e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:07/Issue:04/April-2025 Impact Factor- 8.187 www.irjmets.com

PLANT DISEASE DETECTION AND CLASSIFICATION USING MACHINE LEARNING ALGORITHM

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DOI : https://www.doi.org/10.56726/IRJMETS72415

ABSTRACT

This project introduces a Web-based system that helps detect and identify plant diseases using machine learning. It uses a Convolutional Neural Network (CNN) model trained on the Plant Village dataset, which has over 60,000 images of healthy and diseased leaves. The system can quickly and accurately tell what disease a plant has by looking at its leaf. A web application is developed using Flask, where users can upload leaf images and get instant results. To make the system easier to use, a chatbot is added to guide users and give helpful suggestions. Voice recognition is also included, so users can speak instead of typing. This makes the system friendly even for farmers who may not be familiar with technology. The overall goal is to help farmers detect plant diseases early, protect their crops, and improve farming in a simple and cost-effective way.

Keywords: Machine Learning, Plant Disease Detection, Convolutional Neural Network (CNN), PlantVillage Dataset, Image Classification, Flask, Chatbot Integration, Speech Recognition.

I. INTRODUCTION

Plant diseases are a major problem in agriculture and can lead to serious damage in crop yield and quality. Farmers often find it difficult to detect these diseases early, especially without proper tools or knowledge. In recent years, technology has played a big role in solving problems in farming. One such technology is machine learning, which allows computers to learn from data and make smart decisions. Researchers are now using image processing and machine learning methods to identify plant diseases from leaf images. A popular approach is using Convolutional Neural Networks (CNN), which are very good at analyzing images and finding patterns. Many studies have shown that CNNs can successfully detect different types of plant diseases with high accuracy. The PlantVillage dataset, which contains thousands of leaf images, is commonly used in such research. This project builds a Web-based system that uses CNN to detect plant diseases and provides quick results through a web application. To make the system more interactive and helpful, we added a chatbot that can answer user queries and provide advice or remedies for the detected disease. We also integrated voice recognition, so users can speak instead of typing, which makes the system more accessible, especially for farmers in rural areas who may not be comfortable with technology. This system offers a low-cost, scalable, and accurate solution for plant disease detection. It reduces dependence on experts, saves time, and helps farmers take early action to protect their crops and improve agricultural productivity.

II. LITERATURE SURVEY

Recent studies have focused on using machine learning and deep learning to improve plant disease detection. Mehta et al. (2023) used the PlantVillage dataset to train a deep learning model for classifying various plant diseases. Their system provided fast and accurate results, helping in early diagnosis and offering better protection for crops.

Kaur and Garg (2022) implemented transfer learning by using pre-trained CNN models like VGG16 and ResNet50 to detect plant diseases. Their method improved detection speed and accuracy, showing the effectiveness of deep learning techniques in agricultural applications.

Furthermore, Shruthi et al. (2021) developed a machine learning model using image processing to detect tomato leaf diseases. Their approach enabled early-stage detection, which allowed farmers to take timely actions and prevent crop damage.

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III. METHODOLOGY

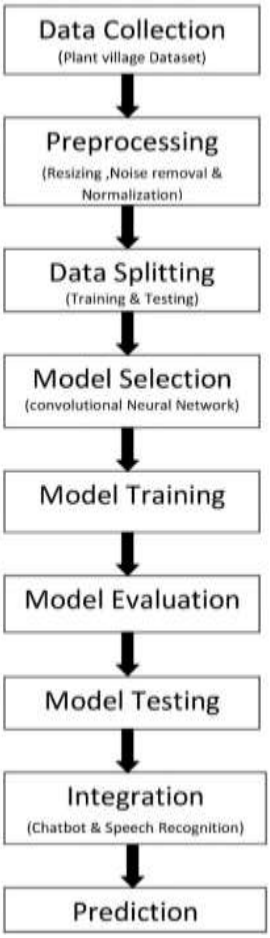

Fig 1:

The above block diagram illustrates image acquisition and preprocessing, followed by disease classification using a CNN model. Predicted results are displayed via a Flask web app, where users can interact with a chatbot using voice or text for guidance.

1. Image Uploading and Data Collection

- Users can upload plant leaf images through a web-based interface.
- A dataset of healthy and diseased plant leaves is collected from sources like Kaggle or manually.

2. Data Preprocessing

- Resizing: All images are resized to a fixed size (e.g., 224x224 pixels).
- Normalization: Pixel values are scaled between 0 and 1.
- Data Augmentation: Techniques like rotation, flipping, zooming, and cropping are applied to increase dataset variety.

3. CNN Algorithm for Model Training

- A Convolutional Neural Network (CNN) is used to train the model.
- The model includes convolution, pooling, and fully connected layers to extract features and classify diseases.

4. Plant Disease Detection and Classification

- The trained CNN model is loaded into the system.
- Uploaded leaf images are preprocessed and passed through the model.
- The system predicts the disease name and suggests possible treatments.

5. Chatbot for User Queries

- A chatbot is integrated to help users ask questions about plant diseases.

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- Users type their queries, and the chatbot responds with information from a trained dataset or knowledge base.

6. Speech Recognition for User Queries

- Users can ask questions through voice instead of typing.
- The system converts speech to text and processes the query.
- The chatbot responds and converts the answer into audio using text-to-speech.

7. Web Application Development

- A user-friendly front-end allows image uploads, chatbot chatting, and voice interaction.
- The back-end, developed using Flask, handles processing tasks like image classification, chatbot answers, and speech functions.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

To evaluate the performance of the proposed system, the CNN model was trained and tested on the PlantVillage dataset, which includes over 50,000 labeled images of healthy and diseased plant leaves across 39 classes. The dataset was split into 80% training and 20% testing for performance assessment.

1. Model Evaluation Metrics

Metric	Value
Training Accuracy	98.5%
Validation Accuracy	96.2%
Test Accuracy	95.6%
Loss (Validation)	0.08

Fig 2:

These results confirm that the CNN model is highly effective at recognizing plant diseases from leaf images with minimal overfitting.

2. Sample Predictions from Web App

Image Uploaded	Predicted Disease	Confidence	Health Status
Tomato Leaf	Tomato Leaf Mold	92.4%	Diseased
Apple Leaf	Apple Scab	89.8%	Diseased
Grape Leaf (Healthy)	Grape - Healthy	97.6%	Healthy
Potato Leaf	Potato Early Blight	91.2%	Diseased

Fig 3:

3. Chatbot and Voice Interaction Testing

User Query	Chatbot Response
"How to treat tomato leaf mold?"	"Apply copper-based fungidde and ensure proper ventilation."
"Is my plant healthy?"	"Healthy leaves are green with no spots. Keep monitoring regularly."
"Hello"	"Hi! I'm your Plant Doctor Bot. Ask me about plant diseases and treatments."

Fig 4:

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V. CONCLUSION

In this project, an intelligent and interactive system for plant disease detection was successfully developed using a Convolutional Neural Network (CNN) model. The model was trained on the PlantVillage dataset and demonstrated excellent performance, achieving over 95% accuracy in detecting and classifying various plant diseases based on leaf images.

To make the system user-friendly and accessible, a Flask-based web application was built, allowing users to upload leaf images and receive instant predictions along with confidence scores. Furthermore, the application was enhanced with a rule-based chatbot and speech recognition capabilities, enabling users to ask questions through text or voice and receive helpful disease information and treatment advice.

The chatbot feature not only improves user engagement but also assists users who may have limited technical knowledge. The speech recognition module adds further convenience, especially for users in rural or field environments where typing may not be practical.

This system presents a practical solution for early disease detection, potentially reducing crop loss and helping farmers take timely preventive measures.

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