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Plant Disease Detection Using Machine Learning

Suyash Mane[1], Shreyash Chavare[2], Sarvesh Redekar[3]

[1] *B.E. Student, Dept. of Computer Science and Engineering (Artificial Intelligence and Machine Learning), S.S.P.M's College of Engineering, Kankavli, Maharashtra, India*
[2] *B.E. Student, Dept. of Computer Science and Engineering (Artificial Intelligence and Machine Learning), S.S.P.M's College of Engineering, Kankavli, Maharashtra, India*
[3] *B.E. Student, Dept. of Computer Science and Engineering (Artificial Intelligence and Machine Learning), S.S.P.M's College of Engineering, Kankavli, Maharashtra, India*

Abstract - *This project uses deep learning to detect plant diseases from leaf images using a method called Convolutional Neural Networks (CNN). The goal is to build a smart and reliable system that can find and recognize different plant leaf diseases easily and accurately. Finding plant diseases early is very important for farmers because it helps protect crops and avoid big losses. The model is trained on a public dataset that contains many pictures of healthy and sick plant leaves. Before training, the images are processed by resizing and enhancing them to make the model work better. CNN automatically learns useful features from the images, so we don't need to manually choose them. The model's performance is tested using measures like accuracy and precision. It gives very good results in detecting various diseases. This system can be helpful for farmers by giving quick and correct information about plant health. It can also be added to mobile or web apps, so it can be used anytime and anywhere. This project supports smart farming by giving a fast, low-cost, and easy solution to check crops and improve farming methods.*

Key Words: **Plant Disease Detection, Deep Learning, CNN, Leaf Image, Smart Farming, Image Processing, Crop Health, Agriculture**

1.INTRODUCTION

Farming is very important for India and the whole world. One big problem farmers face is plant diseases. These diseases can damage crops and reduce the amount and quality of food. If these diseases are found early, farmers can save their plants and avoid losing money. But checking for diseases by hand takes time and needs experts, which is not always possible for farmers, especially in villages.

Now, with the help of technology like Artificial Intelligence (AI) and Deep Learning, we can create smart systems that find plant diseases by just looking at pictures of leaves. A special method called Convolutional Neural Networks (CNN) is very good at learning from images without any manual effort.

In this project, we made a CNN model that can detect different plant diseases from leaf images. We used a free dataset with images of healthy and diseased leaves. The model learns from these images and can correctly tell what disease a plant has. This system can also be added to mobile or web apps, so farmers can use it anytime to check their crops.

This project gives farmers and agriculture workers a smart and easy tool to check plant health. It also helps modern farming by using technology to grow better and healthier crops.

2. .LITERATURE REVIEW

Many people have done research on finding plant diseases by using pictures of leaves. In the past, experts had to look at the leaves with their own eyes to find out what disease the plant had. This method takes a lot of time and is not always possible, especially in villages where experts may not be available.

Later, computer methods like Support Vector Machines (SVM) and k-Nearest Neighbours (k-NN) were used. These needed people to choose important parts of the leaf image by hand before training the model. This was not always easy or accurate.

Now, deep learning methods like Convolutional Neural Networks (CNN) are used. CNN can learn directly from images and find patterns without any manual work. Many researchers have used CNN to detect plant diseases and got good results. Most of them used the **Plant Village** dataset, which has images of plants like tomato, potato, and grape.

But most of these projects focus only on a few common plants. Our project is different because we also added leaf images of **mango**, **coconut**, and **cashew** plants. These are important crops in India, but not many research papers have used them. Finding diseases early in these plants can help farmers a lot.

By using more types of plants and leaf images, our project becomes more useful and can help more farmers in real life.

Table 1- In this table we will discuss about some existing research paper

Year	Literature Reference	Feature selection Approach	Classification Approach	Datasets	Result (Accuracy %)
2021	LILI LI, SHUJUAN ZHANG, BIN WANG LILI LI, SHUJUAN ZHANG, BIN WANG	Deep Learning	Supervised	PlantVillageice, Corn, Tomato, Potato, Mango	92-99%
2022	Sunil S.Harakannanavar et al.	Computer Vision & ML	Supervisd	Custom dataset of plant leaves	96% (SVM), 98% (CNN)
2023	Emmanuel Moupjou et al.	Deep Learning & Field Image Processing	Supervised	**FieldPlant Dataset** (Real-world plant images)	91.3% (CNN), 94.5% (Transfer Learning)
2021	LILI LI, SHUJUAN ZHANG, BIN WANG	Deep Learning	Supervised	ImageNet, Plant Disease Databases	95.6% (CNN), 98.2% (Hybrid Models)

3. RESEARCH GAPS

Although many researchers have worked on plant disease detection using deep learning, several important gaps still remain:

1. **Limited crop coverage**
   Most existing research focuses only on a few crops like tomato, potato, and maize. Rare but important crops such as **mango**, **coconut**, and **cashew** are often ignored.

2. **Unbalanced Datasets:**
   Many datasets used in past research are **imbalanced**, meaning they contain more images of some diseases and fewer of others. This affects the model's ability to detect less common diseases accurately.

3. **Lack of Disease Stage Detection:**
   Most models only detect **if a disease is present or not**, but they do not recognize the **stage** of the disease (early, moderate, severe), which is important for taking action.

4. **Low Accuracy on Similar-looking Diseases:**
   Some diseases look very similar on leaves, which leads to **misclassification**. There is a need for better feature extraction and fine-grained classification.

5. **Generalization Issues:**
   Many models perform well on training data but do not work well when tested on **new or unseen images**, especially from real farms. This shows that the models are not generalized.

6. **Environmental Variation Handling:**
   Changes in lighting, background, leaf angle, or image quality affect model accuracy. Few models have been tested under such real-world conditions.

7. **Lack of Farmer-Friendly Interfaces:**
   While many models are developed, not all are converted into **simple mobile or web apps** that farmers can easily use in their local language.

4.PROBLEM STATEMENT AND OBJECTIVES

4.1 PROBLEM STATEMENT

Plant diseases are one of the major problems faced by farmers. These diseases can damage crops and reduce the amount of food produced. Many farmers are not able to detect diseases early because they don't have expert knowledge or tools. Most of the existing systems focus only on common crops like tomato or potato and ignore important crops like **mango**, **coconut**, and **cashew**. Also, many models are not easy for farmers to use in real life.

There is a need for a smart, simple, and low-cost system that can detect diseases from **leaf images** of different plants, especially tropical crops. The system should be accurate, fast, and easy to use on a mobile or web platform.

4.2 OBJECTIVES

The main goals of this project are:

1. To build a system that can find plant diseases by looking at pictures of leaves.
2. To use a deep learning method called CNN (Convolutional Neural Network) to detect and identify different diseases.
3. To include more plants like mango, coconut, and cashew, which are not used much in earlier projects.
4. To improve the model by using image processing methods like resizing and image flipping.
5. To make the system simple so that farmers can use it easily through a mobile phone or website.
6. To help farmers find diseases early and protect their crops, so they can grow better and more healthy plants.

5.PROPOSED SYSTEM

This system is built to find plant diseases using leaf images. It uses a deep learning method called CNN (Convolutional Neural Network).

The user uploads a leaf image, and the system checks if the leaf is healthy or has a disease. If there is a disease, it shows the name of the disease and the plant type.

The model is trained on images from 12 types of plants, including mango, coconut, and cashew, which are not used much in earlier research.

The result is shown in simple form, and the system can also suggest basic actions. It can be used through a mobile app or website.

This helps farmers to detect diseases early and protect their crops better.

6.METHODOLOGY

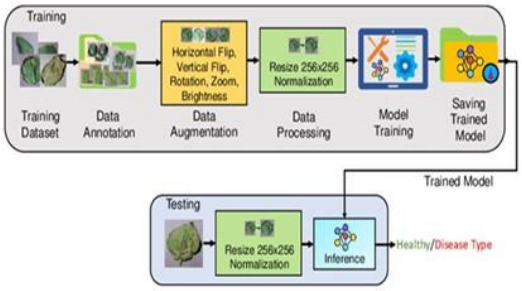

Fig 6.1. Working of project

The methodology of this project explains how the system detects plant diseases using images of leaves. The process is divided into the following steps:

6.1 Dataset Collection:

The dataset contains images of healthy and diseased leaves from **12 different crops**, such as:

- Apple (4 diseases), Blueberry (1), Cherry (2), Corn (4), Grape (4), Mango (8), Potato (3), Soybean (1), Strawberry (1), Tomato (10), Coconut (4), and Cashew (3).
- The images were collected from the following sources:
- Publicly available datasets on Kaggle, including the popular *Plant Village* dataset.
- Agriculture colleges and research institutions, which provided local leaf disease samples from real farming conditions.
- Field data collection, where plant leaf images were captured directly from farms using smartphones and digital cameras.
- Each image in the dataset is properly labelled with the crop name and disease type (or marked as healthy). This combination of online and real-world sources has helped to build a more diverse, accurate, and practical dataset. It also ensures that the system can detect diseases in both common and region-specific crops, making it more helpful to Indian farmers.

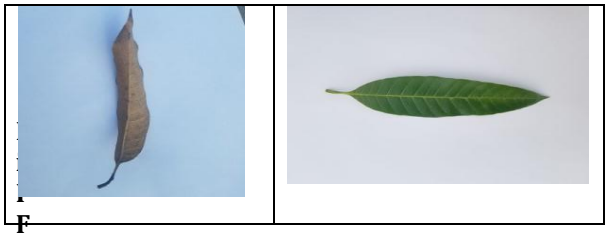

Fig 6.2 Mango Die Black **Fig 6.3** Mango Healthy

6.2 Image Preprocessing:

Before training the model, the images go through preprocessing steps to improve performance:

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

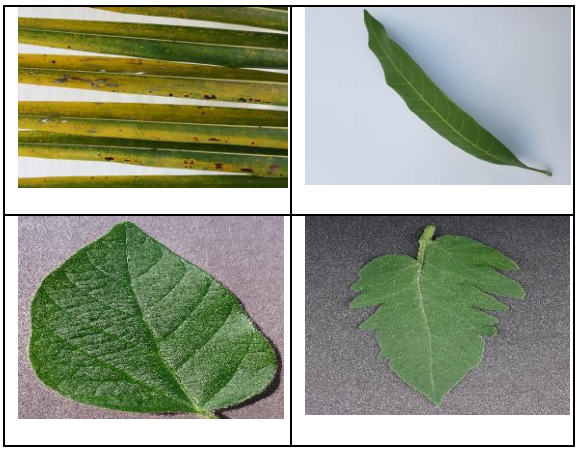

Fig 6.4: *Sample Leaf Images from the Dataset*

6.3 CNN Model Architecture:

A Convolutional Neural Network (CNN**)** is used to detect features from leaf images and classify the diseases. The model includes:

- **Convolutional layers**: To extract features from the image.
- **ReLU activation**: To add non-linearity.
- **Pooling layers**: To reduce the size of feature maps.
- **Flatten layer**: To convert features into a single vector.
- **Fully connected (Dense) layers**: To make predictions.
- **SoftMax output layer**: To classify the image into one of the disease categories.

6.4 Dataset Splitting:

The processed images are divided into three subsets:

– Training Set: Used to train the deep learning model.

–Validation Set: Used for hyperparameter tuning and optimization.

–Test Set: Used for evaluating the final model performance.

6.5 Training and Evaluation:

- The dataset is divided into training and testing sets.
- The CNN model is trained for several epochs using a categorical cross-entropy loss function and Adam optimizer.

After training, the model is evaluated using the test dataset. Performance metrics such as accuracy, precision, recall computed to determine the model's effectiveness. This assessment ensures that the model generalizes well to unseen plant disease samples.

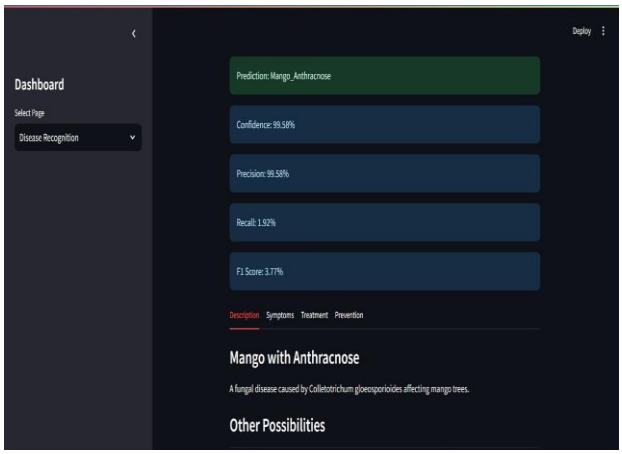

Fig 6.5 *Disease prediction output for Mango Anthracnose with confidence, precision, recall, and F1 score displayed, along with disease description and suggestions.*

6.6 Plant Disease Classification:

The final stage involves classifying plant diseases based on the trained model's predictions. The system outputs the disease category of the input leaf image, enabling farmers and agricultural experts to take necessary preventive measures for crop protection.

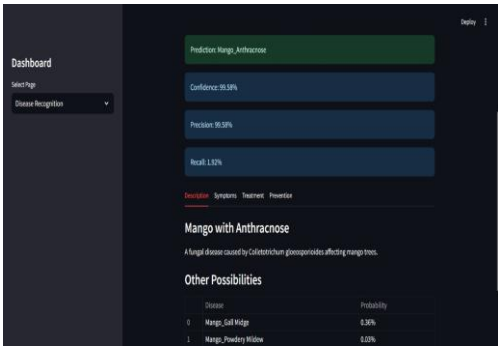

Fig 6.6 *Classification of disease infected Mango plant*

7.CHALLENGES

- Symptoms of various disorders have a lot in common. Diseases, dietary shortages, pests, phytotoxicity, extreme cold or heat, and a variety of mechanical damage are all examples. In order to resolve this challenge the working model needs to be re-train frequently with respect to the diseases.
- So far, the techniques suggested have been restricted in reach and are reliant on ideal capture conditions to function properly. This is due to the existence of complex contexts

that make it difficult to distinguish the area of interest from the context (usually leaf and stem).For Example: in a crop a disease named aster yellows is detected, now if it has another disease named bacterial wilt. Then our trained model won't be able to identify it. The solution of this challenge would be Transfer Learning. In which the existing trained model can be used in such cases.

- To help the growing global population and improving living standards, there is a growing demand for com- plete, healthy, and diverse foods. Nowadays, people are becoming more professional in terms of their diet i.e., what they eat. So, the food(crops) should be free from all the diseases.

8.CONCLUSION

This project presents an effective and automated solution for detecting plant leaf diseases using deep learning, specifically Convolutional Neural Networks (CNN). The main goal was to create a system that can help farmers identify plant diseases early by simply uploading an image of a leaf. The model was trained using a diverse dataset of 12 crops, including commonly grown and region-specific plants such as mango, coconut, cashew, and tomato. By applying image preprocessing techniques like resizing, normalization, and augmentation, the model performance was improved, resulting in high accuracy. The system is designed to be simple, fast, and user-friendly. It provides not only the prediction of the disease but also confidence scores, making it suitable for real-time use in mobile or web-based applications. This can be very helpful for farmers, especially in rural areas, where expert advice is not always available. By offering a low-cost, accurate, and easy-to-use solution, this project contributes to smart and precision agriculture. It can help reduce crop loss, improve productivity, and support sustainable farming practices using modern AI-based technology.

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