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Potato Disease Identification Using Deep Learning

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Abstract: Potato diseases, such as late blight and early blight, pose significant threats to global agricultural productivity. Manual disease detection is time-intensive and error-prone, necessitating automated solutions. This study proposes a deep learning-based system using Convolutional Neural Networks (CNNs) for identifying potato leaf diseases. The model was trained and tested on an augmented dataset, achieving a classification accuracy of 97%. It effectively distinguishes healthy leaves from diseased ones. The system's robustness is validated through cross-validation and practical testing. Key advantages include high accuracy and scalability for agricultural applications. The approach can be extended for real-time use through IoT devices. This work aims to assist farmers in early disease detection, reducing crop losses and enhancing productivity.

Index Terms - Potato disease identification, deep learning, CNNs, late blight, early blight, image classification, agricultural technology.

I. INTRODUCTION

Potatoes are one of the most important crops globally, contributing significantly to food security and agricultural economies. However, diseases such as late blight and early blight pose a serious threat to potato cultivation, leading to considerable yield losses. Traditionally, disease detection relies on manual inspection, which is often slow, costly, and prone to human error. With the advancement of deep learning, particularly Convolutional Neural Networks (CNNs), automated solutions for disease identification have shown great promise. This paper introduces a CNN-based approach for identifying potato leaf diseases, specifically late blight, early blight, and healthy conditions. By employing deep learning techniques, this study aims to provide a reliable, efficient, and scalable solution for early disease detection, helping farmers take timely actions to minimize crop damage and enhance productivity.

II. LITERATURE SURVEY

[1] This study explores the potential use of various machine learning algorithms such as Decision Tree, Random Forest, and Neural Networks for plant disease detection. It discusses the accuracy ranges based on different datasets used for classification tasks in agriculture.

[2] This research focuses on the challenges in detecting and classifying diseases in plants using hybrid models. It addresses the gaps in existing datasets and the feature engineering techniques, which can significantly improve detection performance.

[3] The study investigates the application of cognitive science principles to machine learning models for real-time plant disease detection, emphasizing the importance of classification techniques in enhancing accuracy and speed.

[4] This paper reviews the current trends in plant disease detection using machine learning algorithms such as SVM and Decision Trees.

III. SCOPE AND METHODOLOGY

Scope

The scope of this study focuses on the automated identification of potato leaf diseases, specifically late blight, early blight, and healthy conditions, using deep learning techniques. The system aims to assist farmers in early disease detection, reducing reliance on manual observation. The solution is designed to be scalable, accurate, and efficient, offering a user-friendly interface for practical deployment. The study evaluates the model's performance using a publicly available dataset, augmented to enhance training data diversity and improve model generalization. While the system focuses on potato diseases, the methodology can be extended to other crops with similar disease identification challenges.

Methodology

The methodology for potato disease detection using deep learning involves several key steps. Initially, a comprehensive dataset of potato leaf images is collected, containing healthy, late blight, and early blight categories. The images are preprocessed, including resizing to a uniform size and augmenting the dataset through transformations such as rotation and flipping to enhance model robustness. Feature extraction techniques are applied to enhance key attributes relevant to disease classification.

The primary model used for disease detection is a Convolutional Neural Network (CNN), which is well-suited for image classification tasks. CNNs are trained on the preprocessed data, with several convolutional layers followed by pooling layers and fully connected layers to classify the images. The model is trained using a training-validation split, with cross-validation techniques to ensure the model generalizes well.

Evaluation of the model's performance is crucial. Metrics like accuracy, precision, recall, and F1-score are calculated to assess the model's effectiveness in disease classification. A confusion matrix is also used to visualize the results. The final model is tested on a separate test dataset to assess its performance in real-world applications, with the potential for real-time deployment in agricultural practices.

IV. SYSTEM ARCHITECTURE

Fig shows the system architecture for plant disease detection and cure recommendation. The user logs in and registers with a valid username and password, gaining access to the system. The system then receives a plant leaf image, which undergoes **data preprocessing** to clean and convert the image to binary format. **Feature extraction** follows, identifying relevant features to improve prediction accuracy. The system uses a **Convolutional Neural Network (CNN)** model to classify the image as healthy or diseased. If a disease is detected, the system recommends the appropriate pesticide. This architecture ensures a seamless flow from user authentication to disease detection and treatment suggestions.

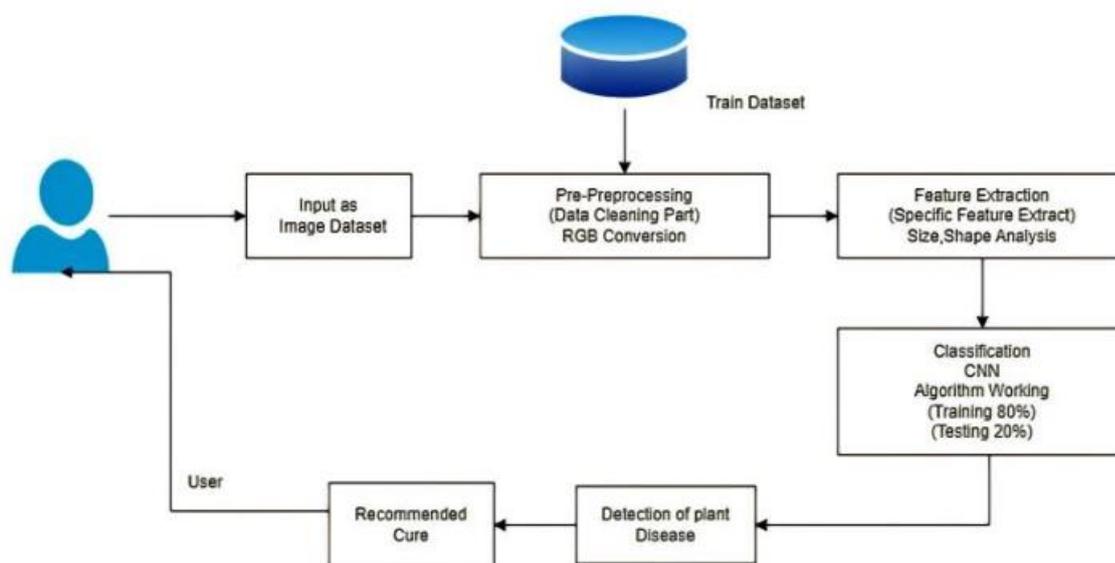


Figure 4.1: System Architecture

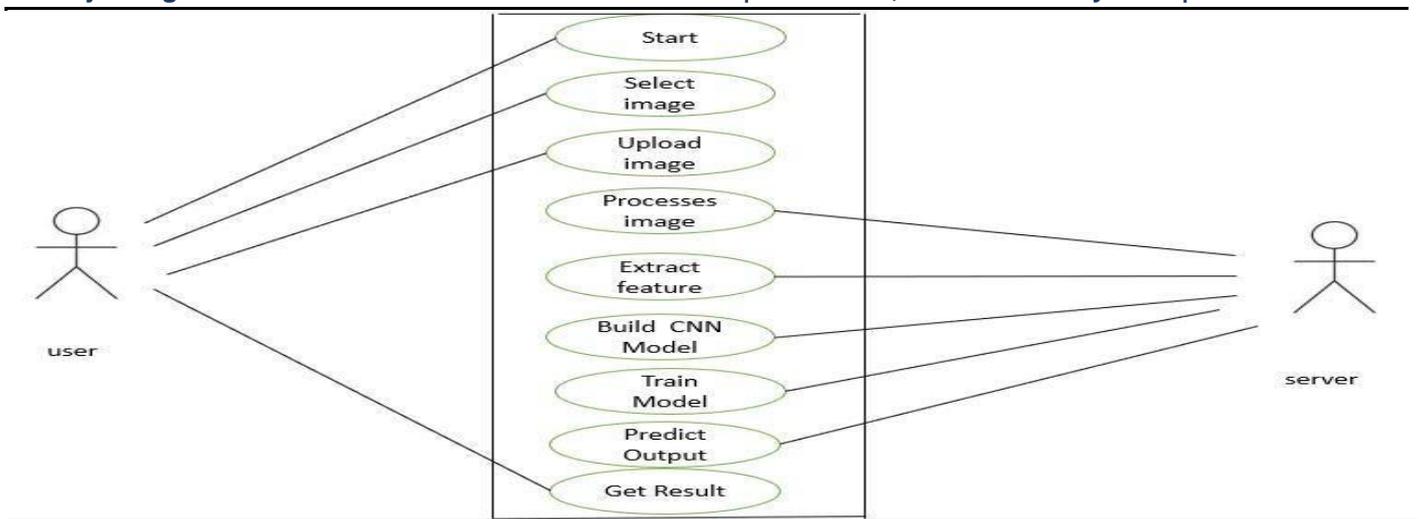


Figure 4.2: Use Case Diagram

V. CONCLUSION

The potato disease detection system effectively leverages deep learning, specifically Convolutional Neural Networks (CNN), to provide accurate and efficient identification of potato diseases, ensuring quick and precise results. This system is not only cost-effective but also scalable, reducing both storage and operational costs, while offering the potential for application to other crops. It enables timely intervention for farmers by facilitating early disease detection, allowing for preventive measures that help reduce crop loss and optimize pesticide usage. Additionally, the system is designed to be reliable and future-ready, with built-in disaster recovery features and the capacity for continuous model updates, ensuring long-term effectiveness in agricultural health management. As the model improves over time, its ability to enhance disease detection accuracy and broaden its application to various crops will contribute significantly to modern agricultural practices.

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