

Integrated Agricultural Advisor: AI Chatbot for Crop Disease Detection and Recommendations

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Abstract:

The AI Chatbot for Plant Disease Detection and Recommendation System is an integrated web platform utilizing computer vision, machine learning, and recommendation algorithms. Users can upload plant images for instant disease diagnosis (e.g., fungal infections, bacterial blight) with treatment suggestions, while also receiving tailored crop/plant recommendations based on soil type, climate, location (like Telangana, India), and farming constraints. This dual-function tool enhances agricultural productivity, minimizes losses through early intervention, and promotes optimal planting choices via conversational AI, accessible on mobile browsers for real-time decision support

The proposed system integrates computer vision, machine learning, and recommendation techniques to assist farmers in disease detection and crop selection [1], [5]. It enables real-time diagnosis using convolutional neural networks and provides recommendations based on environmental parameters [2], [6].

Keywords: Plant Disease Detection, Crop Recommendation System, Artificial Intelligence (AI), Machine Learning (ML), Convolutional Neural Networks (CNN), Computer Vision, Natural Language Processing (NLP), Agricultural Advisory System.

I. INTRODUCTION:

Agriculture is very important for the economy, especially in India where many people depend on farming. Farmers face challenges like unpredictable weather, soil differences, and plant diseases, which reduce crop yield and cause losses. Traditional methods are slow and not always accurate. With technologies like Artificial Intelligence, Machine Learning, and Computer Vision, farming can become more efficient and data-driven. CNN models help in detecting plant diseases from leaf images accurately. Choosing the right crop based on soil nutrients, pH, temperature, and rainfall is also important for better yield. Machine learning models can analyze these factors and suggest suitable crops. This project introduces an AI-based Integrated Agricultural Advisor that combines disease detection and crop recommendation. It helps farmers by providing quick diagnosis, treatment suggestions, and personalized crop advice through a simple chatbot system.

Agriculture is a key sector in India, facing challenges such as climate variability and plant diseases [7]. Artificial Intelligence (AI) and Machine Learning (ML) offer efficient solutions for smart farming [8]. Deep learning models such as CNNs have demonstrated high accuracy in plant disease classification tasks [5]. Additionally, crop recommendation systems using ensemble models improve yield prediction and decision-making [6], [9].

II. RELATED WORK

Recent advancements in Artificial Intelligence and Machine Learning have greatly contributed to automated systems for plant disease detection and crop recommendation. A 2023 study on deep learning-based crop disease prediction combined deep learning models with web and mobile applications to enable real-time disease diagnosis for farmers. It also showed that incorporating user feedback improves model accuracy over time by adapting to local environmental conditions. In 2024, research on machine learning-based detection and extraction of crop diseases highlighted the effectiveness of Convolutional Neural Networks (CNNs) and transfer learning techniques. The study demonstrated that data augmentation and transfer learning improve model performance, especially under varying lighting and complex field conditions. Another 2024 study explored multiple machine learning methods for plant disease detection across different crops and found that ensemble learning methods help handle class imbalance and improve prediction accuracy. It also revealed that environmental factors can increase disease spread by about 15–25%, emphasizing the importance of early detection. In crop recommendation, an AI-based system developed in Karnataka (2024) used Random Forest and XGBoost algorithms to suggest suitable crops based on soil nutrients, pH, humidity, temperature, and rainfall. The results showed better accuracy compared to traditional methods, especially in handling imbalanced data and providing reliable crop suggestions.

Recent studies emphasize the use of deep learning for plant disease detection [1], [5]. Transfer learning techniques improve performance in complex environments [10]. Research also highlights the importance of environmental factors in disease spread and crop yield optimization [3], [4]. Machine learning-based crop recommendation systems using Random Forest and XGBoost provide reliable predictions [6], [9].

III. PROPOSED SYSTEM

The system integrates image-based disease detection and crop recommendation modules into a unified platform. Image inputs are processed using CNN models for classification and treatment suggestions [5]. Environmental inputs such as soil nutrients and weather data are analyzed using ML algorithms to recommend suitable crops [6]. The chatbot interface utilizes NLP for user interaction and intent detection [11].

A. Overview of the Proposed System

The proposed system is an AI-based Integrated Agricultural Advisor designed to help farmers make better decisions by combining plant disease detection and crop recommendation in a single platform. It is implemented as a web-based chatbot interface, allowing users to interact easily through text and image inputs. The system accepts multi-modal inputs such as crop images and environmental parameters including soil nutrients (NPK), pH level, temperature, humidity, and rainfall. For disease detection, uploaded plant images are processed using Convolutional Neural Networks (CNNs) to identify diseases and provide diagnosis along with treatment suggestions. The model also provides confidence levels to ensure reliability and allows users to re-upload images if accuracy is low. For crop recommendation, the system uses machine learning models such as Random Forest and Gradient Boosting to analyze environmental conditions and suggest the most suitable crops. It predicts top crop recommendations and provides explanations to improve user understanding and trust. A key feature of the system is its local adaptability, where models are trained using region-specific data (such as Telangana conditions) and support regional languages like Telugu. The system also addresses real-world challenges by handling low-quality images through preprocessing and expanding coverage to include rare and region-specific diseases.

B. Overall System Architecture

The overall system architecture of the AI-based Integrated Agricultural Advisor is designed as a unified and modular framework that integrates image processing, machine learning models, and a chatbot

interface to provide real-time agricultural support. The system begins with a user-friendly web-based interface where farmers can interact through text or upload plant leaf images. These inputs are processed in the backend using a multi-modal input handling mechanism. Images undergo preprocessing steps such as resizing, normalization, and augmentation, while numerical inputs like soil nutrients (NPK), pH, temperature, humidity, and rainfall are scaled for proper analysis. An intent detection mechanism using Natural Language Processing identifies whether the user requires disease detection or crop recommendation. If the input is an image, it is sent to the disease detection module, where Convolutional Neural Networks classify plant diseases and generate outputs such as disease type, confidence score, severity level, and suitable treatment suggestions.

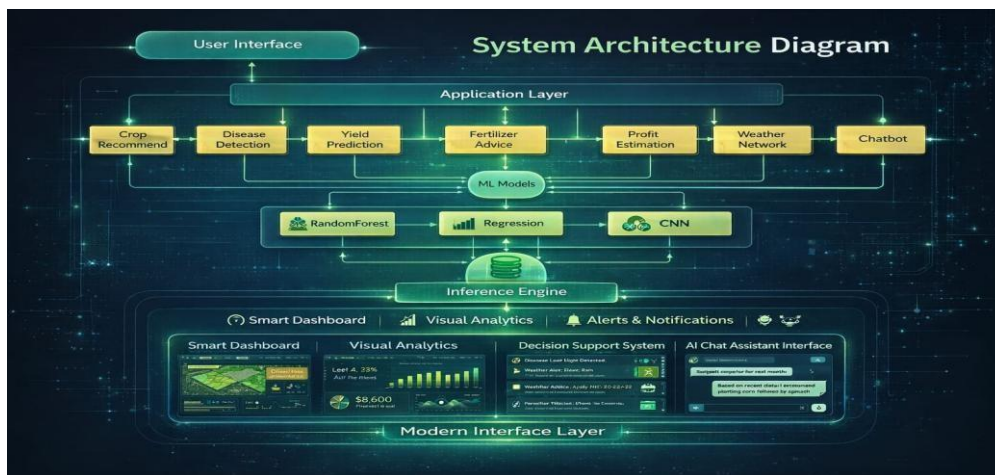


Figure.1: System Architecture

C. Data Collection Module:

The Data Collection Module plays a crucial role in the proposed system by gathering and organizing all the necessary data required for training and prediction. The system collects two primary types of data: image data and environmental data. Image data consists of plant leaf images from various crops such as rice, tomato, and chilli, which include both healthy and diseased samples. These images are used to train the disease detection model based on Convolutional Neural Networks, enabling accurate classification of plant diseases under different conditions. In addition to image data, the system collects environmental and soil-related parameters, including Nitrogen (N), Phosphorus (P), Potassium (K) values (ranging from 0–200), soil pH levels, temperature (20–40°C), humidity, and rainfall. This structured data is essential for training the crop recommendation module, which utilizes machine learning algorithms such as Random Forest and Gradient Boosting to predict suitable crops based on local conditions. The collected data is sourced from agricultural datasets, research studies, and publicly available repositories, as well as user inputs provided through the chatbot interface. Additionally, the system incorporates location-specific data (e.g., regional climate conditions) to improve the accuracy and relevance of recommendations. All collected data is stored in a centralized database, which supports preprocessing, model training, and continuous system improvement through feedback and retraining mechanisms.

D. Performance Optimization and Security:

The proposed system incorporates several strategies to ensure efficient performance and secure operation in real-world agricultural environments. For performance optimization, the system applies preprocessing techniques such as image resizing (224×224), normalization, and data augmentation to improve the efficiency and accuracy of the disease detection model based on Convolutional Neural Networks. Additionally, input feature scaling (e.g., min-max normalization for NPK values, temperature, and other parameters) enhances the performance of machine learning models like Random web-based deployment help reduce latency and make the system accessible even in low-resource and rural settings.



E. Data Storage and Processing:

The Data Storage and Processing module is responsible for managing, organizing, and transforming the data required for efficient functioning of the proposed system. All collected data, including plant images, disease labels, soil parameters (NPK values), pH levels, temperature, humidity, rainfall data, and treatment information, is stored in a centralized database. This structured storage enables easy retrieval and supports both model training and real-time predictions. During processing, image data undergoes several preprocessing steps such as resizing (to 224×224 pixels), normalization, and augmentation to improve the performance of the disease detection model based on Convolutional Neural Networks.

F. System Integration and Acceptability:

The proposed system is designed as an integrated platform that combines multiple components, including the user interface, data processing modules, disease detection model, crop recommendation engine, and chatbot system into a unified workflow. All modules are interconnected to ensure seamless data flow, where user inputs are processed, analyzed, and converted into meaningful outputs in real time. The integration of image-based disease detection using Convolutional Neural Networks and data-driven crop recommendation using algorithms like Random Forest and Gradient Boosting allows the system to provide comprehensive agricultural support within a single platform.

IV. IMPLEMENTATION DETAILS:

The system is implemented using Python, Flask, and machine learning libraries such as TensorFlow and scikit-learn. Image preprocessing techniques such as normalization and augmentation improve model performance [5]. The trained models are deployed on cloud platforms to ensure scalability and accessibility [11].

A. Project setup:

The project is developed using Python Flask for the backend and HTML, CSS, and JavaScript for the frontend. The system is structured with organized folders such as /templates for HTML pages, /static for CSS, JavaScript, and images, and /model for storing trained machine learning and deep learning models. Required Python libraries include TensorFlow/Keras for deep learning, scikit-learn for machine learning, pandas and NumPy for data handling, and OpenCV for image processing. This setup enables seamless integration between the user interface and backend processing modules. The web application is designed to be lightweight and accessible, ensuring smooth interaction between users and the AI system.

B. Prepare Data:

The dataset consists of two main types of data: plant image data and environmental data. Plant images include both healthy and diseased samples of crops such as rice, tomato, and chilli, covering multiple disease classes. Environmental data includes soil nutrients (N, P, K values ranging from 0–200), pH levels, temperature (20–40°C), humidity, and rainfall. The dataset is collected from agricultural sources, research datasets, and user inputs. Data preprocessing includes cleaning, normalization, and augmentation of images to improve model performance. This preparation ensures that the system can handle real-world variations and provide accurate predictions.

C. Train ML Model:

For disease detection, images are preprocessed (resized to 224×224, normalized, augmented) and trained using Convolutional Neural Networks, which classify plant diseases and output confidence scores along with treatment suggestions. For crop recommendation, structured environmental data is used to train models such as Random Forest and Gradient Boosting, which predict suitable crops based on input conditions. The dataset is split into training and testing sets to evaluate performance. The trained models are saved and integrated into the backend for real-time predictions.



D. Frontend Layout:

The frontend is designed as a chatbot-based web interface that is simple and user-friendly. It includes options for image upload and text input, allowing users to interact easily with the system. The interface is responsive and accessible on mobile devices, ensuring usability in rural areas. Clear navigation, readable fonts, and interactive elements are used to enhance user experience. The chatbot provides a conversational flow, making the system intuitive for farmers.

E. Disease Detection Module:

In this module, users upload images of plant leaves. The system processes the image and uses the trained CNN model to classify the disease. The output includes:

- Disease name
- Confidence score
- Severity level
- Suggested treatment

If the confidence is low, the system prompts the user to re-upload a better image. This module enables early detection and reduces crop loss.

F. Crop Recommendation Module:

Users provide environmental details such as soil nutrients, pH, temperature, humidity, and rainfall. The system processes this data and uses machine learning models to recommend the top suitable crops. The output may also include explanations to help users understand why a particular crop is recommended. This module helps farmers make better planting decisions.

G. Chatbot Interaction Module:

The Chatbot Interaction Module serves as the primary user-facing interface and communication hub of the system, enabling seamless interaction between users and backend services. It leverages Natural Language Processing (NLP) techniques such as text classification and intent recognition, implemented using models like BERT, spaCy, or Dialogflow, to understand user queries expressed in natural language. The module extracts key entities such as crop names, symptoms, soil type, and seasonal context to intelligently route requests to relevant subsystems like disease detection or crop recommendation. It also incorporates context management capabilities, allowing multi-turn conversations where the system maintains dialogue state and supports smooth transitions between different functionalities without requiring session restarts. To enhance accessibility, the module integrates regional language support using translation APIs and Indic NLP libraries, along with optional speech-to-text and text-to-speech features for users with limited literacy.

H. Feedback and Learning Module:

The Feedback and Learning Module is designed to ensure continuous system improvement by incorporating user-driven insights into the model lifecycle. It captures feedback after each prediction, allowing users to confirm accuracy or provide corrective input through ratings or additional data such as images and descriptions. The system monitors model confidence levels using probabilistic outputs (e.g., softmax scores) and prompts users for better inputs when confidence is low, thereby maintaining reliability. All feedback data is systematically stored in structured repositories, forming a growing dataset that supports periodic retraining of machine learning models. This retraining process, conducted at defined intervals, enhances model accuracy, adaptability, and localization.

I. Deployment and Accessibility:

The Deployment and Accessibility component focuses on making the system scalable, reliable, and widely accessible across diverse environments. The application is deployed as a web-based platform on

cloud infrastructure such as AWS, Azure, or Google Cloud, utilizing lightweight backend frameworks like Flask, FastAPI, or Django and modern frontend technologies such as React or Vue.js. This approach eliminates the need for installation, allowing users to access the system through browsers or progressive web applications on mobile devices. To ensure high performance, the system employs load balancing, caching mechanisms, and a microservices architecture that enables independent scaling of individual modules. Special attention is given to rural and low-connectivity scenarios through support for offline or edge-based inference using lightweight, optimized models, as well as media compression techniques for efficient data transfer.

V. ALGORITHM:

A. Designing the Main Interface with Web-Based Chatbot Layout:

The system interface is designed as a responsive, web-based chatbot platform that enables easy interaction between farmers and the application. The main interface includes a simple input area where users can upload plant images or enter environmental parameters such as soil nutrients, pH, temperature, humidity, and rainfall. The layout is developed using HTML, CSS, and JavaScript to ensure clarity, responsiveness, and accessibility across devices, especially mobile phones. A clean and intuitive design is maintained to reduce complexity for rural users, with clearly visible input options and chatbot responses displayed in a conversational format. The interface supports real-time interaction and ensures smooth navigation, making it user-friendly and efficient.

B. Multi-Modal Input Handling and Intent Detection

The system accepts multi-modal inputs, including both image data and text-based environmental parameters. When the user provides input, the system first processes it and identifies the user's intent using Natural Language Processing techniques. The intent detection mechanism determines whether the user is requesting plant disease detection or crop recommendation. Based on this classification, the input is directed to the appropriate processing module. This approach ensures that the system can handle multiple functionalities within a single platform while maintaining accuracy and efficiency.

C. Image Processing and Disease Classification Algorithm:

When a plant image is uploaded, it undergoes preprocessing steps such as resizing to 224×224 pixels, normalization, and augmentation to improve robustness. The processed image is then passed into a deep learning model based on Convolutional Neural Networks, which extracts features and classifies the disease. The algorithm outputs the predicted disease class along with a confidence score and severity level. Based on the prediction, the system retrieves appropriate treatment suggestions from the knowledge base. If the confidence score is below a defined threshold (e.g., 90%), the system prompts the user to re-upload a clearer image, ensuring reliability of results.

D. Crop Recommendation Algorithm and Prediction Logic

For crop recommendation, the system processes structured input data such as NPK values (0–200), soil pH, temperature (20–40°C), humidity, and rainfall. These inputs are normalized and fed into machine learning algorithms such as Random Forest and Gradient Boosting. The algorithm analyzes patterns in the data and predicts the most suitable crops for the given conditions. The system typically outputs the top recommended crops along with reasoning or explanation to help users understand the decision. This ensures informed decision-making and improves agricultural productivity.

E. Result Generation, Chatbot Response, and Feedback Loop:

After processing, the results from both disease detection and crop recommendation modules are integrated and presented to the user through a chatbot interface. The chatbot generates natural language responses, including disease diagnosis, treatment suggestions, recommended crops, and additional guidance. The

system supports multi-turn conversations, allowing users to refine inputs or ask follow-up questions. A feedback loop is also incorporated, where user interactions and corrections are stored for future model retraining and improvement. This continuous learning mechanism enhances system accuracy over time and ensures adaptability to real-world agricultural conditions.

VI. RESULTS:

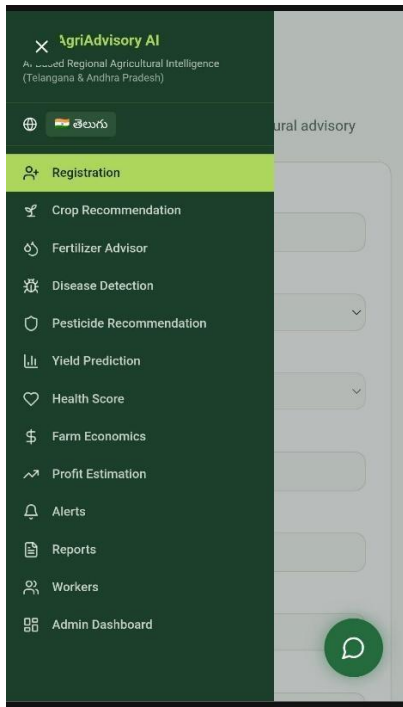


Fig 2

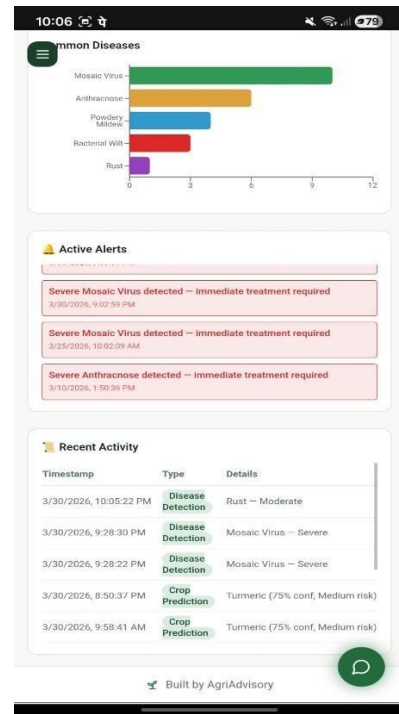


Fig 3:

Fig 2: This figure shows the admin dashboard Displaying disease trends, alerts, and recent activity for monitoring system performance.

Fig 3: This figure shows the application menu with different features like registration, crop recommendation, disease detection, and admin dashboard for user navigation

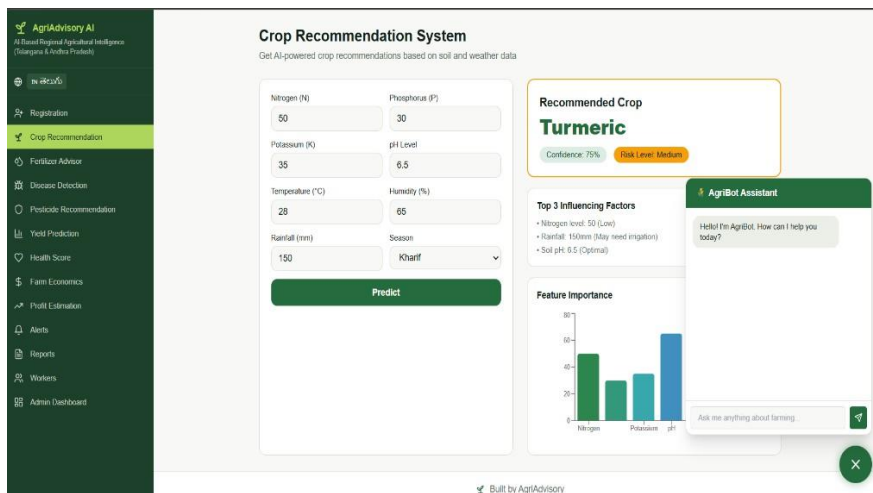


Fig 4: Crop Recommendation System

This diagram shows a system that uses soil and weather data to recommend the best crops using machine learning.

Farmer Registration
Register to access AI-powered agricultural advisory

Name * Enter name State * Select State

District * Select District Mandal Enter mandal

Land Size (acres) e.g. 5 Soil Type Select Soil Type

Email * farmer@example.com Phone * 9876543210

Preferred Language English

Built by AgriAdvisory

Fig 5: Farmer Registration

This diagram shows farmer registration, where users enter their details to get personalized services.

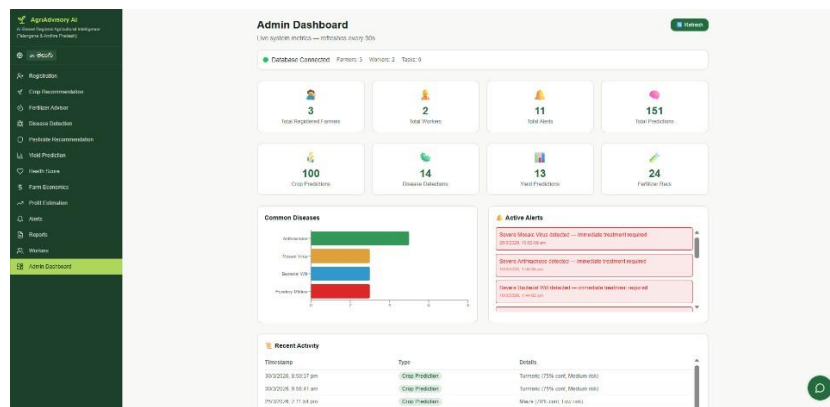


Fig 6: Admin Dashboard

This diagram shows the admin dashboard used to monitor data, predictions, and system performance.

VII. CONCLUSION:

The AI-based agricultural advisory system effectively combines plant disease detection and crop recommendation using machine learning and computer vision. It helps farmers identify diseases early, choose suitable crops, and make better decisions. The system reduces manual effort by providing instant, accurate results through a userfriendly chatbot interface. It also supports location-based recommendations, making it practical for real-world agricultural use. Overall, this project enhances productivity, minimizes crop losses, and promotes smart, efficient, and sustainable farming practices. The integrated AI-based agricultural advisor enhances decision-making by providing accurate disease detection and crop recommendations. It reduces crop loss, improves productivity, and supports sustainable farming practices [12].

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