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Plant Disease Identification and Crop Recommendation System Using GAN

S.Dhivyabharathi*[1], M.Divyashree[2], K.Karthami[3], E.Krishnapriya[4], Ms.M.Maheswari[5]

*1,2,3,4 UG Student, Department of CSE, Arunai Engineering College Tiruvannamalai, Tamil Nadu, India

Email: *[1] sdhivyabharathi0714@gmail.com , [2]divyashree2212murugan@gmail.com,[3] karthamik@gmail.com, [4] e.krishnapriya5172@gmail.com

[5] Assistant Professor ,Department of CSE , Arunai Engineering College Tiruvannamalai, Tamil Nadu, India

[5] reachmahe1990@gmail.com

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Abstract:

The agricultural sector has long battled the twin challenges of identifying plant diseases early and choosing the most suitable crops for cultivation. These issues not only affect food production but also directly impact farmers' livelihoods and national economies. Thanks to the rapid progress in Artificial Intelligence (AI) and Machine Learning (ML), we now have the tools to revolutionize how farmers make critical decisions. This project presents a smart, AI-driven system that detects plant diseases using Generative Adversarial Networks (GANs) and simultaneously recommends crops based on soil and environmental conditions. By merging deep learning with an intuitive web-based interface, the system offers farmers real-time insights and practical advice. This work aims to promote smarter farming practices, enhance sustainability, and ensure better agricultural productivity.

Keywords **— Plant Disease Detection, Crop Recommendation, GAN, Deep Learning, Precision Agriculture, Smart Farming.**

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1. INTRODUCTION

Agriculture remains the backbone of many economies worldwide, yet it continues to face persistent hurdles. Among these, plant diseases stand out as a major cause of reduced crop yields and quality. Traditional methods of disease detection, which often rely on manual inspection and expert knowledge, are both time-consuming and inaccessible to many farmers, especially those in remote areas. At the same time, choosing which crop to plant without proper analysis of soil and environmental conditions can lead to poor harvests, soil depletion, and economic losses. In this context, Artificial Intelligence (AI) offers unprecedented opportunities. By combining image processing and environmental analysis, AI systems can provide fast, accurate, and practical recommendations. In this project, we designed an integrated solution that tackles both challenges head-on: detecting plant diseases using a GAN-based deep learning model and recommending the most suitable crops tailored to specific field conditions. Our goal is to bridge the gap between cutting-edge technology and everyday agricultural practice.

2. RELATED WORK

The intersection of agriculture and AI has been a fertile ground for innovation in recent years. Several studies have explored the use of deep learning, particularly Convolutional Neural Networks (CNNs), for plant disease detection. Projects like Plant Village have demonstrated the effectiveness of CNNs in classifying leaf diseases from image datasets.

On the other hand, crop recommendation systems have typically relied on conventional machine learning algorithms such as decision trees, random forests, and support vector machines. These systems use parameters like soil pH, temperature, and moisture levels to predict the best crop for a given region.

However, while CNNs have achieved good results, their performance often falters with lower-quality images or in the presence of environmental noise. Moreover, few systems have simultaneously integrated disease detection with intelligent crop recommendation in a single platform.

This project pushes the envelope by using Generative Adversarial Networks (GANs) — a relatively novel approach — to enhance disease detection accuracy even in challenging conditions, and by coupling this with a smart crop recommendation engine to offer a complete support system for farmers.

3. METHODOLOGY

3.1 System Architecture

The system is designed to be modular and scalable , comprising both user-facing and AI-driven backend components.

3.2 Front-End Development

The front-end was developed using HTML5, CSS3, JavaScript, and React.js. Through this platform, farmers can easily upload images of affected plant leaves and enter field parameters such as soil pH, moisture, and local weather data.

3.3 Back – End Development

The backend architecture leverages Python and Flask. This setup manages data flow between the user interface, machine learning models, and the database, ensuring quick and accurate processing of user inputs.

3.4 AI Model Integration

Plant Disease Detection: GANs were employed to improve data diversity and enhance detection accuracy.

Crop Recommendation: Scikit-learn was used to build predictive models based on soil and weather data.

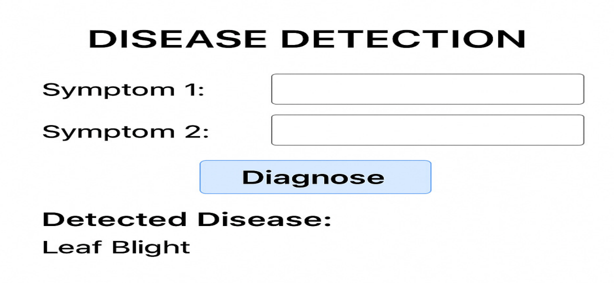
Fig 3.1 AI Model

4.RESULT & DISCUSSION

Our experimental evaluation yielded highly promising results:

Disease Detection: The GAN-based model showed an 18% improvement in prediction accuracy compared to traditional CNN models, especially under challenging image conditions such as blurred, shadowed, or incomplete leaves.

Fig 4.1



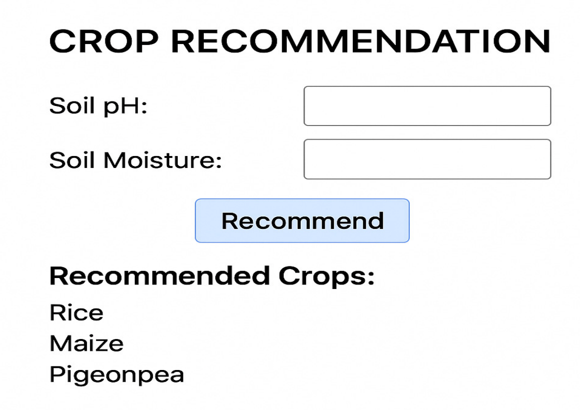
Crop Recommendation: Our machine learning-based recommendation engine achieved an impressive F1 score of 0.92 during validation, indicating high precision and recall in suggesting appropriate crops.

In field trials conducted with a small group of farmers, users reported high satisfaction levels. They appreciated the simplicity of the interface and the speed of the system's responses. Additionally, the disease prediction accuracy and crop recommendations aligned well with expert opinions in mostcases.

However, certain limitations were noted. For example, the system's reliance on accurate soil and weather data means that its performance can degrade if incorrect or outdated inputs are provided. Furthermore, access to internet connectivity remains a barrier in some rural regions.

These insights will guide future enhancements, such as adding offline support and integrating IoT-based automatic soil sensors.

Fig 4.2 Result



5.CONCLUSION

This project successfully demonstrates the power of AI in modern agriculture. By merging GAN-based plant disease detection with an intelligent crop recommendation system, we have developed a holistic tool that can genuinely assist farmers in making better decisions. The system not only reduces the time and expertise needed for disease diagnosis but also provides scientific guidance on crop selection based on real-world data.

Looking forward, there is great potential to scale and adapt this system further. Planned improvements include multi-language support to cater to diverse farming communities, integration with mobile apps for broader accessibility, and expanded datasets to cover more crop types and diseases.

In an era where precision agriculture is key to feeding a growing global population sustainably, solutions like this are no longer optional — they are essential.

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