AI-DRIVEN CROP DISEASE PREDICTION AND MANAGEMENT SYSTEM

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ABSTRACT-Agriculture significantly contributes to food production and the economy, but crop diseases can lead to severe yield and quality losses if not detected early. Traditional manual inspection methods are time-consuming, costly, and prone to inaccuracies. This paper presents an AI-Driven Crop Disease Prediction and Management System leveraging Deep Learning and Convolutional Neural Networks (CNN) to automate disease detection from crop leaf images. The system is trained on the Kaggle Crop Disease Dataset and deployed via a user-friendly web application developed using Python, Flask, HTML, and CSS. Users upload leaf images, which the system analyzes to accurately predict diseases. It also provides detailed information on disease symptoms, treatment options, and preventive measures, empowering farmers to manage crop health efficiently. This solution offers a cost-effective, scalable tool for early disease detection, enhancing agricultural productivity and supporting smart farming practices through AI-driven insights.

Keywords: Artificial Intelligence, Deep Learning, Convolutional Neural Network (CNN), Crop Disease Prediction, Flask, TensorFlow.

INTRODUCTION

An AI-driven crop disease prediction and management system combines advanced technologies to help farmers detect, predict, and manage plant diseases effectively. The core components include data collection, disease detection, prediction models, and management recommendations. Data collection involves gathering images of crops, environmental factors like temperature and humidity, and soil conditions. This data is usually acquired through drones, sensors, and mobile apps. Disease detection uses computer vision and image processing techniques powered by AI models such as convolutional neural networks (CNNs) to identify symptoms on leaves or stems. These models are trained on large datasets of diseased and healthy plants to ensure accuracy. Prediction models leverage machine learning algorithms to analyze environmental data and historical disease occurrences to forecast potential outbreaks. This early warning system helps farmers take preventive measures Management recommendations are generated based on the predicted disease type and severity. The system suggests appropriate treatments, such as pesticide application or cultural practices, optimizing resource use and reducing crop loss. Overall, the system integrates AI technologies, IoT devices, and expert knowledge to support sustainable agriculture by providing timely, accurate, and actionable insights for disease control and crop health management.

LITERATURE SURVEY

Research on AI-driven crop disease prediction and management highlights significant advances. One study used convolutional neural networks (CNNs) to classify plant diseases from leaf images with high accuracy, demonstrating AI's effectiveness in early detection. Another developed a deep learning model to identify multiple crop diseases, showing AI's scalability across crops. Combining image processing and machine learning, researchers improved disease severity estimation in wheat and barley, enabling timely management. Reviews emphasize the benefit of integrating multispectral imaging with AI for better disease detection in real field conditions. Additionally, integrating IoT sensors with AI algorithms has been proposed for real-time disease forecasting and precision agriculture. Some studies also explore the use of drone-based imaging combined with AI for large-scale monitoring, enhancing disease surveillance efficiency. Others focus on the development of decision support systems that provide actionable management advice tailored to specific crops and local conditions. These contributions demonstrate that AI-driven systems not only improve detection accuracy but also facilitate sustainable farming by optimizing resource use, reducing pesticide application, and minimizing crop losses. Collectively, these studies show AI systems delivering accurate, scalable, and timely solutions for effective disease management.

RELATED WORK

Researchers have developed smart home systems to improve comfort, energy efficiency, security, and automation. Early systems focused on basic automation, where household appliances were controlled manually or through simple rule-based rules. These systems used wired communication and fixed schedules, offering limited flexibility and intelligence. Similarly, AI-driven crop disease prediction and management are revolutionizing agriculture. Traditional methods rely on manual monitoring, which can be slow and less accurate. AI systems use data from sensors, weather, and satellite images to predict disease outbreaks early. This enables timely and precise interventions, reducing crop damage and minimizing chemical use. Both smart homes and AI in agriculture demonstrate the shift from simple automation to intelligent, adaptive systems. AI helps optimize resources and improve outcomes. While smart homes enhance daily living, AI in farming supports sustainable food production. These advances show how technology can improve quality of life and address global challenges.

EXISTING SYSTEM

The existing crop disease detection methods mainly rely on manual observation by farmers or consultation with agricultural experts. Farmers identify diseases by examining visible symptoms such as leaf spots, discoloration, yellowing, and wilting. This approach requires experience and expertise, making it difficult for inexperienced farmers to accurately diagnose crop diseases. In many cases, diseases with similar symptoms are easily confused, resulting in incorrect treatment and reduced crop productivity. Traditional methods are also time-consuming, as farmers often need to visit agricultural centers or wait for expert advice. Most existing systems provide only basic information and do not utilize artificial intelligence to automatically analyze crop leaf images. They lack real-time disease prediction, confidence scoring, and personalized disease management recommendations. Early disease detection is often delayed, increasing the risk of disease spread and economic loss. Overall, the existing system lacks automation, intelligent image analysis, rapid diagnosis, and accurate decision support, highlighting the need for an AI-driven crop disease prediction and management system.

PROPOSED SYSTEM

The proposed system implements an AI-driven Crop Disease Prediction and Management System that uses deep learning techniques to detect diseases from crop leaf images. The system allows users to upload an image of a crop leaf through a user-friendly web application. The uploaded image is pre-processed by resizing and normalizing it before being analyzed by a trained Convolutional Neural Network (CNN) model developed using TensorFlow and Keras. Based on the analysis, the system accurately predicts the disease and displays the disease name along with its confidence score. It also provides detailed information about the disease, including symptoms, possible causes, preventive measures, and recommended treatment. The application is developed using the Flask framework with HTML, CSS, and JavaScript for the frontend, ensuring a simple and interactive interface. By enabling early disease detection and timely management recommendations, the system helps farmers reduce crop losses, improve agricultural productivity, and make informed decisions. Overall, it offers an efficient, accurate, and cost-effective solution for modern crop disease management.

SYSTEM ARCHITECTURE

The architecture of the AI-Driven Crop Disease Prediction and Management System consists of a user interface, image upload module, image preprocessing module, CNN-based disease prediction model, disease information database, and result display module. The user uploads a crop leaf image through the web application, which is then sent to the preprocessing module. The preprocessing module resizes, normalizes, and converts the image into the required format for prediction.The processed image is passed to the trained Convolutional Neural Network (CNN) model, which analyzes the leaf and predicts the crop disease along with its confidence score. Based on the prediction, the system retrieves detailed disease information, including symptoms, causes, preventive measures, and treatment recommendations, from the JSON database. Finally, the prediction results and management suggestions are displayed to the user through the web interface. This architecture provides an accurate, efficient, and user-friendly solution for early crop disease detection and management.

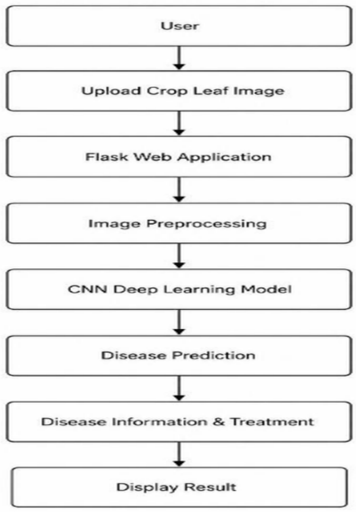

Fig. 1: System Architecture

METHODOLOGYDISCRIPTION

The AI-Driven Crop Disease Prediction and Management System follows a simple and efficient methodology for detecting crop diseases. The user uploads a crop leaf image through the Flask web application. The uploaded image is preprocessed by resizing and normalizing it before being passed to the trained Convolutional Neural Network (CNN) model. The CNN analyzes the image and predicts the crop disease with a confidence score. Based on the prediction, the system retrieves disease details, including symptoms, preventive measures, and treatment recommendations from a

JSON database. Finally, the prediction results and management suggestions are displayed through a user-friendly interface. This methodology enables early disease detection, reduces manual effort, supports timely treatment, and helps farmers improve crop health and agricultural productivity.

RESULT AND DISCUSSION

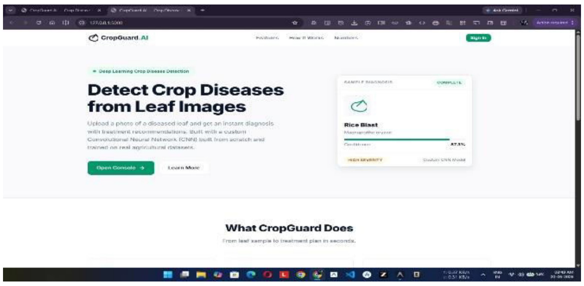

Fig 2: Home page of Crop Disease prediction

The above figure shows the home page of the AI-Driven Crop Disease Prediction and Management System. It provides a simple and user-friendly interface that introduces the application's features and functionality. Users can navigate through the system and access the disease prediction module using the Open Console option. The home page highlights the use of a CNN-based deep learning model for crop disease detection and provides an overview of the system's capabilities. Its responsive design ensures easy accessibility and improves the overall user experience.

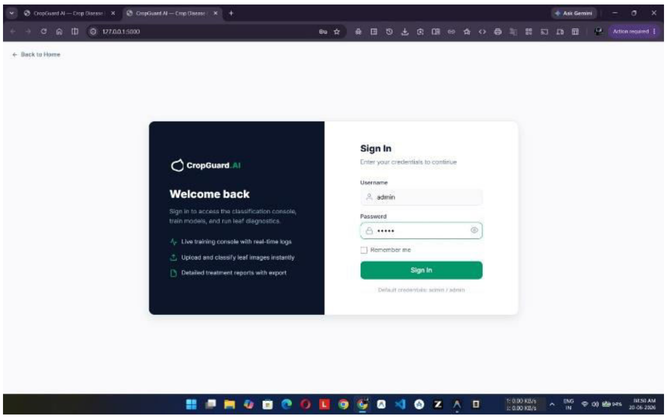

Fig 3: Login page

The login page allows registered users to securely access the AI-Driven Crop Disease Prediction and Management System by entering their valid credentials. It ensures secure and authorized access to the application.

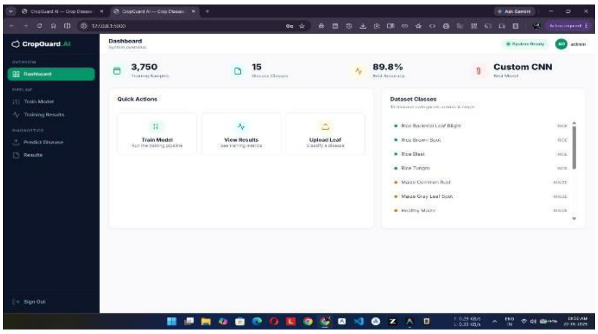

Fig 4: Dashboard

The Dashboard provides an overview of the AI-Driven Crop Disease Prediction and Management System, including model status and key functionalities. It enables users to easily access training, disease prediction, and result modules from a single interface.

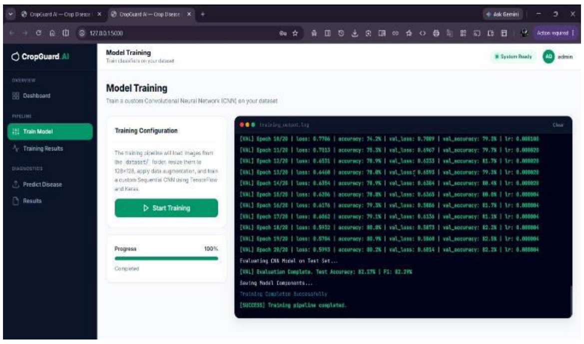

Fig 5: Training model

The Training Model module trains the CNN using the crop disease dataset to learn disease patterns from leaf images. After training, the model is saved and used for accurate crop disease prediction.

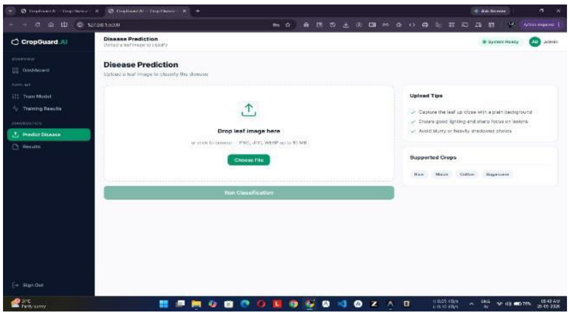

Fig 6: Disease Prediction

The Disease Prediction module analyzes the uploaded crop leaf image using the trained CNN model to identify the disease. It displays the predicted disease along with the confidence score and treatment recommendation

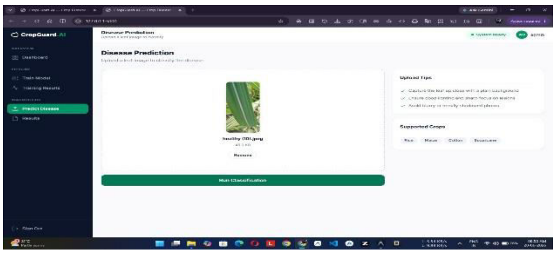

Fig 7: Run Classification

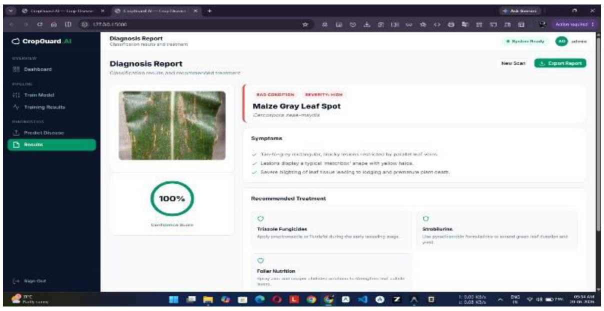

Fig 8: Result

The Results module displays the predicted crop disease along with its confidence score. It also provides disease information, preventive measures, and recommended treatment for effective crop management.

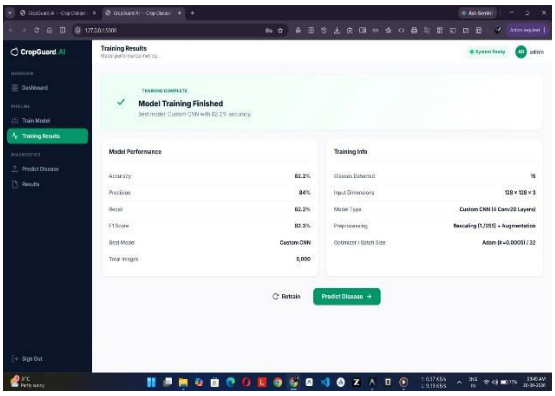

Fig 9: Training Result

CONCLUSION

The AI-Driven Crop Disease Prediction and Management System enables accurate disease detection, early diagnosis, and timely treatment, helping improve crop health and agricultural productivity**.**

FUTURE SCOPE

The system can be enhanced by supporting more crop varieties and diseases, integrating real-time weather data, providing multilingual support, developing a mobile application, and using cloud-based deployment. Future improvements can also include IoT sensors and drone-based monitoring for large-scale, real-time crop health management.

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