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Deep Learning-Based Rice Crop Disease Detection and Automated Pesticide Control

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ABSTRACT

Agriculture plays a vital role in ensuring food security, but crop diseases remain a major challenge that can significantly reduce yield and quality. Traditional disease detection methods rely on manual observation, which is time-consuming, error-prone, and requires expert knowledge. To address this issue, this project proposes a CNN-based Rice Crop Disease Detection and IoT-Enabled Smart Spraying System using Raspberry Pi.The system employs a Convolutional Neural Network (CNN) deep learning model trained on rice leaf images to accurately detect and classify common rice diseases such as Brown Spot, Leaf Blast, and Bacterial Leaf Blight. The trained model is integrated with a Raspberry Pi, enabling on-field deployment where farmers can upload or capture leaf images using a connected camera module. Once the model identifies the disease, the system automatically displays the result along with the recommended pesticide or biological treatment suitable for the detected condition. Additionally, the project integrates an IoT-based smart spraying mechanism that activates a pump or spraying motor when a disease is detected. This ensures targeted pesticide application, minimizing chemical usage and promoting eco-friendly precision agriculture. The system also provides visual and textual alerts to the farmer through a display or IoT dashboard, enabling timely preventive action. Overall, this project demonstrates a practical, low-cost, and intelligent solution for real-time crop disease detection and smart pest management, combining the power of AI, IoT, and automation to enhance productivity and sustainability in modern agriculture

***Key Words*: -** *Rice Crop Disease Detection, Convolutional Neural Network (CNN), Raspberry Pi, IoT, Smart Spraying System, Deep Learning, Image Classification, Precision Agriculture, Pesticide Recommendation, Automation, Sustainable Farming. etc.*

I.INTRODUCTION

Agriculture is the backbone of many developing economies; with rice being one of the most widely cultivated and consumed crops globally. However, rice production is often threatened by various diseases such as Brown Spot, Leaf Blast, and Bacterial Leaf Blight, which can cause significant yield losses and economic damage to farmers. Early and accurate detection of these diseases is essential to prevent large-scale outbreaks and ensure healthy crop growth.

Traditional methods of disease detection rely heavily on manual observation and expert diagnosis, which are time-consuming, subjective, and often inaccurate. Farmers, especially in rural areas, may not have immediate access to agricultural experts or advanced diagnostic tools, leading to delayed treatment and widespread infection. In addition, excessive or incorrect use of pesticides not only increases production costs but also has harmful effects on the environment and soil fertility.

Recent advancements in Artificial Intelligence (AI), Deep Learning (DL), and Internet of Things (IoT) have revolutionized the agricultural domain by enabling smart, data-driven decision-making. Convolutional Neural Networks (CNNs), a class of deep learning models, have shown exceptional performance in image classification tasks and can be effectively used to detect plant diseases through leaf image analysis.

II.PROPOSED METHODOLOGY

The proposed system follows a layered architecture consisting of Image Acquisition, Disease Detection, Decision-Making, and Automated Spraying modules.
Rice leaf images are uploaded and processed through a trained CNN model. The model identifies diseases such as Brown Spot, Leaf Blast, and Bacterial Leaf Blight. Based on the classification results, the system generates pesticide recommendations and activates a relay-controlled spraying mechanism through Raspberry Pi GPIO interfaces.
The system also provides visual alerts, stores detection records, and supports future cloud integration for smart farming applications.

III.PROCEDURE

1. User uploads a rice leaf image.
2. Image is resized and preprocessed.
3. CNN model analyzes the image.
4. Disease class is identified.
5. Confidence score is calculated.
6. Disease information is displayed.
7. Recommended pesticide is generated.
8. Raspberry Pi activates the spray motor if disease is detected.
9. Spraying operation is completed.
10. Detection results are stored in the database.
11. Reports are generated.
12. System returns to monitoring mode.

IV.ALGORITHM

A. Algorithm

1. Start
2. Initialize Raspberry Pi and CNN model
3. Upload rice leaf image
4. Preprocess image
5. Perform CNN classification
6. Identify disease category
7. Generate confidence score
8. Display disease result
9. Recommend pesticide and dosage
10. Activate spray motor if required
11. Store detection records
12. Generate report
13. Return to monitoring mode
14. End

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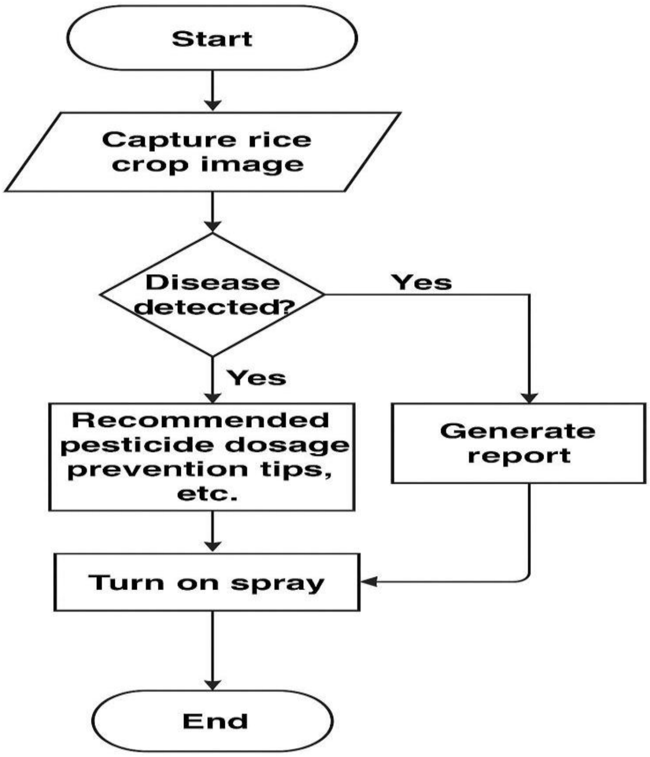
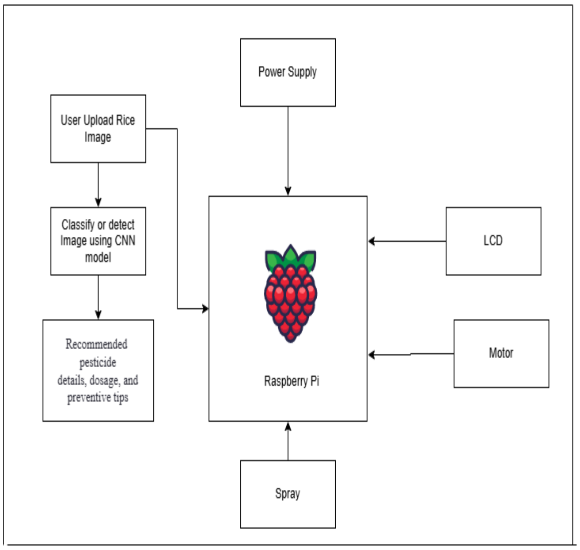
B. Flowchart



C. Block Diagram



V.CONCLUSION

The Deep Learning-Based Rice Crop Disease Detection and Automated Pesticide Control System provides an intelligent solution for modern agriculture. The system accurately identifies rice crop diseases using CNN-based image classification and assists farmers through automated pesticide recommendations and spraying operations.

The integration of Raspberry Pi, IoT technologies, and automation reduces manual effort, minimizes pesticide wastage, and promotes sustainable farming practices. The proposed solution improves crop health management, increases productivity, and supports precision agriculture. Future enhancements may include mobile application support, cloud-based monitoring, real-time camera integration, and advanced deep learning models for higher accuracy.

VI.LITERATURE SURVEY

Recent research demonstrates the effectiveness of Deep Learning and IoT technologies in agricultural disease management. CNN-based approaches have achieved high classification accuracy for rice crop diseases. Advanced models such as Rice Transformer and Rice-Fusion have improved detection performance by combining image and sensor data.

Researchers have also explored data augmentation techniques using GANs to improve model robustness and reduce overfitting. These studies highlight the potential of AI-driven disease detection systems for increasing agricultural productivity and enabling sustainable farming practices.

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