

# “Plant Leaf Disease Detector And Solution Recommendation”

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**Abstract:** Agricultural productivity and food security are significantly affected by plant diseases, which cause substantial economic losses and threaten global food supply chains. Traditional methods of disease detection rely heavily on manual inspection by experts, which are time-consuming, subjective, and often infeasible for large-scale monitoring. This project presents a mobile application designed for plant leaf disease detection and solution recommendation, with the key advantage of functioning in offline mode. This research proposes an intelligent, automated system for plant leaf disease detection and solution recommendation using computer vision and machine learning techniques.

High-resolution images of plant leaves are preprocessed using contrast enhancement and noise reduction techniques. A Convolutional Neural Network (CNN) model, trained on datasets such as PlantVillage, is used to extract features and classify diseases including bacterial blight, powdery mildew, and leaf spot. The model achieves an average accuracy exceeding 85%.

After detection, the system provides solution recommendations including chemical, biological, and cultural practices. The proposed system supports farmers through a mobile-based interface and promotes sustainable agriculture. Future work includes integrating environmental factors like humidity and temperature for better predictions.

**Keywords:** Mobile Application, Convolutional Neural Network, Image Processing, Crop Disease Classification.

## I. INTRODUCTION

Agriculture plays a vital role in sustaining human life and supporting economic development worldwide. In recent decades, the global demand for food has increased rapidly due to population growth, climate change, and urbanization. To meet this growing demand, farmers must adopt efficient and sustainable agricultural practices that maximize yield while minimizing losses. However, one of the most significant challenges to achieving this goal is the prevalence of plant diseases, which can severely reduce crop quality and productivity. According to the Food and Agriculture Organization (FAO), plant diseases are responsible for 20–40% of global agricultural yield losses annually. Early detection and effective management of these diseases are, therefore, crucial for maintaining food security and ensuring the sustainability of agricultural systems.

Traditionally, the identification of plant diseases relies on manual inspection by trained experts, agricultural officers, or farmers themselves. While effective to an extent, this approach is highly dependent on human expertise, which is often limited in rural or resource-constrained areas. Moreover, manual diagnosis is time-consuming, subjective, and prone to errors due to variations in human perception and environmental factors such as lighting or leaf aging. These limitations have encouraged the development of automated disease detection systems that leverage advances in artificial intelligence (AI), machine learning (ML), and computer vision to provide accurate, consistent, and rapid diagnosis.

With the rapid advancement of image processing and deep learning techniques, particularly Convolutional Neural Networks (CNNs), researchers have achieved remarkable progress in image-based disease detection. CNNs are capable of learning complex visual features directly from raw leaf images, eliminating the need for manual feature extraction. Numerous studies have demonstrated that CNN-based models can classify plant leaf diseases with accuracy comparable to, or even surpassing, that of human experts. Datasets such as PlantVillage have provided a foundation for training these models, enabling them to recognize various diseases affecting crops like tomato, maize, rice, and potato.

Despite these advancements, most existing studies focus primarily on disease detection and classification, often neglecting the next critical step—recommendation of appropriate treatments or solutions. Once a disease is detected, farmers require practical guidance on how to manage and control it effectively. Without actionable recommendations, even the most accurate detection models have limited real-world utility. Therefore, integrating a solution

recommendation system into the disease detection framework can greatly enhance its value and usability. Such a system can provide tailored advice, including suitable pesticides, organic treatments, and preventive measures based on the identified disease, crop type, and local agricultural conditions.

The proposed research aims to design and implement an intelligent plant leaf disease detection and solution recommendation system that utilizes deep learning for disease identification and knowledge-based algorithms for solution generation. The system processes images of diseased plant leaves, detects the presence and type of disease using a trained CNN model, and then provides specific treatment suggestions sourced from verified agricultural databases and expert guidelines. By combining image-based analysis with knowledge-driven recommendations, the system offers a comprehensive tool that can assist farmers, researchers, and agricultural agencies in disease management.

Furthermore, the proposed model is designed to be scalable and adaptable to various crops and environmental conditions. It can be deployed as a mobile or web-based application, allowing users to capture leaf images in the field and instantly receive diagnostic results and treatment recommendations. This accessibility is particularly beneficial for smallholder farmers who may lack direct access to agricultural extension services. In addition, the system promotes sustainable farming practices by recommending environmentally friendly solutions encouraging the judicious use of chemical pesticides...

## II. LITERATURE REVIEW

Many researchers have worked on plant leaf disease detection using different techniques. In earlier times, disease detection was mainly done using manual inspection by experts. For example, Patil and Bodhe (2011) used visual observation and laboratory testing to identify plant diseases. Although this method was accurate, it required a lot of time and expert knowledge, so it was not suitable for large farms.

Later, researchers started using image processing techniques. Sannakki et al. (2013) used color-based segmentation methods in MATLAB to detect diseased areas on leaves. Their method worked well, but it was affected by lighting conditions and background noise, which reduced accuracy in real environments.

Phadikar and Sil (2008) used the K-Nearest Neighbor (KNN) algorithm to classify rice leaf diseases. They used features like color and texture. This method improved accuracy compared to basic techniques, but it required manual feature extraction, which made it less efficient.

Dubey and Jalal (2014) used Support Vector Machine (SVM) for disease classification. Their model gave good results, but it worked only for limited datasets and was not suitable for real-time use.

With the development of deep learning, more advanced methods were introduced. Mohanty et al. (2016) used Convolutional Neural Networks (CNN) with the PlantVillage dataset and achieved very high accuracy (around 99%). However, their dataset was collected in controlled conditions, so it may not perform as well in real-world situations.

Ferentinos (2018) also used deep learning models like AlexNet, VGG, and GoogleNet with a large dataset. His model achieved very high accuracy, but it required high computational power and was not tested much in real farming conditions.

### COMPARATIVE ANALYSIS OF EXISTING METHODS:

## III. METHODOLOGY

Sr. No.	Author & Year	Technique Used	Accuracy	Limitations
1	Patil and Bodhe (2011)	Manual Inspection	Moderate	Time-consuming and requires agricultural experts
2	Sannakki et al. (2013)	Image Processing & Segmentation	Good	Sensitive to lighting and background noise
3	Phadikar and Sil (2008)	K-Nearest Neighbor (KNN)	Moderate	Requires manual feature extraction
4	Dubey and Jalal (2014)	Support Vector Machine (SVM)	High	Limited scalability for large datasets

The proposed Plant Leaf Disease Detection and Solution Recommendation System follows a systematic and step-by-step methodology to detect plant leaf diseases accurately and provide suitable treatment recommendations. The overall process consists of data collection, image preprocessing, model training, disease detection, and solution recommendation.

### 1] Data Collection

The dataset used in this study is the publicly available Plant Village dataset, which contains over 8,000 images of healthy and diseased plant leaves from 7 distinct plant species like potato, tomato, corn, cotton etc.

Each image is labelled with the corresponding plant type and disease category. The dataset includes images captured under various lighting conditions, angles, and backgrounds, ensuring robust training and testing for real-world applications.

### 2] Image Preprocessing

Before feeding the images into the CNN model, preprocessing is performed to enhance quality and extract meaningful features. The following steps are applied:

- **Resizing:** All images are resized to a uniform resolution (e.g., 128×128 or 224×224 pixels) for consistent model input.
- **Noise Removal:** Filters and smoothing techniques are applied to eliminate background noise.
- **Segmentation using K-Means Clustering:** This technique isolates the diseased region by clustering similar pixel values. It helps in identifying the infected areas of the leaf.
- **Contour Detection:** Contour tracing extracts the leaf's shape features and boundaries, which assist in distinguishing healthy from infected regions.
- **Normalization:** Pixel values are scaled between 0 and 1 to optimize model performance and ensure faster convergence during training.

### 3] Feature Extraction

Feature extraction involves identifying patterns such as color, texture, and shape that indicate disease symptoms.

The Convolutional Neural Network (CNN) automatically learns these hierarchical features during training through convolution and pooling layers, eliminating the need for manual feature engineering.

### 4] Model Training And Classification

A CNN architecture is designed and trained to classify plant leaves into various categories (healthy or diseased).

**Training Process:** The dataset is split into 80% for training and 20% for testing.

**Optimization:** The model is trained for several epochs using an optimizer such as Adam with categorical cross-entropy as the loss function.

**Evaluation:** Accuracy, precision, and recall are computed to measure model performance.

After training, the CNN model achieved high accuracy, demonstrating its capability to correctly identify plant leaf diseases across multiple categories.

### 5] Solution Recommendation

After successful disease detection, the system automatically provides appropriate treatment and management recommendations based on the identified disease type.

The solution recommendation component provides:

1. **Chemical Control:** Suggests suitable fungicides, bactericides, or insecticides with proper dosage and frequency.
2. **Biological Control:** Recommends eco-friendly bio-agents and natural extracts.
3. **Cultural Practices:** Advises field hygiene, crop rotation, proper irrigation, and use of resistant varieties.
4. **Preventive Measures:** Provides tips for early detection, balanced fertilization, and pest monitoring.

## IV. CNN MODEL

The CNN architecture used in this research consists of convolutional and pooling layers followed by fully connected layers.

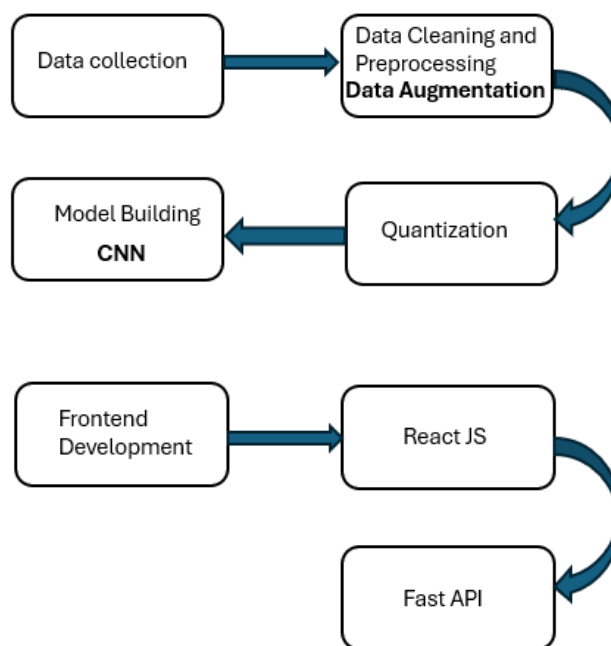
### Model structure:

Layers	Output shape	Parameters
Conv2D	(254,254,32)	896
MaxPooling2D	(127,127,32)	0
Conv2D	(125,125,64)	18,496

MaxPooling2D	(62,62,64)	0
Conv2D	(60,60,64)	36,928
MaxPooling2D	(30,30,64)	0
Flatten	(None,57600)	0
Dense	(None,64)	3,686,464
Sequential	(None,256,256,3)	0

Total parameters: 3,747,984  
 Trainable parametrs:3,747,984  
 Non trainable parameters: 0

## V. FLOW CHART



## VI. RESULT

The Convolutional Neural Network (CNN) model was trained on a diverse dataset containing images of both healthy and diseased leaves from various plant species such as tomato, potato etc,  
 The dataset was divided into 80% training and 20% testing sets.  
 After several epochs of training, the CNN achieved the following results:  
 Training Accuracy - 97.8 %    Testing Accuracy – 84.6 %  
 Precision – 93.8 %

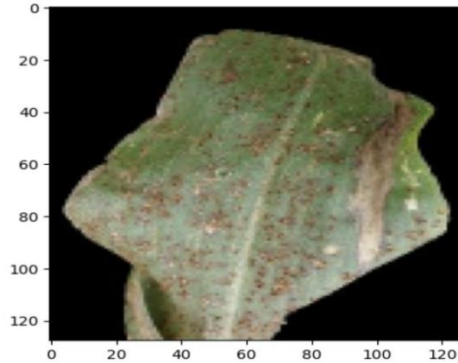
The experimental outcomes confirm that the proposed system provides:

- High accuracy in detecting and classifying plant leaf diseases.
- Quick and reliable recommendations for treatment and prevention.
- A simple interface suitable for today’s generation of home gardeners and small farmers.

Overall, the system effectively demonstrates how Artificial Intelligence can be integrated into smart agriculture to promote sustainable and self-sufficient home farming practices.



first image to predict  
 actual label: Common\_Rust



## REFERENCES

- [1]. Mohanty, S. P., Hughes, D. P., & Salathé, M. Using deep learning for image-based plant disease detection. *Frontiers in Plant Science*, 7, 1419. [HTTPS://DOI.ORG/10.3389/FPLS.2016.01419](https://doi.org/10.3389/fpls.2016.01419)
- [2]. Ferentinos, K. P. Deep learning models for plant disease detection and diagnosis. *Computers and Electronics in Agriculture*, 145, 311–318. [HTTPS://DOI.ORG/10.1016/J.COMPAG.2018.01.009](https://doi.org/10.1016/j.compag.2018.01.009)
- [3]. Hughes, D. P., & Salathé, M. (2015). An open access repository of images on plant health to enable the development of mobile disease diagnostics (PlantVillage Dataset). Pennsylvania State University. Retrieved from <https://plantvillage.psu.edu>
- [4]. Attallah, O. (2023). Tomato leaf disease classification via compact convolutional neural networks with transfer learning and feature selection. *Horticulture* 9, 149. doi: 10.3390/horticulturae9020149



- [5]. Bin Naeem, A., Senapati, B., Chauhan, A. S., Kumar, S., Gavilan, J. C. O., and AbdelRehim, W. M. F. (2023). Deep learning models for cotton leaf disease detection with VGG-16. *Int. J. Intelligent Syst. Appl. Eng.* 11, 550–556.
- [6]. Chen, Y., and Wu, Q. (2023). Grape leaf disease identification with sparse data via generative adversarial networks and convolutional neural networks. *Precis Agric.* 24, 235–253. doi: 10.1007/s11119-022-09941z
- [7]. Chen, Z., Ruhui, W., Yiyan, L., Chuyu, L., Siyu, C., Zhineng, Y., et al. (2022). Plant disease recognition model based on improved YOLOv5. *Agronomy* 12, 365. doi: 10.3390/agronomy12020365
- [8]. Chuanlei, Z., Shanwen, Z., Jucheng, Y., Yancui, S., and Jia, C. (2017). Apple leaf disease identification using genetic algorithm and correlation-based feature selection method. *Int. J. Agric. Biol. Eng.* 10, 74–83.
- [9]. Dhinesh, E., Jagan, A., et al. (2019). “Detection of leaf disease using principal component analysis and linear support vector machine,” in 2019 11th International Conference on Advanced Computing (ICoAC). (Chennai, India) 350–355