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GREENLENS: AN INTELLIGENT CNN-BASED LEAF DISEASE DETECTION AND AGRICULTURAL RECOMMENDATION SYSTEM

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Abstract: Early detection of crop diseases is essential for improving agricultural productivity and reducing crop loss. The proposed system presents an automated crop disease recognition framework using Convolutional Neural Networks (CNN) and image processing techniques. Leaf images from the PlantVillage dataset are preprocessed and classified to identify healthy and diseased crops based on visual symptoms such as discoloration, spots, and texture variations. The model was achieved high training and testing accuracy, demonstrating reliable classification performance. The proposed approach provides an efficient, accurate, and user-friendly solution for smart agriculture applications and supports farmers in taking timely preventive measures for crop protection.

Keywords: CNN, Crop Disease Detection, Deep Learning, Image Processing, PlantVillage Dataset.

I.INTRODUCTION

Agriculture is a vital sector that supports human life and contributes significantly to the economy. However, crop diseases remain a major challenge, reducing both yield and quality. Traditional detection methods rely on manual observation by farmers or experts, which can be time-consuming, less accurate, and often inaccessible in rural areas. With advancements in technology, image processing and deep learning techniques, particularly Convolutional Neural Networks (CNNs), have enabled more efficient and accurate disease detection. By analyzing leaf images, these models can identify disease patterns that are not easily visible to the human eye.

The proposed system, GreenLens:An Intelligent CNN-Based Leaf Disease Detection and Agricultural Recommendation System, provides an intelligent solution for plant disease detection. It processes leaf images through preprocessing, segmentation, and feature extraction, and applies CNN classification along with Histogram of Oriented Gradients (HOG) features for accurate identification. In addition to disease detection, the system offers crop recommendations based on soil nutrients (NPK), prediction of suitable farming conditions such as temperature, humidity, and pH, and weather prediction based on location. Implemented as a desktop application with separate admin and user modules, GreenLens supports efficient usage and aims to improve crop management, enhance productivity, and promote smart and sustainable agriculture.

II. OBJECTIVES

The main objective of the proposed system is to develop an intelligent and efficient solution for detecting crop diseases using image processing and deep learning techniques. The system aims to assist users in identifying plant diseases at an early stage and support better agricultural decision-making. The proposed framework utilizes Convolutional Neural Networks (CNN) for accurate disease classification from leaf images and applies preprocessing and segmentation techniques to enhance image quality and isolate infected regions. Feature extraction methods are incorporated to identify important disease-related patterns for improving classification performance. The system also provides a user-friendly interface that allows users to upload leaf images and obtain disease detection results easily. In addition, the proposed system is designed to provide detailed disease information, including symptoms, causes, and pesticide recommendations. Furthermore, it supports crop recommendation based on soil nutrient values, prediction of suitable farming conditions such as temperature, humidity, and pH level, and weather prediction functionalities to assist users in smart agricultural practices.

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III. LITERATURE REVIEW

Recent advancements in plant disease detection systems have shown significant potential in improving traditional agricultural monitoring methods. Most studies utilize Convolutional Neural Networks (CNNs), deep learning models, and image processing techniques for identifying crop diseases from leaf images. These systems aim to automate disease diagnosis with higher accuracy, reduced human effort, and faster prediction capability, thereby supporting smart agriculture and precision farming applications.

Several studies, such as papers [1], [2], and [3], proposed mobile-based plant disease detection systems using CNN architectures for real-time prediction. These systems focused on improving accessibility and usability for farmers through smartphone applications while maintaining good classification accuracy and computational efficiency. Paper [4] further demonstrated the effectiveness of deep learning models for crop-specific disease diagnosis by applying CNN techniques to cotton leaf disease classification. Paper [5] enhanced agricultural support by integrating fertilizer recommendation with disease prediction using machine learning approaches.

Other research works, including papers [6], [7], and [8], focused on integrating AI-based decision support, pest detection, and scalable disease diagnosis systems for smart farming applications. These studies employed transfer learning, lightweight SSD models, and extensible mobile frameworks to improve real-time performance and adaptability in agricultural environments. Papers [9] to [13] explored lightweight deep learning architectures, hybrid CNN models, fuzzy inference systems, and robust feature extraction methods for improving disease detection accuracy under varying field conditions such as noise, lighting variation, and background complexity.

In papers [14] to [17], CNN-based disease classification systems combined preprocessing, segmentation, and feature extraction techniques for identifying multiple crop diseases. These studies demonstrated that deep learning approaches outperform traditional machine learning methods due to their automatic feature learning capability and improved generalization performance. Some works also incorporated disease solution recommendations and multi-dataset training strategies to enhance robustness and practical usability in real-world agricultural scenarios.

Finally, papers [18] to [20] focused on improving CNN architectures, comparing deep learning models with traditional machine learning algorithms, and evaluating performance metrics such as accuracy, robustness, and computational efficiency. These studies confirmed that deep CNN models provide superior disease classification performance and are highly suitable for automated crop monitoring and intelligent agricultural management systems.

IV. EXISTING SYSTEM

The existing systems for plant disease detection mainly rely on traditional methods and basic machine learning approaches. In conventional practices, farmers identify crop diseases through manual observation or by consulting agricultural experts. This process is time-consuming, requires experience, and may lead to inaccurate results, especially when early symptoms are not easily visible. In many rural areas, access to experts is also limited, which further delays proper diagnosis and treatment.

With the advancement of technology, several automated systems have been developed using image processing and machine learning techniques. Some systems use basic feature extraction methods and classifiers such as Support Vector Machines (SVM), Random Forest, and k-Nearest Neighbors (KNN). More recent approaches utilize deep learning models like Convolutional Neural Networks (CNNs) to improve accuracy. However, many of these systems are trained on controlled datasets and do not perform well in real-world conditions where lighting, background, and image quality vary. Additionally, some systems are limited to specific crops and do not support multi-crop disease detection.

Furthermore, most existing systems focus only on disease identification and lack additional functionalities such as crop recommendation, farming condition prediction, and weather analysis. Some advanced systems require high computational resources or additional hardware like IoT sensors, making them less accessible for common users. Therefore, there is a need for an efficient, accurate, and user-friendly system that can overcome these limitations and provide a complete solution for smart agriculture.

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V. PROPOSED SYSTEM

The proposed system is an intelligent crop disease recognition framework developed using image processing and deep learning techniques for smart agriculture applications. The system utilizes a Convolutional Neural Network (CNN) model to identify plant diseases from leaf images with high accuracy. Initially, leaf images from the PlantVillage dataset are preprocessed using resizing, normalization, and segmentation techniques to enhance image quality and isolate infected regions. Important disease-related features such as texture variations, discoloration, and lesion patterns are extracted and analyzed by the CNN model for accurate classification of healthy and diseased leaves. The system also provides detailed disease information, pesticide recommendations, crop recommendation based on soil nutrient values, farming condition prediction, and weather forecasting functionalities. A user-friendly interface is integrated to allow users to upload images and obtain prediction results efficiently, making the proposed system suitable for real-time smart agriculture and crop monitoring applications.

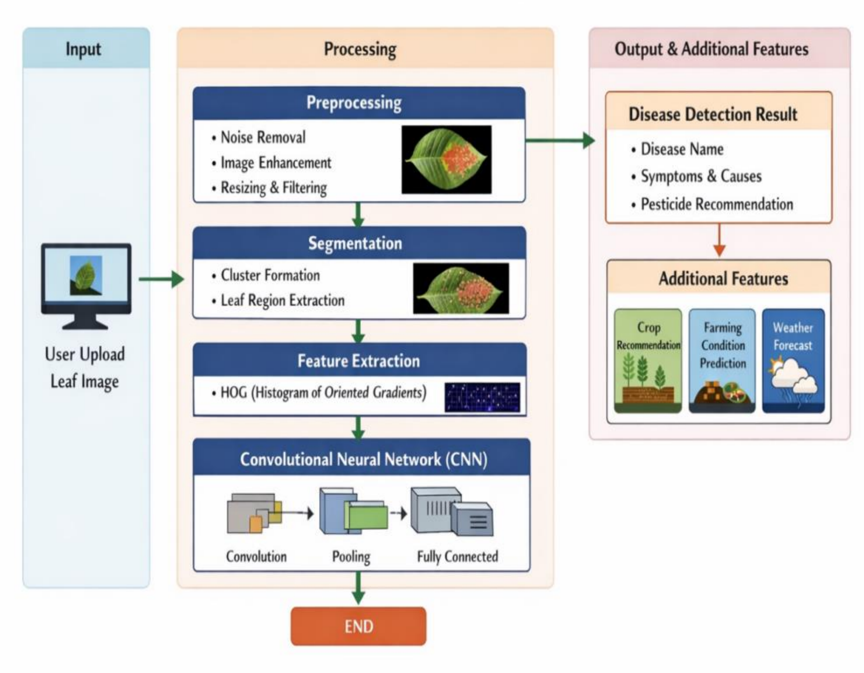

Figure 1: *Architecture of the proposed system[21]*

VI. IMPLEMENTATION

The implementation of the proposed system, GreenLens:An Intelligent CNN-Based Leaf Disease Detection and Agricultural Recommendation System, is carried out using image processing and deep learning techniques for accurate crop disease detection. The system consists of Admin and User modules along with additional features such as crop recommendation, farming condition prediction, and weather analysis.

In the Admin module, the administrator logs into the system and trains the CNN model using leaf images. The uploaded images undergo stages such as slicing, preprocessing, segmentation, and feature extraction. Preprocessing improves image quality through filtering and noise removal, while segmentation isolates the affected region of the leaf. Feature extraction using Histogram of Oriented Gradients (HOG) captures important patterns from the image. These features are then processed using the Convolutional Neural Network (CNN), which classifies the leaf images into healthy or diseased categories.

In the User module, users can register, log in, and upload leaf images for disease detection. The uploaded image passes through preprocessing, segmentation, feature extraction, CNN matching, and HOG analysis. Based on the trained model, the system identifies the disease and displays details such as disease name, symptoms, causes, and pesticide recommendations. Additionally, the system provides crop recommendation based on NPK values, farming condition prediction, and weather prediction, making it a complete smart agriculture support system.

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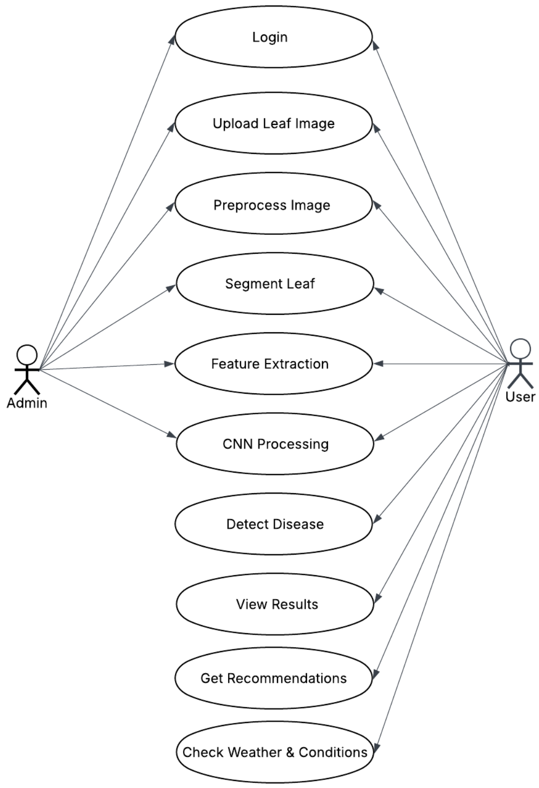

Figure 2 :Use case Diagram

VII. RESULT

Figure 3: Pre-Processing

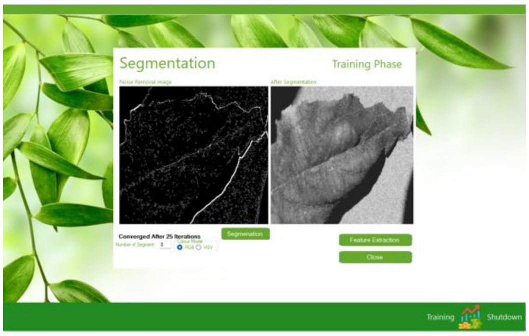

Figure 4: Segmentation

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Figure 5:Feature Extraction

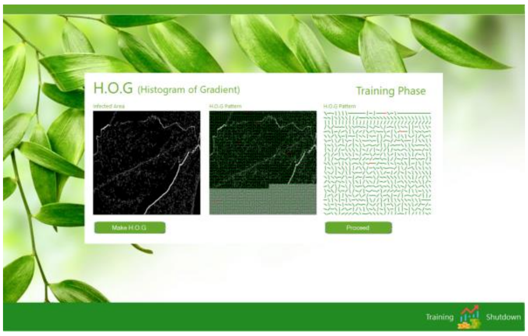

Figure 6: HOG

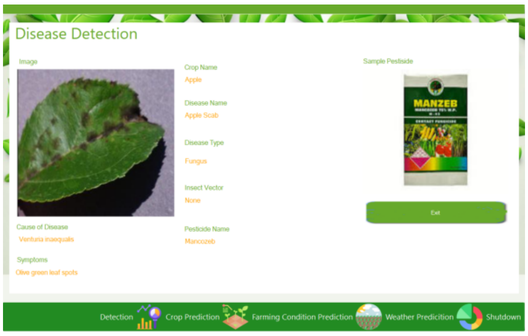

Figure 7:Disease Detection

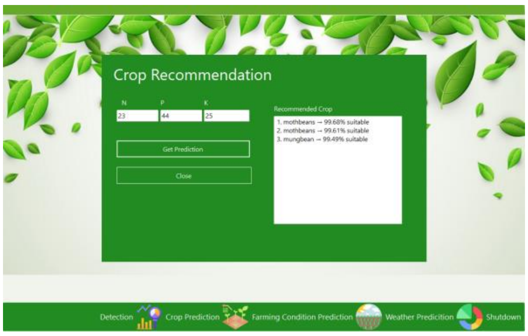

Figure 8:Crop Prediction

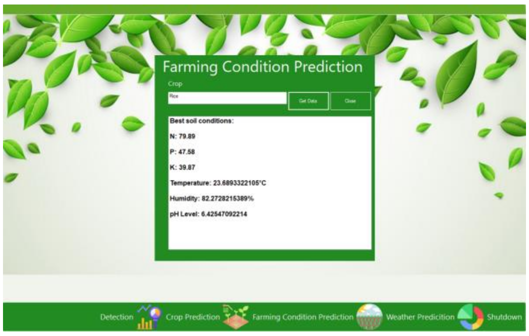

Figure 9:Farming Condition Prediction

Figure 10: Weather Predictio

VIII. CONCLUSION

The proposed system GreenLens:An Intelligent CNN-Based Leaf Disease Detection and Agricultural Recommendation System was successfully designed and implemented to detect plant diseases using image processing and deep learning techniques. The system utilizes a Convolutional Neural Network (CNN) along with preprocessing, segmentation, and feature extraction methods to accurately classify leaf images as healthy or diseased.The results demonstrate that the system achieves a training accuracy of 97.06% and a validation accuracy of 96.84%, making it a reliable and efficient tool for crop disease detection. By automating the detection process, the system reduces the need for manual inspection and helps farmers take timely action to prevent crop loss. The inclusion of additional features such as pesticide recommendations, crop suggestions, and weather insights further enhances the usefulness of the system in real-world agricultural applications.

Overall, the project highlights the potential of artificial intelligence in transforming traditional farming practices into smart and data-driven approaches. The system is user-friendly, cost-effective, and practical for deployment. With further improvements such as larger datasets, real-time detection, and mobile integration, the system can be expanded into a powerful decision-support tool for modern agriculture.

IX. FUTURE SCOPE

The proposed system can be further enhanced in several ways to improve its performance and usability. Integration with mobile applications can make the system more accessible to farmers by enabling easy usage on smartphones. Real-time detection using a camera can be implemented to allow live disease identification through mobile or webcam input. Expanding the dataset by including more crop types and diseases can improve the model's generalization ability. The use of advanced deep learning models such as transfer learning techniques, including ResNet and EfficientNet, can further enhance accuracy. Additionally, multilingual support can be provided to deliver outputs in regional languages, improving usability for farmers. The system can also be integrated with IoT devices to enable real-time monitoring of environmental factors such as soil conditions, temperature, and humidity. Furthermore, deploying the system on cloud platforms can support large-scale access and ensure faster processing.

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