fall below a certain threshold. By doing this, irrigation schedules can be optimized, water waste can be reduced, and plant development can be improved.

INTRODUCTION:

The Smart Soil Moisture Monitoring System utilising AWS IoT and the Raspberry Pi is a system created to track the soil's moisture level in real-time. In order to gather and analyse information on soil moisture levels that can be used to make decisions regarding irrigation and plant health, this system combines hardware and software components.

The Raspberry Pi in the centre of the system serves as the primary hub for data gathering and analysis. A moisture sensor that is buried in the ground and gathers information about the moisture content is connected to the Raspberry Pi. Utilising Amazon Web Services (AWS) IoT, the data is then sent to the cloud, where it may be stored, processed, and displayed.

Users of this device can check the soil's moisture level from a distance and get alerts when it falls below a certain level. By doing this, irrigation schedules may be improved, water waste can be decreased, and plant development can be optimised. In a nutshell, the Smart Soil Moisture Monitoring System, which is powered by AWS IoT and Raspberry Pi, is a simple and inexpensive way to track soil moisture levels in real time, which helps people make better decisions and increases crop yields.

OBJECTIVE:

The Smart Soil Moisture Monitoring System using AWS IoT and Raspberry Pi is a project that aims to address the challenges of efficient irrigation and water conservation in agriculture. The system will provide a cost-effective and efficient way of monitoring soil moisture levels in real time, allowing farmers and cultivators to make informed decisions about irrigation practices. The system will be composed of several key components, including soil-mounted sensors, a Raspberry Pi microcontroller, and an AWS IoT platform. The soil-mounted sensors will collect data on the moisture levels of the soil, which will be transmitted to the Raspberry Pi. The Raspberry Pi will then use an Internet of Things (IoT) protocol to send the data to the AWS IoT platform.

The AWS IoT platform will provide a range of data analytics and visualisation tools, enabling farmers and cultivators to monitor and analyse the data collected by the system. This data will include information on soil moisture levels, as well as other factors such as temperature and humidity. The system's main goal is to optimise irrigation practices and conserve water resources by providing accurate soil moisture data. By doing so, farmers and cultivators can make informed decisions about when to water their crops, how much water to use, and where to focus their irrigation efforts. This can help to reduce water wastage and improve crop yields, making agriculture more sustainable and efficient.

MOTIVATION:

The motivation behind this project stems from the interest in IoT and Raspberry Pi, as well as the desire to help farmers conserve water and reduce the risk of crop failure due to drought or overwatering. Interest in IoT and the Raspberry Pi is the main push, while this project seeks to help farmers conserve water and reduce the risk of crop failure due to drought or overwatering, which may resonate with individuals who are concerned about sustainability and the environment. The skills and knowledge gained from working on the project could be beneficial for seeking to advance the careers in the technology industry or related disciplines.

SUMMARY OF ALL SECTIONS:

BACKGROUND STUDY:

Several studies have been conducted on smart soil monitoring systems, highlighting the importance of real-time monitoring and its impact on agricultural practices. The use of Internet of Things (IoT) devices such as the Raspberry Pi has been shown to provide a cost-effective solution for soil monitoring. AWS IoT has also been utilized in various studies to transmit data to the cloud, enabling real-time analysis and decision-making. Moisture sensors have been used extensively to monitor soil moisture levels, with some studies exploring the use of multiple sensors for greater accuracy. Overall, these studies demonstrate the potential benefits of smart soil monitoring systems in improving crop yield, conserving water resources, and promoting sustainable agricultural practices.

Several systems currently on the market can help farmers keep an eye on how much water is in the soil. But these systems can be expensive, hard to install and keep up, and often require technical knowledge. The "Smart Soil Moisture Monitoring System" takes care of these problems by giving a cheap, easy-to-use, and quick solution.

The endeavour is predicated on the premise that soil moisture is essential to plant growth and health. By monitoring the soil's moisture content, producers can optimise irrigation methods and reduce water loss. In addition, the system can assist farmers in identifying regions of their fields that are more susceptible to drought or excess water, allowing them to take corrective action prior to crop damage.

Multiple comparable initiatives have been created in the past. For instance, "Smart Irrigation System Using IoT" by Adhikari et al. (2019) monitored soil moisture levels, temperature, and humidity using IoT devices. The data was transmitted to the cloud for analysis, and the system provided recommendations for irrigation quantity and timing. Similarly, "Smart Agriculture System using IoT" by Jain et al. (2018) utilised IoT devices to monitor soil moisture levels, temperature, and humidity, as well as provide real-time data analysis and visualisation.

Overall, the "Smart Soil Moisture Monitoring System Using AWS IoT and Raspberry Pi" project builds on prior research in the field of smart agriculture and provides a cost-effective and user-friendly solution for monitoring soil moisture levels.

PROJECT SUMMARY

This project shows us how to use a Raspberry Pi, a moisture sensor, and AWS IoT to monitor the soil moisture level for a house plant or garden. The Raspberry Pi runs code that reads the moisture level and temperature from the sensor and then sends the data to AWS IoT. One must create a rule in AWS IoT that sends an email to an address subscribed to an Amazon SNS topic when the moisture level falls below a threshold.

Step 0: Setting up AWS IoT

Step 1: Creating the AWS IoT policy.

Step 2: Creating the AWS IoT thing, certificate, and private key.

Step 3: Creating an Amazon SNS topic and subscription.

Step 4: Create an AWS IoT rule to send an email.

Step 5: Setting up the Raspberry Pi and moisture sensor

PROPOSED SYSTEM

Description about the proposed work:

In this project, we will initially connect a device to AWS IoT before creating an IoT thing, a device certificate, and an AWS IoT policy. Create an AWS IoT policy that permits your Raspberry Pi to connect to AWS IoT and send messages. Create an object for your Raspberry Pi in the AWS IoT registry.

Create a topic and subscription for Amazon SNS. The rule listens to your Raspberry Pi for moisture data. If the value falls below a specified threshold, a message is sent to the Amazon SNS topic. This message is sent to all email addresses subscribed to the topic by Amazon SNS. Create a rule for AWS IoT to send an email.

Insert the microSD card into the Raspberry Pi and connect the monitor, keyboard, mouse, and Ethernet cable if you're not using Wi-Fi. Do not yet attach the power cord. Connect the JST extension cable to the humidity sensor.

To subscribe an email address to an Amazon SNS topic using the AWS Management Console

- Sign in to the Amazon SNS console.
- In the left navigation pane, choose Subscriptions.
- On the Subscriptions page, choose Create subscription.
- On the Create subscription page, in the Details section, do the following:
- For Topic ARN, choose the Amazon Resource Name (ARN) of a topic.
- For Protocol, choose Email.
- For Endpoint, enter the email address.
- Choose Create subscription.

The console creates the subscription and opens the subscription's Details page.

- You must confirm the subscription before the email address can start to receive messages.

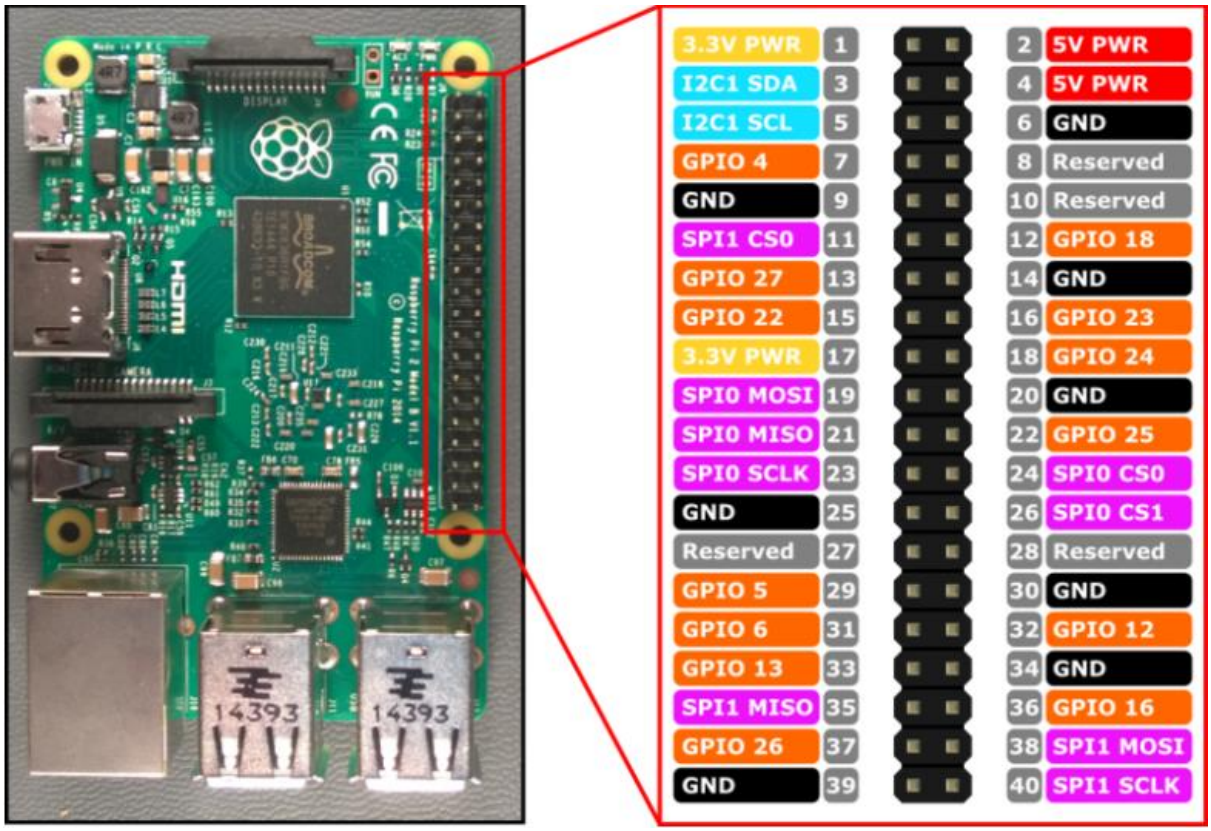
To confirm a subscription

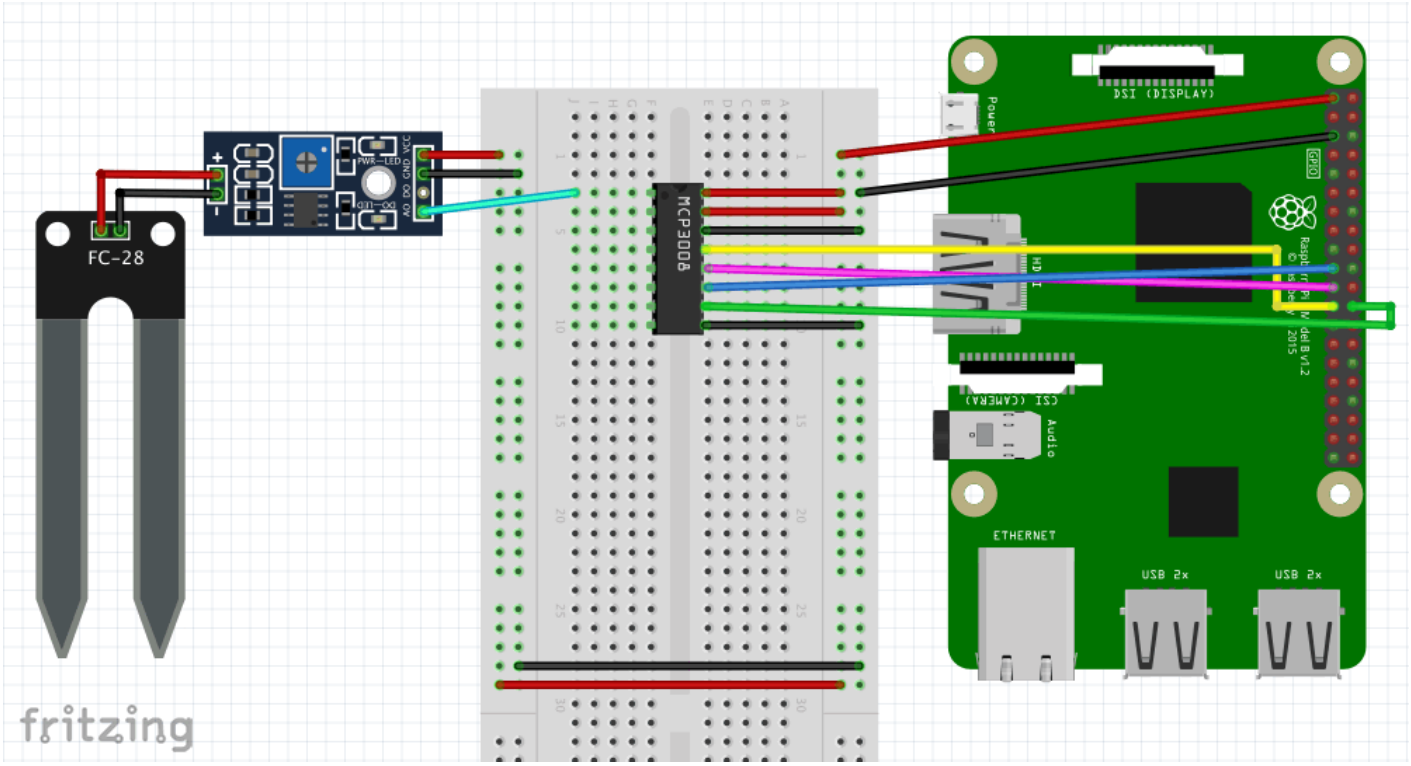
- Check your email inbox and choose Confirm subscription in the email from Amazon SNS.
- Amazon SNS opens your web browser and displays a subscription confirmation with your subscription ID.

ARCHITECTURE DIAGRAM:

Application-to-person (A2P)

Amazon SNS lets you send push notifications to mobile apps, text messages to mobile phone numbers, and plain-text emails to email addresses. You can fan out messages with a topic, or publish to mobile endpoints directly.

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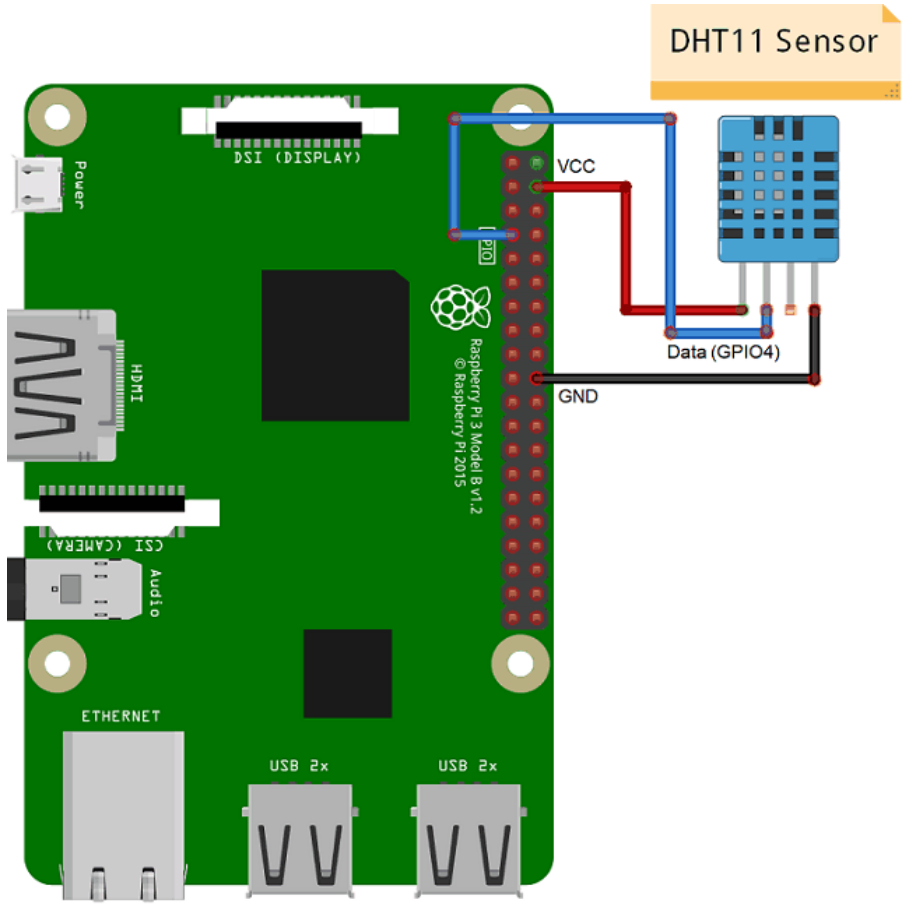
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ETHERNET
USB 2x
USB 2x
VCC
Data (GPIO4)
GND
Raspberry Pi 3 Model B v1.2
© Raspberry Pi 2015

ALGORITHM:

1. **Connect device to AWS IoT**

- Create a device certificate.
- Create an AWS IoT policy.
- Create a policy that allows Raspberry Pi to connect and send messages to AWS IoT
- Create a thing in AWS IoT registry to represent Raspberry Pi

2. **Create Amazon SNS topic and subscription.**

- Create a topic for moisture data.
- Subscribe email addresses to the topic.
- Create an AWS IoT rule to send an email.

3. **Listen for moisture data from Raspberry Pi**

- Create a rule to listen for moisture data.
- Set a threshold value for moisture data.

4. **Send message to Amazon SNS topic.**

- If moisture data is below threshold value, send a message to the Amazon SNS topic.

5. **Send email to subscribed email addresses.**

- Amazon SNS sends the message to all email addresses subscribed to the topic.

6. **Set up Raspberry Pi**

- Insert microSD card into the Raspberry Pi
- Connect monitor, keyboard, mouse.
- If not using Wi-Fi, connect Ethernet cable.
- Connect the JST jumper cable to the moisture sensor.
- Connect and configure the other four wires of the jumper.

7. **Connect power cable to Raspberry Pi.**

This algorithm illustrates the steps necessary to construct a Smart Soil Moisture Monitoring System using AWS IoT and Raspberry Pi. It entails configuring the Raspberry Pi as a gateway device to collect data from a soil moisture sensor and transmit it to the AWS IoT platform.

IMPLEMENTATION DETAILS

COMPONENTS:

Software components:

- AWS IoT console
- Raspbian OS
- IAM user with administrator permissions: An IAM user with administrator permissions is a type of user account used to manage access to Amazon Web Services (AWS) resources. An IAM user with administrator permissions has the highest level of privileges and can access and manage all AWS services, resources, and users within an AWS account. The IAM user with administrator permissions is responsible for creating, managing, and deleting other IAM users, groups, and roles, as well as assigning and revoking permissions and policies for these entities.

Hardware components:

- Development computer running Windows, macOS, Linux, or Unix
- Raspberry Pi 3B or 4B
- Monitor
- Keyboard
- Mouse
- Wi-Fi network or Ethernet connection
- Raspberry Pi-compatible moisture sensor (A resistive soil moisture sensor is a type of sensor that measures the moisture content of soil by using a resistive element to detect changes in the electrical conductivity of the soil. As the soil moisture level changes, the electrical resistance of the sensor also changes, and this change is measured and interpreted as the soil moisture level.)

HARDWARE DETAILS

1. **Development computer running Windows, macOS, Linux, or Unix:**

A development computer is a computer used by software developers to create, test, and deploy software applications. It can run on different operating systems such as Windows, macOS, Linux, or Unix. The development computer typically has a high-performance processor, large storage capacity, and sufficient RAM to support software development activities.

2. **Raspberry Pi 3B or 4B:**

Raspberry Pi 3B or 4B is a single-board computer designed for educational and hobbyist use. It is a small, affordable computer that can be used for a variety of purposes, including learning to code, building projects, and running a variety of software applications. Raspberry Pi 3B or 4B has a quad-core ARM processor, Wi-Fi, Bluetooth, HDMI, USB ports, and GPIO pins, making it a versatile and powerful computing platform.

3. **Monitor:**

A monitor is an output device used to display visual information from a computer.

4. **Keyboard:**

A keyboard is an input device used to enter text, commands, and other information into a computer.

5. **Mouse:**

A mouse is an input device used to navigate the computer's graphical user interface and interact with on-screen objects.

6. **Wi-Fi network or Ethernet connection:**

A Wi-Fi network or Ethernet connection is a means of connecting the Raspberry Pi and development computer to the internet or a local network. Wi-Fi is a wireless connection that allows the devices to connect to a wireless access point and access the network.

7. **Raspberry Pi-compatible moisture sensor**

A resistive soil moisture sensor is a type of sensor that measures the moisture content of soil by using a resistive element to detect changes in the electrical conductivity of the soil. As the soil moisture level changes, the electrical resistance of the sensor also changes, and this change is measured and

interpreted as the soil moisture level. The A2D component converts the analog signal from the resistive sensor into a digital signal that can be processed by a microcontroller or other digital device. This conversion process involves measuring the voltage output of the sensor and converting it into a numerical value that can be used to determine the moisture level of the soil.

SOFTWARE DETAILS

1. **AWS IoT Console:**

- The AWS IoT Console is a web-based user interface that allows users to manage their AWS IoT resources. It is part of the AWS IoT service, which is a cloud-based platform for managing and processing data from connected devices. The AWS IoT Console provides a dashboard for managing IoT devices, creating rules to trigger actions based on data, and monitoring device data in real-time. Here are some of the key features of the AWS IoT Console:
- Device Management: The AWS IoT Console allows you to register and manage your IoT devices. You can create device groups, set device policies, and manage device certificates.
- Rules Engine: The AWS IoT Console provides a rules engine that allows you to define rules to process and act on device data. You can use this feature to trigger actions based on data values, send data to other AWS services, or store data in a database.
- Device Shadow: The AWS IoT Console provides a device shadow feature that allows you to store and retrieve the current state of your devices. This feature allows you to synchronize the state of your devices with AWS services and other devices.
- Security: The AWS IoT Console provides robust security features to protect your data and devices. You can manage device certificates and policies, enable authentication and authorization, and encrypt data in transit.

2. **Raspbian OS:**

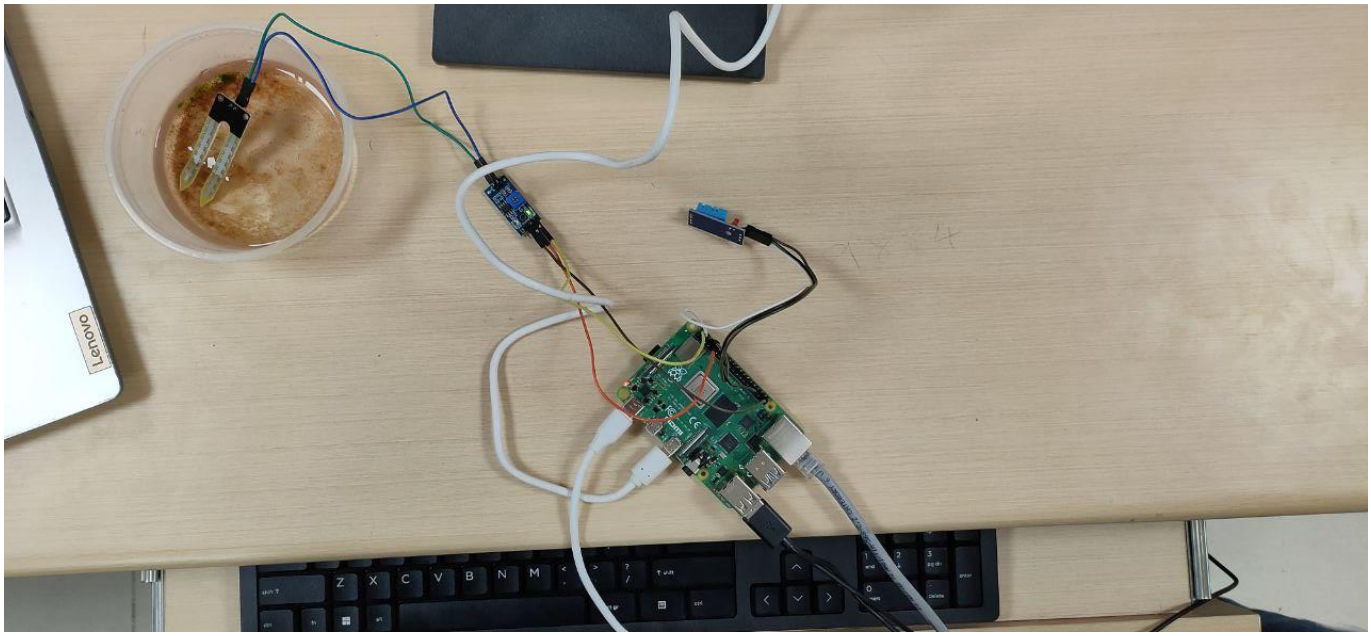
- Raspbian is a Debian-based operating system designed specifically for the Raspberry Pi single-board computer. It is the official operating system for the Raspberry Pi and is maintained by the Raspberry Pi Foundation. Raspbian is a lightweight and optimized operating system that is easy to install and use. Here are some of the key features of Raspbian:

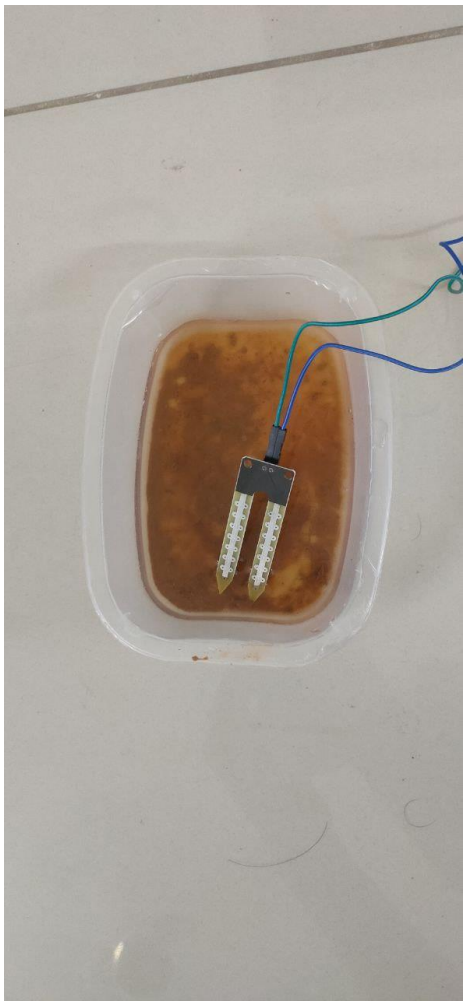
- Debian-based: Raspbian is based on the Debian Linux distribution, which is known for its stability and reliability. This makes Raspbian a robust and reliable operating system for the Raspberry Pi.
- Desktop Environment: Raspbian includes a desktop environment based on the LXDE desktop environment. This allows users to run graphical applications and perform tasks using a mouse and keyboard.
- Raspberry Pi Tools: Raspbian includes a set of tools and utilities designed specifically for the Raspberry Pi. These tools allow users to configure and manage the Raspberry Pi hardware, such as the GPIO pins and camera module.
- Software Packages: Raspbian includes a wide range of software packages, including programming languages, web browsers, media players, and productivity tools. Users can install additional software packages using the apt package manager.
- Easy Installation: Raspbian is easy to install using the Raspberry Pi Imager tool, which can be downloaded from the Raspberry Pi website. The installation process is straightforward and can be completed in a few minutes.

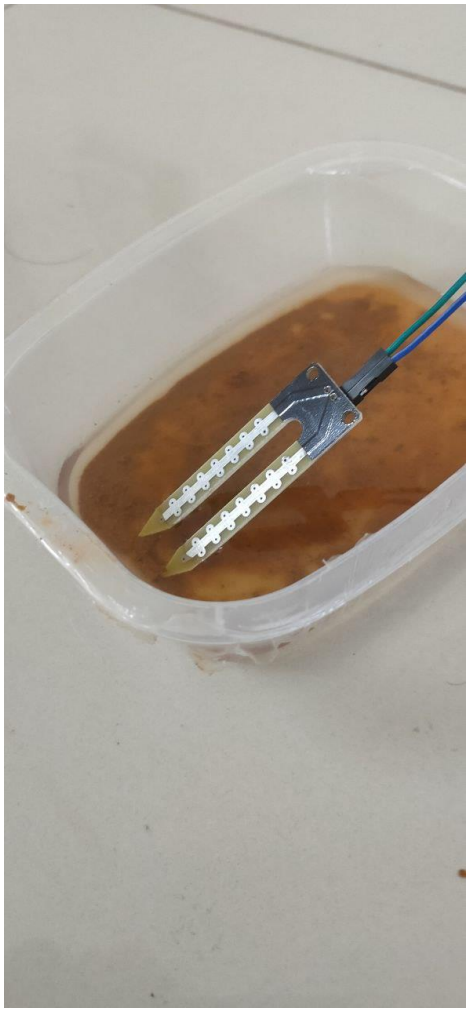
3. WORKING ENVIRONMENT

- Connect the moisture sensor to the Raspberry Pi cable and wires.
- Create an AWS IoT policy that allows the Raspberry Pi to connect and send messages to AWS IoT.
- Create an AWS IoT thing in the registry to represent the Raspberry Pi.
- Create an Amazon SNS topic and subscription to receive notifications.
- Create an AWS IoT rule that listens for moisture data from the Raspberry Pi and sends an email notification through the SNS topic if the value is below a threshold.
- Insert the microSD card into the Raspberry Pi, connect the monitor, keyboard, mouse, and Ethernet cable (if not using Wi-Fi).
- Power on the Raspberry Pi and execute the necessary code to connect to AWS IoT and start sending moisture data.
- If the moisture data falls below the threshold, an email notification is sent to all subscribed email addresses via the SNS topic.

RESULTS AND DISCUSSION





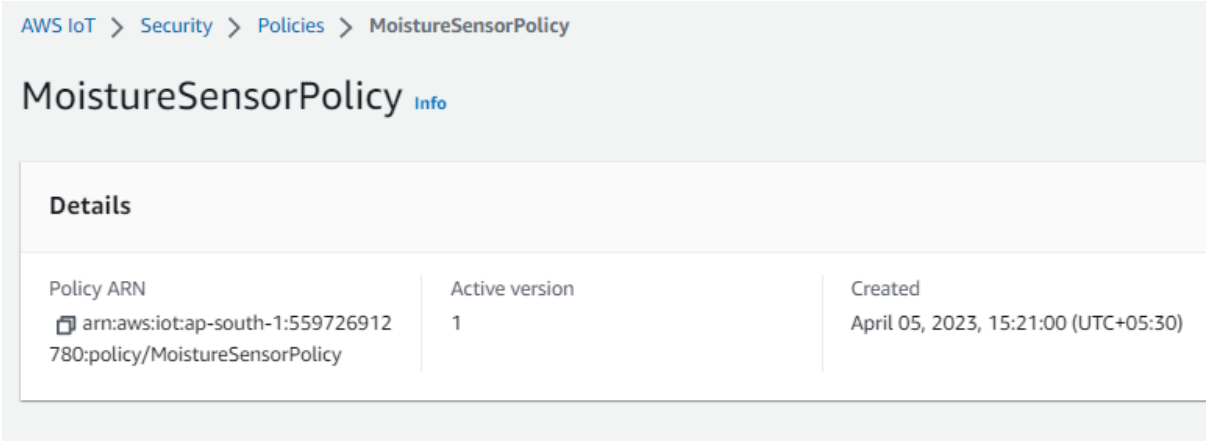


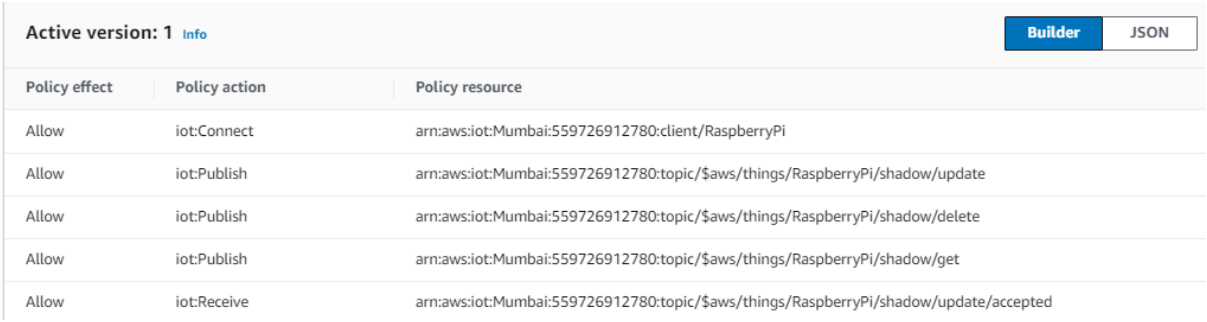
Moisture Sensor results without cloud integration:

```
C:\Users\Deepan>cd Desktop

C:\Users\Deepan\Desktop>py soilmoisture.py
Moisture data: 567 Temperature: 35.0 C Humidity: 32.6 %
Moisture data: 567 Temperature: 35.0 C Humidity: 32.6 %
Moisture data: 567 Temperature: 35.0 C Humidity: 32.6 %
```

Policy:





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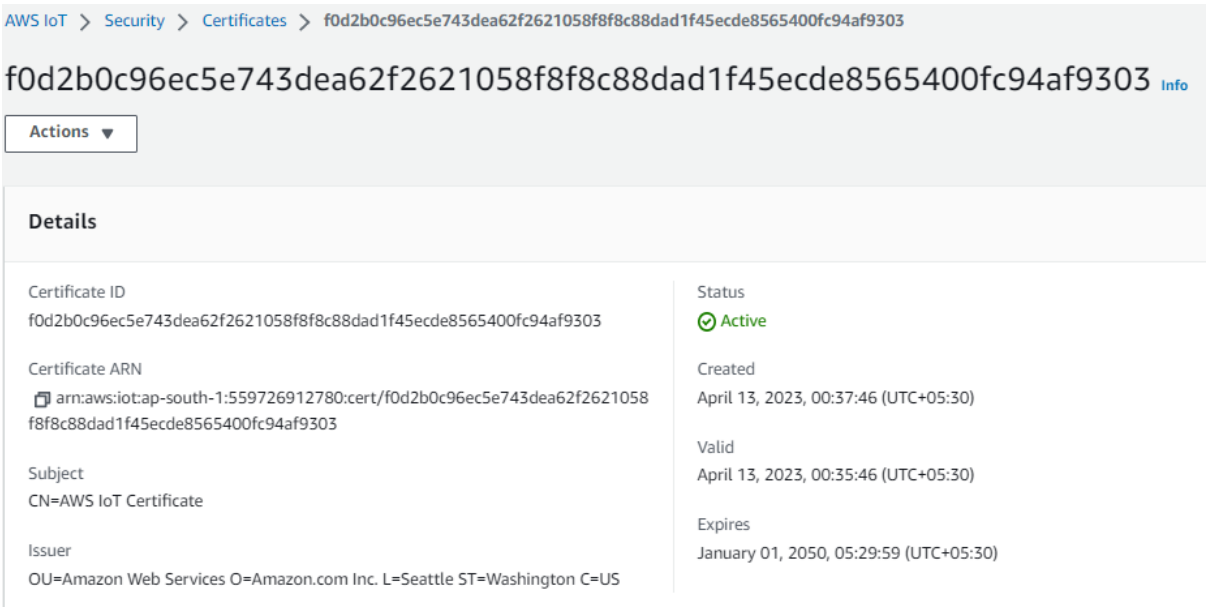
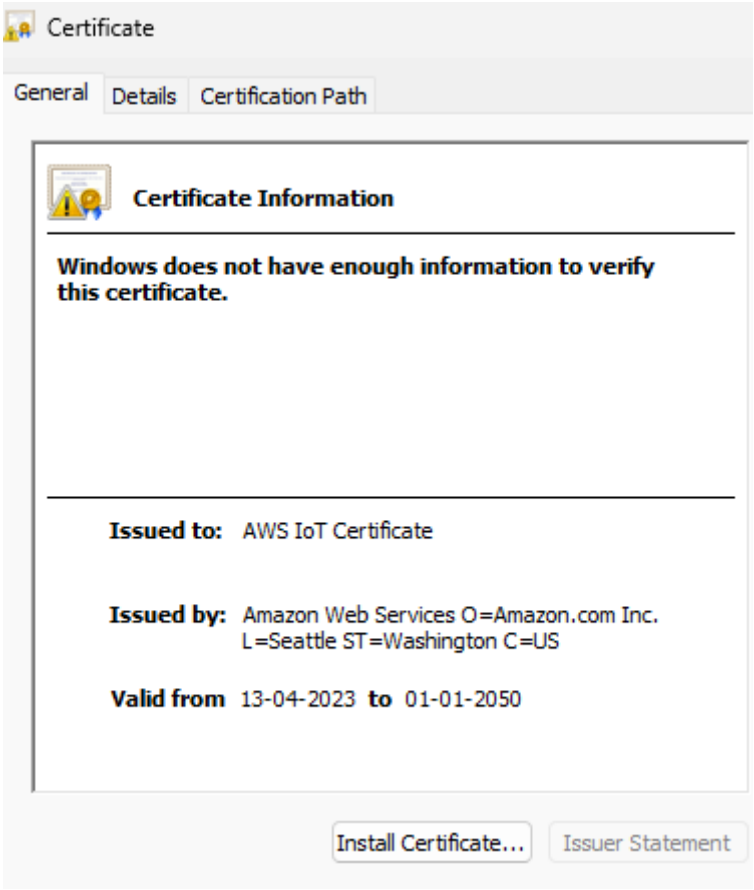
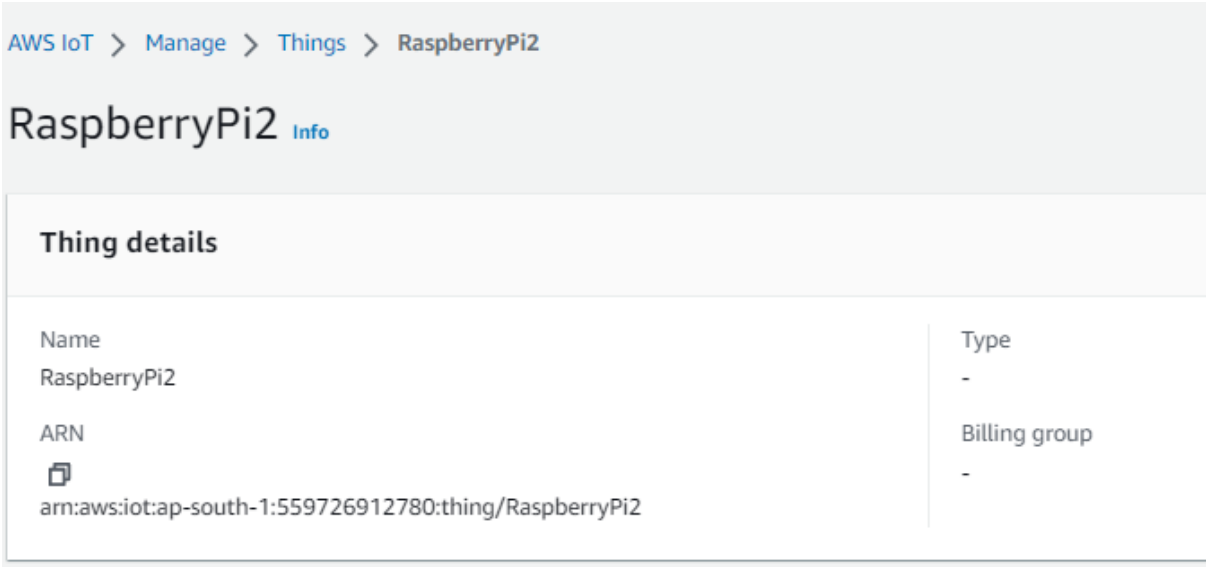
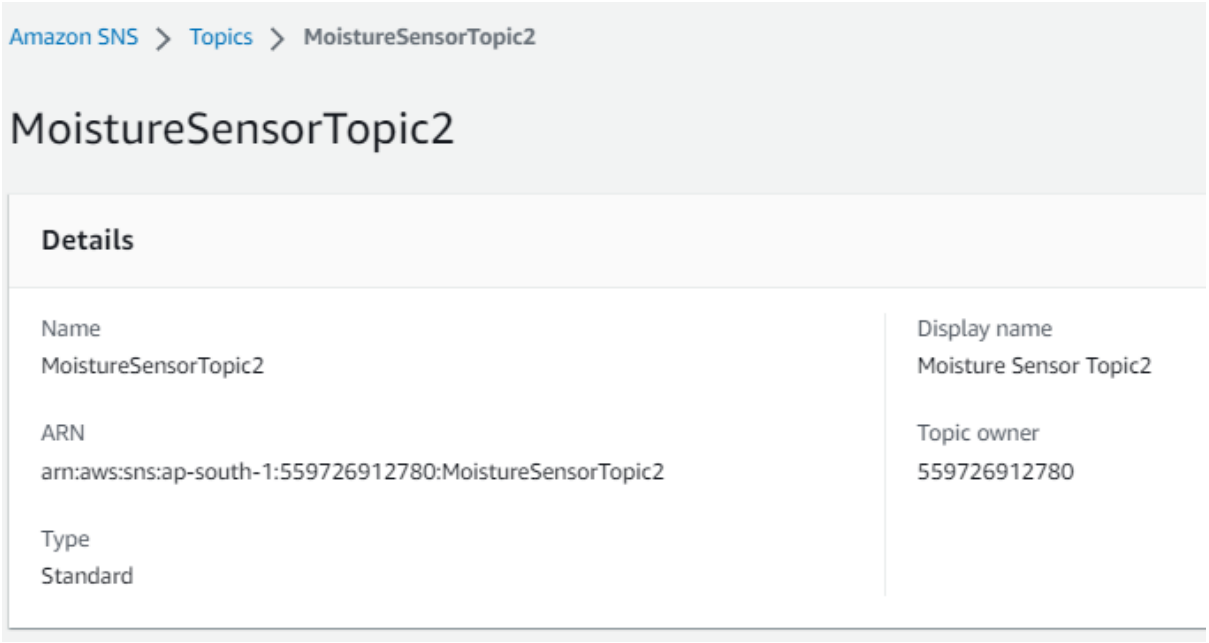




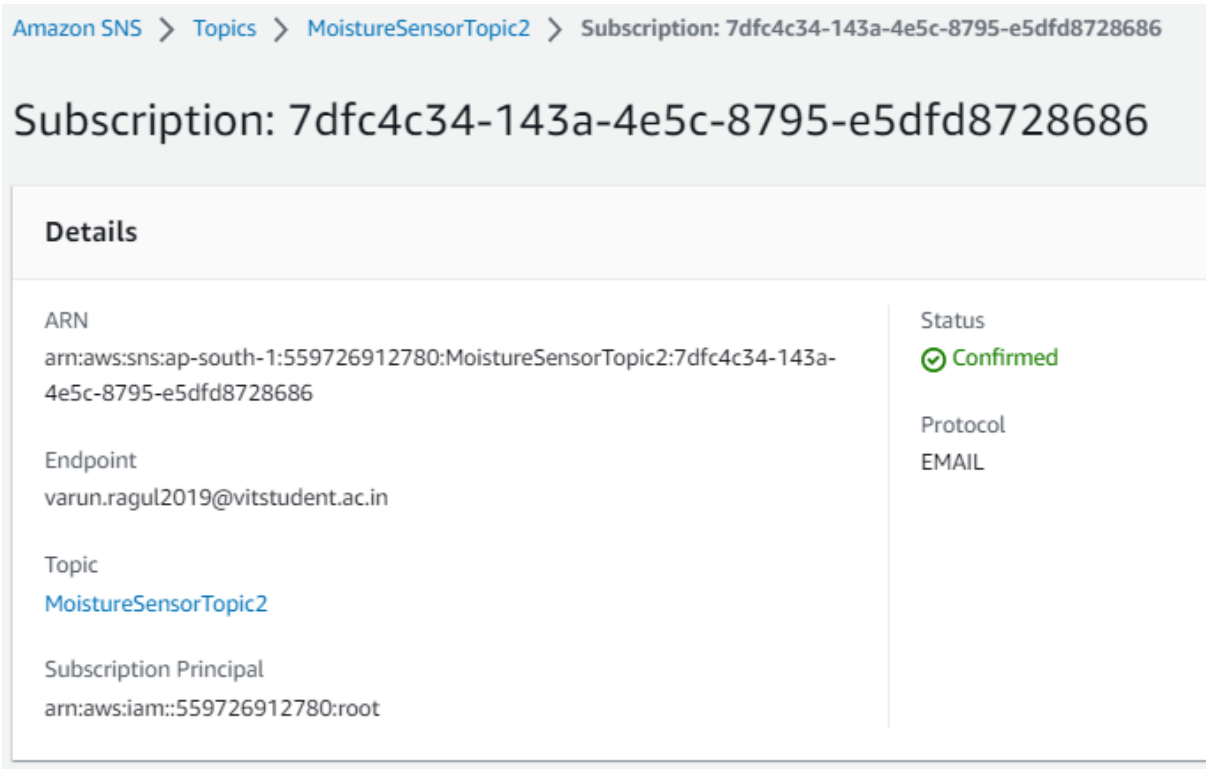
IoT Things:



SNS Topic:

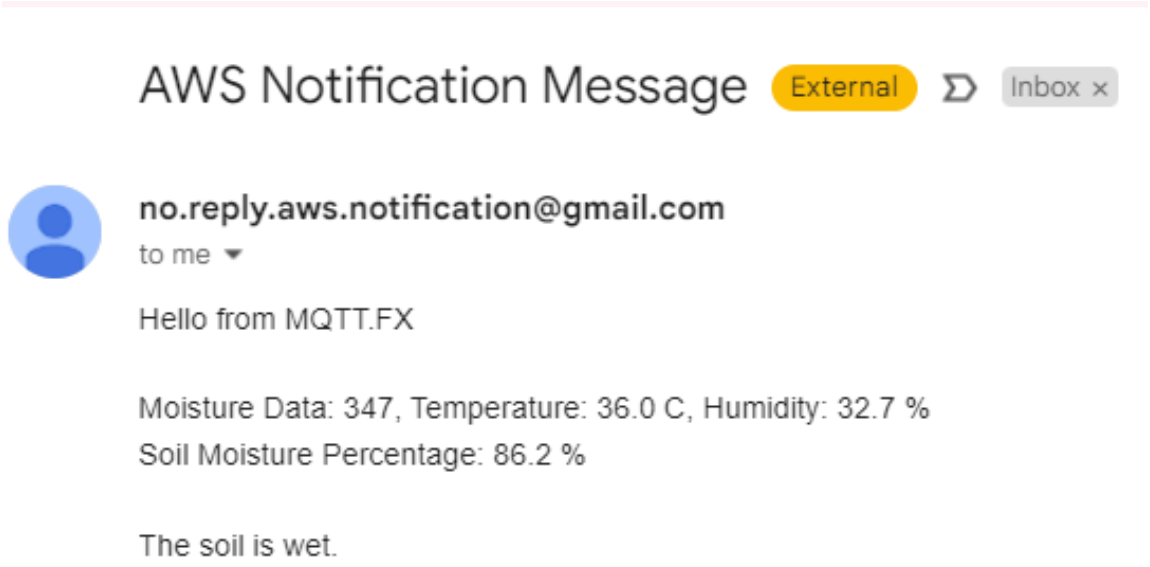


Subscription:



Here client (endpoint) : varun.ragul2019@vitstudent.ac.in
Protocol: EMAIL

Mail Received:



CONCLUSION

In conclusion, the system uses a combination of hardware and cloud-based services to collect data from the soil and send alerts when the moisture level falls below a certain threshold. The Smart Soil Moisture Monitoring System is a reliable and accurate technology solution that can help farmers and gardeners monitor soil moisture levels in real-time. The use of Raspberry Pi and AWS IoT services ensures a cost-effective and scalable platform for collecting, processing, and storing the data, while providing remote access to the data for monitoring and decision-making purposes. The system can improve crop yields, reduce water consumption, and promote sustainable agriculture practices.

FUTURE WORK

After implementing the Smart Soil Moisture Monitoring System, there are several potential areas for future work. One such area is the integration of other IoT devices,. Additionally, advanced analytics could be applied to the collected data to provide insights into soil health, nutrient content, and other factors that impact plant growth. A mobile application could be developed to provide real-time updates on soil moisture levels, allowing farmers and gardeners to monitor the status of their crops from anywhere. The system could also be integrated with an automatic irrigation system that automatically waters plants when the soil moisture level falls below a certain threshold. Finally, cloud-based AI analysis could be applied to the collected data to provide more accurate and advanced insights and predictions, such as plant growth and crop yield predictions. Overall, these future works can further enhance the efficiency and effectiveness of the Smart Soil Moisture Monitoring System, making it a more comprehensive and valuable solution for agriculture and horticulture applications.

REFERENCES

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5. https://www.raspberrypi.org/
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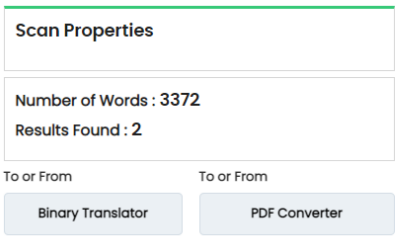
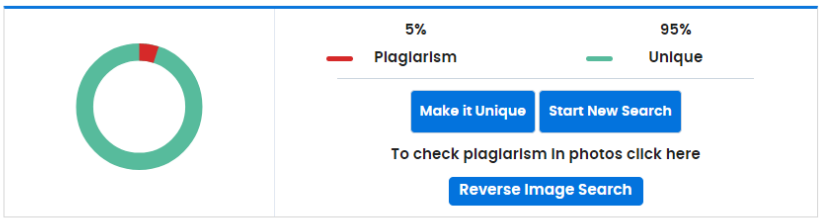
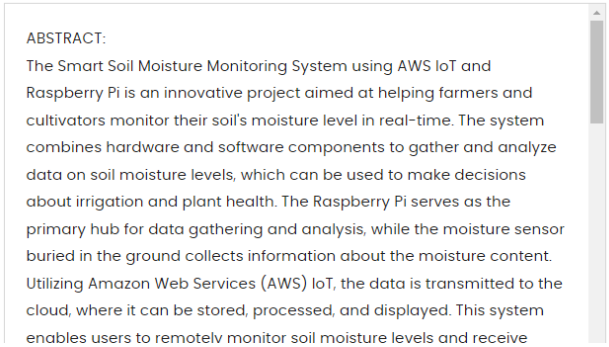
PLAGIARISM REPORT






ABSTRACT:
The Smart Soil Moisture Monitoring System using AWS IoT and Raspberry Pi is an innovative project aimed at helping farmers and cultivators monitor their soil's moisture level in real-time. The system combines hardware and software components to gather and analyze data on soil moisture levels, which can be used to make decisions about irrigation and plant health. The Raspberry Pi serves as the primary hub for data gathering and analysis, while the moisture sensor buried in the ground collects information about the moisture content. Utilizing Amazon Web Services (AWS) IoT, the data is transmitted to the cloud, where it can be stored, processed, and displayed. This system enables users to remotely monitor soil moisture levels and receive