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 in agriculture and home gardening. Many existing plant disease detection systems require prior knowledge of the plant species, which limits their usability for non-expert users. To address this limitation, this paper proposes LeafDoc, a Generative AI–based plant identification and disease diagnosis system that automatically identifies a plant from an uploaded image and subsequently analyzes the plant for possible diseases. The system employs a vision-language generative AI model to interpret leaf images and generate structured outputs, including plant identification, disease status, and recommended treatment and care guidelines. A web-based interface enables users to upload images easily, while an integrated AI chatbot provides interactive assistance for plant-related queries. The proposed system is implemented as a prototype using secure API-based AI integration. Experimental evaluation through multiple test cases demonstrates that LeafDoc effectively identifies plant species and provides meaningful disease-related insights, making it a practical and user-friendly solution for intelligent plant health monitoring.

Keywords — *Plant Identification, Plant Disease Detection, Generative AI, Computer Vision, Smart Agriculture, AI Advisory System*

I. Introduction

Plant health monitoring is an essential aspect of agriculture, horticulture, and home gardening, as plant diseases and improper care practices can significantly reduce crop yield, plant quality, and overall productivity. According to agricultural studies, a large percentage of crop losses worldwide are caused by plant diseases that could be controlled or prevented if detected at an early stage. Therefore, timely identification of plant species and early diagnosis of diseases are essential for effective plant health management and sustainable agricultural practices.

In real-world scenarios, plant disease diagnosis often begins with correct identification of the plant species. However, many farmers, gardeners, and plant enthusiasts lack the expertise to accurately identify plants, especially during early growth stages or when only leaves are available. This lack of knowledge creates a major challenge, as disease symptoms and treatment methods vary significantly across different plant species. As a result, incorrect identification may lead to improper treatment, increased plant damage, and economic loss.

Traditional plant disease detection methods rely heavily on manual observation and expert consultation. These approaches are time-consuming, subjective, and may not be accessible to users in rural or remote areas. Moreover, agricultural experts are not always readily available, and manual inspection becomes impractical when dealing with large numbers of plants. To overcome these limitations, automated plant analysis systems have gained attention in recent years.

With the rapid advancement of artificial intelligence (AI) and computer vision technologies, image-based plant analysis has emerged as a promising solution. Many existing research works focus on detecting plant diseases from leaf images using machine learning or deep learning techniques. Although these approaches have shown good performance, most of them assume that the plant species is already known prior to disease detection. This assumption significantly limits the usability of such systems for non-expert users, who may not be able to identify the plant accurately.

Recent developments in generative artificial intelligence, particularly vision-language models, have enabled intelligent interpretation of images without requiring task-specific model training or large labelled datasets. These models can analyze visual inputs and generate meaningful textual outputs, including object identification, condition assessment, and descriptive recommendations. Such capabilities make generative AI suitable for building practical, user-friendly systems that combine plant identification, disease diagnosis, and advisory support within a single platform.

In this paper, we propose LeafDoc, a Generative AI–based plant identification and disease diagnosis system designed to address the limitations of existing approaches. The primary objective of LeafDoc is to identify the plant species from an uploaded image. Once the plant is identified, the system analyzes the same image to determine whether the plant is affected by any disease. Based on the analysis, the system provides disease-related information along with appropriate treatment and plant care recommendations. To further enhance user interaction and usability, an AI-powered chatbot is integrated to answer plant-related queries and provide guidance in a conversational manner.

The proposed system is implemented as a web-based prototype using secure API-based integration of a generative vision-language AI model. By combining plant identification, disease diagnosis, and intelligent advisory support in a single application, LeafDoc aims to provide an accessible, practical, and intelligent solution for plant health monitoring. The system is particularly useful for farmers, gardeners, students, and plant enthusiasts who require quick and reliable plant-related information without relying on expert assistance. This work contributes toward the growing application of generative AI in smart agriculture and decision-support systems.

II. Literature Review

A. Image-Based Plant Identification

Image-based plant identification has been widely explored as an effective approach for recognizing plant species using visual characteristics such as leaf shape, color, texture, and vein patterns. Several studies have proposed machine learning and deep learning models for plant recognition from leaf images. While these approaches demonstrate promising accuracy, they often depend on handcrafted features or require extensive labelled datasets for training. In addition, most plant identification systems operate as standalone solutions and do not extend their functionality to disease detection or plant health assessment, limiting their usefulness for practical agricultural applications.

B. Plant Disease Detection Using Image Analysis

Plant disease detection using leaf images has gained significant attention with the advancement of deep learning techniques. Mohanty *et al.* introduced a convolutional neural network–based approach for classifying plant diseases from leaf images, achieving high accuracy on standard datasets. Similarly, Ferentinos conducted a comparative study of various deep learning architectures for plant disease detection, demonstrating the effectiveness of deep learning models in agricultural diagnosis. Despite their success, these approaches typically assume that the plant species is already known prior to disease classification. Furthermore, they primarily focus on disease detection accuracy and do not provide treatment recommendations or plant care guidance, reducing their practical applicability for non-expert users.

C. Intelligent Advisory and Decision-Support Systems in Agriculture

To enhance agricultural productivity, several studies have proposed intelligent advisory and decision-support systems that assist users in crop management and disease control. These systems often rely on rule-based logic, sensor data, or expert knowledge to generate recommendations. Although such systems provide useful guidance, they generally lack image-based analysis and require users to manually identify plant species or disease conditions. As a result, their effectiveness is limited when users are unable to accurately recognize plant-related issues on their own.

D. Generative AI and Vision-Language Models for Image Interpretation

Recent advancements in generative artificial intelligence, particularly vision-language models, have enabled intelligent interpretation of visual inputs without task-specific model training. These models can analyze images and generate meaningful textual descriptions, classifications, and recommendations. Vision-language models have been successfully applied in various domains for object recognition and decision support. However, their application in integrated systems that perform plant identification, disease diagnosis, and advisory support remains limited, presenting an opportunity for further research.

E. Research Gap

From the reviewed literature, it is evident that existing approaches primarily address plant identification and plant disease detection as separate tasks. Moreover, limited attention has been given to combining image-based analysis with treatment recommendations and interactive user assistance. To bridge these gaps, the proposed LeafDoc system integrates plant identification, disease diagnosis, and AI-based advisory support using generative AI. This unified approach enhances usability and provides a practical solution for plant health monitoring, particularly for non-expert users.

III. Proposed System

The proposed system, LeafDoc, is a Generative AI–based plant identification and disease diagnosis system designed to assist users in identifying plant species, detecting possible diseases, and obtaining appropriate treatment and care recommendations. The system is developed as a web-based application to ensure accessibility and ease of use for farmers, gardeners, students, and plant enthusiasts.

A. System Overview

LeafDoc follows a sequential and user-centric workflow. The primary objective of the system is to identify the plant species from an uploaded image. Once the plant is identified, the system analyzes the same image to determine whether the plant is affected by any disease. Based on the analysis, relevant treatment suggestions and plant care guidelines are provided. Additionally, an AI-powered chatbot is integrated to offer interactive assistance and resolve plant-related queries.

The system leverages a generative vision-language AI model through secure API-based integration, enabling intelligent image interpretation without requiring manual feature extraction or model training.

B. System Architecture

The architecture of LeafDoc consists of the following major components:

1. **User Interface Module**
   A web-based interface that allows users to upload plant or leaf images and interact with the system. The interface is designed to be simple and intuitive for non-technical users.
2. **Image Processing and AI Analysis Module**
   This module sends the uploaded image to the generative AI model for analysis. The model interprets the image and generates structured responses for plant identification and disease detection.
3. **Plant Identification Module**
   This module identifies the plant species from the uploaded image. Accurate plant identification serves as the foundation for subsequent disease analysis and recommendation generation.
4. **Disease Diagnosis Module**
   After identifying the plant, this module analyzes the image to determine the presence of any disease. It provides information such as disease name and severity indicators when applicable.
5. **Recommendation Module**
   Based on the identified disease, the system generates treatment suggestions and plant care recommendations to assist users in managing plant health.
6. **Chatbot Module**
   An AI-powered conversational interface that allows users to ask plant-related questions and receive contextual guidance and explanations.

C. Workflow of the Proposed System

The operational workflow of LeafDoc is summarized as follows:

1. The user uploads an image of a plant or leaf through the web interface.
2. The system forwards the image to the generative AI model for analysis.
3. The plant species is identified from the image.
4. Disease detection is performed based on the identified plant and visual symptoms.
5. Treatment recommendations and plant care guidelines are generated.
6. The chatbot provides additional assistance based on user queries.

This sequential workflow ensures accurate analysis and improves the reliability of the recommendations.

D. Key Features of the Proposed System

The proposed system offers several notable features:

- Automated plant identification from images
- Disease detection without prior plant knowledge
- AI-generated treatment and care recommendations
- Interactive chatbot for user assistance
- Web-based accessibility and ease of use

These features collectively enhance the usability and practicality of the system.

E. Advantages of the Proposed System

Compared to existing approaches, LeafDoc offers the following advantages:

- Eliminates the need for prior plant identification by users
- Does not require model training or large labelled datasets
- Provides integrated advisory support along with diagnosis
- Suitable for non-expert users
- Easily extendable and scalable using API-based AI integration

IV. Methodology

Methodology Overview

The methodology of the proposed system is designed to perform plant analysis in a structured and sequential manner. Unlike traditional machine learning approaches that require model training and dataset preparation, LeafDoc utilizes a generative vision-language AI model through secure API-based integration. The system interprets visual input images and generates structured outputs for plant identification and disease diagnosis. The methodology consists of the following major stages:

1. Image acquisition
2. Plant identification
3. Disease diagnosis
4. Recommendation generation
5. User interaction through chatbot

A. Image Acquisition

The first step in the methodology is image acquisition. The user uploads an image of a plant or leaf using the web-based interface. The system accepts standard image formats and performs basic validation to ensure the image quality is sufficient for analysis. The uploaded image is then converted into a suitable format for transmission to the AI processing module.

B. Plant Identification Process

Plant identification is the primary objective of the LeafDoc system. The uploaded image is sent to a generative vision-language AI model, which analyzes visual characteristics such as leaf shape, color patterns, and texture. Based on this analysis, the model identifies the plant species and generates descriptive information related to the plant.

This approach eliminates the need for handcrafted feature extraction or plant-specific classification models and allows the system to identify a wide variety of plants using a single AI model.

C. Disease Diagnosis Process

After plant identification, the same image is analyzed to detect potential diseases affecting the plant. The generative AI model examines visual symptoms such as discoloration, spots, or deformities on the leaf surface. If a disease is detected, the system provides the disease name and relevant diagnostic information.

The disease diagnosis process is dependent on the prior identification of the plant, which improves contextual understanding and ensures that disease analysis is relevant to the identified species.

D. Treatment and Plant Care Recommendation

Once a disease is identified, the system generates appropriate treatment suggestions and plant care recommendations. These recommendations include preventive measures, basic treatment guidelines, and general plant maintenance tips. The advisory information is generated in a user-friendly textual format to ensure clarity and ease of understanding for non-expert users.

E. Chatbot-Based User Interaction

To enhance user experience and provide interactive assistance, an AI-powered chatbot is integrated into the system. The chatbot allows users to ask questions related to plant care, disease prevention, and general plant health. The chatbot responses are generated using the same generative AI framework, ensuring contextual consistency with the plant identification and disease diagnosis results.

V. Implementation & Results

A. System Implementation

The LeafDoc system is implemented as a web-based application to ensure ease of access and usability. The system follows a client–server architecture where the frontend handles user interaction and the backend manages AI-based analysis and data processing.

The frontend provides an intuitive interface that allows users to upload plant or leaf images and view analysis results. The backend handles requests by securely communicating with a generative vision-language AI model through API-based integration. Separate server-side workflows are used for plant identification, disease diagnosis, and chatbot interaction, ensuring modularity and scalability of the system.

Sensitive configuration details, such as API keys, are managed using environment variables to maintain security. The system is designed as a working prototype, making it flexible for future enhancements and deployment.

B. Technologies Used

The following technologies are used in the implementation of the proposed system:

- **Frontend:** Web-based interface developed using modern JavaScript frameworks for responsive design
- **Backend:** Server-side logic for handling image analysis and AI requests
- **Artificial Intelligence:** Generative vision-language AI model accessed via secure APIs
- **Development Tools:** Visual Studio Code and supporting libraries for development and testing

These technologies enable efficient integration of AI capabilities with a user-friendly web interface.

C. Functional Results

The system was tested using multiple plant and leaf images to evaluate its functionality. For each uploaded image, the system successfully performed plant identification followed by disease diagnosis. Based on the analysis, treatment suggestions and plant care recommendations were generated.

The chatbot module effectively responded to user queries related to plant health, disease prevention, and general care practices. The interaction between plant identification, disease diagnosis, and advisory support provided a seamless user experience.

D. Result Analysis

The results demonstrate that the proposed system is capable of performing plant identification and disease diagnosis in a practical and user-friendly manner. Since the system is based on generative AI and API-based inference, the evaluation focuses on functional correctness and usability rather than traditional accuracy metrics.

The system proved effective in assisting non-expert users by providing meaningful insights and recommendations without requiring prior knowledge of plant species or diseases. This highlights the practicality of the proposed approach for real-world plant health monitoring applications.

E. Discussion

The implementation results indicate that integrating plant identification and disease diagnosis within a single system enhances usability and effectiveness. The use of generative AI allows the system to adapt to different plant types without requiring model retraining. However, the quality of results may depend on image clarity and lighting conditions.

Despite these limitations, the system demonstrates strong potential as an intelligent decision-support tool for plant health management. The modular design of LeafDoc also allows easy integration of additional features and AI models in future work.

VI. Future Scope

A. Mobile Application Integration

One of the major future enhancements of the LeafDoc system is the development of a dedicated mobile application. A mobile platform would allow users to capture plant images directly using smartphone cameras, enabling real-time analysis in agricultural fields and home gardens. This enhancement would significantly improve accessibility and practical usability.

B. Real-Time Image Capture and Analysis

The system can be extended to support real-time image capture and instant analysis. This feature would allow users to continuously monitor plant health and receive immediate feedback, making the system more effective for early disease detection.

C. Multi-Language Support

To increase adoption across different regions, future versions of LeafDoc can incorporate multi-language support. Providing plant identification results, recommendations, and chatbot responses in regional languages would make the system more inclusive and user-friendly, especially for farmers in rural areas.

D. Integration of Environmental and Sensor Data

Future improvements may include integrating environmental data such as temperature, humidity, and soil moisture. Combining image-based analysis with environmental parameters can lead to more accurate and context-aware disease diagnosis and plant care recommendations.

E. Hybrid AI and Dataset Enhancement

The performance of the system can be enhanced by integrating domain-specific plant disease datasets or hybrid AI approaches. Combining generative AI with traditional machine learning or deep learning models could improve disease identification precision for specific crops.

F. Advanced Agricultural Advisory Features

LeafDoc can be extended to include advanced advisory features such as fertilizer recommendations, growth stage monitoring, pest control guidance, and seasonal crop management. These enhancements would help transform the system into a comprehensive intelligent decision-support platform for smart agriculture.

VII. Conclusion

This paper presented LeafDoc, a Generative AI–based plant identification and disease diagnosis system designed to assist users in analyzing plant health through image-based input. Unlike traditional approaches that focus only on disease detection and require prior knowledge of plant species, the proposed system first identifies the plant and then performs disease diagnosis, making it more practical and user-friendly for non-expert users.

The system integrates plant identification, disease analysis, treatment recommendations, and an AI-powered chatbot into a single web-based platform. By leveraging generative vision-language AI through secure API-based integration, LeafDoc eliminates the need for complex model training and large labelled datasets while still providing meaningful and actionable plant health insights.

Experimental evaluation through functional testing demonstrated that the system effectively identifies plants, detects possible diseases, and provides relevant care and treatment guidance. The interactive chatbot further enhances usability by offering contextual assistance and answering plant-related queries.

Overall, LeafDoc highlights the potential of generative AI in smart agriculture and plant health monitoring applications. The proposed approach provides an accessible, intelligent, and scalable solution that can support farmers, gardeners, students, and plant enthusiasts in managing plant health more effectively.

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