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LeafDoc: A Generative AI–Based Plant Identification and Disease Diagnosis System

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Abstract: *Accurate plant identification and early disease diagnosis are essential for effective plant health management. Many existing disease detection systems assume prior knowledge of plant species, limiting their usability for non-expert users. This paper proposes LeafDoc, a Generative AI–based system that identifies a plant from an uploaded image and subsequently analyzes it for possible diseases. The system utilizes a vision-language generative AI model to generate plant identification results, disease information, and treatment recommendations. A web-based interface and integrated chatbot enhance user interaction and accessibility. Functional evaluation demonstrates that the proposed system effectively supports intelligent plant health monitoring, providing a practical and user-friendly solution for agriculture and home gardening applications.*

Keywords*:* Plant Identification, Plant Disease Detection, Generative AI, Vision-Language Models, Smart Agriculture

I. INTRODUCTION

Plant health monitoring is essential in agriculture and home gardening, as plant diseases can significantly reduce crop yield and quality. Early identification of plant species and timely disease diagnosis are crucial for effective plant management. However, many non-expert users lack the knowledge required to accurately identify plants, particularly during early growth stages or when only leaf images are available. Incorrect identification may result in improper treatment and economic loss. Traditional disease detection methods rely on manual inspection and expert consultation, which are time-consuming and often inaccessible in remote areas. Although recent artificial intelligence and computer vision techniques enable image-based disease detection, most existing systems assume prior knowledge of the plant species, limiting their usability. To address these challenges, this paper proposes LeafDoc, a Generative AI–based plant identification and disease diagnosis system. The system first identifies the plant species from an uploaded image and then analyzes possible diseases, generating treatment and care recommendations. Implemented as a web-based prototype using secure API-based integration of a generative vision-language model, LeafDoc provides an integrated and user-friendly solution for intelligent plant health monitoring.

II. LITERATURE REVIEW

A. Image-Based Plant Identification

Image-based plant identification has been widely studied using visual features such as leaf shape, color, and texture. Machine learning and deep learning models have demonstrated promising accuracy in recognizing plant species from leaf images. However, these approaches often require large labelled datasets or handcrafted features. Moreover, most plant identification systems operate independently and do not integrate disease diagnosis or plant health assessment.

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B. Plant Disease Detection Using Image Analysis
Deep learning techniques have significantly improved plant disease detection from leaf images. Studies by Mohanty et al. and Ferentinos demonstrated the effectiveness of convolutional neural networks for disease classification. Despite high accuracy, these systems generally assume prior knowledge of plant species and focus primarily on classification performance. They rarely provide treatment recommendations or user guidance, limiting their practical usability.

C. Intelligent Advisory Systems in Agriculture
Several decision-support systems have been proposed to assist farmers in crop management and disease control. These systems often rely on rule-based logic or sensor data to generate recommendations. However, they typically lack image-based analysis and require users to manually identify plant conditions, reducing their effectiveness for non-expert users.

D. Generative AI and Vision-Language Models
Recent advancements in generative AI, particularly vision-language models, enable intelligent interpretation of images without task-specific training. These models can generate structured textual outputs from visual inputs, making them suitable for integrated applications that combine identification, diagnosis, and advisory support.

E. Research Gap
Existing research largely treats plant identification and disease detection as separate tasks, with limited integration of advisory support. The proposed LeafDoc system addresses this gap by combining plant identification, disease analysis, and AI-based recommendations into a unified, user-friendly framework.

III. METHODOLOGY
The proposed LeafDoc system is a Generative AI–based plant identification and disease diagnosis framework designed to provide integrated plant health monitoring through image analysis. The system is implemented as a web-based application using secure API integration of a vision-language generative AI model.

A. System Overview
The system operates in a sequential manner. A user uploads a plant or leaf image through the web interface. The image is analyzed by a generative AI model, which first identifies the plant species and subsequently evaluates the image for potential diseases. Based on the analysis, the system generates treatment recommendations and plant care guidance. An AI-powered chatbot enhances user interaction and provides contextual assistance.

B. System Architecture
The architecture comprises the following modules:
- User Interface Module
- AI Image Analysis Module
- Plant Identification Module
- Disease Diagnosis Module
- Recommendation Module
- Chatbot Module

These components work collaboratively to ensure accurate identification, diagnosis, and advisory support.

C. Operational Workflow
The methodology follows five structured stages:
- Image acquisition through web interface

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- AI-based plant identification
- Disease detection based on visual symptoms
- Generation of treatment and care recommendations
- Interactive chatbot support

This integrated approach eliminates the need for manual feature extraction or plant-specific model training and provides a unified solution for intelligent plant health monitoring.

IV. IMPLEMENTATION AND RESULTS

A. System Implementation

The proposed LeafDoc system is implemented as a web-based prototype following a client–server architecture. The frontend is responsible for user interaction, while the backend manages image processing and AI-based analysis through secure API integration.

The user interface allows users to upload plant or leaf images and view structured analysis results. Upon image submission, the backend securely communicates with a generative vision-language AI model to perform plant identification and disease diagnosis. Separate processing workflows are maintained for identification, diagnosis, and chatbot interaction to ensure modularity and scalability.

Sensitive configuration parameters, including API credentials, are managed using environment variables to maintain system security. The prototype implementation demonstrates the feasibility of integrating generative AI into a practical plant health monitoring application.

B. Functional Results

The system was evaluated using multiple plant and leaf images to verify functional performance.

1. Plant Identification

When a plant image was uploaded, the system successfully identified the plant species and generated structured output including the species name and confidence level.

As shown in Fig. 1, the system correctly identified a sunflower image as *Helianthus annuus* with a confidence score of 95%. This demonstrates the capability of the AI model to interpret visual features and provide reliable plant identification results.

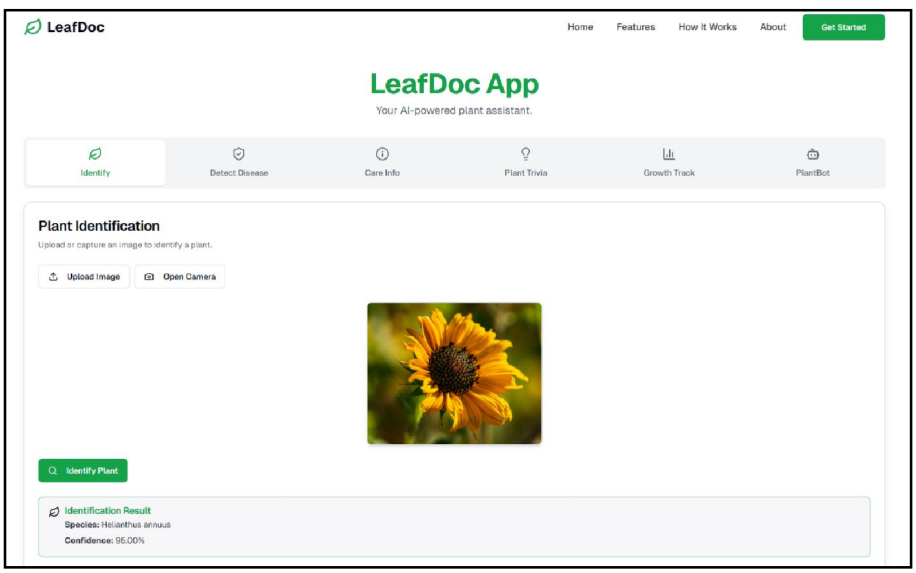

Fig. 1. Plant Identification Result

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2. Disease Detection and Recommendation

Following plant identification, the system performed disease analysis on symptomatic leaf images.

As illustrated in Fig. 2, the system detected Rose Rust disease with a confidence score of 85% based on visible symptoms such as yellowing and brown spots. In addition to identifying the disease, the system generated practical treatment suggestions, including removal of infected leaves and use of appropriate fungicides.

This integrated output highlights the system's ability to combine identification, diagnosis, and advisory support within a single workflow.

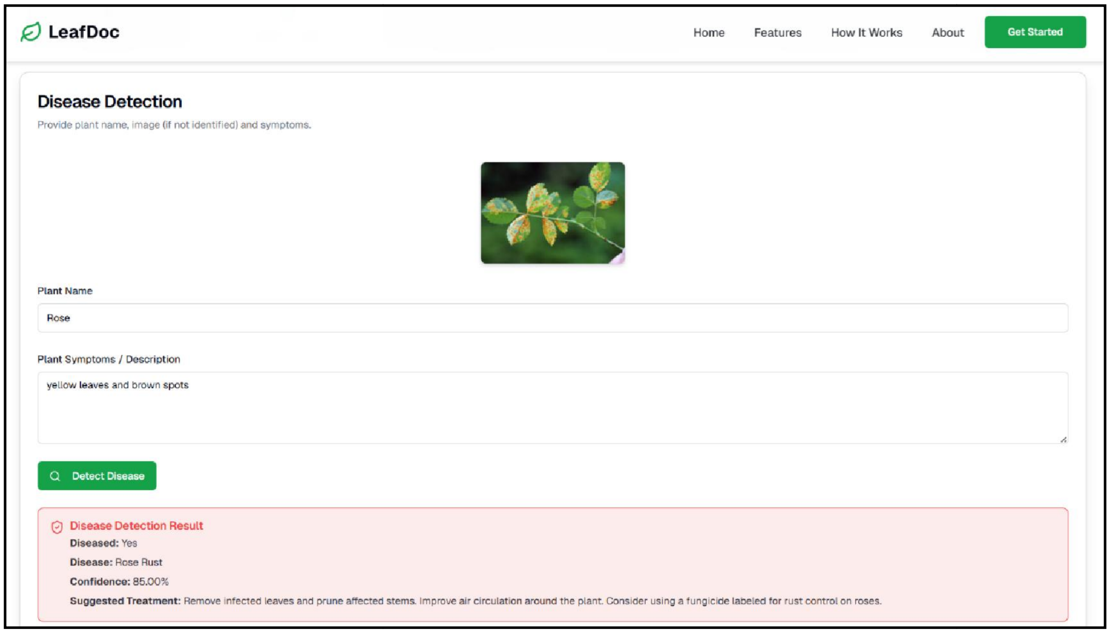

Fig. 2. Disease Detection and Recommendation Output

C. Result Analysis

The experimental results indicate that the proposed system successfully performs sequential plant identification and disease diagnosis using a single generative AI framework. The evaluation focuses on functional correctness and usability rather than traditional dataset-based accuracy metrics, as the system relies on API-based generative inference.

The results demonstrate:

- Accurate plant species identification
- Effective detection of visible plant diseases
- Generation of meaningful treatment recommendations
- Seamless integration between analysis and user interface

The system proved particularly useful for non-expert users by eliminating the requirement for prior plant knowledge before disease diagnosis.

D. Discussion

The implementation confirms that integrating plant identification and disease detection within a unified generative AI framework enhances system usability and practicality. The API-based approach allows the system to analyze a wide variety of plants without requiring model retraining or large labeled datasets.

However, system performance may depend on factors such as image clarity, lighting conditions, and symptom visibility. Despite these limitations, the results demonstrate strong potential for real-world application in agriculture and home gardening.

The modular architecture also enables future enhancements, including multilingual support, environmental data integration, and large-scale deployment.

V. CONCLUSION

This paper presented LeafDoc, a Generative AI–based plant identification and disease diagnosis system for intelligent plant health monitoring. The system first identifies plant species from uploaded images and then performs disease analysis, providing treatment and care recommendations through an integrated web-based platform.

Functional evaluation demonstrated that the system successfully performs plant identification and disease detection while offering user-friendly advisory support through an AI-powered chatbot. The proposed approach eliminates the need for prior plant knowledge and complex model training, making it suitable for non-expert users.

Future enhancements may include mobile application integration, multilingual support, and environmental data incorporation to further improve system scalability and practical usability.

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