

System monitoring Soil PH moisture based IoT

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ABSTRACT

Soil moisture is a water content that wets the soil pores either partially or completely. So far, the process of checking soil moisture is still done manually, where farmers must come directly to the field. To help the process of checking soil pH, this researcher designed and built a soil pH moisture monitoring system based on the Internet of Things which aims to facilitate the process of monitoring the results of soil values including pH and moisture levels. In implementing the development of this monitoring system, it was designed using a soil moisture sensor and pH sensor integrated with an Internet of Things (IoT)-based platform, allowing users to monitor soil conditions in real-time via mobile or web applications. With accurate and continuous data, farmers can take quick steps in irrigating and amending soil pH, thereby increasing plant productivity and maintaining soil health. This system implements an Arduino UNO microcontroller, transmitter, YL-69 soil moisture sensor, and LCD as part of the soil monitoring system. Based on the results of the design and testing of this soil moisture monitoring system, users can get information on the condition of the soil pH moisture content. The test results show that this system has high measurement accuracy and easy data access, making it a potential solution to support sustainable agriculture.

INTRODUCTION

Internet of Things (IoT)-based soil pH moisture monitoring systems are an increasingly popular method in modern agriculture. By utilizing various sensors integrated with IoT technology, farmers can monitor soil conditions in real time, thereby increasing efficiency in land management. In the context of agriculture, soil moisture and pH are two key parameters that greatly affect plant growth. Therefore, it is important to have the right system to monitor and control these two variables. (Talli et al., 2023), a monitoring system built using the NodeMCU ESP8266 module, Arduino Uno, and various sensors, including pH sensors, can provide accurate data on soil conditions. Data obtained from these sensors can be stored in a database and used to inform farmers about watering and fertilization needs. The use of this system shows that soil pH and moisture monitoring can be carried out efficiently and effectively, providing farmers with a useful tool to increase agricultural yields.

The soil pH moisture monitoring system is an important innovation in modern agriculture, especially in the context of utilizing technologies such as IoT (Internet of Things). so that farmers can make real-time data-based decisions for more efficient irrigation and fertilization. This shows that technology can optimize agricultural practices by providing accurate information on soil quality. Soil moisture, a monitoring system can also include other variables such as temperature and humidity. This integration provides a more comprehensive picture of environmental conditions that affect plant growth. With the application of IoT technology, data can be automatically sent to a cloud platform, allowing farmers to monitor remotely through applications such as Firebase. (Yaqin et al. (2024).

In the situation analysis of the Internet of Things (IoT) based soil pH moisture monitoring system, it is important to consider the various components, sensors, and methodologies that have been implemented in related studies. This system is designed to monitor and manage soil conditions in real-time, which is very beneficial for modern agriculture. One of the key components of this system is the use of a microcontroller such as Arduino or NodeMCU ESP8266, which acts as the system's control center.

Monitoring system built using the NodeMCU and Arduino Uno modules, along with soil moisture sensors and pH sensors, successfully collected data on soil quality for chili plants Talli et al. (2023). This data is stored in a database and can be accessed via a web interface, as well as providing notifications to farmers via applications such as Telegram. The use of the DHT11 sensor in this system provides important information on temperature and humidity, which also affect plant growth Talli et al. (2023).

The developed system monitors various variables, including temperature, soil moisture, and air humidity. This study demonstrated its effectiveness in making decisions related to irrigation and fertilization (Yaqin et al., 2024). When low soil moisture is detected, the system automatically signals to irrigate, which helps reduce the workload of farmers. In addition, the monitoring system developed by Daru et al. showed how IoT can be used to automate irrigation based



on soil moisture analysis, significantly improving the efficiency of water use in agriculture (Daru et al., 2021).

IoT-based soil moisture and pH monitoring systems provide effective solutions to improve agricultural efficiency. With this system, farmers can conduct more measurable and responsive monitoring and management of soil and environmental conditions, answering modern challenges in agriculture with technology-based intelligence.

LITERATURE REVIEW

The Internet of Things (IoT)-based soil moisture and pH monitoring system is an important innovation in modern agriculture. By utilizing IoT-based sensors and devices, farmers can effectively monitor and manage their soil conditions to improve agricultural yields. Research by Santoso et al. showed that the system built to monitor soil quality in Sidorejo was successfully implemented, recognizing the speed of control and real-time data access via mobile phones, allowing farmers to immediately respond to their soil conditions (Santoso et al., 2022).

The soil moisture monitoring system and irrigation automation for chili plants, shows that continuous monitoring can help optimal plant growth (Aulia et al., 2024). This system is able to detect soil moisture and temperature, and regulate watering automatically, and this is in line with research by Thoriq et al., who designed a soil temperature and humidity monitoring system with the integration of data backup technology for unstable internet connection situations (Thoriq et al., 2022). The implementation of modules such as NodeMCU and Arduino in the monitoring system helps in measuring pH and soil moisture accurately, as shown by Talli et al. (Talli et al., 2023). This study confirms that the data generated can be stored and communicated via Telegram, notifying farmers about soil conditions and plant needs. A similar system was also reported by Khairunisa et al., who integrated fuzzy logic for monitoring and controlling humidity and temperature in chili plants (Khairunisa et al., 2024).

In addition, the application of an automatic monitoring system via Telegram, which allows efficiency in the process of watering plants (Maulana & Supardi, 2022) (Ula et al., 2024). This shows that the use of IoT-based technology in agriculture can accelerate the response to changes in soil conditions and increase crop yields. However, the importance of electronic components in the soil moisture and temperature monitoring system, although their system uses GSM for notifications, not Telegram (Sintia et al., 2018).

Significant results in the design of a soil moisture and temperature monitoring system for shallot plants. By utilizing humidity and temperature sensors, the system can monitor soil conditions and provide data needed to maintain plant health).

Development of a tool to measure soil pH, temperature, and humidity using the ATmega328P microcontroller. In this study, soil moisture measurements were carried out using a soil moisture sensor, which allows users to obtain accurate data on soil conditions (Jupri et al., 2017). Other systems, such as those proposed by Komarudin and Luqman, apply fuzzy logic to control soil moisture and pH, which provides a data-driven approach to maintaining soil fertility (Komarudin & Luqman, 2023).

The efficiency of this system also emphasizes the aspects of data storage and communication. Thoriq et al. integrated an SD card for data backup when the internet is unstable, while Yaqin et al. used a blend of technologies to combine multiple sensors in a smart crop monitoring (Thoriq et al., 2022; Yaqin et al., 2024). This underscores the importance of solutions that are able to function optimally in various environmental conditions, and emphasizes network stability as a key factor in soil monitoring systems.

In addition, the automatic control system designed by Hakim et al. shows how technology can control soil moisture automatically or manually, serving as an additional tool to reduce farmer labor in land management (Hakim et al., 2019). Uziah et al. on the other hand, introduced an integrated IoT system that monitors soil moisture for automatic fertilization, illustrating the growing application of IoT in real-time soil moisture and fertilization (Uziah et al., 2024).

METHOD

The following is a research methodology on the Internet of Things-based soil pH moisture monitoring system, as follows:

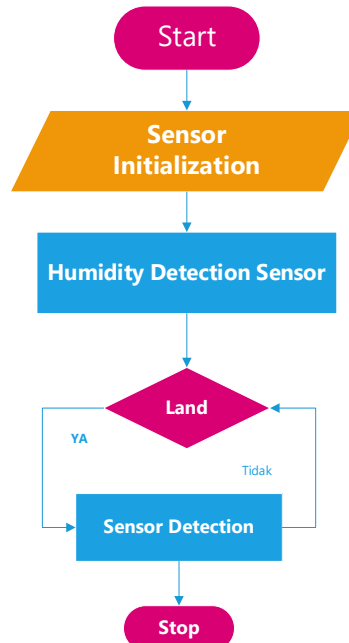


Figure 1. IoT-based soil pH moisture monitoring system

Initialization of the IoT-based soil pH monitoring system with sensors. The sensor searches for soil moisture data whether the soil data includes PH levels and soil moisture. If not, then the system will detect the pH level of the soil moisture. If yes, then the system displays the value seen from the LCD system that comes out in the internet of things-based system that has been created and gets the PH value results from the system that has been completed.

RESULT

Sensor Testing

Initial testing of the sensor as a detector of soil PH moisture was carried out by looking at the comparison between the output voltage on the sensor and the soil moisture value on the comparative measuring instrument (Moisture Meter). The output voltage data from the sensor was taken for each variation of the volume of water inserted into the soil using the IOT detection measuring instrument. Changes in soil moisture occur with each addition of water volume to the soil in the IOT tool test. The increase in the output voltage of the soil moisture sensor occurs as the water volume increases. So that the percentage of soil moisture value also increases. The results of the relationship between the sensor output voltage and the measured soil PH moisture are as follows:

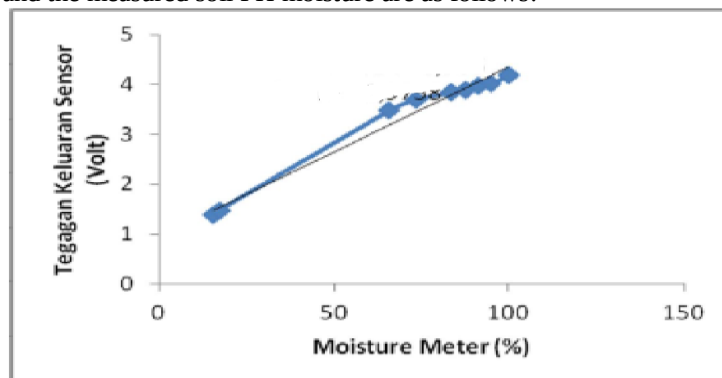


Figure 2. Sensor Test Value Results

Testing Results

The following is the test result of the soil pH humidity monitoring system based on the Internet of Things without soil. When the sensor detects dryness (output_value) > 0, the soil moisture sensor is inactive and commands are as follows:





Figure 3. Testing Results not exposed to objects

Description:

IoT sensors are placed on the ground to monitor soil moisture and plant conditions that are not exposed to the device, without physically penetrating the soil. This IoT detection device without being exposed to the ground does not produce values, as well as unsustainable and inefficient monitoring capabilities.

Wet Soil Results Testing

The following is a test of the results of an Internet of Things-based soil pH moisture monitoring system without soil. When the sensor detects soil moisture of 50 and if water is added to the soil, the soil moisture sensor will increase to 65, for more details in the following image :



Figure 4. Results when the IOT Device Works with Soil Moisture Detection

Description

The test results of the soil pH monitoring system with soil moisture detection of 50 soil in normal conditions, the second test added water, then the soil moisture sensor will increase to 65. The test results proved to increase and the sensor worked well.

DISCUSSION

This system uses the internet of things to detect soil PH moisture. The design of an IoT-based soil PH moisture monitoring system with this water system is expected to help farmers control soil moisture in fields or agricultural land that is in accordance with plant needs for plant growth and of course this can bring hope for more optimal harvest results and increase farmer productivity.



Figure 5. Watering to Check Soil Humidity and PH Tanah

Description :

This IoT-based soil PH monitoring system design must be adjusted to the soil moisture that suits the needs of each plant. The soil PH sensor is tasked with providing information on whether the soil moisture is rated with the soil PH.. The following are the results of the IoT-based soil pH moisture monitoring system with a soil pH value of 6.73 as shown. Results of Watering to See the Results of Soil Humidity and PH.

CONCLUSION

1. Results The Internet of Things (IoT) based soil pH moisture monitoring system is a significant innovation in the agricultural sector. This allows farmers to be the main focus in efforts to improve the efficiency of resource use and increase crop productivity.
2. Test results on soil planted with corn with 68% humidity, after adding water around the IOT testing tool the temperature increased to 27.07 degrees and the first PH was 5.24 after adding water to 6.73. Data collected from sensors is sent in real-time to the LCD layer that can be seen by farmers. This allows farmers to monitor soil conditions directly, so that farmers can make faster decisions and the right information regarding watering and fertilization properly.
3. The results of the implementation of the IoT-based soil pH moisture monitoring system to be able to efficiently use resources by monitoring soil moisture and pH in real-time, farmers can save on water and fertilizer use, thereby reducing operational costs. Furthermore, increasing agricultural yields in better predictions and management of soil conditions contributes to increased crop yields. Finally, this IoT-based soil pH moisture monitoring system enables better decision making with accurate data.

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