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Enhancing Farm Efficiency with IoT-Driven Real-Time Monitoring and Analysis

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Abstract

This project proposes an Internet of Things (IoT) solution for enhancing agricultural practices by leveraging real-time data monitoring and analysis. The system utilizes NodeMCU, DHT11, pH sensor, soil moisture sensor, and an LCD display for data collection and visualization. NodeMCU facilitates internet connectivity, enabling the transmission of data to the ThingSpeak platform. Temperature and humidity are measured by the DHT11 sensor, and soil acidity is tracked by the pH sensor. The moisture content of the soil is detected by the soil moisture sensor. Following collection, the data is processed and shown on the LCD display for local monitoring. Additionally, data is sent to ThingSpeak for remote access and analysis via the Virtuino app. Farmers can schedule irrigation, apply fertilizer, and implement crop protection strategies with knowledge when they regularly evaluate soil parameters and environmental conditions. A user-friendly dashboard that is accessible through online or mobile applications provides farmers with convenient access to vital agricultural information. By informing farmers of conditions that deviate from ideal, including low moisture levels or pest infestations, automated alerts and notifications guarantee timely response. This simplified method improves decision-making and makes proactive farm operations management easier, which eventually boosts agricultural output and sustainability. This IoT-based approach offers a cost-effective and efficient means of optimizing agricultural productivity while conserving resources and protecting crops from water-related damage.

Keywords: IoT, NodeMCU, AGRI Soil maintenance, protection of crop, DHT sensors

INTRODUCTION

Through the Internet of Things, all gadgets are connected to the internet and can communicate with one another online. Without a doubt, the main source of income in India is agriculture. There is a need for agricultural products as the population grows. The need for freshwater for irrigation also grows to sustain increased agricultural output. Currently, 83% of India's water use is related to agriculture. Hence, wastage of water must be prevented by taking.

The Internet of Things is a vast network of interconnected objects that all collect and exchange data about their usage and the settings in which they are situated. IoT improves soil management, pesticide, fertilizer, and insecticide control, time efficiency, water management, crop monitoring, and soil monitoring in several farming domains. Certain systems are fully automated, meaning that human involvement is not required. To create graphs for analysis, the sensor readings are also sent to a Thing talk channel. It's the integration of

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contemporary information and communication technologies with farming practices. An irrigation system is automatically set up and the agricultural field is monitored using sensors (light, humidity, temperature, soil moisture, etc.) in IoT-based smart farming.

These systems use preset parameters or data inputs to automate crucial agricultural operations like fertilization, irrigation, and pest management. Because of this automation, a lot less manual labor is required, which streamlines processes and increases productivity. Furthermore, these systems make use of large amounts of data that are gathered from a variety of devices using IoT-enabled predictive analytics. Farmers can forecast crop yields, possible disease outbreaks, and market demands by combining historical data with present trends. This kind of insight improves not only strategic planning but also decision-making processes all the way through the agricultural cycle.

The predictive capabilities of the system enable precise irrigation and fertilizer control in many agricultural environments, hence maximizing resource consumption and improving crop health. Using collected historical data, the algorithm predicts growth trends for upcoming planting seasons and makes trend identification easier. In addition to improving decision-making, this data-driven strategy promotes sustainable agriculture methods. Strict rules are upheld throughout its operation to ensure the privacy and confidentiality of data. Farmers' private information is protected by secure storage techniques and encrypted data transmission, which promotes confidence and complies with privacy laws. A reliable method for tracking the growth of onion crops is provided by the combination of cloud computing and IoT (Internet of Things). With the help of this cutting-edge framework, farmers can make more educated decisions that increase overall output and resource efficiency by having access to priceless insights into crop conditions and productivity measures [9].

The usage of Internet of Things (IoT)-driven intelligent solutions in agricultural operations is expected to expand significantly in the upcoming years. Compound annual growth rate (CAGR) is expected to hit twenty percent, highlighting how quickly IoT technologies are developing in the agriculture industry. Forecasts indicate that between 2014 and 2024, there will be a significant increase in connected devices in agriculture—from 13 million to 225 million, on average [10].

The continual development of cellular networks and improvements in satellite links are the main forces behind this expansion. Although faulty communication network infrastructures in less developed or rural areas provide issues, network operators are continuously seeking ways to improve dependability and expand access throughout agricultural regions.

With real-time monitoring, data-driven decision-making, and increased operational efficiency made possible by the widespread use of IoT-enabled devices, agricultural practices stand to undergo a radical transformation. This revolutionary movement addresses the changing demands of contemporary farming in a digitally linked world by supporting sustainable agricultural practices while also increasing production and resource management.

PROPOSED SYSTEM

In Undertaking a project focused on " Smart Aquaculture: Enhancing Productivity and Welfare Through Advanced Monitoring Systems " is a valuable initiative with the potential to make a significant impact on agriculture.

Project Goals

Create and put into place an Internet of Things (IoT)-based system to monitor soil conditions and nutrient levels in agricultural areas in real time. Create a mechanism to dispense micro-nutrients to crops based on real-time data, ensuring optimal nutrition. Implement a flood monitoring and control system that utilizes IoT sensors to detect excess water levels and take preventive measures to protect crops.

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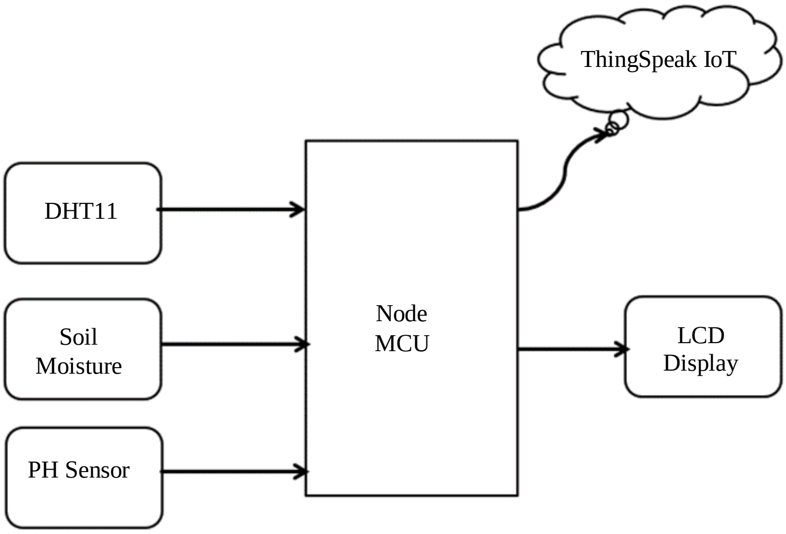

Figure 1. Block Diagram of the proposed system.

The block diagram in Figure 1. illustrates the overall architecture and functional components of the IoT-based agriculture system for soil maintenance and crop protection.

NodeMCU

- At the heart of the system is the NodeMCU microcontroller, serving as the central processing unit and providing connectivity to the internet via Wi-Fi.

Sensors

- *DHT11:* This sensor provides vital information for evaluating the climatic conditions impacting crop growth by measuring the temperature and humidity levels in the surrounding air.
- *pH Sensor:* The pH sensor monitors the acidity levels of the soil, helping to determine its suitability for plant growth and nutrient absorption.
- *Soil Moisture Sensor:* This sensor detects the moisture content in the soil, indicating the need for irrigation and preventing water-related damage to crops.

LCD Display

- The LCD display module serves as a local interface for real-time visualization of the collected data, allowing on-site monitoring and troubleshooting.

NodeMCU to ThingSpeak

- Data collected from the sensors is transmitted to the ThingSpeak IoT platform via the NodeMCU's Wi-Fi connection. ThingSpeak acts as a cloud repository for storing and analyzing the data.

Virtuino App

- The Virtuino mobile application is utilized for remote monitoring and analysis of the agricultural data sent to ThingSpeak. Users can access real-time sensor readings and historical data trends via the app interface.

LITERATURE SURVEY

R. Kumar, S. Kumar, A. K. Singh et. all this paper presents a detailed review of the use of IoT in smart agriculture, covering different applications, technologies, and challenges. Data-Driven Decision-Making: IoT sensors collect data on various parameters, providing valuable insights that can be used to optimize agricultural practices [1].

D. Singh, A. K. Singh, P. Singh, S. Kumar. This paper provides a comprehensive overview of the use of IoT in agriculture, including its applications, challenges, and future trends. Lower Labor Costs: IoT automation can cut costs and boost efficiency by eliminating the need for manual labor [2].

P. Manaswini and R. Anirudh Reddy | MSP 430-based automatic irrigation IoT system that promotes enhancing productivity is an Internet of Things-based Smart Crop-Field monitoring and automation irrigation system. Early Problem Detection: Sensors can detect issues such as diseases and pests early, allowing for timely intervention and minimized crop losses [3].

R. Nageswara Rao, B. Sridhar . This is a suggestion for adopting precision agriculture and adding cloud computing. Previously, SMS or MMS were used to send data to mobile devices. Compatibility Issues: There may be instances where certain IoT systems and devices are incompatible [4].

This is a proposal for the adoption of precision agriculture and the introduction of cloud computing by Nelson Sales, Orlando Remédios | Scalability simplifying the process of growing the irrigation network as needed [5].

Nikesh Gondchawar, Prof. Dr. R. S. Kawitkar | The paper included the automation of irrigation in the farmland | Early Warnings: Detects issues like diseases and pests early, minimizing crop and livestock losses. [6].

Prathibha S R, Anupama Hongal, Jyothi M P Real-Time Monitoring: Real-time data on various elements of agriculture is provided by IoT devices and sensors. The monitoring system uses IoT sensors that may communicate data about the agricultural area. [7].

Internet of Things is being used in Smart Agriculture, mainly for irrigation purposes, according to Dr. Ayyasamy S, Eswaran S, Manikandan B, Mithun Solomon S P, and Nirmal Kumar S. Here, IoT is utilized to manage the waterlog in farms. | Remote Monitoring: Using linked sensors and gadgets, farmers can keep an eye on the health of their crops and soil from a distance. This real-time data is useful for making informed decisions. [8]

RESULT

The system operates on its own with little to no human intervention, ensuring efficient and adaptable farm management. Figure 2 depicts the circuit simulation model as well as the integration and functionality of the sensor network within the agricultural monitoring system.

Figure 3 shows how the project is being implemented. The system incorporates several sensors that are essential for tracking and improving farming conditions. The PH sensor, DHT11 sensor, and soil moisture sensor are important sensors. To protect crops from water-related stress, the Soil Moisture sensor is essential in determining the best time to apply irrigation. When it detects high water levels, urgent preventive measures are taken to safeguard the health of the crop.

Real-time data visualization is made possible by the LCD Display module as shown in Figure 4, which makes on-site monitoring and prompt troubleshooting possible. The DHT11 Sensor collects vital atmospheric data to help determine how the environment affects crop growth. The PH Sensor also detects the pH of the soil, which is important for figuring out whether it is suitable for plant growth and nutrient absorption.

As shown in Figure 5, the ThingSpeak IoT Platform receives the data gathered from these sensors and logs and analyzes it. The platform produces graphical representations of sensor data for in-depth analysis and enables continuous monitoring. This maximizes agricultural productivity by enabling informed judgments about irrigation schedules and environmental factors.

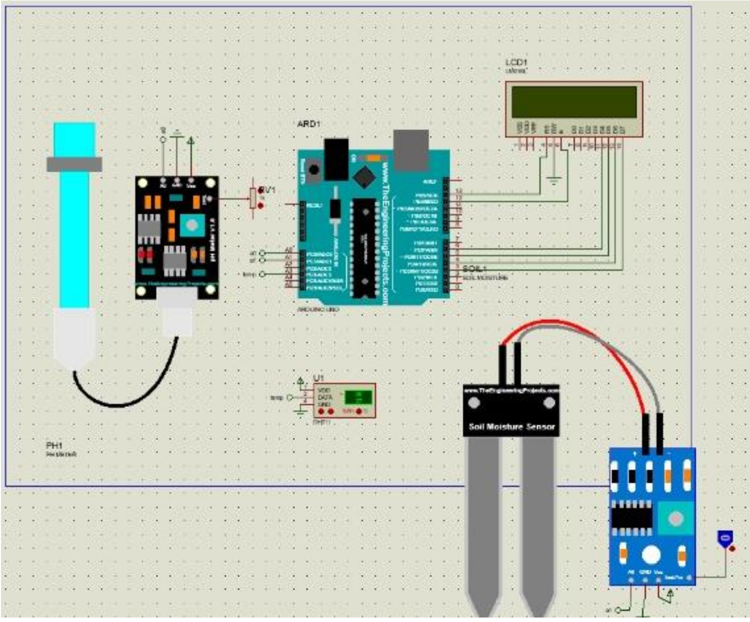

Figure 2. Circuit Simulation model of the proposed system.

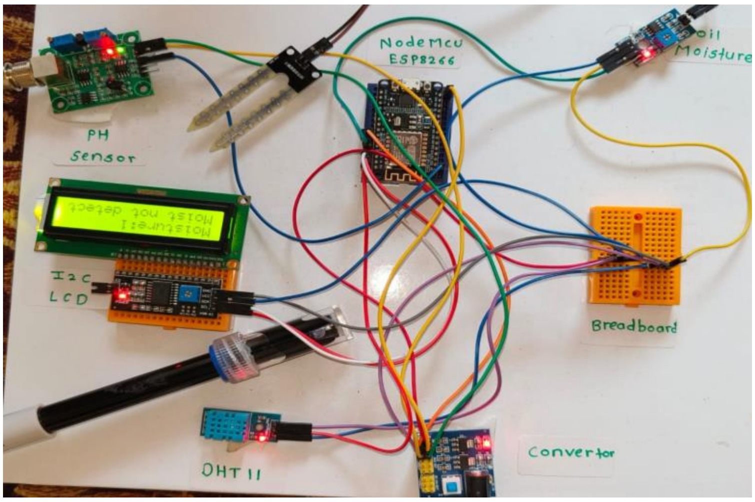

Figure 3. Hardware Setup of the proposed system.

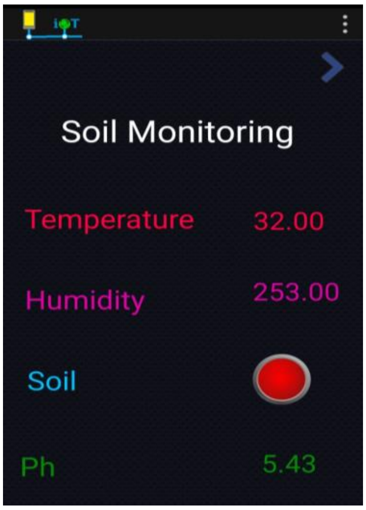

Figure 4. LCD Display Soil Monitoring (Temperature, Humidity, Soil, Ph label).

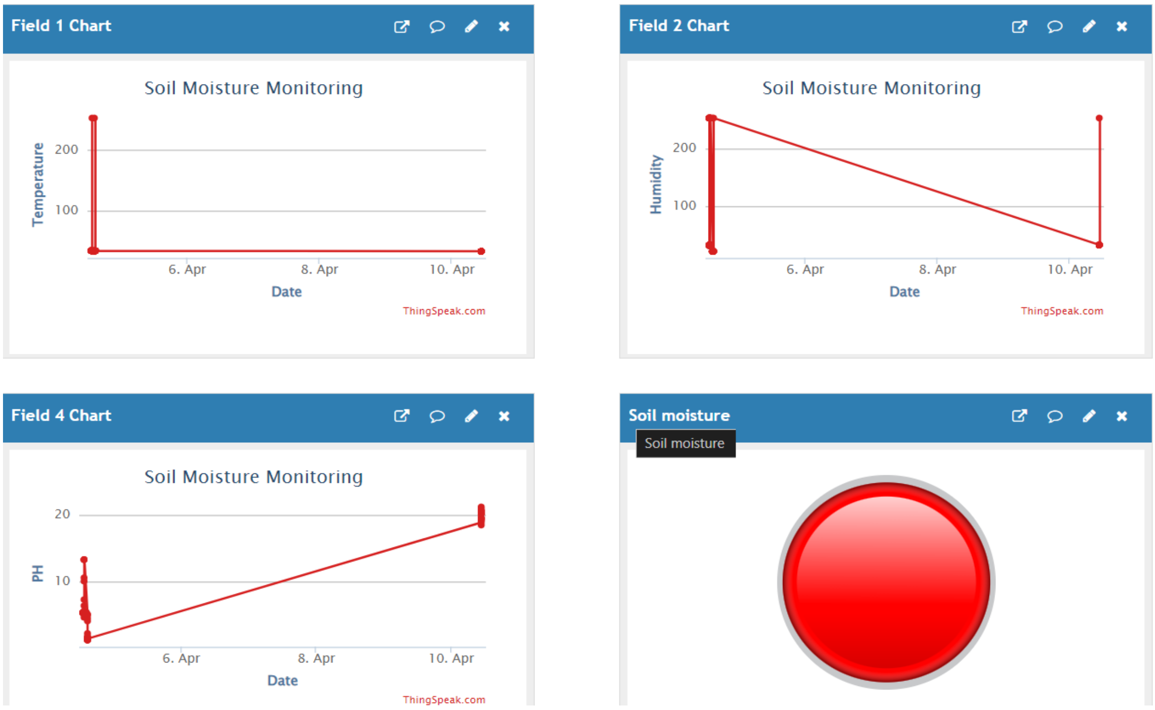

Figure 5. ThinkSpeak soil monitoring graph.

Overall, the system that has been put in place improves agricultural productivity by means of automated data analysis, prompt intervention, and real-time monitoring; this in turn encourages sustainable crop management techniques.

CONCLUSION

In conclusion, the proposed Internet of Things (IoT) solution for enhancing agricultural practices presents a promising approach to revolutionizing modern farming. By leveraging real-time data monitoring and analysis, this system offers farmers valuable insights into environmental conditions and soil parameters, empowering them to make informed decisions to optimize productivity while conserving resources and protecting crops.

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