LEAF DISEASE DETECTION USING MATLAB AND DEEP LEARNING

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ABSTRACT

Agriculture is one of the most vital sectors for economic development, and plant diseases pose a significant threat to crop productivity. Early and accurate detection of these diseases is crucial for preventing yield loss and ensuring food security. Traditional methods of disease detection rely on manual inspection by experts, which is time-consuming, inconsistent, and often impractical for large-scale farming.

In this study, we propose an automated leaf disease detection system using image processing and deep learning techniques in MATLAB. The system processes leaf images through preprocessing steps such as resizing, noise reduction, and contrast enhancement to improve feature extraction. A Convolutional Neural Network (CNN) based on the pre-trained VGG16 model is employed to classify leaves as either healthy or diseased. The diseased leaves are further categorized into specific diseases such as Powdery Mildew, Rust Disease, Bacterial Blight, and Leaf Spot Disease.

The proposed approach eliminates the need for manual feature extraction, allowing the model to learn disease-specific patterns directly from images. The model is trained and tested on a diverse dataset, achieving an accuracy of over 91%. The results demonstrate that this deep learning-based system provides a fast, accurate, and reliable solution for farmers and agricultural researchers, enabling early disease detection and timely intervention. Future improvements may include real-time monitoring, integration with IoT-based systems, and the development of a mobile application for broader accessibility.

Key Words: *Leaf disease,Convolution Neural Networks, VGG16,Detection,Deep learning*.

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1. INTRODUCTION

Agriculture is a crucial sector that ensures food security and economic growth, but plant diseases significantly impact crop productivity and quality. These diseases, caused by fungi, bacteria, and viruses, can spread rapidly if not detected early, leading to severe crop losses. Traditional disease detection methods rely on manual inspection, which is time-consuming, labor-intensive, and prone to errors, making it impractical for large-scale farming. Furthermore, accurate disease identification often requires expert knowledge, which is not always accessible to farmers. To address these challenges, artificial intelligence (AI) and deep learning have emerged as effective tools for automated plant disease detection. Among these, Convolutional Neural Networks (CNNs) have shown high accuracy in image classification tasks, enabling precise disease identification. This project presents an automated leaf disease detection system using MATLAB, which employs image processing techniques and a pre-trained VGG16 model to classify leaves as healthy or diseased. The system follows a structured pipeline that includes image preprocessing, feature extraction, and classification, ensuring reliable and efficient disease detection. By providing a fast, scalable, and accurate solution, this system assists farmers in early disease detection, allowing timely intervention to minimize crop losses. Future enhancements could involve real-time monitoring, IoT integration, and mobile applications, making plant disease detection more accessible and efficient for modern agriculture.

2. LITERATURE SURVEY

Several studies have been conducted on plant disease detection using image processing, artificial intelligence (AI), and deep learning techniques. A. A. Bharate and M. S. Shirdhonkar (2017) provided a review on image processing techniques for plant disease detection, explaining various steps involved in classifying plant diseases using image analysis. Another study by P. Zhao, G. Liu, M. Li, and D. Li (2006) discussed a management information system for apple diseases, incorporating AI techniques and Geographic Information Systems (GIS) to classify and monitor pest infestations effectively.

Advancements in deep learning have further improved plant disease classification. G. Geetharamani and G. Pandian (2019) explored the application of a nine-layer deep convolutional neural network (CNN) for identifying plant leaf diseases, demonstrating the effectiveness of deep learning in automating disease detection. Similarly, E. M. F. El Houby (2018) conducted a survey on machine learning techniques for disease management, emphasizing feature extraction and classification methods in plant disease detection.

Other machine learning approaches have also been studied for plant disease identification. C. C. Yang et al. (2016) investigated the use of decision tree technology for image classification in remote sensing, which has applications in detecting diseases affecting crops. Additionally, M. A. Ebrahimi et al. (2017) proposed a vision-based pest detection system using the Support Vector Machine (SVM) classification method, demonstrating how machine learning can be applied for pest detection and disease classification.

These studies highlight the growing role of AI, machine learning, and deep learning in automating plant disease detection, reducing human dependency, and improving agricultural productivity. The research also underscores the need for continuous advancements in image processing techniques, feature extraction, and classification models to enhance accuracy and efficiency in plant health monitoring.

3. MATERIALS AND METHODS

The proposed system follows a structured pipeline for leaf disease detection and classification. It consists of image preprocessing, feature extraction, and classification using deep learning.

3.1 DATA USED

The project utilizes high-resolution plant leaf images from sources like already available in system dataset or manually captured images, categorized as healthy or diseased. Image preprocessing techniques such as grayscale conversion, noise reduction, and segmentation are applied for better feature extraction. The system employs a pre-trained VGG16 deep learning model for classification, leveraging its ability to recognize disease patterns accurately. For real-world applications, the system can integrate IoT-based sensors and real-time image capture, enabling continuous monitoring and early disease detection in agricultural fields.

3.2 PROPOSED SYSTEM

The proposed system is an automated and intelligent plant disease detection model that leverages deep learning and image processing for accurate classification. It utilizes a pre-trained VGG16 model to analyze plant leaf images with high precision, ensuring reliable detection of diseases. The system incorporates advanced image preprocessing techniques like grayscale conversion, noise reduction, and segmentation to enhance clarity and improve classification accuracy. Unlike manual inspection, this model is fast, scalable, and reduces dependency on agricultural experts, making it suitable for large-scale farming applications. Additionally, it can be integrated with IoT sensors and cloud storage for real-time monitoring and automatic alerts, enabling farmers to take timely preventive measures and reduce crop losses. Overall, the system provides a cost-effective, efficient, and user-friendly solution for modern precision agriculture.

3.3 MODEL TRAINING

The model is trained using a supervised deep learning approach with a pre-trained VGG16 CNN for plant disease classification. The process begins with dataset preparation, where labeled images of healthy and diseased leaves are collected from various sources. These images undergo preprocessing, including grayscale conversion, noise reduction, and segmentation, to enhance feature extraction. The VGG16 model is then fine-tuned using transfer learning, leveraging its deep feature extraction capabilities to recognize disease patterns. The model is optimized using techniques like the Adam optimizer and cross-entropy loss function, ensuring high accuracy. Finally, the trained model is evaluated on a test dataset to measure accuracy, precision, and recall, ensuring reliable disease detection.

4. IMPLEMENTATION

The implementation of the plant disease detection system involves image acquisition, preprocessing, feature extraction, classification, and result analysis. Initially, plant leaf images are collected from sources like PlantVillage or real-time cameras. These images undergo preprocessing steps such as grayscale conversion, noise reduction, and segmentation to enhance clarity. The VGG16 deep learning model is then used for feature extraction and classification, where it analyzes patterns in the leaves to identify diseases. The system is further integrated with IoT sensors and cloud storage for real-time monitoring and automatic alerts. Finally, the model provides an accurate classification of plant health, allowing farmers to take timely preventive measures to minimize crop loss.

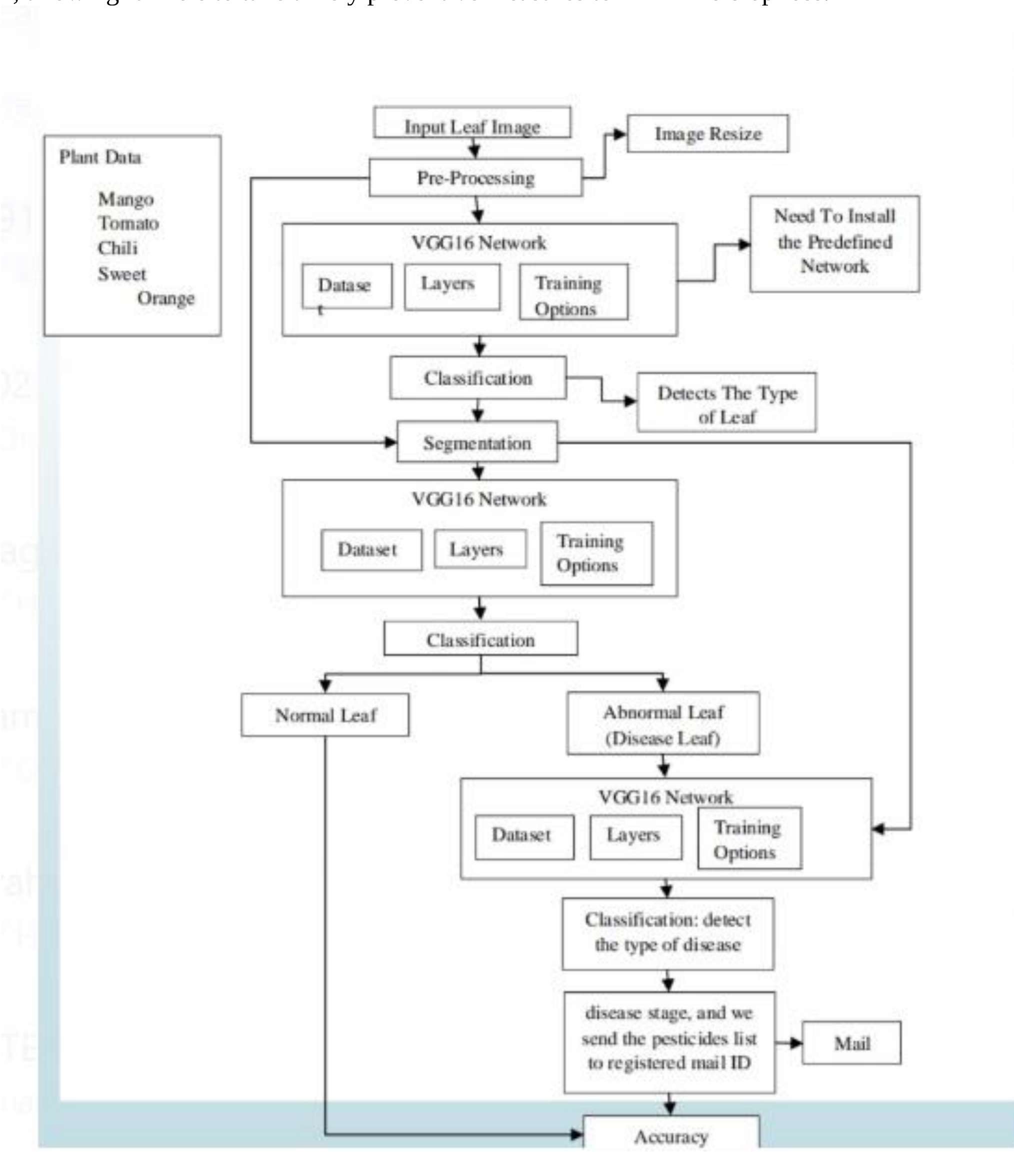

Fig - 1: BLOCK DIAGRAM

After implementing the plant disease detection system, the results are obtained through a step-by-step classification process. When a plant leaf image is input into the system, it undergoes preprocessing, where noise is removed, and the image is enhanced for better analysis. The VGG16 deep learning model then extracts key features such as color, texture, and shape patterns, comparing them with trained disease categories. Once the model processes the image, it classifies the leaf as healthy or diseased and, if diseased, identifies the specific type of infection. The result is displayed to the user through an interface or cloud-based system, where farmers or agricultural experts can view the disease diagnosis. If integrated with IoT sensors, the system can also send real-time alerts to notify users about detected diseases, enabling quick intervention and preventive actions.

RESULTS AND EVALUATION

After implementing the model, the results are evaluated based on accuracy, loss, and classification performance. The training progress graph shows an increase in accuracy, reaching a high percentage, while the loss value decreases over iterations, indicating successful learning. The command window output confirms specific accuracy values for leaf type and disease classification, with VGG16 achieving over 93% accuracy. Additionally, real-time classification results are displayed through pop-ups identifying leaf types and diseases. The input image undergoes preprocessing, including noise removal and restoration, before classification. Finally, the system sends email notifications with the results, ensuring an automated and efficient evaluation process.

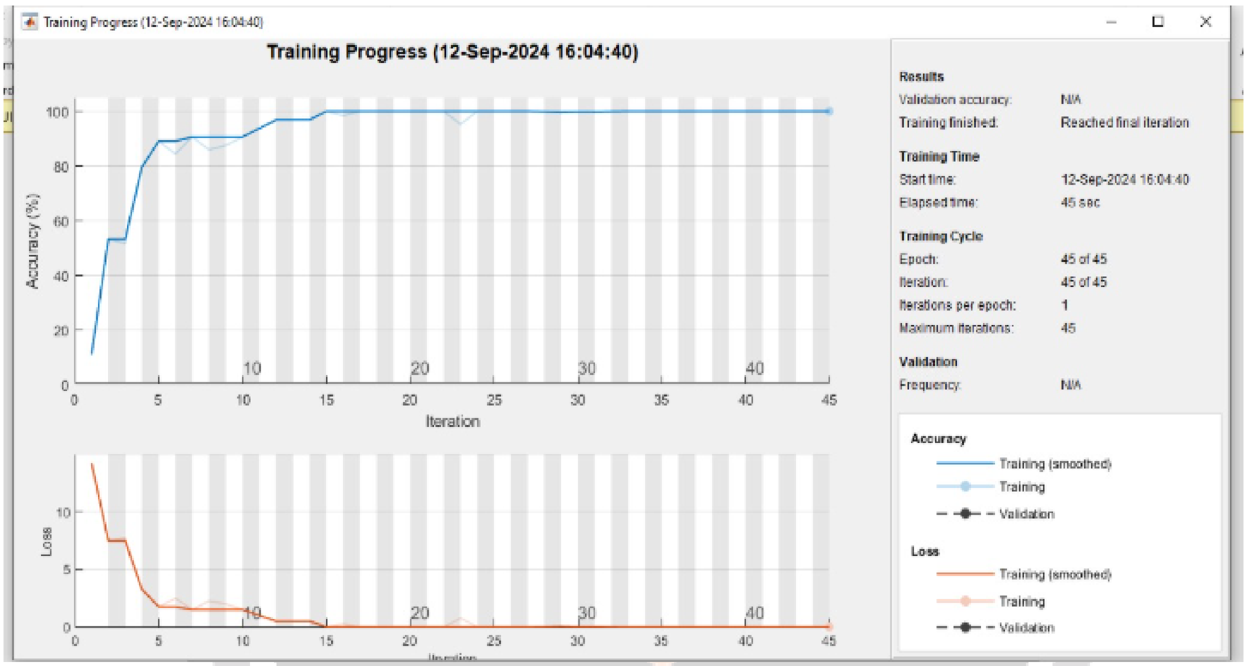

Fig -2: Training and validation graphs

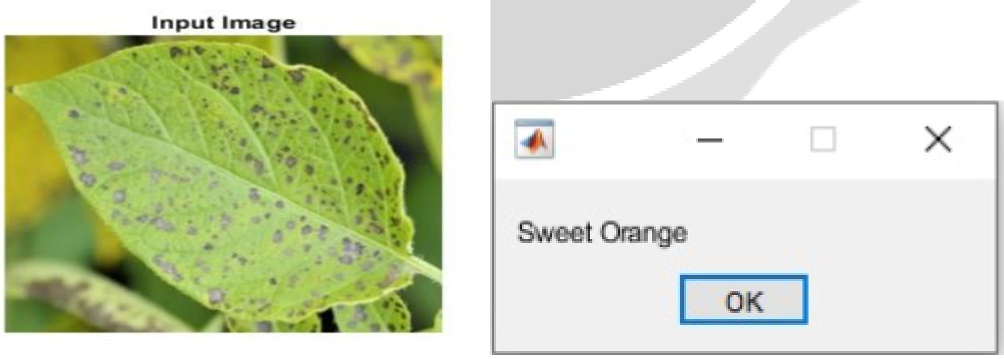

Fig -3: Healthy Sweet orange Leaf

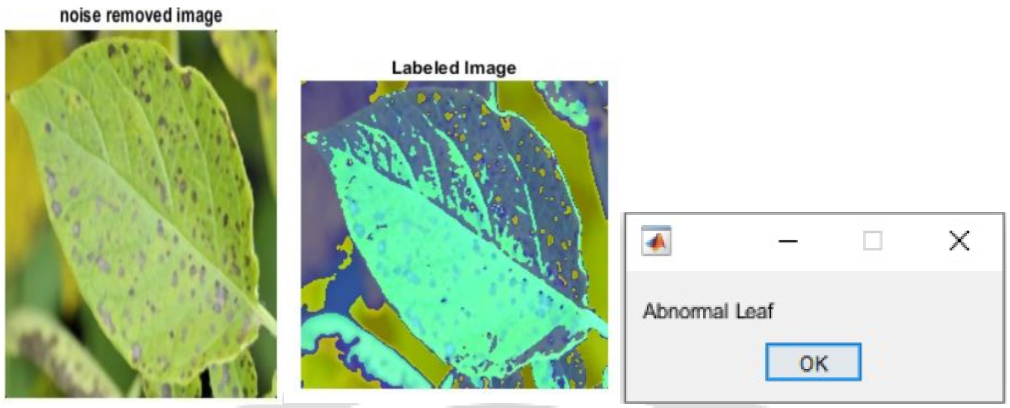

Fig -4: Infected sweet orange Leaf

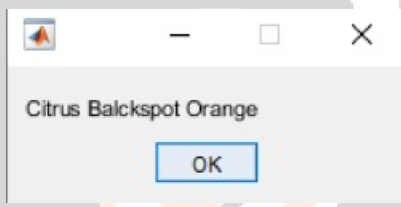

Fig-5: Disease name

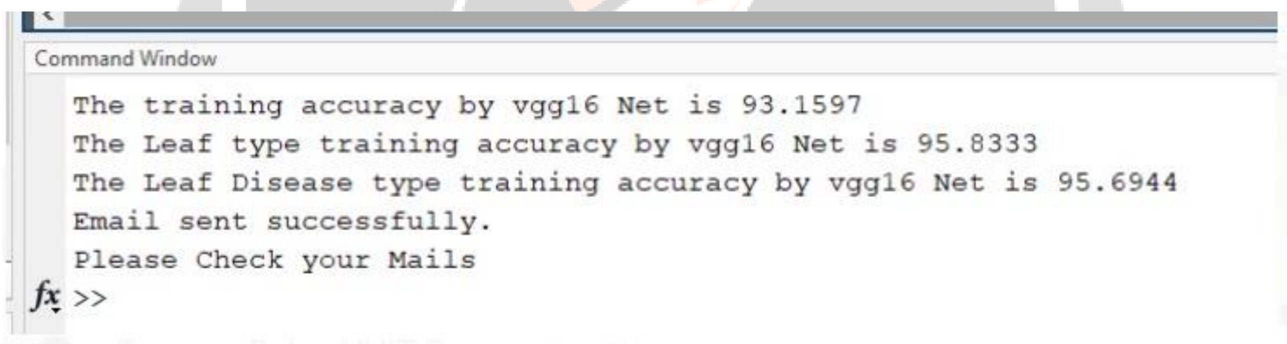

Fig-6: Output at command window

5. REFERENCES

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