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MULTI-CLASS PLANT DISEASE IDENTIFICATION USING SELF-ATTENTION MECHANISM IN VISION TRANSFORMES

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Abstract: Plant leaf diseases significantly impact crop yield and quality. Traditional disease detection methods are time-consuming and prone to errors. The proposed system leverages Vision Transformer (ViT) for multi-class classification, ensuring accurate and automated disease detection. It analyzes leaf images, identifies diseases, and provides fertilizer recommendations for effective treatment. This AI-powered solution enhances precision agriculture, reducing dependency on manual inspection and optimizing farm productivity.

Keywords: Vision Transformer(ViT), Multi-Class Classification, Automated Disease Detection, Smart Farming, Image Classification, Sustainable Farming, Precision Agriculture, Agricultural Technology, Real Time Detection

I. INTRODUCTION

Plant leaf diseases are caused by fungi, bacteria, viruses, and environmental stressors, significantly affecting plant health and agricultural productivity. These diseases manifest in various forms, including spots, discoloration, wilting, blight, and premature leaf fall, ultimately reducing crop yield and quality. If not managed properly, plant leaf diseases can spread rapidly, leading to economic losses and food shortages. Early detection and effective disease management strategies are crucial to ensuring plant health and sustainable farming practices. Among the most common plant leaf diseases, leaf spots are characterized by localized, discolored patches caused by fungal, bacterial, or viral infections. These spots, which can appear in brown, black, or yellow shades, weaken the plant and hinder photosynthesis. Blight is another severe condition that leads to rapid leaf tissue destruction, resulting in wilting, yellowing, and eventual leaf death. Rust, a fungal disease, manifests as raised orange, yellow, or brown pustules on leaves and stems, further reducing plant vigor. Powdery mildew appears as a white, powdery coating on leaves and stems, thriving in warm, dry conditions and stunting plant growth. Similarly, downy mildew develops in cool, wet environments, causing yellow or brown patches with fuzzy fungal growth on the undersides of leaves. Another significant disease, anthracnose, causes dark, sunken lesions on leaves, stems, and fruits, spreading through infected plant debris and water splashes. The symptoms of plant leaf diseases vary but often include spots or lesions, yellowing or chlorosis, wilting, premature leaf fall, and distorted leaves. In many cases, fungal growth is visible on the leaf surface, either in powdery or downy forms. These symptoms weaken the plant, reduce its ability to photosynthesize, and make it more susceptible to further infections and environmental stress. Several factors contribute to the spread of plant leaf diseases. Pathogens, including fungi, bacteria, and viruses, are the primary causes and can be transmitted through wind, water, insects, and contaminated tools. Environmental conditions, such as high humidity, prolonged wetness, and poor air circulation, create favorable conditions for disease development. Additionally, plant stress caused by nutrient deficiencies, drought, or physical damage weakens a plant’s natural defenses, making it more vulnerable to infections. Poor sanitation, such as leaving diseased plant debris in fields, further exacerbates disease spread by allowing pathogens to persist and infect healthy plants.

II.METHODOLOGY

1. **Plant Disease Detector Web App:** The Plant Disease Detector Web App serves as the main interface for users, allowing them to upload images of plant leaves and receive disease diagnoses along with suitable recommendations. It is developed using Python, Flask, MySQL, Bootstrap, and WampServer, ensuring an interactive and responsive platform. The web app facilitates real-time disease detection, result visualization, and recommendation generation, making it accessible for both farmers and agricultural experts.

2. **System User:**

2.1 Admin

The admin module enables system administrators to manage datasets, train the disease detection model, and oversee recommendations. Admins can upload datasets, initiate model training, and add or update recommendations based on the identified diseases. Additionally, they manage registered users and oversee system functionality.

2.2 Farmer/User

This module allows farmers and other users to interact with the system. Users can register, log in, and upload plant leaf images to detect diseases. The system identifies the plant type, classifies diseases, and presents results visually. Additionally, users receive disease-specific recommendations for fertilizers and pesticides to improve crop health.

3. **PlantDisNet Model: Build and Train**

The PlantDisNet Model is the core component responsible for disease detection. It processes datasets, extracts features, and performs multi-class classification using advanced deep learning techniques. The model integrates Vision Transformer (ViT) and Convolutional Neural Networks (CNN) to improve accuracy in disease classification.

3.1 Import Dataset

This submodule collects labeled images of plant leaves to train the model. The dataset is divided into training and testing sets to improve model accuracy and performance.

3.2 Preprocessing

Before training, input images undergo preprocessing, which includes:

Resizing for uniform dimensions.

Converting RGB images to grayscale to simplify computations.

Noise filtering using Gabor or Median filters for enhanced clarity.

Binarization to separate foreground from background.

Segmentation to isolate diseased regions for analysis.

3.3. Feature Extraction

Self-Attention Mechanism from ViT is used to extract deep spatial and contextual features from leaf images. These extracted features help in distinguishing different diseases effectively.

4. **Plant Leaf Disease Detection**

This module allows users to detect plant diseases by uploading leaf images. The uploaded image is processed, and the ViT-based trained PlantDisNet Model identifies the plant type and classifies the disease. The system ensures real-time, high-accuracy detection for multiple plant species.

4.1 Input Image

Users provide an image of an affected plant leaf through the web application.

4.2 Plant Identification

The system recognizes the plant species using the ViT-based trained model, ensuring accurate classification.

4.3 Disease Detection

Once the plant species is identified, the model classifies the disease using deep learning algorithms and presents the results to the user.

5. **Result Visualization**

This module presents the classification results to the user in a clear and understandable format. The system highlights the disease name, severity level, and affected leaf regions. The results are displayed using heatmaps, probability scores, and graphical insights to aid decision-making.

The confidence score (%) indicates the probability of the diagnosis being accurate.

Highlighted areas of concern help users understand the affected regions.

A comparison with reference images is provided for better clarity.

6. **Recommendation**

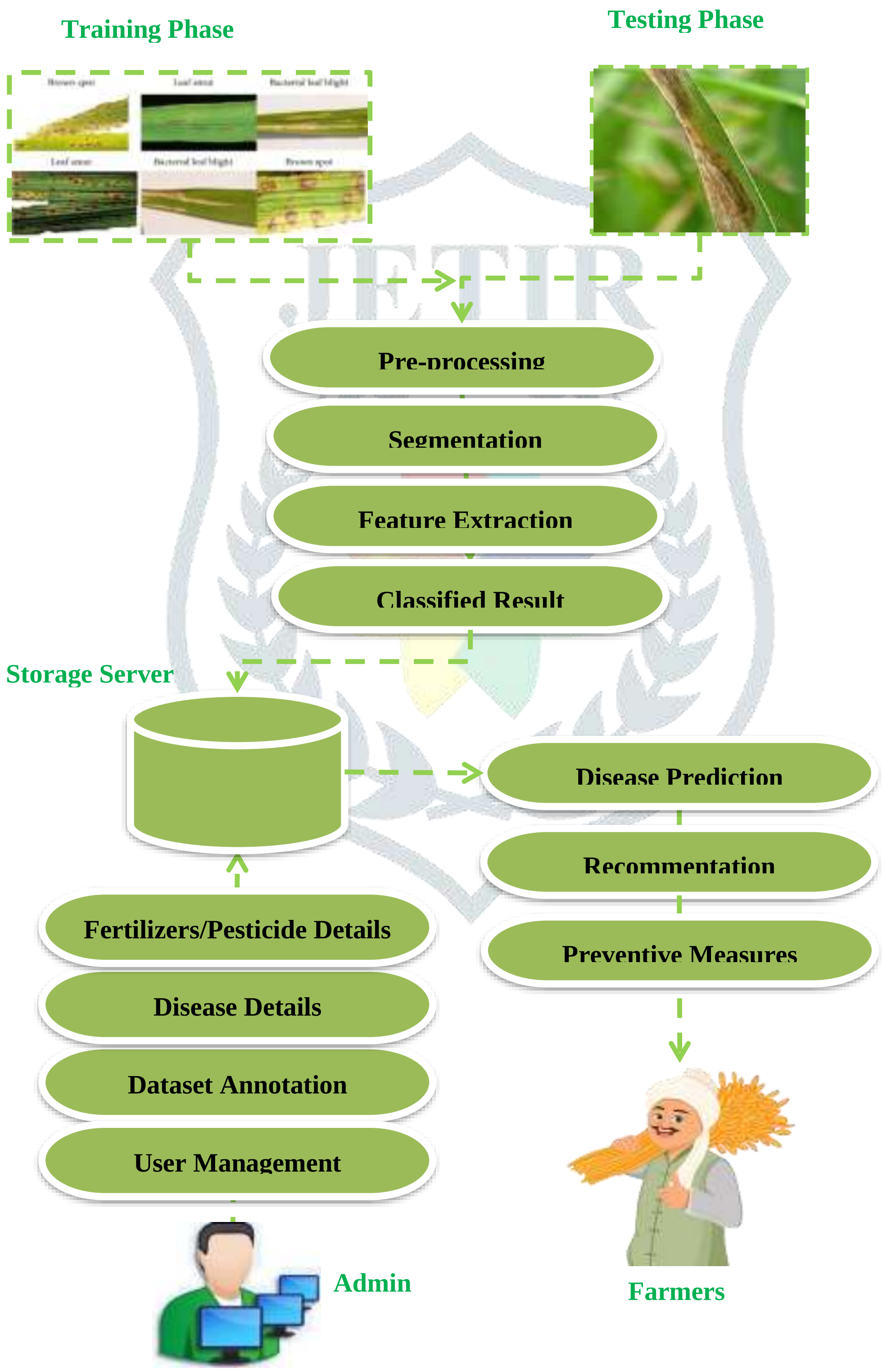
The recommendation module provides personalized suggestions for managing detected plant diseases. Based on the identified disease, the system recommends suitable fertilizers, pesticides, and preventive measures. This ensures optimized crop health management while reducing excessive chemical usage.

Fertilizer Suggestions – Provides optimal fertilizers based on plant type and disease condition.

Treatment Guidance – Suggests pesticide use, organic remedies, and preventive measures.

Best Agricultural Practices – Offers advice on improving crop health and reducing disease impact.

III.SYSTEM ARCHITECTURE



IV.RESULT AND DISCUSSION:

Result: The proposed Plant Leaf Disease Detection System using a Vision Transformer (ViT)-based Multi-Class Classifier achieves higher accuracy and better generalization compared to traditional methods. By analyzing plant leaf images through self-attention mechanisms, the model improves disease identification across multiple classes. This system enables early detection, helping farmers take timely actions to minimize crop losses and promote sustainable agriculture.

Discussion: The integration of Vision Transformers (ViT) in the Plant Leaf Disease Detection System significantly enhances classification accuracy by capturing both local and global features through self-attention mechanisms. This method overcomes the limitations of traditional and existing automated systems, offering better performance even with limited labeled data. By enabling early disease detection, the proposed system empowers farmers to take timely actions, reducing crop losses and supporting sustainable agricultural practices.

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V. CONCLUSION

In conclusion, the project represents a significant advancement in agricultural technology, leveraging the power of Vision Transformer (ViT) and Convolutional Neural Networks (CNN) to achieve accurate plant species identification and disease classification.

By automating the detection process, the system minimizes the reliance on manual inspection, providing farmers with an efficient and reliable solution for early disease diagnosis. Its real-time recommendation system offers actionable insights, including optimal fertilizer suggestions and treatment methods, ensuring effective disease management and healthier crop yields. The intuitive web interface allows users to seamlessly upload plant leaf images, receive instant analysis, and access tailored recommendations, making the system highly accessible and user-friendly. Furthermore, the integration of advanced feature extraction techniques, including self-attention mechanisms, enhances the model's ability to distinguish between different plant diseases with precision. As a step toward sustainable agriculture, this AI-driven solution not only reduces crop losses but also optimizes resource utilization, promoting eco-friendly farming practices. With future enhancements such as real-time field monitoring, IoT integration, and an expanded dataset covering a wider variety of plant species and diseases, the system has the potential to revolutionize modern farming. Ultimately, the Plant Disease Detector Web App stands as a testament to how artificial intelligence can drive agricultural innovation, equipping farmers with the tools necessary to ensure food security, improve productivity, and mitigate the risks posed by plant diseases

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