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Plant Disease Detection using Deep Learning

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ABSTRACT: Plant diseases cause significant losses in agricultural productivity and affect crop quality. Early detection of plant diseases is important to reduce damage and improve yield. This project presents a deep learning based plant disease detection system using Convolutional Neural Networks (CNN). The system analyzes leaf images to identify diseases based on visual features such as color, texture, and shape. The Plant Village dataset containing more than 60,000 images across 39 disease classes is used for training and evaluation. The dataset is divided into training, validation, and testing sets. Due to similarities in leaf patterns, dried leaves, and overlapping disease symptoms, the model achieves an accuracy of approximately 70 percent. The system also provides fertilizer recommendations and supports multiple languages, making it suitable for practical agricultural applications.

KEYWORDS: Plant Disease Detection, Deep Learning, CNN, Image Processing, Agriculture, Flask.

I. INTRODUCTION

Agriculture plays a vital role in the economic development of many countries and serves as the primary source of food for the global population. Healthy crops are essential for achieving high agricultural productivity, but plant diseases remain one of the major factors responsible for crop loss. Diseases caused by bacteria, fungi, viruses, and pests can severely affect plant growth, reduce yield quality, and lead to significant financial losses for farmers.

Traditionally, plant disease detection is performed through manual observation by agricultural experts. This method requires continuous monitoring, specialized knowledge, and considerable time. In rural areas, access to experts is often limited, making early detection difficult. As a result, diseases are frequently identified at later stages when crop damage has already occurred.

With the advancement of artificial intelligence and deep learning, automated plant disease detection has become a promising solution. Deep learning techniques, particularly Convolutional Neural Networks (CNN), have shown excellent performance in image classification tasks. CNN models can automatically extract important visual features such as leaf color, texture, shape, and disease spots without manual feature engineering.

The Plant Village dataset is used for training and evaluation, containing thousands of labeled images of healthy and diseased plant leaves. The dataset is divided into training, validation, and testing sets to ensure reliable model performance.

The proposed system aims to provide an efficient, cost-effective, and user-friendly solution for early plant disease detection, supporting modern smart agriculture practices and helping farmers improve crop productivity.

II. LITERATURE SURVEY

Plant disease detection has been an active area of research for many years due to its importance in agricultural productivity. Early research mainly focused on traditional image processing and machine learning techniques. These methods used handcrafted features such as color, texture, and shape extracted from leaf images. Techniques like thresholding, edge detection, and segmentation were commonly applied to isolate diseased regions. Classifiers such as Support Vector Machine (SVM), k-Nearest Neighbor (KNN), and Decision Trees were then used for disease classification. Although these methods produced acceptable results under controlled conditions, their performance was limited when applied to real-world images with varying backgrounds and lighting conditions.

With the rapid development of deep learning, Convolutional Neural Networks (CNN) have become the most effective approach for plant disease detection. CNN models automatically learn discriminative features directly from raw images, eliminating the need for manual feature engineering. Studies have shown that deep CNN architectures such as AlexNet, VGG16, ResNet, and Inception networks achieve significantly higher accuracy compared to traditional machine learning techniques.

Research using the Plant Village dataset demonstrated that CNN-based models could achieve accuracy above 90 percent under laboratory conditions. However, many researchers observed performance degradation when models were applied to real-field images due to factors such as similar disease symptoms, overlapping patterns, leaf aging, background noise, and uneven illumination.

Recent studies have focused on improving real-world applicability by incorporating data augmentation, transfer learning, and lightweight CNN architectures. Some systems have also integrated mobile-based disease detection and cloud-based

III. METHODOLOGY

The proposed system uses deep learning techniques to detect plant diseases from leaf images. The Plant Village dataset is used, containing images of healthy and diseased leaves. The dataset is divided into training, validation, and testing sets for effective learning and evaluation.

Image preprocessing techniques such as resizing and normalization are applied before training. A Convolutional Neural Network (CNN) is used for feature extraction and classification. The model consists of convolution layers, activation functions, pooling layers, and fully connected layers.

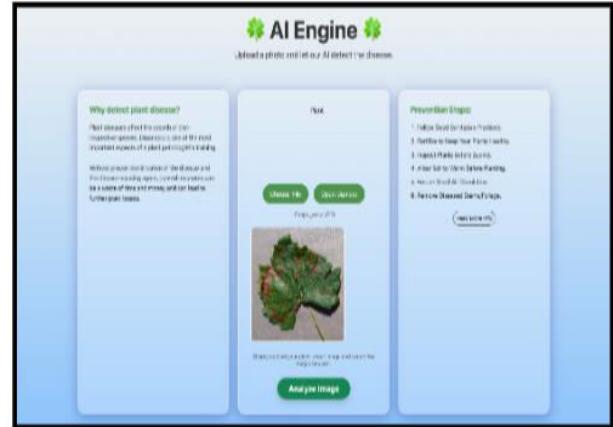
The CNN model is trained using the Adam optimizer and Cross Entropy loss function. After training, the model is evaluated using test data and achieves approximately 70 percent accuracy due to similarities in leaf patterns, dried leaves, and overlapping disease symptoms.

The system predicts plant diseases from uploaded images and also provides fertilizer recommendations with multiple language support. The trained model is deployed using a Flask-based web application for real-time usage.

IV. EXPERIMENTAL RESULTS



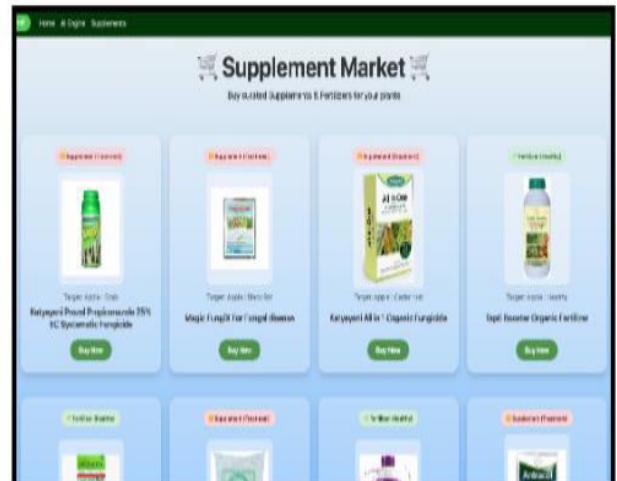
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V. CONCLUSION

The proposed plant disease detection system uses deep learning techniques to identify plant diseases from leaf images effectively. A CNN model is trained using the Plant Village dataset and achieves approximately 70 percent accuracy due to similarities in leaf patterns and environmental variations. The system also provides fertilizer recommendations and supports multiple languages for better usability. This approach helps farmers detect diseases early and reduce crop loss. In the future, the system can be improved using real-field images, mobile application deployment, and advanced deep learning models to increase accuracy and support smart agriculture.

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