International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 1(s) (2026)



ijerst.editor@gmail.com

editor@ijerst.com

International Journal of Engineering Research and Science & Technology
www.ijerst.com
© 2026 IJERST. All Rights Reserved
Peer Reviewed, Referred & Indexed Journal

Research Paper

IoT-Based Smart Agriculture System

Name of Author
Mr. Kiran Dattatray Nikam
Assistant Professor, Department of Computer Science, Jijamata College of Science and Arts,Bhende, Maharashtra, India
nikamkiran1111@gmail.com

****

Abstract **-** Agriculture is a key sector that plays an important role in food production and economic development. Traditional farming methods often result in inefficient use of water, labor, and other resources. To overcome these challenges, the Internet of Things (IoT) provides a smart and automated approach to agriculture. This paper presents an IoT-based smart agriculture system that uses sensors to monitor soil moisture, temperature, and humidity in real time.

The collected data is transmitted to a cloud platform through wireless communication, enabling remote monitoring and automated irrigation control. The proposed system helps optimize resource utilization, improve crop productivity, and reduce human intervention. IoT-based smart agriculture supports sustainable farming practices and offers a promising solution for modern agriculture.

****

Keywords- Internet of Things, Smart Agriculture, Sensors, Automated Irrigation, Precision Farming.

1. Introduction :

Agriculture is the foundation of food security and economic development, especially in countries with large rural populations. Traditional farming practices often rely on manual monitoring and irrigation, which can lead to inefficient use of water, fertilizers, and labor. Moreover, unpredictable weather conditions and lack of timely information affect crop productivity.

The Internet of Things (IoT) is an emerging technology that connects physical devices through the internet, enabling real-time data collection and remote control. Integrating IoT into agriculture offers smart solutions to these challenges by automating processes and providing precise information about crop and soil conditions. Sensors can monitor soil moisture, temperature, and humidity continuously, allowing farmers to make informed decisions and automate irrigation systems.

2. Literature Review:

Several researchers have proposed smart farming solutions using IoT technologies:

- Studies show that soil moisture sensors help in reducing water consumption through automated irrigation systems.
- IoT-based monitoring systems improve crop yield by providing real-time environmental data.
- Wireless Sensor Networks (WSN) have been widely used to collect agricultural field data.
- Cloud-based platforms enable storage and analysis of large agricultural datasets.

Although many systems exist, there is still a need for low-cost, efficient, and easy-to-use solutions for small and medium-scale farmers.

3. Proposed System Architecture:

3.1 Hardware Components:

- **Soil Moisture Sensor:** Measures soil water content. The sensor works on the principle of electrical conductivity or capacitance. When soil contains more water, its electrical conductivity increases, which is detected by the sensor. The sensor outputs either an analog or digital signal, which is read by a microcontroller such as Arduino or ESP32.
- **Temperature Sensor:** Monitors environmental temperature. In an IoT-based smart agriculture system, sensors such as LM35, DHT11, DHT22, or DS18B20 are commonly used. These sensors convert temperature values into electrical signals that are processed by a microcontroller like Arduino or ESP32. The measured data is then transmitted to a cloud platform for real-time monitoring and analysis.
- **Humidity Sensor:** Measures air moisture. In IoT-based smart agriculture systems, sensors such as DHT11 and DHT22 are widely used because they can measure both temperature and humidity. The sensor detects moisture levels in the air and converts them into digital signals, which are processed by a microcontroller like Arduino or ESP32 and sent to a cloud platform for real-time monitoring.
- **Microcontroller (Arduino / ESP8266 / ESP32):** Processes sensor data. The microcontroller reads sensor data such as soil moisture, temperature, and humidity through its input pins. Based on predefined threshold values, it makes decisions like turning the irrigation pump ON or OFF. The ESP8266 and ESP32 microcontrollers have built-in Wi-Fi modules, which allow direct communication with cloud platforms for real-time data monitoring.
- **Water Pump / Motor:** Used for irrigation. In an IoT-based smart agriculture system, the water pump is controlled by the microcontroller through a relay module. When the soil moisture level falls below a predefined threshold, the microcontroller sends a signal to activate the pump. Once the required moisture level is reached, the pump is automatically turned OFF. This ensures efficient and controlled irrigation without manual intervention.
- **Wi-Fi Module:** Sends data to cloud server. Commonly used Wi-Fi modules include ESP8266 and ESP32, which either work as separate modules or are integrated within the microcontroller. The Wi-Fi module connects the system to a local wireless network and sends collected data to cloud services like Thing Speak, Firebase, or AWS IoT.

3.2 Software Components:

- **Embedded Programming Environment:** The microcontroller (e.g., Arduino, ESP8266, or ESP32) is programmed using embedded development platforms like Arduino IDE or PlatformIO. These environments allow writing and uploading code to read sensor data and control actuators.
- **Cloud Platform:** Sensor data is transmitted to cloud services such as ThingSpeak, Firebase, or AWS IoT. These platforms store, process, and analyze real-time data, enabling remote monitoring and decision-making.
- **Mobile or Web Application:** A user-friendly interface accessible via smartphones or computers allows farmers to view sensor readings, receive alerts, and control irrigation remotely. Apps are often developed using web technologies (HTML, CSS, JavaScript) or mobile app frameworks.
- **Data Analytics and Visualization:** Cloud platforms provide tools for graphical visualization of sensor data trends. Advanced systems may integrate machine learning models for predictive analytics to enhance crop management.

4. Working Methodology:

- **Sensor Deployment:** Soil moisture, temperature, and humidity sensors are installed at appropriate locations in the agricultural field near the plant roots.
- **Data Collection:** The sensors continuously measure environmental parameters and send analog or digital signals to the microcontroller.

- **Data Processing:** The microcontroller (e.g., Arduino or ESP32) processes the incoming sensor data and compares the values against predefined threshold limits.
- **Data Transmission:** Using a Wi-Fi module, the processed data is transmitted wirelessly to a cloud platform for real-time storage and monitoring.
- **Remote Monitoring:** Farmers access the data remotely through mobile or web applications to monitor field conditions anytime, anywhere.
- **Automated Irrigation Control:** When the soil moisture level drops below the set threshold, the microcontroller automatically activates the water pump to irrigate the crops.
- **Feedback and Adjustment:** Once the soil moisture reaches the desired level, the system turns off the pump, conserving water and preventing over-irrigation.

5. Advantages of IoT-Based Smart Agriculture:

1. **Efficient Water Management:** Automated irrigation based on soil moisture data reduces water wastage and ensures optimal water usage.
2. **Increased Crop Productivity:** Continuous monitoring of environmental conditions helps maintain ideal growth conditions, resulting in higher crop yield.
3. **Reduced Labour Cost:** Automation minimizes the need for manual field monitoring and irrigation, saving time and labour effort.
4. **Real-Time Monitoring:** Farmers can monitor soil, temperature, and humidity data remotely through mobile or web applications.
5. **Precision Farming:** IoT enables accurate use of resources such as water, fertilizers, and pesticides, improving farming efficiency.
6. **Early Detection of Problems:** Abnormal conditions such as drought, excessive heat, or high humidity can be detected early, reducing crop loss.
7. **Energy Efficiency:** Automated control of pumps and devices helps save electricity by operating only when required.
8. **Support for Sustainable Agriculture:** Optimized resource usage promotes eco-friendly and sustainable farming practices.

6. Applications:

1. **Smart Irrigation Systems:** Automatically control irrigation based on soil moisture levels to reduce water wastage and improve efficiency.
2. **Greenhouse Monitoring and Control:** Monitor temperature, humidity, and light levels to maintain optimal conditions for greenhouse crops.
3. **Crop Health Monitoring:** Continuous monitoring helps detect crop stress, diseases, or nutrient deficiencies at an early stage.
4. **Precision Farming:** Enables accurate application of water, fertilizers, and pesticides based on real-time field data.
5. **Weather Monitoring:** Collects local weather data such as temperature and humidity to assist farmers in planning farming activities.
6. **Soil Condition Monitoring:** Helps analyse soil parameters to improve crop selection and land management.

7. **Remote Farm Monitoring:** Allows farmers to monitor agricultural fields from any location using mobile or web applications.
8. **Livestock Monitoring:** IoT sensors can track animal health, location, and environmental conditions in farms.

7. Challenges and Limitations:

1. **High Initial Cost:** The setup cost of sensors, microcontrollers, and communication modules can be high for small-scale farmers.
2. **Internet Connectivity Issues:** Reliable internet access is required for real-time data transmission, which may not be available in rural areas.
3. **Power Supply Problems:** Continuous power is needed to operate sensors and devices, and power failures can affect system performance.
4. **Maintenance of Sensors:** Sensors exposed to harsh environmental conditions may require frequent maintenance or replacement.
5. **Data Security and Privacy:** Agricultural data transmitted over the internet may be vulnerable to cyber threats if not properly secured.
6. **Technical Knowledge Requirement:** Farmers may require training to operate and maintain IoT-based systems effectively.
7. **Scalability Issues:** Expanding the system to large agricultural fields can increase complexity and cost.
8. **Environmental Interference:** Weather conditions such as rain, dust, and extreme temperatures can affect sensor accuracy.

8. Future Scope:

The smart agriculture system can be enhanced by integrating:

- **Integration with Artificial Intelligence (AI):** AI can be used to analyse sensor data for crop yield prediction, pest detection, and smart decision-making.
- **Machine Learning for Crop Disease Detection:** ML models can identify plant diseases at early stages using sensor data and image processing.
- **Use of Drones in Agriculture:** Drones integrated with IoT can be used for crop monitoring, spraying pesticides, and land surveying.
- **Blockchain for Secure Data Management:** Blockchain technology can ensure secure storage and transparent sharing of agricultural data.
- **Advanced Weather Forecasting:** IoT systems can be combined with weather prediction models to provide accurate, location-based forecasts.
- **Solar-Powered IoT Systems:** Renewable energy sources can be used to reduce dependency on electricity and make systems eco-friendly.
- **Smart Fertilizer and Pesticide Management:** Automated systems can apply fertilizers and pesticides precisely based on crop needs.
- **Large-Scale Precision Farming:** Future IoT systems can support large farms with better scalability, analytics, and automation.

9. Conclusion:

IoT-based smart agriculture has the potential to transform conventional farming into a modern, data-driven, and sustainable system. Its large-scale implementation can significantly contribute to food security, agricultural productivity economic growth, and environmentally friendly agricultural practices.

References:

- IEEE Journals on IoT in Agriculture
- Ministry of Agriculture, Government of India Reports
- Internet of Things: A Survey – IEEE
- Smart Farming Using IoT – International Journal of Computer Applications
- Cloud Computing in Agriculture – Springer