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IoT Based Soil, Water and Air Quality Monitoring System for Pomegranate Farming

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Abstract: In order to increase crop yield and quality, pomegranate cultivation is an essential agricultural technique that requires meticulous monitoring of environmental conditions. An Internet of Things-based system for monitoring the quality of the soil, water, and air is shown in this abstract as a creative way to provide pomegranate growers with up-to-date information for wise decision-making.

Keywords: IoT, Monitoring System, Pomegranate Farming, Computer Networking.

1. INTRODUCTION

The "IoT-Based Soil, Water, and Air Quality Monitoring System for Pomegranate Farming" is an innovative solution designed especially for pomegranate farming. Modern agriculture is fast expanding with the incorporation of technology. By utilizing the Internet of Things (IoT), this project seeks to solve the pressing demand for precision agriculture in pomegranate growing.

Literature Review

[1] Suggested work on Automatic Smart Irrigation System Using IOT, India has a population of about 1.2 billion people and is growing daily. As a result, there will be a severe food shortage in 25 to 30 years, necessitating the growth of agriculture. Due to a lack of rain, farmers now face the issue of water scarcity. [2]. Showing work on IoT based soil testing; Soil analysis is now a crucial component of successful farming. There are numerous approaches currently in use for soil testing. Results from earlier soil testing, which was conducted in labs and research facilities, required a great deal of time and work. Thanks to modern technological and digital advancements, soil testing can now be done with a variety

of portable sensors. It is now feasible to link sensors to the internet thanks to IoT. We plan to do soil testing anywhere, at any time, using these sensors in conjunction with the Internet of Things. [3]. Conclude the works on the soil monitoring using IoT technology, A high-tech, capital-intensive method of producing clean, sustainable food for the general public is called effective cultivation. This research focuses on Internet of Things (IoT), artificial intelligence (AI), and robotic process automation (RPA) based technologies. These technologies enable the creation of a system designed to automate the irrigation system and monitor the crop field using sensors (such as light, humidity, temperature, and soil moisture). Farmers are able to remotely monitor the conditions of their fields. [4].Suggested work on a LoRaWAN-based soil moisture monitoring system. Municipal employees that are concerned about irrigation work use and deploy an Internet of Things (IoT) device that measures soil moisture. The IoT gadget is a preliminary prototype that runs on three AAA batteries and Pycom's LoPy4 expansion board 3.1. The prototype's size, cost, and power consumption make it unsuitable for larger-scale testing. [5]. research on soil testing enabled by IoT. Our nation's primary industry and one that is extremely important to it is agriculture. Overuse of fertilizers can result in crop production that is of lower quality. Therefore, measuring the nutrients in the soil is crucial for improving plant growth. The main task is figuring out how much nutrients are in the soil. One of the most significant and instructive soil parameters to determine soil fertility is pH value, which is measured to determine soil fertility.[6]. Planned work on an innovative real-time pH monitoring and control system for municipal wastewater for gardening and agriculture based on the Internet of Things This paper presents an innovative real-time pH monitoring and control system for municipal waste water that is based on the internet of things (IoT) and can be used in gardening and agriculture. In the last few decades following India's green revolution, the amount of water needed has skyrocketed across all industries, including industry, gardening, and agriculture.[7], work on the water quality monitoring system that is based on the Internet of Things (IoT). Because of its intricate hydro-geological forms, drinking water is scarce throughout Bangladesh's coastal regions. In addition, compared to other parts of the nation, safe water supply is more challenging due to natural disasters and Trans boundary river problems. Industrial pollutants may give rise to concerns regarding achieving equitable and fair access to safe drinking water for coastal communities. One could argue that having access to clean drinking water close to one's home is a basic human right and is necessary for maintaining good health. [8], suggested research on a real-time, IoT-based river water quality monitoring system. The current water quality monitoring system is a labor-intensive, manual procedure that takes a long time. A sensor-based water quality monitoring system is suggested in this paper. A microcontroller for system processing, a communication system for intra- and inter-node communication, and a number of sensors make up the main parts of a wireless sensor network (WSN). Internet of Things (IoT) technology and remote monitoring can be used to access data in real time. [9], suggested work on a pH reader based on IoT. An electrical instrument used to measure the pH of a sample is the microcontroller-based pH reader. In this project, we use the low-cost ATMEGA328 microcontroller to investigate the acidity of a sample paper strip. The microcontroller, color sensor, and buffer circuit are all powered by a low voltage power source. The microcontroller can receive the signal from the color sensor's output.[10], suggested research on temperature monitoring and moisture control using IoT in smart

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farming. The Internet of Things (IoT) has revolutionized every aspect of human existence by enabling intelligent and efficient work. IoT devices, such as sensors, controllers, Wi-Fi modules, and cloud computing, are key components of smart farming, which increases agricultural yield while reducing waste.[11],suggested work on smart agriculture to use the Internet of Things to measure the soil's pH, moisture content, temperature, humidity, and nutrient values. These days, smart agriculture reduces a number of farming-related issues. Farmers can monitor plant growth by using the "INTERNET OF THINGS (IOT)" to connect various sensors, actuators, and other embedded devices, providing them with the necessary information and related data. To produce high-quality crops by maintaining the soil's pH factor, moisture content, and nutrient level. [12], suggested work on an Internet of Things-based smart temperature and humidity monitor. The corona virus spreads quickly in cold temperatures and high humidity during the COVID-19 pandemic. A lot of people are aware of the surroundings in which they live. A smart environment monitoring system is required to assist those people. A temperature sensor and a relative humidity sensor are useful components of a smart Internet of Things (IoT) based temperature and humidity real-time monitoring and reporting system. [13], suggested work on The Pomegranate Farming Ultimate Guide. Dry, semi-arid weather is essential for successful pomegranate cultivation, with cold winters and extremely dry summers facilitating fruit production. Pomegranate plants may be regarded as drought-tolerant and are somewhat resistant to frost.35 to 38 °C is the ideal temperature for fruit development. The best area for pomegranate cultivation is 500 meters above sea level. [14], work on the pomegranate production technology that is being suggested for arid regions. Iran is the birthplace of the pomegranate (Punica granatum L.), a significant fruit crop for arid and semi-arid areas. High temperatures, irregular, low rainfall, and frequent droughts are the hallmarks of arid regions, and the soils lack both water-holding capacity and nutrient availability. The choice of fruit crop for an arid region is crucial for economic production because the environmental conditions there are unfavorable for plant sustainability. [15] Planned improvements to the soil moisture monitoring system The Internet of Things (IoT) is defined as the interconnection of numerous devices via the internet. Through the use of unique identifiers, every object is connected to every other so that data can be transferred between them without requiring human interaction

2. METHODOLOGY

By utilizing the capabilities of the Internet of Things (IoT), the "IoT-Based Soil, Water, and Air Quality Monitoring System for Pomegranate Farming" project aims to transform the management of pomegranate cultivation. With the help of this cutting-edge system, pomegranate farmers will be able to overcome a number of significant obstacles and adopt more productive and sustainable farming methods.

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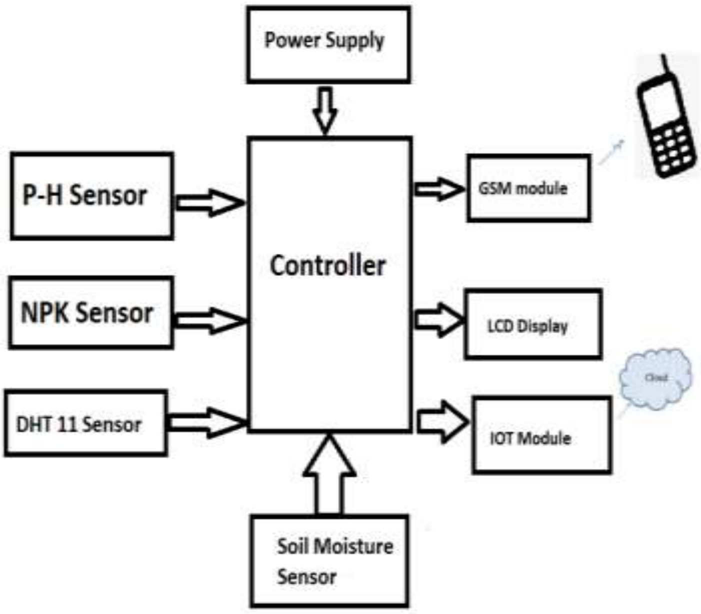

Fig. 1 Block diagram of the proposed system.

In this system, all of the sensors—such as the P-H sensor, NPK sensor, DHT 11 soil moisture sensor—are connected to the controller to provide real-time data on the water's pH level, soil nutrition, and environmental conditions. The controller then processes this data to determine what needs to be done. Through the IOT module, data is sent to the cloud for monitoring and required action purposes.

We will set the standard limit of every sensor parameter in the controller, which will help the pomegranate plant grow and stay healthy. The controller will instruct the GSM module to notify the farmer to take the appropriate action when any sensor parameter is above or below the predetermined limit.

Here are the key components and functionalities of system.

A. NodeMCU ESP8266:

Fig. 2 NodeMCU ESP8266.

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NodeMCU ESP8266 acts as the central microcontroller and IoT device for collecting and transmitting data from sensors. Developing an IoT-based Soil, Water, and Air Quality Monitoring System for Pomegranate Farming with NodeMCU ESP8266 entails integrating various sensors to measure key parameters, sending data to a central server or cloud platform, and providing a user interface for monitoring and control.

B. NPK Sensor:

Fig.3 RS485 NPK Sensor.

The Nitrogen (N), Phosphorus (P), and Potassium (K) levels in the soil are measured by the RS-485 NPK sensor. RS-485 is a communication protocol that allows data to be transmitted over long distances, making it ideal for applications such as agriculture where sensors may be scattered across a field.

C. DHT 11 Sensor:

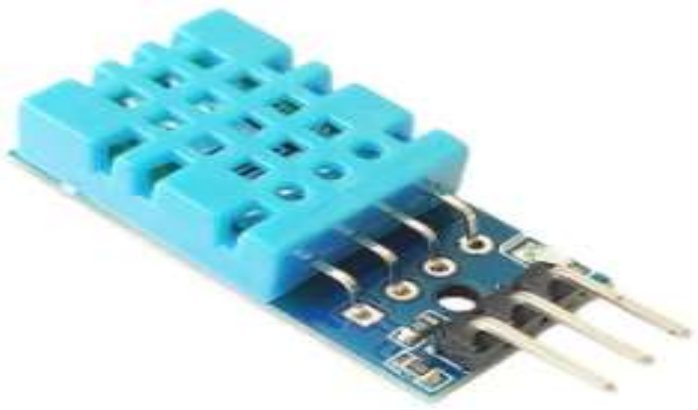

Fig.4 DHT11 Sensor.

The DHT11 sensor is a low-cost, basic digital temperature and humidity sensor that is commonly used in weather stations, home automation systems, and Internet of Things (IoT) applications. It allows you to easily measure the ambient temperature and relative humidity.

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D. Soil Moisture Sensor:

Fig.5 Soil Moisture Sensor.

Soil moisture sensors are instruments used to determine the volumetric water content of soil. They are critical in agriculture because they allow farmers to monitor soil moisture levels and optimize irrigation practices.

Soil NPK Monitoring System

An IoT (Internet of Things)-based soil NPK (nitrogen, phosphorus, and potassium) monitoring system uses contemporary technology to track and control the amount of nutrients in the soil. For maximum agricultural productivity, the levels of NPK, the main nutrients in soil, must be closely monitored. NPK is essential for plant growth. Real-time data from soil sensors can be gathered thanks to Internet of Things technology. This data can then be analyzed and utilized to make knowledgeable decisions about fertilization and other agricultural practices.
Here's a breakdown of the key components and functionalities of a Soil NPK Monitoring System using IoT:

1. Soil Sensors: To measure the concentrations of potassium, phosphorus, and nitrogen in the soil, specialized sensors are embedded in the soil. These sensors come in a variety of technological forms, such as spectroscopy-based sensors, electrical conductivity sensors, and others.

2. IoT Devices: The soil sensors are linked to these gadgets, which include microcontrollers and hardware that supports the Internet of Things, such as Arduino or Raspberry Pi. They collect sensor data and send it to a central data storage facility.

3. Connectivity: Data is transmitted by IoT devices via wired or wireless connectivity. Frequently used communication protocols for Internet of Things applications comprise MQTT, HTTP, and other protocols.

4. Centralized Server or Cloud Platform: The data collected from the sensors is sent to a centralized server or a cloud platform for storage and further analysis. Cloud platforms like AWS, Azure, or Google Cloud are commonly used for this purpose.

5. Data Processing and Analysis: Algorithms are employed to process and analyze the raw data, providing insights into the nutrient levels of the soil. Machine learning models may be used to make predictions and recommendations based on historical data.

6. User Interface: Farmers or users can access the data through a user-friendly interface, often in the form of a web or mobile application. This interface displays real-time and historical data, making it easier for farmers to understand the soil conditions.

7. Alerts and Notifications: The system can be configured to send alerts or notifications to farmers when nutrient levels fall below or exceed certain thresholds. This proactive approach allows for timely intervention.

8. Integration with Agricultural Practices: The data collected from the sensors is sent to a centralized server or a cloud platform for storage and further analysis. Cloud platforms like AWS, Azure, or To provide comprehensive insights, the system can be integrated with other agricultural management practices. For a more comprehensive approach to crop management, it might be linked to weather information or irrigation systems, for instance**.**

9. Fertilization Recommendations: The system may produce recommendations for the kind and quantity of fertilizers to be applied in order to maximize crop yield and soil health based on the data that has been analyzed.

Water pH Monitoring System

An IoT (Internet of Things)-based water pH monitoring system is a technological advancement intended to continuously measure and track the pH levels of water in real-time. In many different applications, such as water treatment, aquaculture, agriculture, and environmental monitoring, it is crucial to keep an eye on the pH of the water. The Internet of Things (IoT) component enables automated and remote monitoring, delivering timely data for

improved decision-making.
Here are the key components and functionalities of a Water pH Monitoring System using IoT:

1. pH Sensor: The data collected from the sensors is sent to a centralized server or a cloud platform for storage and further analysis. Cloud platforms like AWS, Azure, or To determine how acidic or alkaline the water is, specialized pH sensors are submerged in it. Accurate pH readings are made possible by these sensors, which produce electrical signals proportionate to the concentration of hydrogen ions.

2. IoT Devices: The pH sensors are connected to microcontrollers or Internet of Things (IoT)-capable devices like Arduino or Raspberry Pi. These gadgets gather pH data and send it to a cloud platform or central server.

Connectivity: To transfer pH data from the Internet of Things devices to a central server or cloud platform, use wired or wireless communication protocols, such as MQTT or HTTP.

3. Cloud Platform or Centralized Server: The pH data is transferred to a cloud platform or centralized server for storage, analysis, and visualization.

4. Centralized Cloud Platform or Server: After being gathered, the pH data is transferred to a cloud platform or centralized server, where it is stored and available for analysis and visualization.

5. Data Analysis and Processing: The pH data is processed and analyzed by algorithms, which then look for trends, patterns, or departures from the ideal pH range. Predictive analytics may use machine learning models.

6. User Interface: Offer a simple user interface for displaying both historical and real-time pH data via a mobile and web application. This enables users to keep an eye on water conditions and react quickly to changes.

7. Notifications and Alerts: Set up an alert system to inform users when pH levels deviate from predetermined bounds. Prompt notifications allow for prompt action to stop negative impacts on aquatic life, crops, or water quality.

8. Connectivity to Water Treatment Systems: When water treatment systems are connected to the pH monitoring system, pH levels can be automatically adjusted as needed.

Temperature, Humidity and Moisture monitoring
For pomegranate growers, a temperature, humidity, and moisture monitoring system is intended to give them up-to-date information on the environmental circumstances in their orchard. It is essential to keep an eye on these factors in order to maximize growing conditions, avoid illnesses, and guarantee a good harvest.

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Here's an overview of the components and functionalities of such a monitoring system:

1. Temperature Sensors: Place temperature sensors in the orchard to gauge the temperatures of the soil and air. This is necessary to determine temperature variations and evaluate the general climate.

2. Humidity Sensor: Install humidity sensors to keep an eye on the amount of moisture in the air. It's essential to maintain the proper humidity levels to keep diseases at bay and encourage strong plant growth.

3. Moisture Sensors: To determine the amount of water in the soil, soil moisture sensors should be inserted into the root zone. This aids in maximizing irrigation techniques and prevents over- or under watering

4. Connectivity: To transfer data from IoT devices to a central server or cloud platform, use wireless communication protocols like MQTT or other appropriate protocols.

5. Centralized Server or Cloud Platform: To gather, store, and handle the data, set up a centralized server or make use of a cloud platform. Scalability and accessibility are two reasons why cloud platforms like AWS, Azure, or Google Cloud are frequently used.

6. Data Processing and Analysis: Create algorithms to handle and examine the information gathered from sensors measuring moisture, humidity, and temperature. Trends, patterns, and correlations can be understood through the analysis that follows.

7. User Interface: Create a user-friendly interface that is accessible via a web or mobile application. This interface should provide farmers with real-time and historical data on temperature, humidity, and soil moisture, allowing them to monitor conditions at a glance.

8. Notifications and Alerts: Implement an alert system that notifies farmers when conditions deviate from optimal ranges. Temperature extremes, low humidity, or insufficient soil moisture, for example, can all trigger alerts.

9. Irrigation System Integration: Connect the monitoring system to irrigation systems to enable real-time soil moisture data-driven adjustments. This ensures that water is used efficiently and that overwatering is avoided.

3. CONCLUSION

Pomegranate farming is taking a revolutionary step with the "IoT-Based Soil, Water, and Air Quality Monitoring System for Pomegranate Farming". Through the integration of IoT technology and precision agriculture methods, this system enables farmers to safeguard their crops, make well-informed decisions, and ultimately prosper in the ever-changing landscape of contemporary agriculture.

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