



Smart Farming Solution: Integrating IoT, Cloud Services, and Direct Messaging for Enhanced Agricultural Management

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Abstract. The Smart Farming Solution (SFS) outlined in this paper represents a pioneering approach to modern agricultural management, addressing the evolving challenges faced by farmers through the integration of cutting-edge technologies. By harnessing Internet of Things (IoT) technologies, Raspberry Pi, and cloud services, SFS provides real-time monitoring and actionable insights to farmers, enabling remote monitoring of field conditions and precise control over irrigation systems via a user-friendly web interface. SFS employs an array of sensors including soil moisture sensors, NPK sensors and DHT11 sensors for environmental monitoring, managed by Raspberry Pi and processed through Django, with data storage facilitated by an AWS database for scalability and reliability. Notably, the system incorporates a direct messaging feature to alert farmers of critical conditions such as low soil moisture levels or adverse weather forecasts, empowering them to respond promptly and make informed decisions to mitigate risks. By facilitating timely alerts and actionable insights, SFS enhances farm management practices, optimizes resource utilization, and promotes sustainability in agriculture. Ultimately, the integration of IoT technologies, cloud services, and direct messaging capabilities in SFS represents a significant advancement in modern agriculture, enabling farmers to adapt efficiently and sustainably to changing conditions, thereby ensuring the continued success of agricultural operations.

Keywords: Smart Farming Solution, IoT, Internet of Things, Cloud Services, Direct Messaging, Agriculture, Farm Management, Remote Monitoring, Irrigation Control, Environmental Monitoring, Sustainability, Real-time Alerts, Resource Optimization, Crop Yield, Raspberry Pi, Django, AWS Database.

1 INTRODUCTION

Efficient resource utilization in agriculture is a critical component for sustaining food production and meeting global demand. However, traditional farming methods often face challenges such as unpredictable weather patterns and inefficient resource management. To address these issues, this paper presents a transformative approach to agricultural management by leveraging cutting-edge technologies, specifically edge technologies. By integrating essential crop parameters into a real-time monitoring system, this innovative solution aims to revolutionize farming practices and enhance productivity. The incorporation of Internet of Things (IoT) technologies, cloud services, and direct messaging capabilities enables farmers to optimize resource utilization while mitigating risks. Through the seamless integration of these advancements, farmers are empowered to make informed decisions, thereby driving substantial change in agricultural practices. This paper emphasizes the significance of leveraging modern technologies to address the evolving challenges faced by farmers, ultimately leading to more efficient and sustainable agricultural operations.

2 DHT11 Temperature & Humidity Sensor

The DHT11 temperature and humidity sensor is a versatile device designed to provide accurate readings of both temperature and humidity levels in the atmosphere. Operating within a voltage range of 3.5V to 5.5V, this sensor utilizes a serial data transmission method to relay collected data. Its compact design features three terminals: Pin 1 serves as the VCC (Voltage Common Collector) terminal for power input, Pin 2 functions as the Data pin for communication, and Pin 3 acts as the Ground (GND) terminal for completing the circuit. With a low operating current of 0.3mA during measurements and a standby current of 60uA, the DHT11 sensor ensures minimal power consumption, making it suitable for prolonged use in various applications. The sensor offers a wide temperature range spanning from 0°C to 50°C and a humidity range from 20% to 90%, enabling comprehensive environmental monitoring. [3] Both temperature and humidity readings boast a high resolution of 16 bits, ensuring precise data acquisition for accurate analysis and decision-making in agricultural, industrial, and domestic settings. The DHT11 sensor's efficient design and reliable performance make it a valuable tool for monitoring and controlling environmental conditions with ease and accuracy.

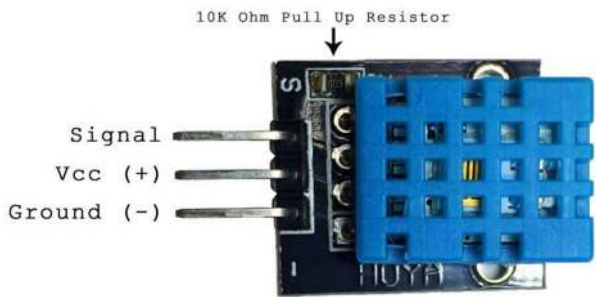


Fig.1. Pin Diagram of DHT11 Temperature & Humidity Sensor

SOIL MOISTURE SENSOR

The soil moisture sensor utilized in this project is of the capacitive type, designed to accurately measure the water content present in the soil and provide percentage-based readings. [5] Specifically, the FC-28 analog sensor is employed, featuring four pins: VCC for power input, GND for ground connection, and either an analog or digital pin for data output. Within its structure, a variable potentiometer allows for adjustments that can yield values up to 1024, translating to varying levels of soil moisture. The digital output provides a binary signal (0 or 1) indicative of soil moisture conditions, making it versatile for different applications. Additionally, the sensor module incorporates a potentiometer to set a threshold value, which is then evaluated by the LM393 comparator. This comparison determines whether the soil moisture level exceeds the set threshold, triggering the LED indicator to turn on or off accordingly. Operating within a power supply range of 3.5 to 5 volts, the sensor requires a minimal current of less than 20mA, ensuring energy efficiency. With a recommended working temperature of up to 30°C, the FC-28 soil moisture sensor proves to be a reliable tool for monitoring soil moisture levels in agricultural settings, facilitating efficient irrigation practices and ensuring optimal plant growth.

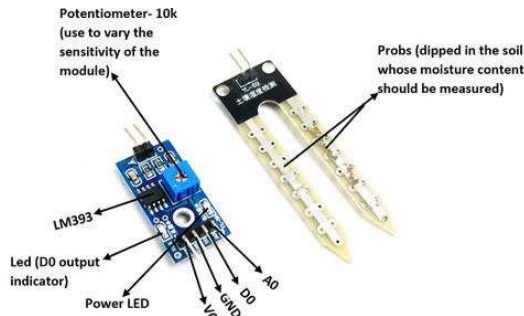


Fig. 2. Pin Diagram of Soil Moisture Sensor(FC-28)
SUBMERSIBLE PUMP



Fig. 3. Submersible pump

- A submersible pump is an essential component in automated irrigation systems, particularly when integrated with a soil moisture sensor like the FC-28. The soil moisture sensor continuously monitors the moisture level in the soil, providing real-time data on whether the soil is too dry or adequately moist. When the soil moisture drops below a predefined threshold, indicating a need for irrigation, the soil moisture sensor sends a signal to activate the submersible pump.
- The submersible pump, typically placed in a water source such as a well or reservoir, is designed to be submerged in water. When triggered by the soil moisture sensor, the submersible pump activates and draws water from the water source. This water is then pumped through irrigation pipes or hoses to deliver it directly to the roots of the plants in the field.
- By integrating the soil moisture sensor with a submersible pump, farmers can automate the irrigation process based on actual soil conditions, ensuring that plants receive water precisely when needed. This automation reduces the risk of overwatering or underwatering, optimizing water usage and promoting healthier plant growth. Additionally, it minimizes the need for manual intervention in irrigation scheduling, saving time and labour for farmers. Overall, the combination of a soil moisture sensor and a submersible pump offers an efficient and effective solution for irrigation management in agriculture.

Overall, the utilization of submersible pumps in irrigation contributes to more efficient and sustainable agricultural practices, ensuring optimal crop yields while conserving water resources.

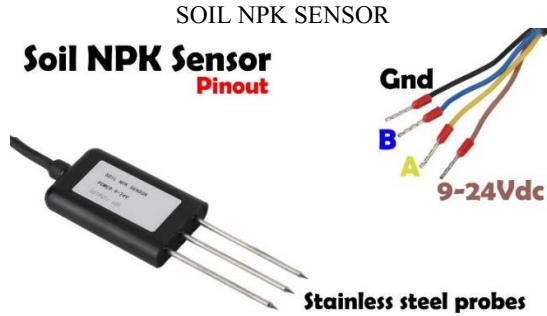


Fig. 4. Pin Diagram of NPK Sensor

The working of Soil NPK sensor follows the following points

- **Soil Sample Collection:** A soil sample is collected from the agricultural field or target area using a soil probe or auger.
- **Soil Preparation:** The soil sample may undergo preparation procedures such as drying, grinding, or sieving to ensure uniformity and facilitate accurate analysis.
- **Ion Selective Electrode (ISE) Method:** The soil NPK sensor often employs ion-selective electrodes to detect the concentration of N, P, and K ions in the soil solution. These electrodes are sensitive to specific ions and generate an electrical signal proportional to the ion concentration.
- **Calibration:** Before use, the soil NPK sensor may require calibration to establish a relationship between the electrical signal generated by the electrodes and the concentration of N, P, and K ions in the soil. Calibration involves testing the sensor with known standard solutions of N, P, and K concentrations to create calibration curves.
- **Soil Testing:** The prepared soil sample is mixed with a suitable extraction solution to extract the N, P, and K ions from the soil matrix. The soil solution is then brought into contact with the ion-selective electrodes of the sensor.
- **Ion Detection:** When the soil solution comes into contact with the ion-selective electrodes, the electrodes selectively react with the N, P, and K ions present in the solution. This reaction generates an electrical signal proportional to the concentration of each ion.
- **Signal Processing:** The electrical signals generated by the ion-selective electrodes are processed by the sensor's electronics to quantify the concentration of N, P, and K ions in the soil. The processed data may be displayed on a digital screen or transmitted to a computer or mobile device for further analysis.

- Interpretation and Action: The measured concentrations of N, P, and K ions provide valuable information to farmers for optimizing fertilizer application, adjusting nutrient management practices, and ensuring balanced soil nutrition for optimal plant growth and productivity.
Overall, the soil NPK sensor facilitates efficient soil nutrient management, enabling farmers to make informed decisions to enhance agricultural productivity and sustainability.

3 WEB TECHNOLOGIES

Relational Database(RDS)

- [6] Amazon Relational Database Service (Amazon RDS) is a fully managed relational database service provided by Amazon Web Services (AWS) that streamlines the setup, operation, and scaling of relational databases in the AWS Cloud. It supports multiple popular database engines such as MySQL, PostgreSQL, MariaDB, Oracle, and Microsoft SQL Server, offering users flexibility in choosing the database engine that best suits their needs. With features like resizable capacity, automated backups, automated failover, and Multi-AZ deployments, Amazon RDS ensures high availability, durability, and scalability of databases.
- It prioritizes security with encryption at rest and in transit, network isolation, and fine-grained access control. Additionally, Amazon RDS provides monitoring and metrics through Amazon CloudWatch for performance tracking and cost-efficient pricing based on usage.
- Overall, Amazon RDS simplifies database management, enhances security and scalability, and reduces operational overhead, making it an essential service for storing and managing data collected from sensors in diverse applications and industries.

CASCADE STYLE SHEET(CSS)

- [8] CSS, or Cascading Style Sheets, plays a crucial role in web development by defining the visual appearance and layout of web pages. It addresses the challenge of consistent styling across multiple pages by allowing developers to apply styles universally or selectively to elements within HTML documents.
- However, CSS development and maintenance present challenges due to the lack of rigorous methods for validation and debugging. Existing approaches primarily rely on validators and runtime debuggers, which are effective for checking syntactic rules and assessing behavior in specific instances but fall short when applied to entire sets of documents defined by schemas.
- To address this limitation, a novel approach is proposed, drawing inspiration from logic and compile-time verification techniques. This approach utilizes tree logics to statically analyze CSS style sheets, enabling the detection of errors and verification of properties across sets of documents. By complementing existing debugging tools, this approach aims to enhance the quality and efficiency of CSS development, ensuring consistent and reliable styling across web pages.

4 Working

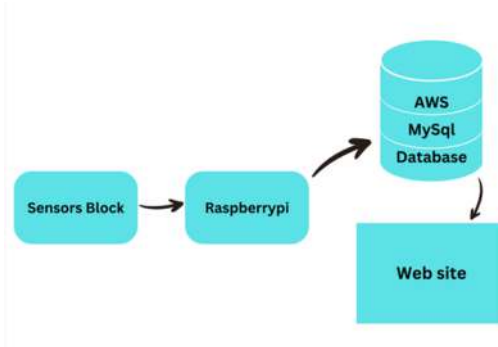


Fig. 5. Block Diagram

Sensor Deployment and Data Gathering:

The initial step involves deploying sensors in the agricultural field to gather essential data related to field conditions and environmental parameters. These sensors collect data such as soil moisture levels, temperature, humidity, and other relevant metrics. The data is then transmitted to a central processing unit, which in this case is the Raspberry Pi 3. The Raspberry Pi 3 serves as the core processing unit, efficiently handling the incoming data and preparing it for further processing.

Data Processing and Storage:

Upon receiving data from the sensors, [1] the Raspberry Pi 3 processes the collected information. This processing may involve data filtering, aggregation, and analysis to derive meaningful insights. Once processed, the data is securely stored in an AWS Relational Database Service (RDS) MySQL database. Leveraging the scalability and reliability of AWS RDS ensures efficient management of the agricultural data. The AWS RDS platform allows for seamless scaling of database resources based on demand, ensuring optimal performance and data reliability.

User Interface Development:

In order to provide farmers with real-time monitoring and data visualization capabilities, a user-friendly interface is developed. This interface is built using HTML and CSS for the frontend design, ensuring an intuitive and visually appealing platform for users. Additionally, the Django web framework is utilized for the backend development. Django facilitates seamless communication between the frontend interface and the MySQL database, enabling farmers to remotely monitor field conditions and control irrigation systems with ease. The integration of Django with the database ensures efficient data retrieval and display, empowering farmers to make informed decisions based on real-time data insights.

Seamless Communication:

The integration of the Django backend with the MySQL database ensures seamless communication between the frontend interface and the backend database. Django's robust capabilities for data handling and processing enable efficient retrieval and display of real-time data insights for users. This seamless communication empowers farmers to access critical information promptly, facilitating informed decision-making and enhancing overall agricultural productivity.

5 **Results**

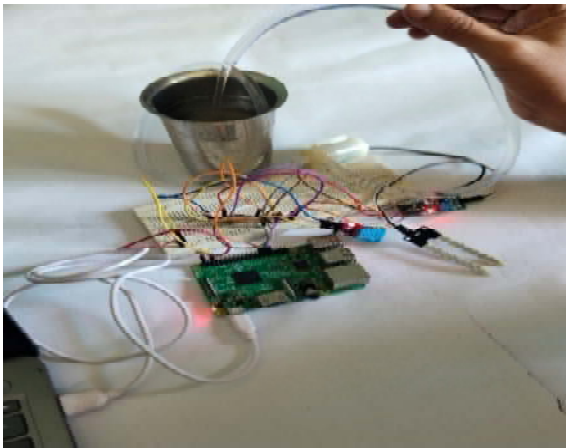


Fig. 6. Hardware Simulation



Fig. 7. a. Software Simulation

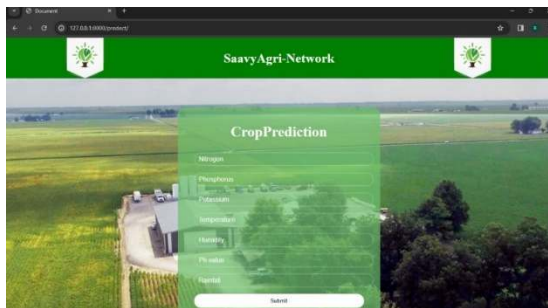


Fig. 7.b. Crop Prediction Simulation

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

References

1. Kumar, Somansh, and Ashish Jasuja. "Air quality monitoring system based on IoT using Raspberry Pi." In *2017 International conference on computing, communication and automation (ICCCA)*, pp. 1341-1346. IEEE, (2017).
2. Ahlgren, Bengt, Markus Hidell, and Edith C-H. Ngai. "Internet of things for smart cities: Interoperability and open data." *IEEE Internet Computing* 20, no. 6 (2016): 52-56. (2016)
3. <https://components101.com/sensors/dht11-temperature-sensor>
4. https://www.researchgate.net/publication/353983263_Review_of_research_progress_on_soil_moisture_sensor_technology
5. Yu, Limin, Wanlin Gao, Redmond R Shamshiri, Sha Tao, Yanzhao Ren, Yanjun Zhang, and Guilian Su. "Review of research progress on soil moisture sensor technology." (2021).
6. <https://docs.aws.amazon.com/pdfs/AmazonRDS/latest/UserGuide/rds-ug.pdf#Welcome>
7. <https://en.wikipedia.org/wiki/HTML>
8. <https://www.researchgate.net/topic/CSS/publications>
9. <https://www.instructables.com/Raspberry-Pi-3-Model-B-a-Beginners-Guide/>

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