International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 05 | May - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

# IOT Driven Pest and Disease Detection System for Crop Protection

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***Abstract***

Agricultural productivity is significantly impacted by pests, diseases, and environmental conditions, requiring intelligent and automated solutions for effective crop protection. This project introduces an IoT-driven pest and disease detection system that integrates PIR sensors, an ESP32-CAM module, a soil moisture sensor, and a DHT11 sensor to create a smart monitoring and control mechanism for farms. The PIR sensor detects pest movements, activating a servo-controlled spray system to precisely apply pesticides, reducing chemical overuse and ensuring targeted pest control. The ESP32-CAM module enhances pest detection by capturing real-time images of affected areas, which are then sent to a Telegram bot for remote monitoring. This enables farmers to assess pest infestations quickly and take necessary actions. Additionally, the system includes an automated irrigation mechanism driven by a soil moisture sensor, which monitors soil conditions and activates the watering system when moisture levels drop below a predefined threshold. This ensures optimal soil hydration, preventing under- or over-watering. Furthermore, the DHT11 sensor continuously tracks temperature and humidity levels, providing real-time environmental data that is transmitted to the Blynk IoT platform. This allows farmers to remotely monitor field conditions and make informed decisions to improve crop health. By combining automated pest control, image-based monitoring, smart irrigation, and climate sensing, this project enhances efficiency, reduces manual labor, and promotes sustainable farming practices. The system's real-time updates, remote accessibility, and precision control make it a powerful tool for modern agricultural management.

***Keywords:***

***Internet of Things(Iot)***

## 1. INTRODUCTION

Agricultural productivity is significantly impacted by pests, diseases, and environmental conditions, requiring intelligent and automated solutions for effective crop protection. This project introduces an IoT-driven pest and disease detection system that integrates PIR sensors, an ESP32-CAM module, a soil moisture sensor, and a DHT11 sensor to create a smart monitoring and control mechanism for farms. The PIR sensor detects pest movements, activating a servo-controlled spray system to precisely apply pesticides, reducing chemical overuse and ensuring targeted pest control. The ESP32-CAM module enhances pest detection by capturing real-time images of affected areas, which are then sent to a Telegram bot for remote monitoring. This enables farmers to assess pest infestations quickly and take necessary actions. Additionally, the system includes an automated irrigation mechanism driven by a soil moisture sensor, which monitors soil conditions and activates the watering system when moisture levels drop below a predefined threshold. This ensures optimal soil hydration, preventing under- or over-watering. Furthermore, the DHT11 sensor continuously tracks temperature and humidity levels, providing real-time environmental data that is transmitted to the Blynk IoT platform. This allows farmers to remotely monitor field conditions and make informed decisions to improve crop health. By combining automated pest control, image-based monitoring, smart irrigation, and climate sensing, this project enhances efficiency, reduces manual labor, and promotes sustainable farming practices. The system's real-time updates, remote accessibility, and precision control make it a powerful tool for modern agricultural management.LITERATURE SURVEY

The integration of IoT in healthcare has led to significant advancements in remote monitoring and smart diagnostics. A congestion-free routing mechanism was proposed to enhance Wireless Sensor Networks (WSNs) for smart healthcare, improving data delivery and network efficiency [1]. Güntner et al. developed breath sensors to enable real-time health monitoring, aiding in early diagnosis of respiratory conditions [2]. Kakria et al. designed a smartphone-based remote cardiac monitoring system, demonstrating the potential of mobile health (mHealth) technologies [3]. An ontology-based IoT framework was introduced for intelligent patient monitoring, supporting semantic interoperability and decision-making [4]. Another scalable green healthcare system combined cloud and IoT to improve energy efficiency and scalability [5]. Mao and Zhang optimized medical consultation services using AI and IoT, enhancing accessibility and responsiveness [6]. Bhuiyan et al. reviewed IoT-enabling technologies, highlighting challenges in standards, security, and market adoption [7]. Xue et al. studied smart healthcare development in China, emphasizing sustainable application systems [8]. Zhu et al. provided an overview of smart healthcare trends in the IoT era, identifying future directions [9]. Chen et al. proposed a zero-trust security model for 5G-enabled healthcare systems to address growing cybersecurity threats [10].

## 2. METHODOLOGY

The proposed smart agriculture system employs a microcontroller-based approach to detect pests and monitor environmental conditions in real time. An Arduino UNO serves as the central processing unit, interfacing with various sensors and components. The DHT11 sensor is used to measure temperature and humidity, providing critical data for assessing crop health. A PIR sensor detects motion indicative of pest presence, triggering automated responses. The ESP8266 (NodeMCU) Wi-Fi module enables wireless data transmission to an IoT platform, allowing users to remotely monitor farm conditions via a web interface or mobile app. A relay module controls devices such as pesticide sprayers or irrigation systems, which are activated based on predefined thresholds. Power is supplied through a full-wave rectifier, step-down transformer, and regulated 5V-12V DC circuit, ensuring stable operation in field conditions. Sensor readings and system status are displayed on an IoT-compatible display for local monitoring. Data is transmitted using HTTP protocols, ensuring efficient and secure communication with cloud servers. This integrated system reduces manual labor, enhances pest detection accuracy, and supports precision farming through real-time analytics and automation. The methodology focuses on cost-effective implementation, scalability, and ease of use for farmers, contributing to improved crop productivity and sustainable agricultural practices.

## 3. EXISTING SYSTEM

Traditional pest and disease control in agriculture primarily relies on manual inspection and widespread chemical pesticide application. Farmers typically monitor crop conditions through visual observation, identifying visible symptoms of diseases or pest damage. This approach is time-consuming, labor-intensive, and often lacks accuracy, especially over large agricultural fields. In many cases, preventive spraying of pesticides is carried out at fixed intervals, regardless of actual pest presence, leading to overuse of chemicals, increased costs, and environmental degradation. These practices contribute to pesticide resistance, harm beneficial organisms, and reduce soil and crop health over time. Additionally, traditional systems do not provide real-time feedback or predictive insights, making early detection and timely intervention challenging. Environmental conditions such as humidity, temperature, and rainfall—critical factors influencing pest and disease outbreaks—are rarely monitored systematically, further reducing the effectiveness of control measures. Overall, the existing systems are reactive rather than proactive, lacking automation, data integration, and precision. This creates a need for a more intelligent, sensor-driven, and sustainable approach, such as the IoT-based system proposed, which enhances monitoring accuracy, reduces resource wastage, and supports environmentally friendly pest and disease management strategies.

## 4. PROPOSED METHOD

The proposed IoT-based pest and disease detection system offers a smart, sustainable, and data-driven alternative to traditional crop protection methods. This system integrates various sensors—including DHT11 for temperature and humidity, PIR for motion detection, and soil moisture sensors—connected via an ESP8266 microcontroller for seamless data transmission. These sensors are deployed throughout the agricultural field to monitor environmental conditions in real time. Additionally, imaging devices capture high-resolution images of crops, enabling the use of image processing algorithms to detect early signs of disease or pest infestation. The collected data is processed through a central control unit, where machine learning algorithms analyze patterns to predict potential outbreaks. When a threat is detected, the system triggers automated responses, such as activating relay modules for localized pesticide spraying, or alerting farmers via an IoT-based mobile application. Real-time alerts and remote monitoring capabilities allow farmers to make timely and informed decisions, reducing dependency on manual labor and minimizing chemical usage. The proposed system not only improves crop health and yield but also promotes eco-friendly practices by optimizing resource use and preventing unnecessary pesticide application. This integration of IoT and AI transforms pest and disease management into a proactive, efficient, and scalable solution for modern agriculture.

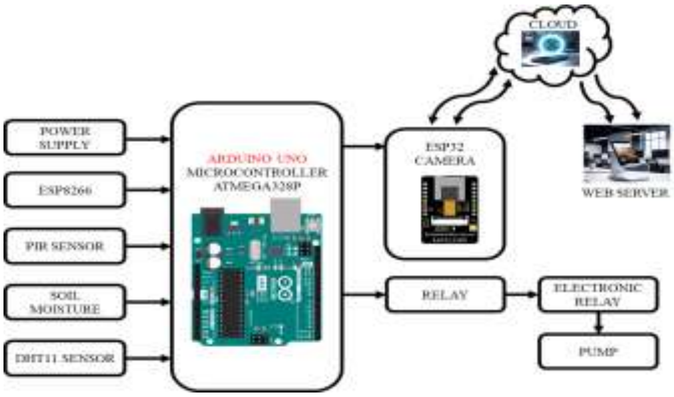


Figure 5.1 Block Diagram

## 5. RESULTS AND DISCUSSIONS

Figure 6.1 Hardware View

The figure illustrates a smart irrigation system prototype comprising an Arduino microcontroller, ESP8266 Wi-Fi module, DHT11 temperature and humidity sensor, PIR motion sensor, relay modules, and a water pump. The system automates irrigation by continuously monitoring environmental parameters and triggering watering based on predefined conditions. It demonstrates real-time sensing, wireless data transmission, and efficient water resource management, making it suitable for precision agriculture and home gardening applications.

Figure 6.2 IOT display

This figure shows the IoT-based display used in the Pest and Disease Detection System for crop protection. The interface presents real-time environmental data, including temperature (34 °C) and humidity (71%), which are critical indicators for detecting and predicting pest and disease outbreaks. By providing continuous monitoring, the system enables timely intervention, supporting smart and sustainable agricultural practices.

## 6. CONCLUSION

The IoT-driven pest and disease detection system developed in this project represents a transformative step toward smarter, more sustainable agriculture. By leveraging real-time environmental sensing, image capture, and machine learning, the system enables early identification and precise response to pest infestations and crop diseases. Core components such as the DHT11 temperature-humidity sensor, soil moisture sensor, PIR motion sensor, and ESP32 camera collectively provide accurate and continuous monitoring of field conditions. The integration of the ESP8266 module ensures cloud-based connectivity, allowing for remote access, real-time alerts, and automated control of systems such as irrigation and pesticide application. This automation reduces dependency on manual interventions and chemical usage, helping to mitigate environmental impact while boosting operational efficiency. By improving detection accuracy and facilitating timely interventions, the system enhances crop yield, reduces resource waste, and promotes data-driven farming decisions. Its adaptability and scalability make it suitable for a wide range of agricultural environments, from small farms to large-scale operations. Ultimately, this project showcases the potential of IoT in revolutionizing modern agriculture through intelligent monitoring, predictive analytics, and automated responses, paving the way for a more resilient and eco-friendly food production system.

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