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A Smart Agriculture Platform for Crop Health Monitoring and Personalized Farm Advisory Using Artificial Intelligence

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ABSTRACT

Agriculture continues to face significant challenges due to increasing crop diseases, unpredictable climatic conditions, soil degradation, lack of timely advisory support, and fluctuating market prices. These issues directly affect crop productivity and farmer income, especially in developing regions where access to expert guidance and technological resources remains limited. Recent advancements in artificial intelligence have shown strong potential in addressing individual agricultural problems such as crop disease detection and climate analysis. However, most existing solutions focus on isolated functionalities and fail to provide a comprehensive decision support mechanism for farmers. This paper presents a smart agriculture platform for crop health monitoring and personalized farm advisory using artificial intelligence, designed to address multiple agricultural needs through a unified system. The proposed platform integrates a deep learning–based crop disease detection module that analyzes crop images using convolutional neural networks to identify diseases at early stages. In addition to crop health monitoring, the system incorporates soil report analysis, real-time weather information with short-term forecasting, crop calendar guidance, and location-based market price updates to support informed farming decisions. A conversational advisory chatbot powered by generative artificial intelligence is included to provide instant responses to farmer queries, improving accessibility and ease of use. The platform also features a moderated community forum to encourage farmer interaction and knowledge sharing, along with gamification elements to promote consistent engagement. The system is implemented as a web-based platform and evaluated using publicly available crop disease datasets, demonstrating effective performance in disease classification under real-world conditions. By integrating heterogeneous data sources and intelligent advisory mechanisms into a single platform, the proposed system aims to assist farmers in timely decision-making, enhance crop management practices, and contribute toward sustainable and technology-driven agriculture.

Keywords: - Smart Agriculture, Crop Health Monitoring, Artificial Intelligence, Deep Learning, Personalized Farm Advisory, Decision Support System

1. INTRODUCTION

Agriculture plays a crucial role in ensuring food security and economic stability, particularly in developing countries where a large population depends on farming for livelihood. Despite technological progress, farmers continue to face several challenges such as crop diseases, unpredictable weather conditions, declining soil fertility, lack of timely advisory support, and unstable market prices. These issues often result in reduced crop yield and increased financial risk for farmers. Traditional farming practices rely heavily on manual observation and experience-based decision-making, which may lead to delayed identification of crop health issues and inefficient farm management. Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have created new opportunities to support farmers through automated crop monitoring and decision support systems [1].

1.1 Background of Smart Agriculture

Smart agriculture refers to the use of modern technologies such as artificial intelligence, data analytics, and digital platforms to improve agricultural productivity and sustainability. In recent years, AI-based solutions have been widely explored for crop disease detection, weather analysis, soil health assessment, and advisory services. Among these, image-based crop disease detection using deep learning techniques has shown promising results due to its ability to automatically extract features and classify diseases with high accuracy. Convolutional Neural Networks (CNNs) are commonly used for this purpose, as they perform well on agricultural image datasets captured under varying environmental conditions [2]. However, focusing only on disease detection is insufficient for effective farm management, as multiple factors influence crop growth and yield.

2. LITERATURE REVIEW

Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have significantly influenced agricultural research, particularly in the areas of crop disease detection, climate analysis, and intelligent advisory systems. Several studies have explored the application of image processing and deep learning techniques to assist farmers in early identification of crop diseases and reduction of yield loss. At the same time, researchers have highlighted the importance of integrating environmental and contextual data to provide meaningful agricultural decision support [1]. This section reviews existing research work and agricultural systems relevant to the proposed smart agriculture platform.

2.1 Review of Research Papers

Jafar et al. [1] presented a comprehensive review on the use of artificial intelligence for plant disease detection, discussing convolutional neural networks, transfer learning techniques, and image-based classification methods. The study also identified major challenges such as imbalanced datasets, low-quality images, and varying lighting conditions, which affect real-world performance. Neik et al. [2] emphasized the role of environmental factors such as temperature, humidity, and rainfall in plant disease development, highlighting the limitation of image-only approaches. Their work demonstrated the necessity of incorporating weather-based information into advisory systems. Shehu et al. [3] conducted a systematic review on AI-based detection of tomato leaf diseases caused by *Tuta absoluta*, comparing multiple machine learning and deep learning models. The authors discussed practical challenges such as overlapping leaves and blurred images captured in real farming environments. Kothari et al. [4] proposed an AI-driven crop disease detection system integrated with a chatbot interface, demonstrating how conversational systems can improve accessibility and farmer interaction. Akhtar et al. [5] presented a recent study on AI-driven crop disease detection and management, highlighting the benefits of early detection and fast prediction using deep learning models.

3. PROPOSED SYSTEM

The proposed work presents a smart agriculture platform designed to provide crop health monitoring and personalized farm advisory using artificial intelligence. The system aims to support farmers by integrating multiple agriculture-related services into a single decision support platform. The architecture is designed to combine crop disease detection, environmental analysis, advisory services, and farmer interaction in an efficient and scalable manner. By integrating heterogeneous data sources and AI-driven modules, the system assists farmers in making timely and informed decisions throughout the crop lifecycle.

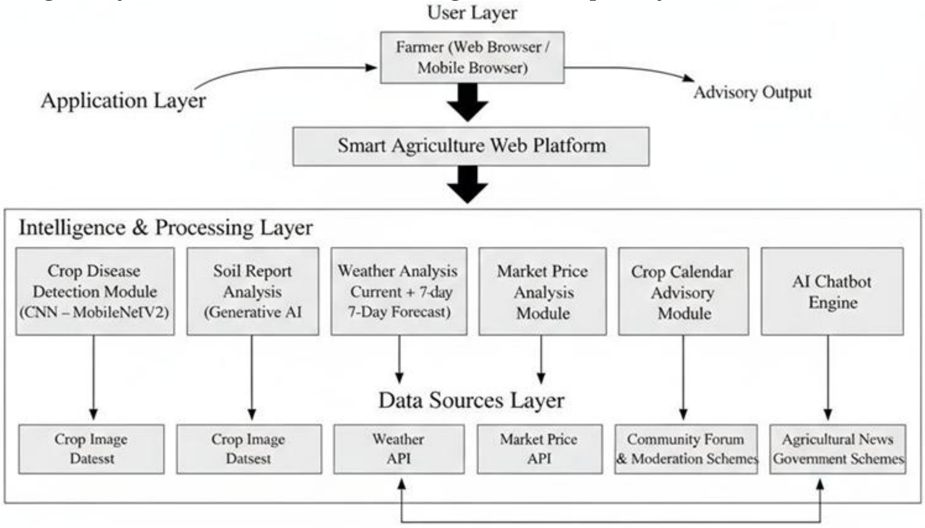

Figure 1 - Proposed System Diagram

3.1 System Architecture

The proposed system follows a modular architecture consisting of data acquisition, intelligence processing, advisory generation, and application layers. Crop images uploaded by users are processed for disease detection, while environmental data such as temperature, humidity, and rainfall are obtained through external weather services. Soil- related inputs provided by users are analyzed to generate relevant recommendations, and crop-wise market price information is retrieved dynamically based on geographical location. This modular design enables flexibility and allows future expansion of system functionalities without affecting existing components.

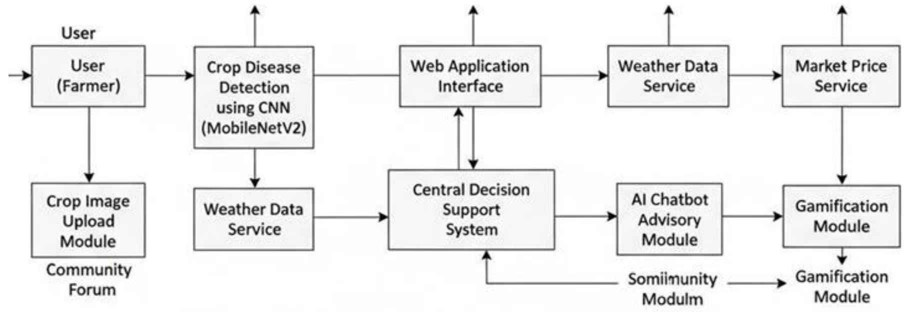

Figure 2 - System Architecture Diagram

3.2 Crop Health Monitoring and Advisory Module

Crop disease detection is performed using a deep learning–based convolutional neural network model trained on publicly available crop disease datasets. Lightweight architectures are preferred to ensure faster inference and reliable performance under real-world conditions, including variations in image quality and lighting. Image preprocessing techniques such as resizing and normalization are applied prior to classification. The disease detection output is combined with contextual information such as weather conditions, soil data, and crop growth stages to generate personalized farm advisory. A conversational chatbot interface is incorporated to provide instant responses to farmer queries and improve system accessibility. Additionally, a moderated community forum is included to encourage knowledge sharing while maintaining a safe and constructive environment.

Table 1 - Functional overview of modules in the proposed smart agriculture platform

Module Name	Input Data	Technique Used	Purpose
Crop Disease Detection	Crop leaf images	CNN (MobileNetV2)	Identification of crop diseases from images
Soil Report Analysis	Soil parameters (textual data)	Generative AI	Soil health interpretation and advisory
Weather Analysis	Location-based weather data	Weather API & analytics	Current conditions and 7-day forecast
Crop Calendar	Crop type, season	Rule-based advisory	Stage-wise crop activity guidance
Market Price Analysis	Crop name, location	Market data APIs	Live crop price information
.AI Chatbot Advisory	User queries	Generative AI	Instant agriculture-related assistance
Community Forum	User posts and comments	Content moderation rules	Knowledge sharing with restricted misuse
Gamification Module	User activity data	Point-based logic	User engagement and motivation

4. RESULTS AND DISCUSSION

The performance of the proposed smart agriculture platform was evaluated to assess its effectiveness in crop disease detection and advisory support. The crop disease detection module was tested using publicly available crop disease image datasets containing multiple disease classes across different crops. The dataset was divided into training and testing sets to evaluate the generalization capability of the deep learning model. The convolutional neural network– based model demonstrated reliable performance in identifying crop diseases from leaf images captured under varying conditions. Lightweight architectures such as MobileNetV2 enabled faster inference while maintaining satisfactory classification accuracy, making the system suitable for real-world deployment. The results indicate that the model can effectively detect common crop diseases at an early stage, which is essential for timely intervention and loss reduction.

In addition to disease detection, the integrated advisory framework enhanced the overall usefulness of the system. Weather-based insights and short-term forecasts supported better planning of irrigation and spraying activities, while soil report analysis contributed to more context-aware recommendations. Location-based market price information enabled farmers to make informed decisions regarding crop selling strategies. The conversational chatbot further improved accessibility by allowing users to obtain instant responses to agriculture-related queries. Compared to existing agricultural applications that focus on individual functionalities, the proposed system offers a unified decision support platform. By integrating multiple data sources and AI-driven modules, the platform reduces dependency on multiple tools and improves usability. The results demonstrate that the proposed system effectively combines crop health monitoring with personalized advisory services, supporting informed decision-making and efficient farm management.

5. CONCLUSION

This paper presented a smart agriculture platform designed for crop health monitoring and personalized farm advisory using artificial intelligence. The proposed system integrates deep learning–based crop disease detection with contextual advisory services such as weather analysis, soil report interpretation, crop calendar guidance, and market price information within a unified decision support framework. The experimental results indicate that the system is capable of identifying crop diseases effectively and providing relevant advisory support under real-world conditions. By combining multiple agricultural services into a single platform, the proposed approach reduces dependency on isolated tools and improves accessibility for farmers. The system demonstrates the potential of AI- driven integrated platforms in supporting informed decision-making, improving farm management practices, and promoting sustainable agriculture.

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