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Quantifying the Impact of Soil Moisture Sensor Technology on Crop Productivity in Smart Gardening Systems

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Abstract. Water is a valuable resource, but not all communities can afford to use it liberally. It is now crucial to use the water that is available as effectively as possible, particularly in agriculture. An unattended ground moisture sensor can be used to monitor the present moisture level in the soil surrounding the plants in order to decrease overwatering of crops. So, a farmer will be able to decide when to water and when to stop. The user should receive the moisture data information wirelessly for convenience. It is detailed how to develop a wireless communication and user interface system for an unattended ground moisture sensor. The Wheat stone bridge for determining il is followed by a differential amplifier in the resistance of the sensor design. Transforming the resistance that was measured into a voltage. This is carried out because resistance and moisture are correlated. A Lora communication transmitting node sends this voltage together with a Lora communication receiving node, where a microcontroller interprets it as moisture data. The receiving node then transmits the data to a PC host so the user can access it. a power circuit that uses a linear regulator and a battery.

1 Introduction

The IoT, abbreviated to "Internet of Things" (IoT), can be defined as the communication among different objects in a real-world scenario, which can be used for the implementation of Automated software. IoT is extremely useful in developing software that uses machine learning, Data mining, and other Computer science engineering techniques to implement the project for creating a product that adds some value to the existing world.

2 Existing methods

Nageshwara Rao and colleagues demonstrated a solution that will support smart agriculture. The suggested remedy boosts agricultural productivity and is based on Raspberry Pi automation. IoT provides numerous applications for crop growth as well as when needed, decision support. This study's main objective is to increase agricultural

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productivity while using less water. This article provided a strategy to effectively control the watering system with the least amount of complexity in order to reduce the loss. Sensor data, including moisture content, humidity, and soil temperature, is used to power this system. The primary advantage of this system is that it employs an intelligent irrigation system for farming, which reduces water usage [1].

Based on the fact that some places have water restrictions, Tanu Sahu and Ashok Verma devised a self-contained watering system. The crop will suffer from over watering as well. In order to reduce crop loss, this system was designed with an automatic sprayer that will administer water to all crops effectively and without water waste. As a result, soil fertility and agricultural yield will suffer. This method is based on information gathered about the soil's temperature, humidity, and weather. This information will be gathered using the temperatures and humidity sensors. The envisioned system's brain is the Raspberry Pi. The immediately send transmit data to the raspberry pi, which notifies the emitters and performs controlled irrigation, when the heat or moisture content changes. This article focuses on creating an autonomous sprinkler using the Raspberry Pi and discussing the need for an independent sprinkler system for proper irrigation. [2]. The "IoT" is the term used to describe the connecting of objects, machinery, automobiles, and other electronic devices to a network for data exchange (IoT). The Internet of Things (IoT) is increasingly being utilized to connect objects and collect data. As a result, it is crucial that the Internet of Things be used in agriculture. The project's objective is to create an internet-connected smart farming system. The technique is combined with irrigation technique in Malaysia to address the country's weather. Additionally, it will have a favorable effect on agricultural output. Using IoT-based drip irrigation instead of conventional ones helps Malaysia save about 24.44 percent annually. This will reduce water waste from daily needs while also saving money on labor. [3].

Both the Indian economy and the existence of its population depend on agriculture. The objective of this endeavor is to develop an ingrained irrigation and soil monitoring system that will replace Using a mobile app, conduct human field surveillance and submit data. The goal of the initiative is to assist farmers in increasing agricultural productivity. The soil is examined using tools like a pH sensor, a thermometer, and a sensor system. Farmers may create the best produce for the market based on the findings. area. Wi-Fi is used to relay the sensor data to the field manager, and a mobile app is used to create crop recommendations. [4]. Another vital requirement for farmers in the agricultural sector is the creation of an effective IoT-based smart irrigation system. A low-cost, temperature smart irrigation system is the goal of this study. to plants in response to soil moisture levels. Next, an IoT-based communication feature is added to this water-saving watering system to increase its effectiveness. This feature enables a remote user controls water flow while keeping an eye on soil moisture levels. Updated temperature, humidity, and raindrop sensors are also included of the system, allowing for online remote monitoring of these elements. These field meteorological variables are immediately preserved in a distant database. Finally, a weather prediction system is used to govern water distribution depending on current weather conditions [5].

3 Proposed method

3.1 Problem statement

Soil moisture sensors are devices that measure the amount of moisture present in soil. These sensors can be used to determine when plants need to be watered and how much water they require. There are different types of soil moisture sensors, but most work by measuring either the electrical conductivity or the dielectric constant of the soil. Some common types of soil moisture sensors include tensiometers, which measure the tension or suction of water in the soil; capacitance sensors, which measure the dielectric constant of the soil; and resistance sensors, which measure the electrical conductivity of the soil. Soil moisture sensors are typically installed at various depths in the soil, depending on the root depth of the plants being grown. They can be connected to a data logger or other monitoring system to provide real-time measurements of soil moisture levels. This information can be used to optimize irrigation and fertilizer applications, reduce water use, and improve crop yields. Monitored performance is as follows;

- -40 to +80 °C Soil temperature
- ±0.5 °C(temperature) and ±5%(moisture) Maximal Fluctuation
- IP66 Rating
- 4~20mA Output
- ±2% Accuracy measure Areas of application

3.2 Objectives

The objectives of a Smart Gardening system using IoT (Internet of Things) may include:

- Optimize plant growth: A smart gardening system can help optimize plant growth by providing the right amount of water, nutrients, and light for each plant.
- Reduce water usage: A smart gardening system can help reduce water usage by monitoring soil moisture levels and watering only when necessary.
- Save time and effort: With automation and remote access, a smart gardening system can save time and effort in maintaining a garden.
- Prevent plant damage: A smart gardening system can prevent plant damage by monitoring environmental conditions and alerting gardeners to any issues such as extreme temperatures or low soil moisture.
- Increase yield: By optimizing plant growth and reducing plant damage, a smart gardening system can increase yield, providing more fruits, vegetables, or flowers for harvest.

3.3 Architecture diagram

Figure 1 represents the architecture diagram of the proposed method.

3.4 Modules - connectivity diagram

In a home monitoring and security system, sensors play a vital role. In addition, the Twilio API can be used to enable remote communication and notification capabilities, allowing the system to send alerts or messages to the owner's mobile device or email address in the event of a security breach or other critical events collecting important information that can help the owner identify any intruders. One of the most commonly used sensors is the PIR (Passive Infrared) sensor, which is designed to differentiate between the heat emitted by moving individuals and the ambient heat in the surrounding area. Another important sensor used in home security systems is the magnetic switch, which is typically used to monitor the status of doors or windows. To coordinate and enhance the overall security of the system, various modules and components can communicate with one another. For example, the ESP32 module is a powerful microcontroller board that can be used to interface with sensors and control electronic devices. It can also communicate with other modules or devices over WiFi or Bluetooth.

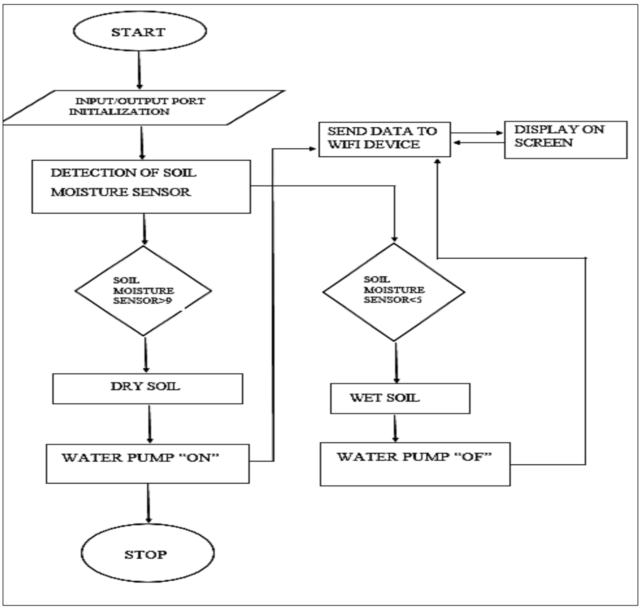

Fig. 1. Architecture diagram.

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3.5 Modules and description

3.5.1 Module 1: Detection and analysis

Each sensor delivers the data it has picked up to the microcontroller, which then analyzes it and sends the data it has gathered to the web application or application at the same time. The user can get the scanner's finding.

3.5.2 Module 2: Implementation

The working of this technique operated using threshold: Implementation of Smart Gardening Automation is done using ESP32 microcontroller chip via Wi-Fi. While code is uploaded in Arduino IDE as shown in fig: 17 and it is also connected to the firebase and Kodular platform is integrated to firebase We are utilizing the Modular Application as the user interface; while it is in programmed mode, fields and plants are mechanized to operate, including everything the sensors detect. The user may monitor and operate each garden or farm locally or remotely by using their smart phones mobile phone or from their PC in the firebase console

3.5.3 Module 3: Results

The android firm's design perspective. We can manually adjust the land value by assessing the soil in this lawn and garden automated processes. We use a soil humidity, heat, and moisture sensor that can encompass and control Soil Water, Heat, and moisture position. The live results are quickly previewable in the Modular Application. Block diagram of a monitoring system with a grounding response for a soil moisture detector.
The block diagram of a surveillance system based on a soil humidity sensor. A microcontroller, power supply unit, TV screen, keyboard, buzzer, LED pointer, and humidity sensor are all included in the full system. The system's main component is an ESP32 microprocessor, which is run on a 5V power supply. The components of the Electric Unit Circuit include a demitasse oscillator with a 4 MHz timer frequency, a reset button, an LED indicator, and two noise-suppressing capacitors with 22 pF each. Because it has an integrated 10-bit ADC and a high performance, improved flash it, device is preferred over other controllers. The microcontroller is coupled to a humidity sensor. The requested value of moisture in the field is entered using the 3-switch keypad. It consists of three switches: one for proliferation, one for diminishment, and one for entering or saving the required value. The humidity detector determines humidity from the environment once the stoner sets the requested value. The asked value is entered and this value is compared. However, if the moisture is below the required level, irrigation is required. Additionally integrated with the regulator is a buzzer that turns ON and OFF depending on the humidity levels. The moisture value is expressed as a percentage of the volume of water in the air. The diagram of the inflow concept. It demonstrates how a detector gets humidity from the environment. Additionally, these numbers are contrasted with the value that the stoner was requested to enter. Different methods are employed to alert the stoner that irrigation is necessary since the humidity is low [11].

4 Results and discussions

4.1 Implementation of module 1

Each sensor delivers the data it has picked up to the microcontroller, which then analyses it and sends the data it has gathered to the web application or application at the same time. The user can get the scanner's findings.

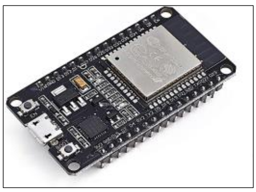

Fig. 2. Firebase console.

4.2 Implementation of module 2

The Realtime data of the sensors is updated to Firebase.

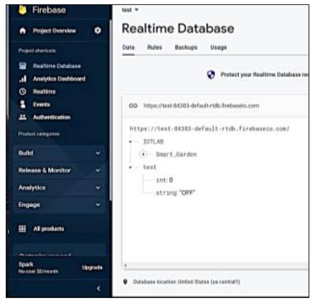

Fig. 3. Firebase console.

4.3 Implementation of module 3

The Android Firm has developed a design perspective for their lawn and garden automated processes, which includes the ability to manually adjust the land value by assessing the soil. This is achieved through the use of a soil humidity, heat, and moisture sensor that can control soil water, heat, and moisture position. Live results are quickly previewable in the Modular Application. A block diagram has been developed for the monitoring system, which is based on a soil humidity sensor. The full system includes a microcontroller, power supply unit, TV screen, keyboard, buzzer, LED pointer, and humidity sensor. The system's main component is an ESP32 microprocessor, which is run on a 5V power supply. The Electric Unit Circuit includes a demitasse oscillator with a 4 MHz timer frequency, a reset button, an LED indicator, and two noise-suppressing capacitors with 22 pF each. The microcontroller is preferred over other controllers due to its integrated 10-bit ADC and high performance improved flash.

The microcontroller is connected to a humidity sensor, and the requested value of moisture in the field is entered using the 3-switch keypad. The humidity detector determines humidity from the environment once the stoner sets the requested value, and the moisture value is expressed as a percentage of the volume of water in the air. The requested value is then compared to the actual value, and if the moisture is below the required level, irrigation is required. Additionally, the system includes a buzzer that turns ON and OFF depending on the humidity levels. The inflow concept diagram demonstrates how a detector gets humidity from the environment and compares it to the value that the stoner requested to enter. The Android Firm is committed to developing innovative and effective solutions for smart gardening and is dedicated to creating systems that optimize plant growth, reduce water usage, save time and effort, prevent plant damage, and increase yield.

4.4 Significance of proposed method with advantages

Less likely to over or under water crops In husbandry, overwatering crops can impact the quantum of oxygen that enters the roots, precluding them from typically growing. Any trees, on the other hand, can also beget root spoilage, which can eventually beget the crop to fail. In comparison, under soddening shops generally have the same goods as overwatering crops cannot grow duly without acceptable irrigation or can eventually go down and die. More water conservation husbandry and husbandry use about 70 of the world's brackish force, grounded on the World Wildlife Fund check and study. Water operation will insure the soil water reserves aren't depleted or that redundant soil is diverted into gutters and other water body. Save time and coffers from another field examination angle, soil moisture situations can be tested manually, and temperature ensures further time will be spent on other areas of the association, similar as secretary or meeting guests. Conserving time and plutocrat also leads to advanced income, with also lower prices and time spent tracking crops, Increased Production Crop management that is optimized, such as precision seeding, water, weed killers, and picking, has a direct impact on production rates. Water may be used just when and where it is necessary thanks to weather forecasts and soil moisture sensors. Real-Time Data and Production Insight Farmers can remotely and in real time visualise production levels, soil moisture, sunlight intensity, and other factors to hasten the decision-making process.

5 Conclusion

Recommendation system for crops and soil grounded. This operation is stoner friendly so everyone can use it fluently. We've developed a portable tackle that can be used by the growers fluently in their granges. Also the mobile operation designed is stoner friendly and give clear and crisp information to druggies. The soil surveillance system is being designed using a method for measuring and controlling the soil humidity, which is a key aspect in industrial growth. The data we obtain from the dimensions has demonstrated that the system's operation is generally accurate and trustworthy. Soil moisture detectors are used to calibrate irrigation methods and to detect the required changes. These small adjustments to irrigation techniques increase productivity while using less water. Monitoring the detectors to determine the soil humidity level when the data obtained is within the specified range for the particular soil type is the key to irrigation water operation utilizing soil humidity detectors.

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