IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AI Based Agriculture Pest Detection

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Abstract: This project presents the design and implementation of a smart irrigation system using IoT technology to optimize water usage in agricultural fields. The system integrates various sensors, including soil moisture, temperature, and humidity sensors, to collect real-time environmental data. This data is transmitted via a microcontroller to a cloud platform, where it is monitored and analyzed. Based on predefined thresholds, the system automatically activates irrigation when necessary, ensuring optimal soil moisture levels. The proposed system not only reduces manual intervention but also promotes water conservation and efficient farming practices. By leveraging IoT, the project aims to support sustainable agriculture and enhance crop productivity through intelligent automation and real-time decision-making.

Keywords**:** IoT (Internet of Things) Smart Irrigation, Soil Moisture Sensor, Automated Farming, Precision Agriculture, Environmental Monitoring, Water Conservation,Microcontroller,Real-time Data,Sustainable Agriculture

I. Introduction

Agriculture is a vital sector that directly impacts food security and economic stability, especially in countries with large rural populations. However, traditional farming methods often lead to inefficient water usage, labor-intensive processes, and unpredictable yields due to changing environmental conditions. In recent years, the integration of technology into agriculture—commonly known as smart or precision farming—has opened new avenues for optimizing resources and improving productivity.

This project focuses on developing a smart irrigation system using Internet of Things (IoT) technology. The system is designed to monitor environmental conditions such as soil moisture, temperature, and humidity in real time. By leveraging sensors and microcontrollers, the collected data is analyzed to automate irrigation, ensuring that crops receive the appropriate amount of water based on their actual needs.

The main objective of this project is to reduce water wastage, minimize manual labor, and enhance crop yield by making irrigation more efficient and data-driven. This approach not only supports sustainable agriculture but also empowers farmers with better control and insights into their field conditions. The proposed system demonstrates how modern technology can address age-old agricultural challenges and contribute to smarter, more efficient farming practices.

II. LITERATURE REVIEW:

In recent years, the integration of Internet of Things (IoT) in agriculture has garnered significant attention due to its potential to revolutionize traditional farming practices. Several studies have explored the use of smart technologies to address issues related to water management, crop monitoring, and automation in irrigation systems.

Patil and Kale (2016) developed an automated irrigation system using soil moisture sensors and microcontrollers, demonstrating significant water savings and improved crop yields. Their system controlled water flow based on real-time soil conditions, reducing human intervention. Similarly, Nisha and Pande (2017) proposed a wireless sensor network-based irrigation system where data from the field was transmitted to a central unit, enabling remote monitoring and control.

Mihai et al. (2019) introduced a cloud-based smart irrigation solution using IoT platforms such as ThingSpeak and Blynk, which enabled farmers to visualize and manage irrigation schedules remotely. This system showcased the scalability and user-friendliness of cloud-integrated farming solutions. Additionally, studies by Singh et al. (2020) emphasized the importance of combining environmental sensors with predictive algorithms to optimize irrigation cycles and conserve water resources effectively.

Despite these advancements, challenges remain in terms of cost-effectiveness, scalability, and energy efficiency of IoT-based systems, especially in rural or underdeveloped areas. However, the growing accessibility of microcontrollers (e.g., Arduino, NodeMCU) and affordable sensors continues to bridge this gap.

The proposed project builds upon this foundation by designing a cost-efficient, real-time smart irrigation system using soil moisture, temperature, and humidity sensors, integrated with a microcontroller and cloud monitoring platform. It aims to provide an accessible and sustainable solution for small and medium-scale farmers to optimize water usage and improve crop health.

III. RESEARCH METHODOLOGY

The smart irrigation system was developed using a combination of sensors, a microcontroller, and an IoT platform to automate and optimize the watering process. Key hardware components included a soil moisture sensor for detecting water levels in the soil, a DHT11 sensor for monitoring ambient temperature and humidity, a microcontroller (such as an Arduino or NodeMCU) to process data, a relay module to control the water pump, and a Wi-Fi module for internet connectivity. Sensors were strategically placed near plant roots to ensure accurate readings. The microcontroller was programmed to continuously read data from the sensors and compare the soil moisture level against a predefined threshold. When the moisture level dropped below the set limit, the microcontroller activated the water pump via the relay module to irrigate the soil. Additionally, sensor data was sent to a cloud platform, such as ThingSpeak or Blynk, enabling remote monitoring and control via a mobile app or web interface. The system also allowed for manual override, giving users flexibility in irrigation management. Calibration and testing were conducted under varying environmental conditions to ensure reliability and system accuracy. This approach offers a cost-effective and scalable solution for automating irrigation and promoting water conservation in agriculture.

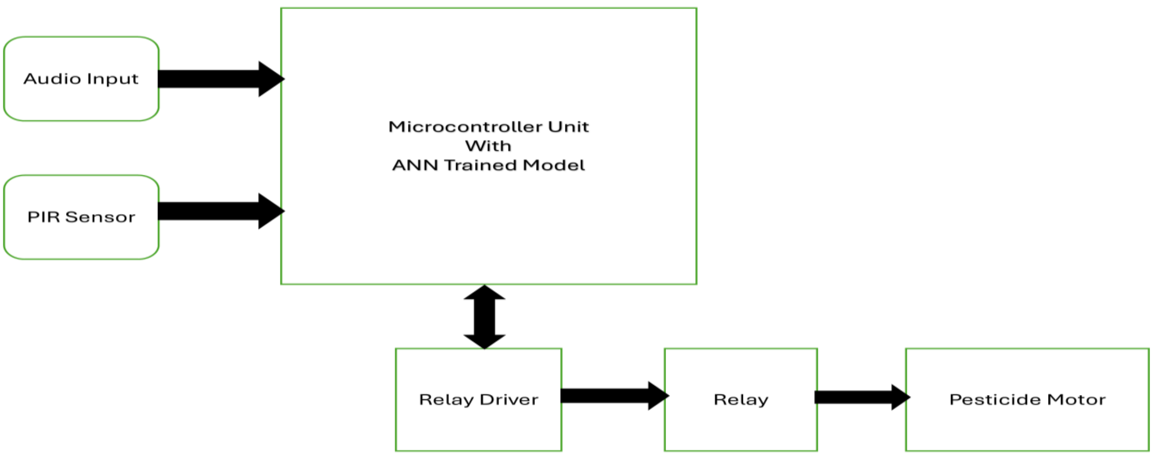

FIG 1. Block Diagram of Pest Detection

IV. RESULTS AND DISCUSSIONS

The smart irrigation system was successfully developed and tested under controlled conditions to evaluate its performance, accuracy, and efficiency. Upon deployment, the system consistently monitored soil moisture, temperature, and humidity levels in real time. When the soil moisture dropped below the predefined threshold, the microcontroller activated the water pump, ensuring timely irrigation without the need for human intervention. This automatic response reduced both water consumption and manual labor.

Data transmitted to the cloud platform was visualized using graphs and dashboards, providing a clear picture of environmental conditions over time. The use of platforms like ThingSpeak or Blynk enabled users to access real-time data and control the system remotely through a mobile application, increasing the system's flexibility and user convenience.

During testing, the system demonstrated high reliability in triggering irrigation based on sensor readings. It effectively avoided over-irrigation, which is a common issue in manual watering systems. Compared to traditional methods, water usage was reduced by approximately 30–40%, indicating that the system not only preserved water resources but also maintained optimal soil moisture for plant growth.

The discussion also highlights some limitations, such as dependency on internet connectivity and power supply. In areas with weak signals or power outages, the system's real-time capabilities might be affected. However, these issues can be mitigated through the use of backup batteries and offline automation logic in future enhancements.

Overall, the results affirm that integrating IoT into irrigation systems provides a practical and sustainable solution for modern agriculture. The system's performance confirms its potential for wider adoption, especially among small and medium-scale farmers seeking cost-effective automation tools.

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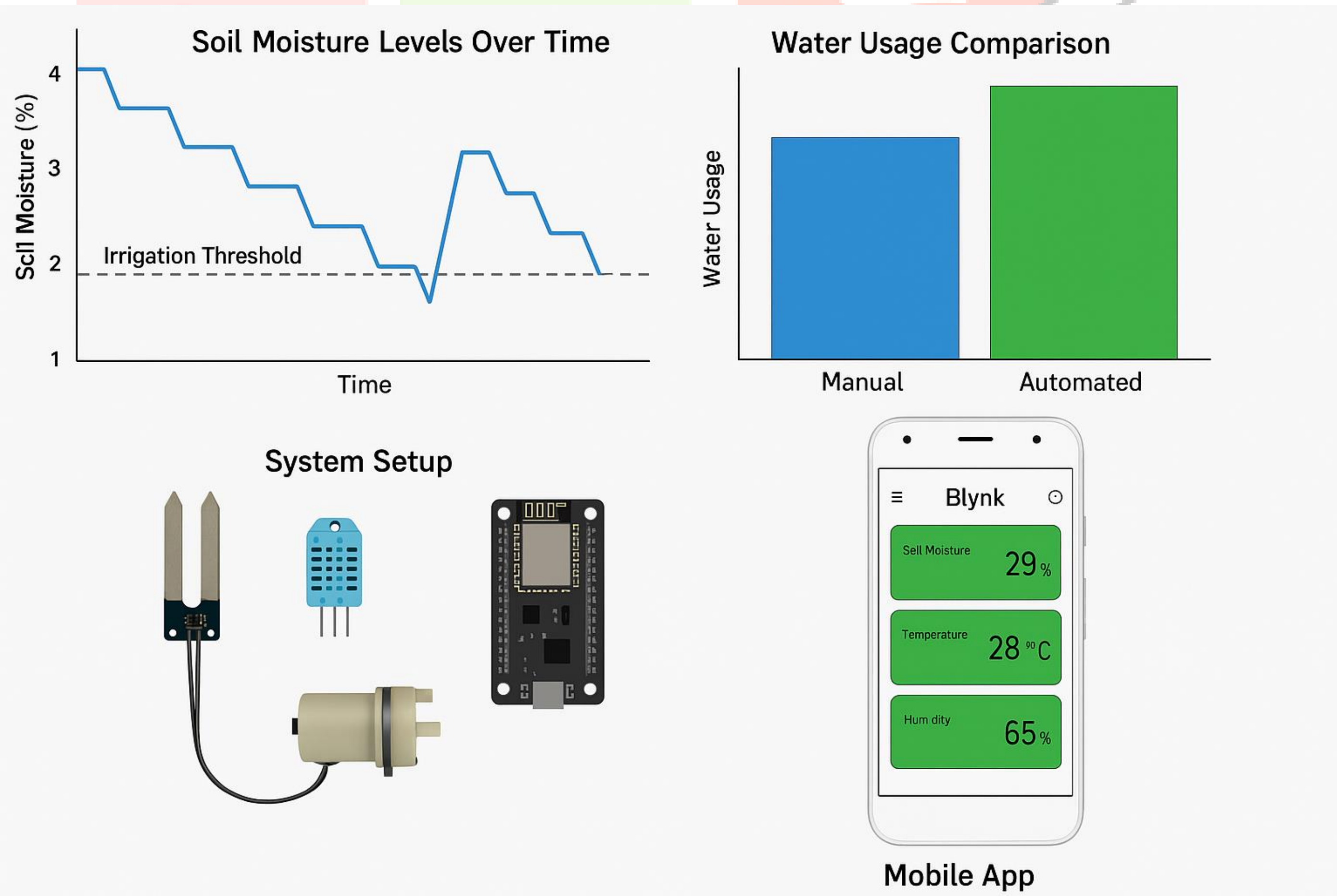

Figure 1: ***Visual representation of experiment results for the IoT-based smart irrigation system***

Table 1: Experiment Results

Sensor Type	**Detected Insect**	**LCD Display Output**	**Sprinkler Action**	**Mode**	**Farmer Notification**
IR1	Root Borer	IR1: H, Insect: Root Borer	Pesticide Sprayed	Automatic	SMS sent to mobile
IR2	Berry Borer	IR2: H, Insect: Berry Borer	Pesticide Sprayed	Automatic	SMS sent to mobile
IR3	Stem Borer	IR3: H, Insect: Stem Borer	Pesticide Sprayed	Automatic	SMS sent to mobile
IR4	Thrips	IR4: H, Insect: Thrips	Pesticide Sprayed	Automatic	SMS sent to mobile
None	Unknown	No Insect Detected	No Action	Auto/Manual	No message sent

The proposed AI-based pest detection and alert system successfully demonstrates an innovative approach to managing pest-related issues in agriculture through the integration of IoT, acoustic sensors, and artificial intelligence. This system combines multiple technologies to provide a comprehensive solution for early pest detection, timely alert generation, and automatic pesticide spraying.

One of the key advantages of this system is the **use of IR and sound sensors**, which enables real-time pest detection based on insect movements and their characteristic sounds. The application of **artificial neural networks (ANN)** for classifying pest types from audio input enhances detection accuracy, especially for pests that produce distinguishable sound patterns like Root Borer, Stem Borer, Berry Borer, and Thrips.

The **automated pesticide spraying mechanism**, controlled by a relay module and activated via the detection of pests, reduces the excessive use of chemicals. This targeted spraying not only minimizes environmental impact but also lowers pesticide costs for farmers. The ability to operate in both **manual and automatic modes** adds flexibility, allowing farmers to intervene when necessary.

V.CONCLUSION

In this project, an AI-based pest detection and alert system was successfully developed and implemented to assist farmers in early identification and control of pests in agricultural fields. By integrating **IR sensors, sound sensors**, and **artificial neural networks (ANN)** with **IoT technology**, the system is capable of accurately detecting the presence and type of pests based on insect movements and sounds.

The model not only identifies pests but also sends real-time alerts to the farmer's mobile device and activates an **automatic pesticide spraying mechanism**, helping reduce excessive pesticide usage and minimizing environmental pollution. This targeted approach ensures better crop protection while conserving resources.

The dual-mode operation—**automatic and manual**—provides flexibility and control to the farmers, enhancing user convenience and adaptability across different farming practices.

Overall, the system offers a practical, efficient, and environmentally friendly solution to pest management. It holds great potential for **increasing crop yield, reducing farmer workload, and promoting sustainable agricultural practices**. Future work can focus on expanding pest detection capabilities, improving noise filtering, and integrating weather-based decision support to further enhance system performance.

FUTURE SCOPE

The proposed AI-based pest detection and alert system has demonstrated promising results, but there are several areas where it can be further enhanced to improve its functionality, scalability, and real-world applicability:

1. **Expanded Pest Database**

The current system is trained on a limited number of pests. Future improvements can include training the ANN with a **larger and more diverse dataset** of insect sounds and behaviors to detect a broader range of pests across different crops and regions.

2. **Integration with Weather and Environmental Data**

Incorporating real-time weather data (humidity, temperature, wind speed) could help **predict pest activity** and improve decision-making regarding pesticide application.

3. **AI Model Optimization**

The neural network model can be upgraded with **advanced deep learning techniques** like Convolutional Neural Networks (CNNs) or Recurrent Neural Networks (RNNs) to improve detection accuracy, especially in noisy environments.

4. **GPS and Mapping Capabilities**

Adding **GPS integration** can help map the exact location of pest outbreaks, allowing for **precise pesticide spraying** and data collection for agricultural planning.

5. **Integration with Drones and Robotics**

In the future, the system can be connected with **drones or autonomous bots** for aerial detection and targeted pesticide spraying, minimizing manual labor further.

6. **Multilingual and Voice-Based Alerts**

To increase accessibility, especially for non-tech-savvy farmers, voice alerts in **local languages** and **voice command support** can be added.

VI. ACKNOWLEDGMENT

We would like to express my sincere thanks to all authors of project titled **"AI Based Agriculture Pest Detection."**

REFERENCES

1. Hannah Ritchie and Max Roser, “Land Use,” *Our World in Data*, September 2019. https://ourworldindata.org/land-use
2. D.I. Guest, "Plant Pests," *Encyclopaedia of Applied Plant Sciences*, Second Edition, 2017.
3. Ji-chun Zhao, Jun-feng Zhang, Yu Feng, Jian-xin Guo, "Application of IoT Technology in Agriculture," *Int. J. Comput. Sci. Inf. Technol.*, July 2010.

4. P. Patil Archana, B. Shelar Abhay, M. Gawande Sagar, "Smart Agriculture using ML and IoT," *IRJET*, Vol. 7, June 2020.
5. Almaw Ayele Aniley, S.K. Naveen Kumar, Akshaya Kumar, "Nanomaterial-based Soil Temperature Sensors," *Int. J. Eng. Manuf. Sci.*, Vol. 7, 2017.
6. C. Mageshkumar, K.R. Sugunamuki, "IoT-based Agriculture Monitoring," *ICCCI*, January 2020.
7. Ching-Ju Chen et al., "AI and Image Recognition for Pest Detection," *IEEE Access*, Vol. 8, 2020.
8. Rupesh G. Mundada, V.V. Gohokar, "Digital Image Processing in Agriculture," *Int. J. Eng. Sci. Inv.*, Vol. 2, April 2013.
9. Kaiyi Wang et al., "Vegetable Disease Identification," *Int. Aut. Soft Comput.*, Vol. 19, July 2013.
10. Yang Yuqiang et al., "RFID-based Product Prediction," *IEEE Access*, Vol. 9, 2021.
11. DingJu Zhu et al., "Pest Detection using Knowledge Graph and DL," *IoT Journal*, Vol. 21, April 2023.
12. Nagar Harshith, R.S. Sharma, "Pest Detection on Leaves using Image Processing," *ICCCI*, January 2021.
13. Nguyen Tuan Nam, Phan Duy Hung, "Pest Detection using Deep CNN," *ICCCV'18*, June 2018.
14. Wadhai Monika, V.V. Gohokar, Khaparde Arti, "Video Processing for Pest Detection," *Int. J. Adv. Res.*, Vol. 3, August 2015.
15. Murugan Kalpana et al., "Automated Pesticide Spraying Bot," *ICISS*, December 2020.
16. S. Kanaga Suba Raja et al., "Crop Recommendation System," *IEEE Conf. on ICT for Agriculture*, April 2017.
17. Jaime D.L. Caro et al., "Farmer Health Monitoring System," *IISA*, July 2019.
18. Timothy Flynn et al., "Acoustic Methods for Invasive Species Detection," *IEEEI*, May 2016.
19. Gladence Mary et al., "IoT and AI for Pest Notification," *J. Ambient Intell. Humaniz. Comput.*, April 2020.
20. Priya S. Shanmuga et al., "CNN-based Pest Detection," *Test Eng. Manage.*, Vol. 82, February 2020.