Plant Disease Detection from Leaf Images

Abstract

Agriculture plays a vital role in the economy and food security of any country. Plant diseases significantly reduce crop yield and quality, often going undetected until too late. Traditional manual detection methods are time-consuming and require expert knowledge. This project aims to develop an automated system for detecting plant diseases from leaf images using image recognition techniques and deep learning (CNNs). By training a Convolutional Neural Network on the PlantVillage dataset, the model can classify different plant diseases with high accuracy. A simple Graphical User Interface (GUI) and Streamlit deployment enable users to upload leaf images, get predictions, and view disease classifications, thereby making disease detection more accessible and efficient.

Introduction

Plant health is a crucial factor in ensuring sustainable crop production. Farmers often face challenges in diagnosing plant diseases due to limited resources and expertise. Early and accurate detection of plant diseases can help prevent large-scale agricultural losses and reduce dependency on chemical pesticides. Recent advances in Artificial Intelligence (AI), particularly in Computer Vision and Deep Learning, provide powerful tools for solving such problems. Convolutional Neural Networks (CNNs) have proven to be highly effective in image classification tasks, making them suitable for plant disease detection. This project leverages CNNs to analyze leaf images, classify diseases into different categories, and provide a user-friendly interface for farmers and researchers.

Tools Used

1. Programming Language – Python
2. Libraries & Frameworks
- TensorFlow & Keras → Model building (CNN)
- OpenCV → Image preprocessing (resizing, normalization)
- NumPy, Pandas, Matplotlib → Data handling & visualization
- Streamlit → Web deployment
- Tkinter (optional) → GUI creation
3. Dataset – PlantVillage dataset (containing healthy and diseased leaf images of multiple crops).

Steps Involved in Building the Project

1. Dataset Collection & Preparation – Used the PlantVillage dataset, selected 4–5 disease classes, resized and normalized images.
2. Data Preprocessing – Applied OpenCV for resizing, noise removal, and normalization. Split dataset into training, validation, and testing sets.
3. Model Building (CNN Architecture) – Input: 128×128×3 image size, convolutional + max pooling layers, dense layers with ReLU, softmax output.
4. Training the Model – Compiled with categorical crossentropy loss and Adam optimizer, achieved ~90%+ accuracy.
5. Model Evaluation – Tested on unseen data, generated classification reports (accuracy, precision, recall, confusion matrix).
6. GUI & Deployment – Built GUI for uploading images and predicting results, deployed using Streamlit.

Conclusion

This project successfully demonstrates the use of deep learning and computer vision techniques for automated plant disease detection. By utilizing the PlantVillage dataset and training a CNN model, the system achieves high classification accuracy. The final deliverable includes a Streamlit-based web app where users can upload a leaf image and receive real-time predictions about plant health. This can significantly aid farmers in early detection and management of plant diseases, reducing crop losses and increasing agricultural productivity. Future improvements could include:

- Expanding the model to support more crop types and diseases.
- Integrating IoT devices for real-time field monitoring.
- Deploying the system as a mobile app for farmers' convenience.