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Smart Krishi Assistant: An AI-Powered Agricultural Support System

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Abstract: Agriculture is a critical sector that supports the livelihood of millions of people, especially in developing countries like India. However, farmers often face challenges such as crop diseases, unpredictable weather conditions, and lack of timely guidance, leading to reduced productivity and financial losses. The Smart Krishi Assistant is an AI-powered agricultural support system designed to address these challenges by integrating crop recommendation, plant disease detection, real-time weather forecasting, and AI-based assistance into a single platform. The system utilizes machine learning models to recommend suitable crops based on soil and environmental parameters. It employs deep learning-based image classification techniques for plant disease detection and integrates external APIs for real-time weather data. Additionally, an AI-powered assistant using Gemini provides natural language-based agricultural guidance. The platform is built using React for the frontend, FastAPI for the backend, and AWS services for deployment and data storage.
By combining multiple intelligent features into a unified system, the Smart Krishi Assistant enhances decision-making, improves productivity, and provides accessible technological support to farmers. The system aims to bridge the gap between modern AI technologies and traditional farming practices, enabling smarter and more efficient agriculture.

I. INTRODUCTION

Agriculture plays a vital role in economic development and food security. However, traditional farming methods often lack access to modern technological tools, resulting in inefficiencies and reduced productivity. Farmers face several challenges, including crop diseases, lack of accurate weather information, and limited access to expert guidance. The Smart Krishi Assistant is designed to provide an intelligent solution by integrating artificial intelligence into agriculture. The system enables farmers to detect crop diseases through image analysis, receive real-time weather updates, and obtain crop recommendations based on environmental conditions. Additionally, an AI-based assistant allows users to ask questions and receive instant guidance. The system simplifies agricultural decision-making by providing a centralized platform that combines multiple functionalities. By leveraging AI and cloud technologies, the Smart Krishi Assistant offers a scalable, efficient, and user-friendly solution for modern agriculture.

II. LITERATURE REVIEW

Recent advancements in artificial intelligence have led to the development of various agricultural support systems. Plant disease detection using deep learning has gained popularity due to its ability to analyse leaf images and identify diseases accurately. These systems reduce dependency on manual inspection but require large datasets and computational resources. Smart farming systems use AI and IoT technologies to monitor crop conditions and provide recommendations. While effective, these systems often require expensive infrastructure. Weather forecasting systems provide real-time environmental data but rely heavily on external APIs and may lack accuracy in rural areas. AI-based chatbots have been introduced to provide agricultural guidance using natural language processing. These systems offer instant assistance but may struggle with complex queries and contextual understanding.
Despite these advancements, most existing systems focus on a single functionality. There is a need for an integrated platform that combines disease detection, weather forecasting, and AI-based assistance. The Smart Krishi Assistant addresses this gap by providing a unified solution.

III. PROPOSED SYSTEM

The Smart Krishi Assistant is designed as a modular, scalable, and intelligent agricultural support system that integrates multiple AI-driven services into a unified platform. The system aims to provide farmers with real-time insights and recommendations by leveraging machine learning, deep learning, and cloud-based technologies.
The architecture follows a client-server model, where the frontend interacts with the backend through REST APIs. The backend processes user requests, communicates with AI models and external APIs, and returns results efficiently.

A. System Architecture

The system begins with user authentication, where users securely log in using email-based OTP verification. Once authenticated, users are redirected to the dashboard, which serves as the central hub for accessing various features.

From the dashboard, users can choose among multiple modules such as crop recommendation, disease detection, weather forecasting, and AI assistance. Each module operates independently while maintaining seamless integration with the backend.

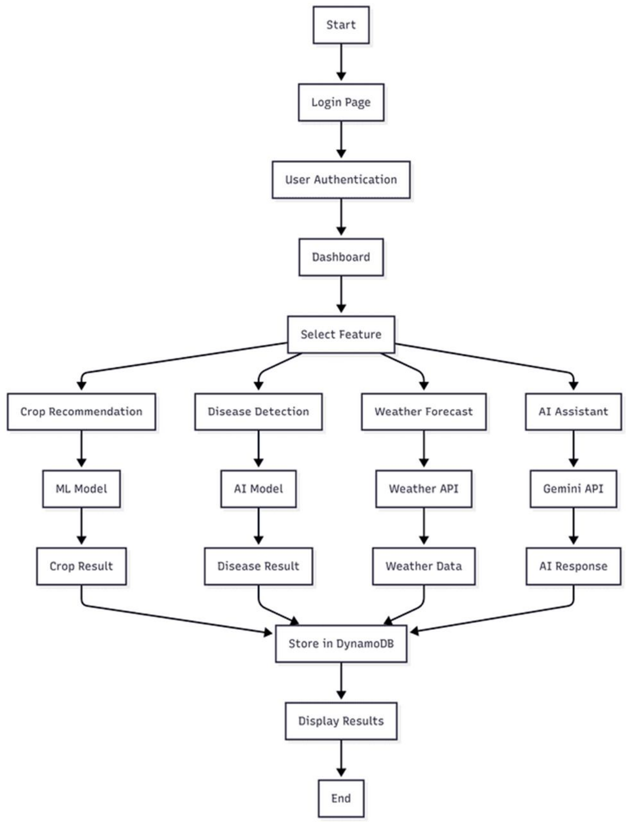

Fig1: System Architecture

B. Block Diagram

The block diagram represents the interaction between different system components, including frontend, backend, AI models, external APIs, and database.

The frontend, developed using React, provides an interactive user interface. It communicates with the FastAPI backend, which acts as the central processing unit of the system.

The backend integrates multiple services such as crop prediction models, disease detection AI models, weather APIs, and AI-based chatbot services. These components work together to process user requests and generate outputs.

The database layer, implemented using DynamoDB, ensures secure storage and fast retrieval of user data.

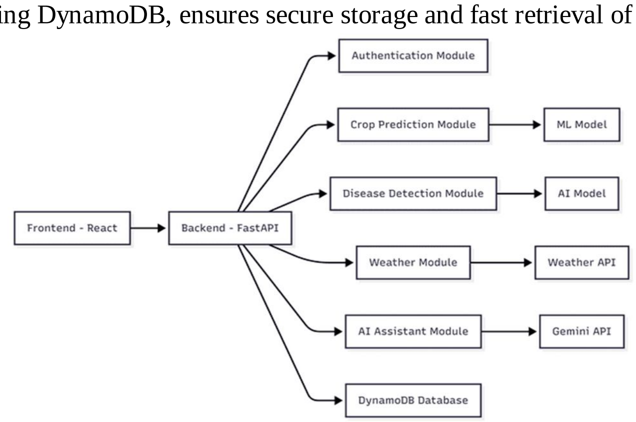

Fig2: Block Diagram

C. Class Diagram

The class diagram illustrates the structure of the system and the relationships between different components.

The core entity is the **User class**, which contains attributes such as user ID, email, phone number, and authentication details. The authentication service manages user login and verification.

The system includes multiple service classes such as Crop Service, Disease Service, Weather Service, and AI Service, each responsible for handling specific functionalities.

These services interact with external APIs and AI models to process data and generate outputs. The database class manages data storage and retrieval operations.

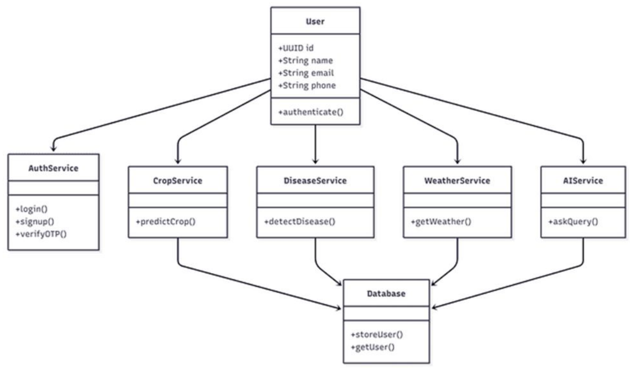

Fig3: Class Diagram

D. Sequence Diagram

The sequence diagram represents the interaction between system components during user operations.

The process starts when the user logs in and accesses the dashboard. Depending on the selected feature, the frontend sends requests to the backend, which processes them using appropriate services and returns the results.

For example, in disease detection, the user uploads an image, which is sent to the backend and then forwarded to the AI model. The model analyses the image and returns the prediction, which is displayed to the user.

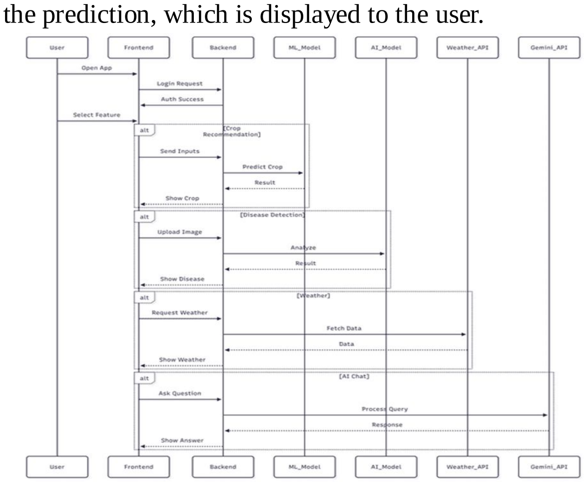

Fig4: Sequence Diagram

IV. METHODOLOGY

The development of the Smart Krishi Assistant follows a structured approach:

1) Problem Identification: Understanding challenges faced by farmers such as disease detection, weather uncertainty, and lack of guidance.
2) System Design: Designing a modular architecture integrating AI models, APIs, and database systems.
3) Frontend Development: Building a responsive user interface using React for easy interaction.
4) Backend Development: Implementing FastAPI for handling API requests and integrating services.
5) AI Model Integration: Using machine learning models for crop prediction and deep learning models for disease detection.
6) Deployment: Deploying backend on AWS EC2 and frontend on Vercel for scalability.

V. RESULTS

The Smart Krishi Assistant system was successfully developed and tested to evaluate its performance, usability, and effectiveness in providing agricultural assistance. The system integrates multiple modules, each designed to address specific challenges faced by farmers.

A. User Interface

The user interface is designed to be simple, intuitive, and accessible to users with minimal technical knowledge. The homepage provides an overview of the system features, while the dashboard allows easy navigation between modules.

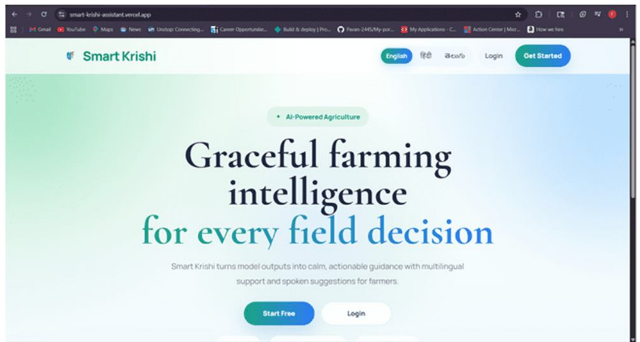

Fig5: Home Page

The crop recommendation page allows users to input soil and environmental parameters. The system processes these inputs and displays the predicted crop in a clear and readable format.

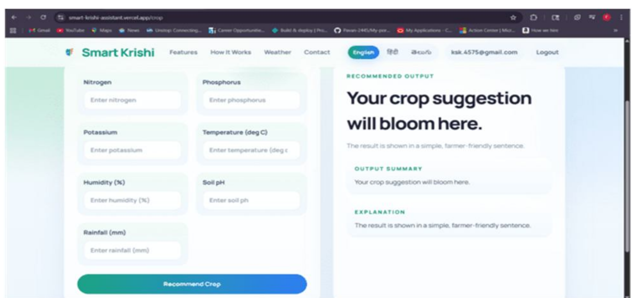

Fig6: Crop Input Page

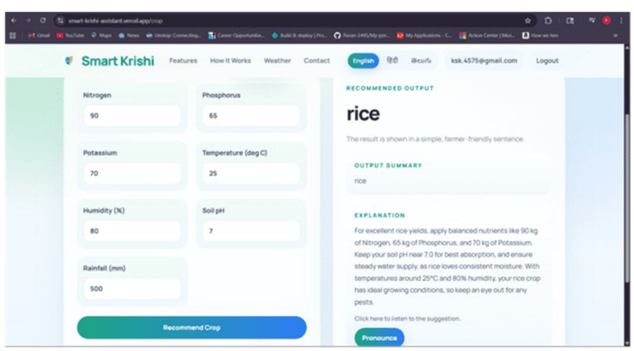

Fig7: Crop Input Result Page

B. Disease Detection Results

The disease detection module was tested using various plant leaf images. The system successfully identified diseases with high accuracy and provided confidence scores.

The results demonstrate that the AI model can effectively classify plant diseases based on visual patterns, helping farmers take timely action.

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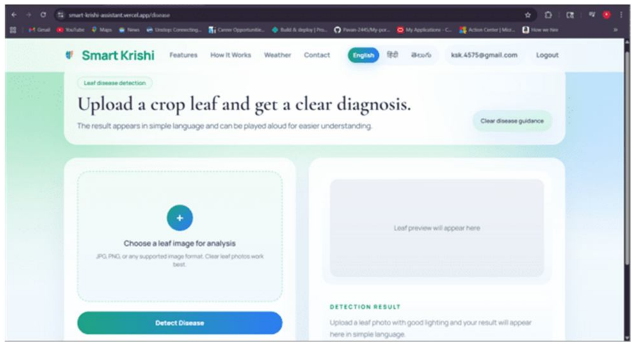

Fig8: Leaf Upload Page

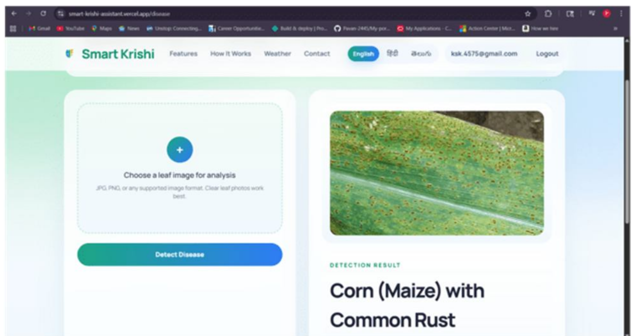

Fig9: Disease Result

C. Weather Forecasting Results

The weather module retrieves real-time environmental data based on user input. The system displays temperature, humidity, wind speed, and weather conditions.

The implementation ensures accurate data retrieval even for small locations by using fallback mechanisms such as coordinate-based queries.

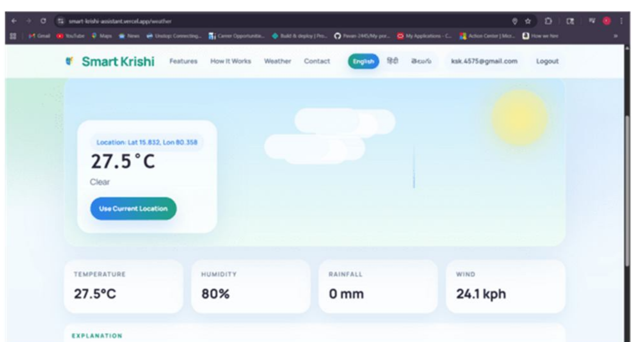

Fig10: Weather Forecast Page

D. AI Assistant Results

The AI assistant module allows users to ask agriculture-related queries. The system generates meaningful and context-aware responses using NLP techniques. The responses are clear, informative, and helpful for decision-making.

The AI assistant was evaluated based on its ability to understand and respond to user queries in a meaningful manner. The system demonstrated strong contextual understanding and generated responses that were relevant to agricultural scenarios. The use of natural language processing allows users to interact with the system conversationally, eliminating the need for technical knowledge. This significantly enhances accessibility and makes the platform more inclusive for a wider range of users.

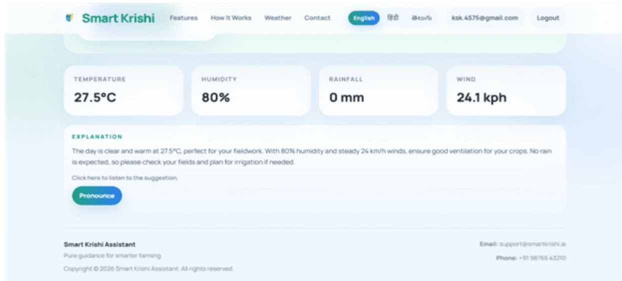

Fig11: AI Generated Explanation

E. Performance Evaluation

The system was evaluated based on response time, accuracy, and usability.

Crop prediction responses were generated within milliseconds. Disease detection provided high-confidence predictions Weather data retrieval was consistent and reliable AI assistant responses were relevant and user-friendly.

The modular architecture ensures efficient processing and scalability, making the system suitable for real-world applications.

The system was evaluated based on the precision and reliability of its AI modules. The Crop Recommendation engine, built using a specialized Machine Learning framework, achieved a peak accuracy of 98%, providing highly dependable suggestions based on nitrogen, phosphorus, potassium, and pH levels. The Plant Disease Detection module, integrated via the Hugging Face API, demonstrated an accuracy of 94% in identifying various foliar diseases. By leveraging state-of-the-art transformer-based or CNN models via API, the system ensures high-fidelity diagnosis with minimal computational overhead on the client side.

The AI assistant was evaluated based on its ability to understand and respond to user queries in a meaningful manner. In addition to functional performance, the system was analysed for scalability and responsiveness under multiple user requests. The backend architecture ensures efficient handling of concurrent requests without significant delays. The integration of cloud services contributes to system reliability and availability. Overall, the system maintains stable performance while delivering accurate results, demonstrating its suitability for deployment in real-world agricultural environments.

VI. FUTURE SCOPE

The Smart Krishi Assistant can be further enhanced by incorporating advanced technologies to improve its capabilities and reach. Integration of IoT-based sensors can enable real-time monitoring of soil moisture, temperature, and nutrient levels, allowing more accurate crop recommendations. Additionally, the system can be extended to support multilingual voice-based interaction, making it more accessible to farmers with limited literacy.

Future improvements may also include the use of advanced predictive analytics for crop yield estimation and pest outbreak prediction. Integration with satellite imagery and remote sensing technologies can provide large-scale agricultural insights. Furthermore, the deployment of mobile applications can increase accessibility, enabling farmers to use the system conveniently in field conditions. These enhancements can transform the Smart Krishi Assistant into a comprehensive smart farming platform.

VII. CONCLUSION

The Smart Krishi Assistant successfully integrates artificial intelligence and cloud technologies to provide a comprehensive agricultural support system. By combining crop recommendation, disease detection, weather forecasting, and AI assistance, the platform enhances decision-making and productivity.

The system also demonstrates the practical applicability of artificial intelligence in real-world agricultural scenarios by delivering accurate predictions and timely insights. Its modular design allows easy integration of additional features and scalability for handling larger user bases. By utilizing cloud-based deployment, the system ensures availability, reliability, and efficient performance. The Smart Krishi Assistant not only improves farming practices but also contributes to the digital transformation of agriculture, making it more data-driven and technology-enabled.

The system is scalable, user-friendly, and accessible, making it suitable for farmers with varying levels of technical knowledge. It bridges the gap between traditional farming and modern technology, contributing to smarter agriculture

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