CNN-Based Plant Health Diagnosis Model for Agricultural Efficiency

a Deep Learning and Applications (UEC642) project

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Introduction

The prevalence of plant diseases threatens agricultural sustainability and productivity, which can lead to significant economic losses and food insecurity. Traditional disease detection methods require extensive expertise and can be time-consuming, especially in regions lacking adequate agricultural support. The rise of intense machine learning has enabled automated, efficient approaches to detect plant diseases from images, offering timely interventions. Convolutional neural networks (CNNs) are particularly effective in image classification and have proven helpful for plant disease diagnosis, potentially assisting farmers in preventing crop losses and improving yield quality.

Plant diseases cause crop degradation, reducing yield and impacting food security. Traditional identification methods are limited by labor and expertise requirements, delaying disease detection. Early diagnosis is essential to prevent the spread of diseases, but farmers in many areas lack access to quick, accurate diagnostics. This study formulates the problem of plant disease detection as an image classification task using deep learning. By leveraging CNNs, the model can identify specific diseases based on symptoms visible on plant leaves, thus providing a reliable, automated solution that could aid farmers with limited resources in managing crop health.

This study is unique because it applies a fine-tuned CNN architecture for plant disease classification using diverse color and grayscale leaf images, enhancing model robustness across various visual conditions. Additionally, the project introduces a comparative analysis of data preprocessing methods to determine the most effective approach for disease classification.

Objectives

1. To develop an automated system for early and accurate detection of plant diseases using leaf images.
2. To evaluate the effectiveness of CNN architectures in diagnosing multiple plant diseases.
3. To analyze the impact of data augmentation and preprocessing on model performance.

Methodology

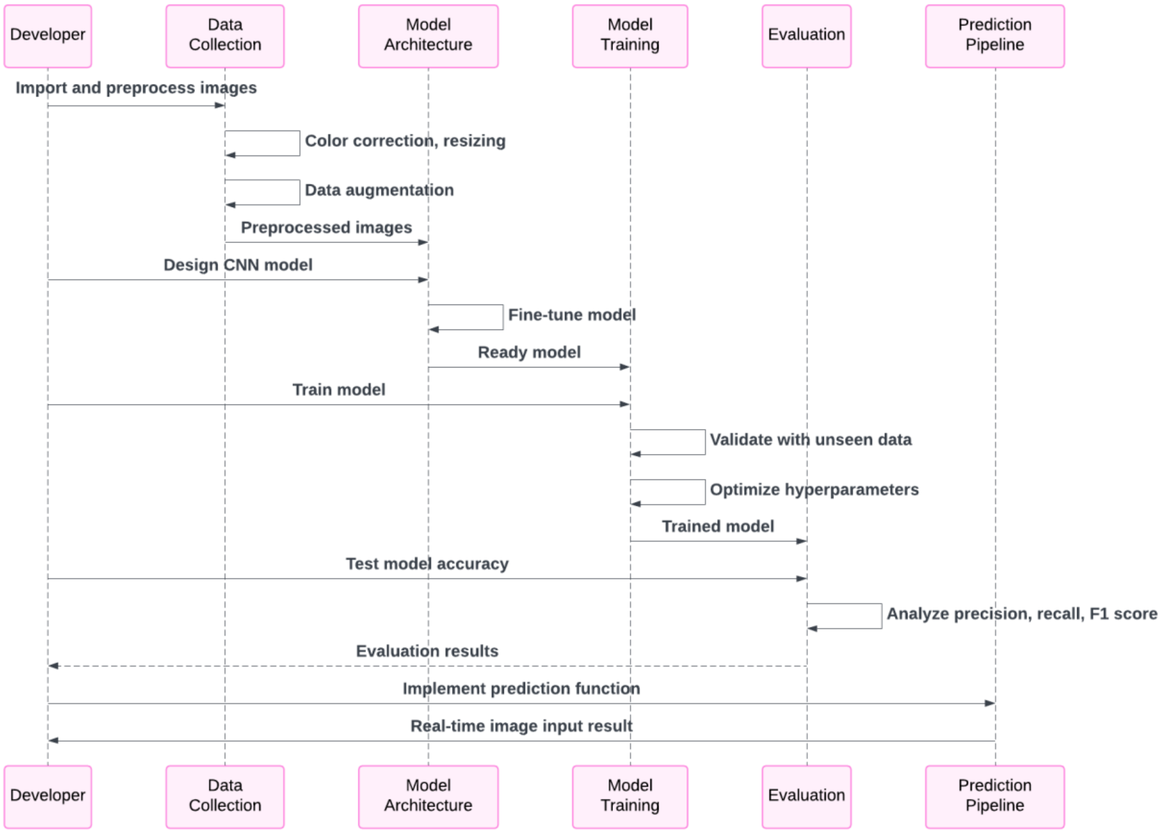

Fig: Sequence Diagram Explain the Methodology

Code

[CNN_crop_disease_model]

Results

The model was trained and evaluated on a dataset containing images of healthy and diseased plant leaves across multiple categories. The CNN achieved an accuracy of approximately 90%, with notable precision and recall in detecting specific disease classes. The training process showed that data augmentation techniques, including rotation and zoom, contributed to better generalization, especially for classes with fewer examples.

Upon evaluation, the model demonstrated strong performance in identifying diseases like early blight and leaf spot, showing sensitivity to subtle visual patterns. Some limitations were observed in detecting diseases with overlapping visual symptoms, indicating a potential area for improvement with more complex architectures or additional preprocessing. The model's ability to analyze leaf images in real-time offers a practical solution for rapid diagnosis, supporting farmers in implementing timely interventions to minimize crop loss.

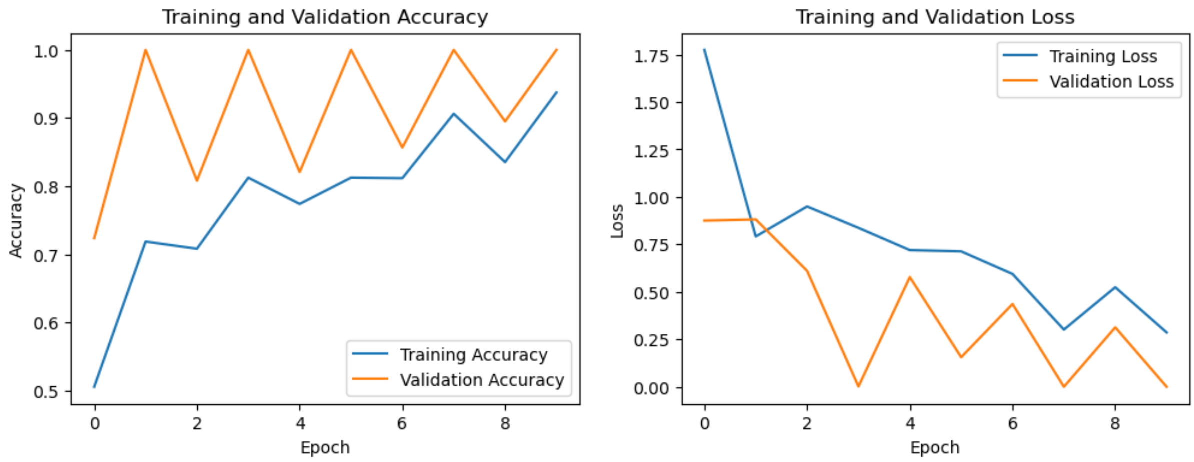

Fig: Training of the CNN Model

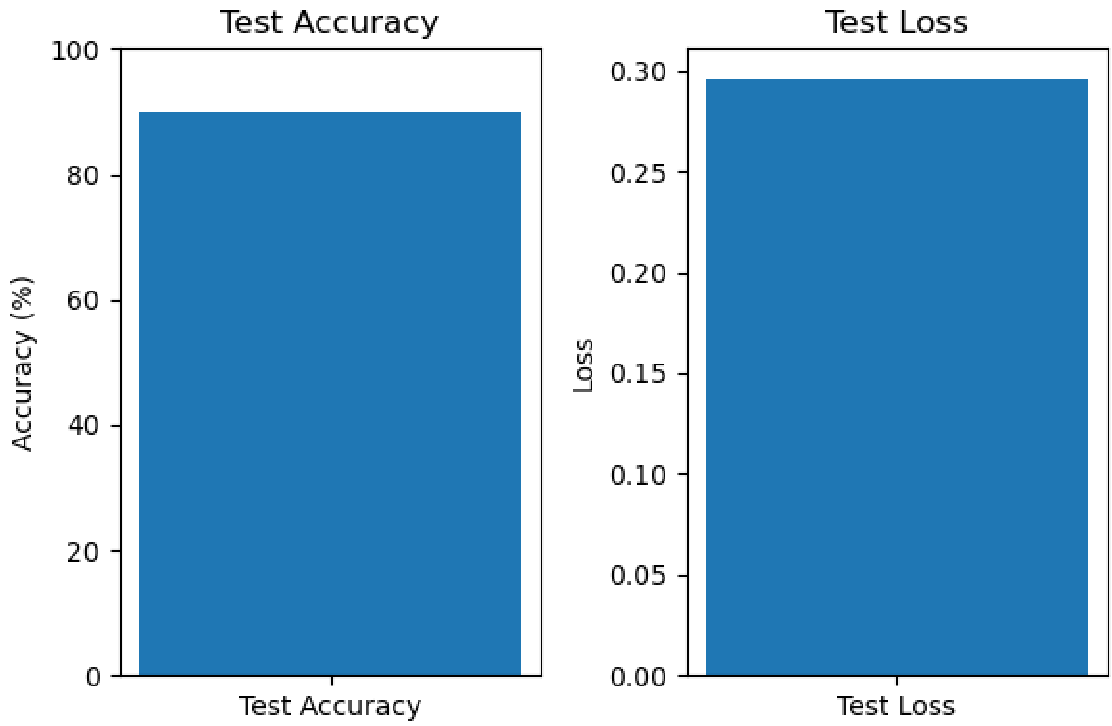

Fig: Showing Test results

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