International Journal of
AI ELECTRICAL CIVIL AND MECHANICAL ENGINEERING
Peer Reviewed, Referred & Indexed Journal
ISSN: 3070-0434 www.zesterapublications.com Original Research Paper

IOT BASED SMART FARMING SYSTEM USING SENSORS FOR AGRICULTURAL TASK AUTOMATION

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ABSTRACT

Agriculture remains the backbone of many economies, yet traditional farming practices often rely heavily on manual labor and subjective decision-making, which reduce productivity and efficiency. This paper proposes an **IoT-based Smart Farming System** that employs various sensors and microcontrollers to automate key agricultural tasks such as soil moisture monitoring, irrigation control, temperature regulation, and environmental monitoring. The system collects real-time data from sensors like soil moisture, humidity, temperature, and light intensity, which is transmitted to a cloud server for analysis. Based on the gathered data, automated actions—such as activating irrigation pumps or adjusting environmental conditions—are triggered. The data is also accessible through a mobile or web application, enabling farmers to monitor and manage their fields remotely. This intelligent system reduces water wastage, enhances crop yield, and minimizes manual intervention, contributing toward sustainable and precision agriculture.

Keywords: IoT, Smart Farming, Automation, Sensors, Agriculture, Cloud Computing, Precision Agriculture.

I. INTRODUCTION

With the global population increasing rapidly, there is a growing demand for efficient and sustainable agricultural systems capable of producing more food with fewer resources. Traditional farming practices are often labor-intensive and lack real-time data support, leading to inefficiencies in irrigation, crop monitoring, and resource management. Farmers face challenges such as unpredictable weather patterns, over-irrigation, and soil degradation, all of which reduce productivity and profitability.

The emergence of the **Internet of Things (IoT)** has revolutionized agriculture by enabling smart farming—a data-driven approach that integrates sensors, microcontrollers, and wireless communication technologies. IoT devices allow real-time monitoring of environmental and soil parameters, automate decision-making processes, and optimize resource utilization. For example, moisture sensors help determine precise irrigation needs, while temperature and humidity sensors help regulate environmental conditions for optimal plant growth.

By connecting these sensors to the cloud, the proposed system provides farmers with actionable insights via a web or mobile interface. This helps in automating tasks such as irrigation, pest detection, and fertilizer scheduling. Such systems not only improve crop yield and resource efficiency but also contribute to sustainable agricultural practices and climate resilience. Thus, IoT-based automation represents a significant step toward transforming conventional farming into **Smart Agriculture**.

II. LITERATURE SURVEY

[1] Shihao Tang, Qijiang Zhu, Xiaodong Zhou, Shaomin Liu, Menxin Wu — "A Conception of Digital Agriculture"

Shihao Tang and colleagues proposed the concept of Digital Agriculture, emphasizing the integration of remote sensing, GIS (Geographic Information Systems), and information technologies to improve agricultural productivity and decision-making. Their research focused on developing a comprehensive digital framework that allows precise monitoring and management of farmlands using spatial data. This approach helped in understanding how environmental factors influence crop growth and in optimizing agricultural resource allocation.

The authors explored how satellite imaging and GIS mapping can provide large-scale insights into soil conditions, crop health, and climatic variations. The integration of these technologies enables farmers and agricultural policymakers to make data-driven decisions, which reduces waste and enhances sustainability. By combining environmental monitoring with data analytics, the study highlighted the potential of digital transformation in agriculture.

The study's contribution lies in establishing a conceptual foundation for smart farming and precision agriculture through digitization. It demonstrated how digital data collection, cloud storage, and real-time analysis could replace traditional, intuition-based farming practices. This laid the groundwork for integrating IoT sensors and automated systems, which form the core of modern smart farming architectures.

[2] Nattapol Kaewmard, Saiyan Saiyod — "Sensor Data Collection and Irrigation Control on Vegetable Crop Using Smart Phone and Wireless Sensor Networks for Smart Farm"

Kaewmard and Saiyod introduced a wireless sensor network (WSN) based approach to automate irrigation and crop monitoring. Their system utilized soil moisture and temperature sensors connected through ZigBee technology to monitor environmental conditions in vegetable farms. Data collected from sensors was transmitted to a central node and made available to farmers through a smartphone application for real-time analysis and decision-making.

The study demonstrated how IoT-enabled WSNs can facilitate efficient water management by automatically controlling irrigation systems. By setting threshold values for soil moisture, the system could activate or deactivate irrigation pumps without human intervention. This significantly improved water conservation and reduced manual effort in field management.

The integration of mobile applications with WSN technology was a major contribution of this research. It provided a user-friendly interface for farmers to visualize environmental data and remotely control farming operations. This work effectively bridged the gap between field-level data collection and end-user accessibility, forming a foundation for scalable IoT-based smart farming systems.

[3] Sudhir Rao Rupanagudi, Ranjani B.S., Prathik Nagaraj, Varsha G. Bhat, Thippeswamy G — "A Novel Cloud Computing-Based Smart Farming System for Early Detection of Borer Insects in Tomatoes"

Rupanagudi et al. developed a cloud-enabled smart farming system focused on the early detection of pest infestations, specifically borer insects in tomato crops. The system used image processing algorithms combined with IoT sensors and cloud computing to identify pest attacks before they spread. This approach leveraged real-time image capture and analysis to provide farmers with timely alerts and recommendations.

Their research highlighted the integration of cloud computing and IoT for real-time agricultural monitoring. Images of tomato plants were processed using machine learning models hosted on the cloud to classify pest presence accurately. Once an infestation was detected, the system automatically notified the farmer, enabling immediate corrective action and minimizing crop damage.

This study made a significant contribution by showing how data analytics and IoT can be combined to create proactive agricultural management systems. By automating pest detection and using cloud infrastructure for large-scale computation, the authors provided a blueprint for precision farming that reduces pesticide use and enhances crop health.

[4] G. Angel and A. Brindha — "Real-Time Monitoring of GPS-Tracking Multifunctional Vehicle Path Control and Data Acquisition Based on ZigBee Multi-Hop Mesh Network"

Angel and Brindha's research introduced a ZigBee-based multi-hop mesh network for real-time vehicle tracking and data acquisition. Although focused on vehicular systems, their work is directly applicable to smart agricultural vehicle management, such as monitoring tractors, drones, and automated irrigation systems. The use of ZigBee technology enabled efficient communication across large areas with minimal energy consumption.

The system combined GPS tracking with ZigBee networking to provide location updates and operational data of moving vehicles in real-time. This ensured continuous connectivity even in remote agricultural regions where cellular coverage may be limited. The authors demonstrated that multi-hop communication networks could effectively extend data transmission range without excessive power use.

In the context of agriculture, their work suggests how multi-sensor, multi-node networks can support precision operations like autonomous seeding, soil mapping, and irrigation control. The study's findings contribute to the IoT ecosystem by proving that low-

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power, reliable communication networks can sustain large-scale smart farming deployments.

[5] K. Taylor, C. Griffith, L. Lefort, R. Gaire, M. Compton, T. Wark, D. Lamb, G. Falzon, and T. Trotter — "Farming the Web of Things"

Taylor and his team presented the concept of "Farming the Web of Things," which extends the Internet of Things paradigm to agricultural environments. Their work focused on developing interoperable frameworks that connect heterogeneous sensors, data services, and farming applications under a unified network. The goal was to enable seamless data exchange and intelligent automation in agricultural systems.

The study proposed a semantic web-based approach that standardizes communication between devices and services in a farming context. By creating ontologies for agricultural data, such as soil moisture or crop growth stages, the system allowed for better integration and automation across various platforms. This interoperability is essential for scalable and flexible smart farming applications.

Their research significantly advanced the vision of connected agriculture, demonstrating how IoT technologies, when structured through semantic frameworks, can provide intelligent decision support. This work inspired modern smart farm ecosystems that rely on data sharing, real-time analytics, and interoperability among devices and cloud services.

III. EXISTING SYSTEM

Traditional agricultural systems are primarily dependent on manual observation and labor-intensive methods. Farmers often rely on personal experience to make decisions about irrigation and soil conditions, leading to inconsistent results. While some systems use timers or basic electronic controllers for irrigation, these lack intelligence and adaptability to changing environmental conditions. Moreover, there is limited data collection or communication with farmers for remote decision-making.

IV. PROPSOED SYSTEM

The proposed **IoT-based Smart Farming System** automates agricultural processes using various sensors and wireless communication modules. Sensors such as **soil moisture, humidity, temperature, and light sensors** are deployed in the field to continuously monitor environmental and soil parameters. A **microcontroller unit (like Arduino, ESP32, or Raspberry Pi)** processes this data and makes intelligent decisions. For example, if soil moisture levels fall below a predefined threshold, the system automatically activates a water pump to irrigate the field and switches it off when optimal moisture is reached.

Data collected by the sensors is sent to a **cloud platform (like ThingSpeak or Firebase)** for storage and visualization. The farmer can access real-time data and control farm operations through a **mobile app or web interface**. The system also includes alert mechanisms (SMS or notifications) to inform the farmer about abnormal conditions, such as extreme temperature or water shortages.

Received: 03-03-2026 | Accepted: 11-04-2026 | Published: 18-04-2026

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V. SYSTEM ARCHITECTURE

The system architecture consists of the following modules:

1. **Sensor Module:** Includes soil moisture, humidity, temperature, and light sensors to collect real-time environmental data.
2. **Processing Unit:** A microcontroller (Arduino/ESP32/Raspberry Pi) processes sensor data and triggers actions.
3. **Communication Module:** Wi-Fi, GSM, or LoRa is used to transmit data to the cloud.
4. **Cloud Platform:** Stores and visualizes data; supports analytics and decision-making.
5. **Actuator Module:** Controls irrigation pumps, valves, or sprayers based on sensor feedback.
6. **Mobile/Web Application:** Displays live field data, status, and allows remote control.

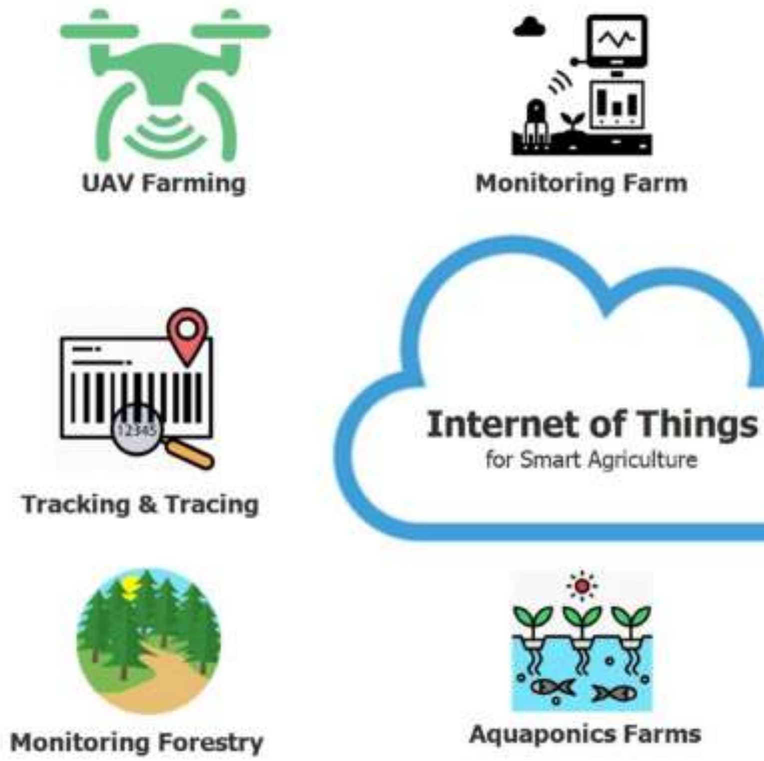

Fig.5.1: Architecture image

VI. IMPLEMENTATION

The implementation of the proposed system involves both **hardware** and **software** components.

- **Hardware:** The soil moisture sensor measures soil water content, the DHT11/DHT22 sensor measures temperature and humidity, and the LDR sensor monitors light intensity. These sensors are interfaced with the Arduino or ESP32 microcontroller, which controls water pumps via a relay module.
- **Software:** The Arduino IDE is used to write control logic. Data is transmitted to the cloud (ThingSpeak/Firebase) for visualization. A web or Android application

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displays field parameters and allows the farmer to control irrigation remotely.

When the soil moisture sensor detects dryness below a set level, the system automatically turns on the pump. Similarly, temperature and humidity readings can trigger greenhouse ventilation or irrigation adjustments. Notifications are sent to the farmer through SMS or app alerts for transparency and control. The system was tested under simulated farm conditions, showing significant improvements in water efficiency and crop monitoring accuracy.

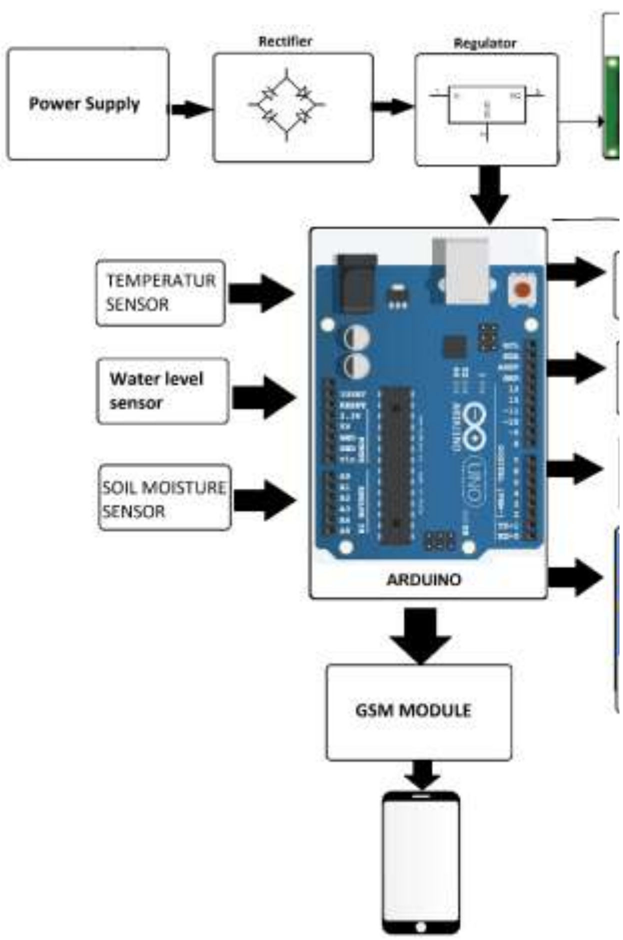

Fig.6.1: Implementation of proposed model

VII. CONCLUSION

The **IoT-based Smart Farming System** provides a comprehensive, automated solution for efficient agricultural management. By integrating sensors, IoT communication, and automation, it ensures optimal resource utilization, minimizes manual intervention, and enhances productivity. The system demonstrates how modern technology can address key agricultural challenges such as over-irrigation and inconsistent monitoring. The implementation results indicate that the proposed model can significantly contribute to sustainable and precision agriculture.

VIII. FUTURE SCOPE

Future enhancements can include the integration of **AI and Machine Learning algorithms** for crop disease prediction and yield forecasting. The system can be expanded with **drone-based imaging** for aerial monitoring, **fertilizer dispensing automation**, and **solar-powered IoT nodes** for energy efficiency. Implementation of **LoRa or NB-IoT networks** can improve scalability for large agricultural areas. Furthermore, linking the system with **blockchain-based agricultural supply chain platforms** can ensure transparency and traceability of produce from farm to market.

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