Agrocure: Crop Disease Detection, integrated with Crop and Fertilizer Recommendation, Chatroom and E-Commerce

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Abstract

Agriculture is considered as the main source of income for majority of the population, with almost the whole population depending on it for their livelihood. However, many farmers do not have the complete knowledge about crops and their related diseases. The arrival of new diseases affecting crop yields makes the issue even more difficult to tackle. Proper detection of these diseases can significantly provide benefits to the farmers, helping them to protect their crops and also better productivity. Today, various image processing techniques are being used to analyze crop images and identify the diseases. Manual detection relies on individual expertise, which is sometimes time-consuming and variable in accuracy and not every farmer is able to analyze the diseases. To improve speed and precision, computer-aided techniques are now utilized in the agricultural sector. Deep learning models, specifically Sequential Convolutional Neural Networks (CNN), automatically extracts the features and classifies the images with the help of a fully connected network. In this study, we have trained a Sequential CNN for disease detection and also integrating the Random Forest Algorithm to provide crop and fertilizer recommendations. In addition to that, our system incorporates a chatroom and an e-commerce platform, offering farmers fertilizers, manure, and seeds, providing a comprehensive farming solution.

Index Terms Crop Disease Detection, Deep learning in Agriculture, Random Forest Algorithm, Convolutional Neural Networks, E-commerce for Farmers.

I.Introduction

Agriculture is an important sector, with a notable portion of the population relying on it for their livelihood and it is the only source from where we intake food. However, the productivity and the health of crops is often hampered by pests and diseases, which can lead to significant losses if not identified and looked over in time. Farmers, particularly those with limited knowledge of crop diseases, are facing challenges in recognizing and treating these issues effectively and efficiently. To address this problem, technology can play a crucial role in recognizing and providing best solution for this.

Our project focuses on developing a system that will make the crop disease detection process easy and automated using deep learning techniques, mainly the Convolutional Neural Network (CNN). By examining and analyzing crop images, the system will be able to precisely diagnose diseases and find out which category it belongs to: healthy, powdery or rust, thereby allowing the farmers to take timely action and minimize the crop damage. In addition to disease detection, the system integrates a chatroom and an e-commerce platform where farmers can purchase essential agricultural products such as fertilizers, manure, and seeds. In order to help the farmers with the selection of crops and fertilizers a crop and fertilizer recommendation system has also been introduced. This combination of disease detection, crop and fertilizer recommendation system, a marketplace for farmers to buy all the products and a chat room for expert suggestions provides a comprehensive solution which will improve both crop health and an access to the required resources without much hassle.

II.Related Work

The study "Application of AI-driven cloud services in intelligent agriculture pest and disease prediction" by Lin, Yiyu, Huixiang Li and Ang Li [1] examines Cloud computing and also improves agriculture by making real-time monitoring possible, data-driven decision-making, and also improves productivity. It supports crop growth, livestock management, e-commerce, and disease prediction. The article also

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includes a tea disease detection model that uses advanced AI techniques.

The work "Data-driven agriculture: Software innovations for enhanced soil health, crop nutrients, disease detection, weather forecasting, and fertilizer optimization in agriculture" by Hridesh Harsha Sarma and Bikash Chandra Das [2] is based on the process of integrating software technologies into the modern agriculture which is important for handling farm operations, resource management, and decision-making. These tools assist in crop planning, irrigation, fertilization, and provide real-time data on weather, pests, and market trends. Common agricultural software includes Meghdoot, Mausam, and KisanSuvidha. These technologies help the farmers to manage risks, adapt to climate variability, and improve productivity.

The paper "Intelliagric: An Intelligent, Integrated Farm Assistant" by Alfaneti and Tinotenda Rodney Choto [3] presents IntelliAgric is an intelligent farm assistant system designed to help African small-scale farmers handle challenges caused by population growth and climate change. It integrates IoT and AI, using soil sensors for real-time monitoring and machine learning for maize disease prediction and market forecasting. The system employs ConvNeXt for disease detection, and transformers for data interpretation and farmer interactions. It has been developed using Agile methodology. IntelliAgric enhances resource optimization, sustainability, and yields, thereby providing data-driven insights.

In "AI can empower agriculture for global food security: challenges and prospects in developing nation" by Ali, Ahmad et al. [4] the paper is focusing on enhancing agricultural efficiency using AI in developing nations through applications like crop monitoring, irrigation, and yield forecasting. It improves food security using remote sensing but also has challenges like financial constraints and infrastructure gaps. Overcoming these barriers can make sustainable development and support the goal of ‘zero hunger’ by 2030.

The research "A cloud enabled crop recommendation platform for machine learning-driven precision farming" by Navod Neranjan et al. [5] explains the AI-driven precision farming that improves agricultural productivity by coming up with data-driven decision-making. This study proposes a cloud-based ML-powered crop recommendation platform, comparing five ML algorithms—KNN, DT, RF, XGBoost, and SVM—to identify the model with highest accuract.

The work "Evaluation of Machine Learning approaches for precision farming in Smart Agriculture System-A comprehensive Review" by Ghulam Mohyuddin and Muhammad Adnan Khan [6] explores how Machine Learning is transforming agriculture by integrating ICT with smart and precise farming. ML analyzes data for crop selection, disease detection, and irrigation optimization and also enabling autonomous farming with drones and vehicles.

In "Machine learning enabled IoT system for soil nutrients monitoring and crop recommendation" by Md Reazul Islam et al. [7] the authors have introduced an ML-enabled IoT device for soil nutrient monitoring and crop recommendations. Using sensors like FC-28, DHT11, and JXBS-3001, it collects real-time data, analyzes it via ML to suggest high-yield crops and fertilizers. Data is stored for quality assessment via a mobile app. Field tests have shown improved productivity and resource efficiency.

The paper "Proprietor: A Farmer Assistance Smartphone Application with Crop Planner, Crop Disease Help, Agri-expert Search, and Crop Suggestion Features" by Mahfuzulhoq Chowdhury et al. [8] proposes an intelligent farmer assistance app to address farming challenges like funding shortages and rising costs. It includes features such as online crop selling, expert consultation, weather updates, loan applications, crop disease assistance, and fertilizer recommendations. User evaluations show that at least 56% provided positive feedback on its practicality and effectiveness.

This project "A Recommended System for Crop Disease Detection and Yield Prediction Using Machine Learning Approach" by Pooja Akulwar [9] focuses on developing an intelligent agricultural system using machine learning to help farmers in decision-making. It helps predict market prices, assess risks, optimize investments, and improve crop management through yield prediction and disease detection.

This paper "A Recommendation System for Integrated Agriculture Using Neural Networks with Random Forest Algorithm" by Shubham Gaud et al. [10] focuses on developing an AI-driven agricultural system to improve crop selection, disease detection, and market access for farmers. A random forest-based recommendation system (96% accuracy) suggests the best crops that can be grown, while a CNN model (75% accuracy) detects plant diseases. I addition to that, an e-commerce platform has been integrated for the farmers to sell produce directly, thereby modernizing farming practices.

This book "Artificial Intelligence and Smart Agriculture" by Varsha Kanojia et al. [11] focuses on the integration of AI in smart farming to optimize agricultural practices using precision agriculture

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practices. It makes the use of AI algorithms, remote sensing, and data analytics to improve crop monitoring, resource allocation, and livestock management. The study highlights AI's potential to improve yields, reduce waste, and transform traditional farming while addressing the benefits and challenges.

The study "The Transformation of Agriculture by Artificial Intelligence in Smart Farming" by Mohammed Abd. Mohammed et al. [12] focuses on the impact of AI-powered smart farming in transforming agriculture by providing automation and data-driven decision-making. It highlights AI's role in improving the efficiency, decreasing the labor costs, optimizing irrigation, and increasing productivity. The study emphasizes on AI's potential to revolutionize food production while catering challenges like data misuse and accessibility, advocating for ethical and sustainable implementation.

This work "Enhancing Crop Management: Ensemble Machine Learning for Real-Time Crop Recommendation System from Sensor Data" by Sadia Hossain et al. [13] focuses on developing a Crop Recommendation System (CRS) that leverages AI and real-time soil monitoring to optimize crop selection. The use of sensor-based data and machine learning models with 99% accuracy, the system provides tailored recommendations through a user-friendly interface. This integration of AI and hardware sensing aims to revolutionize crop management and support agricultural stakeholders with actionable insights.

This research "Understanding farmers engagement and barriers to machine learning-based intelligent agricultural decision support systems" by Damilola Tobiloba Adereti et al. [14] focuses on analyzing the problems and opportunities for adopting decision support systems (DSS) in precision farming. A survey of 312 South Dakota farmers provided key concerns, including cost, knowledge gaps, confidence, and security issues, using exploratory factor and latent profile analysis. Understanding farmer concern profiles can help improve engagement strategies, leading to wider DSS adoption among farmers.

This paper "Artificial Intelligence and the Internet of Things-Enabled Smart Agriculture for the Modern Era" by K.Shashidhar Reddy et al. [15] focuses on the integration of AI and IoT in smart agriculture to enhance efficiency and sustainability. By combining AI's data analytics with IoT's real-time connectivity, farmers are able to gain valuable insights for improved decision-making. While this technology transforms agriculture, challenges like data security and accessibility should be addressed for widespread adoption.

I.Table Summary of the literature survey

SR NO	AUTHOR	TITLE-AND PUBLICATION	KEY FINDINGS
1.	Lin, Yiyu, Huixiang Li, Ang Li	"Application of AI-driven cloud services in intelligent agriculture pest and disease prediction"	This paper explores Cloud computing which enhances agriculture by enabling real-time monitoring, data-driven decision-making, and improved productivity.
2.	Hridesh Harsha Sarma, Bikash Chandra Das	" Data-driven agriculture: Software innovations for enhanced soil health, crop nutrients, disease detection, weather forecasting, and fertilizer optimization in agriculture"	Examines the integration of different software technologies in the modern agriculture which is essential for optimizing farm operations, resource management, and decision-making.
3.	Alfaneti, Tinotenda Rodney Choto	" Intelliagric: An Intelligent, Integrated Farm Assistant "	Integrates IoT and AI, using soil sensors for real-time monitoring and machine learning for maize disease prediction and market forecasting.

III.Methodology

A. Crop Disease Detection

The crop disease detection model utilizes a Convolutional Neural Network (CNN) to classify crop images into three disease categories: Powdery Mildew, Healthy and Rust. The project begins with data collection, followed by organizing images into training, validation, and testing sets. The process of data preprocessing includes image resizing, normalization, and data augmentation (rotation, zooming, flipping) which not only improves model generalization but also prevents overfitting.

The Crop disease detection model has been developed using Keras and TensorFlow. This model has convolutional and pooling layers that facilitate feature extraction and fully connected layers that help in classification. The model undergoes training and validation, where performance is being monitored using accuracy metrics. After training, the model is saved for real-time predictions, thereby allowing efficient and automated disease identification.

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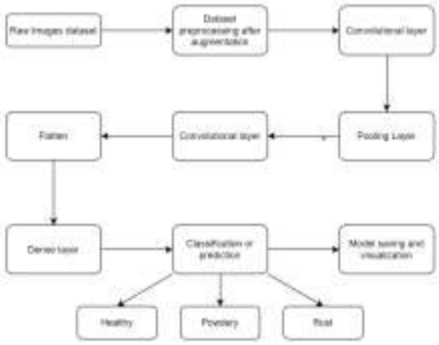
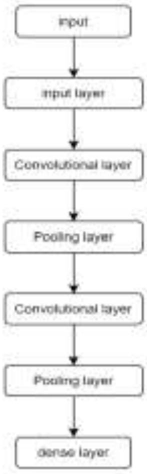
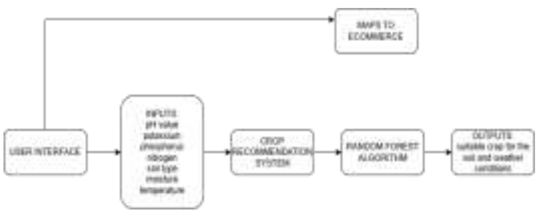




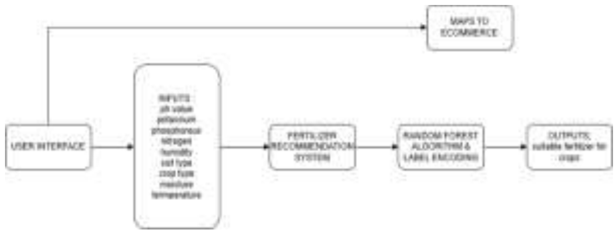
B. Crop Recommendation System

This system makes the use of Random Forest Algorithm using libraries, to analyze input parameters and provide accurate crop recommendations to the farmer. The user-friendly interface allows farmers to input data such as soil type, pH value, location, and environmental conditions. The model processes this data and suggests the best suitable crop, ensuring sustainable farming practices.



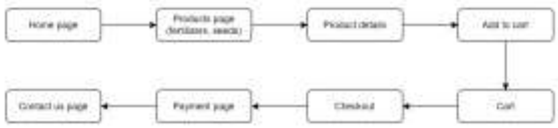
C. Fertilizer Recommendation System

The system implements machine learning techniques, specifically a Random Forest Classifier, to analyze input parameters and provide proper fertilizer recommendations. The user-friendly interface allows farmers to input data such as soil type, crop type, and other environmental conditions. The model processes this data and suggests the optimal fertilizer, ensuring improved crop yield and soil health. To enhance usability, categorical variables like Soil Type, Crop Type, and Fertilizer are preprocessed using Label Encoding, converting them into numerical values for efficient model training and predictions. In addition, the trained model is stored using Pickle, enabling fast and efficient predictions without the need for retraining the model. This ensures that farmers can receive real-time fertilizer recommendations, which helps them make informed decisions for better agricultural productivity.



D. E-commerce

An E-commerce website is developed to provide a platform for selling essential agricultural products, including fertilizers, manures, and seeds. The website is designed with a user-friendly interface, allowing customers to easily browse through product categories. Each product page includes detailed descriptions, specifications, and high-quality images to assist users in making informed decisions. The customers can add any product to the cart and can easily edit the cart section if needed. Additionally, the website has a secure payment gateway and a streamlined checkout process to facilitate smooth transactions.



E. Chatroom

The development of the chatroom system follows a structured approach to ensure seamless communication between farmers and agricultural experts. The system has been designed with the help of a web-based architecture, integrated real-time messaging, and topic-based discussion communities for effective knowledge exchange. The backend was implemented using a Node.js server with WebSocket technology, ensuring low-latency communication, while the frontend was developed using React.js for an intuitive and responsive user experience.

IV.Results

A.Crop Disease Detection System

The developed crop disease detection model effectively classifies leaves into three categories:

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Powdery Mildew, Rust, and Healthy. It utilizes Sequential Convolutional Neural Networks (CNNs), to achieve high accuracy in identifying disease symptoms based on leaf images. The dataset was curated to include diverse samples, ensuring the system's strength in recognizing disease patterns.
The results shows that the model can accurately detects Powdery Mildew, that can be identified as the white fungal growth, and Rust Disease, which can be observed as reddish-brown dots. Healthy leaves are correctly classified with no to minimal misclassification errors. The evaluation metrics, like accuracy, precision, recall, and F1-score tells us about the model's effectiveness.

Fig.1.Prediction of a healthy plant

Fig.2.Prediction of a Powdery Mildew plant

Fig.3.Prediction of a plant having Rust disease

B.Crop Recommendation System
The Crop Recommendation System successfully analyzes soil type, pH value, location, and other environmental conditions to suggest the most suitable crops. Using a Random Forest Classifier, the system provides accurate recommendations, promoting sustainable farming. The user-friendly interface allows farmers to input data without much efforts. By enabling data-driven decision-making, the system enhances precision agriculture, ensuring efficient land use and improved productivity.

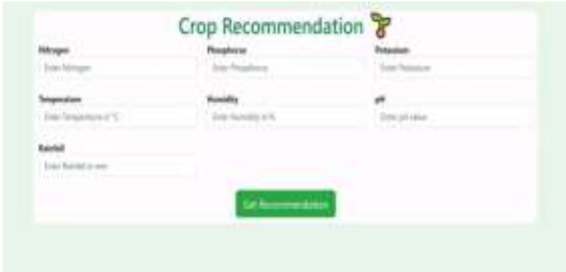

Fig.4.Crop Recommendation System

Fig.5.Prediction of Crop from the inputs

C.Fertilizer Rcommendation System
The system efficiently recommends the most suitable fertilizer by analyzing the key agricultural parameters using Random Forest Classification Algorithm. It ensures fast and accurate predictions by leveraging preprocessed data and a stored model for real-time recommendations. With a user-friendly interface, farmers can easily input details such as soil type, crop type, humidity, moisture, and many more essential details to receive precise fertilizer suggestions.

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Fig.6.Fertilizer Recommendation System

Fig.7.Prediction of Fertilizer from the inputs

C.E-commerce

In parallel, an e-commerce platform was developed to facilitate access to essential agricultural inputs, including fertilizers, seeds, pesticides, and herbicides. The platform integrates seamlessly with the disease detection system, allowing farmers to receive disease diagnoses and purchase recommended treatments directly.

Fig.8.E-commerce Home page

Fig.9.E-commerce Products page

D.Chatroom for farmers

The developed chatroom system serves as an interactive platform where farmers and agricultural experts can communicate, share knowledge, and seek real-time advice on issues such as crop diseases, soil health, and best farming practices. Featuring real-time messaging and topic-based discussions, the system ensures seamless interaction and accessibility for users with varying technical expertise. By facilitating expert guidance and peer discussions, the chatroom enhances decision-making, accelerates problem-solving, and promotes sustainable farming practices.

Fig.10.Joining chatroom

Fig.11.Communications in the chatroom

E.Formulas

In order to check the performance of the crop disease detection model, standard evaluation metrics, like Precision, Accuracy, and F1-Score, have been used. These metrics provide a quantitative measure of the

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model's effectiveness in distinguishing between different categories of diseases.

Precision

Precision is a measure of the proportion of correctly predicted positive cases upon the predicted positive cases, indicating how well the model reduces false positives. It is expressed as:

$$\text{Precision} = \frac{TP}{TP + FP}$$

where TP stands for True Positive (diseased leaves), and FP stands for False Positive (healthy leaves incorrectly classified as diseased leaves).

Accuracy

Accuracy is the measure to check the overall correctness of the model. It is calculated by evaluating the proportion of correctly classified instances across all of the categories. It is defined as:

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

where TN represents True Negative (healthy leaves), and FN refers to False Negative(diseased leaves incorrectly classified as healthy).

F1-Score

F1-Score provides a balanced measure for both false positives and false negatives. F1-Score is referred to as the harmonic mean of Recall and Precision. It is specifically useful when dealing with imbalanced datasets. The formula is given as:

$$\text{F1-Score} = 2 \times \frac{\text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

These evaluation metrics provide a comprehensive assessment of the model's classification performance.

E.Accuracy Calculation of the Algorithms

The Random Forest (RF) algorithm was chosen for both crop and fertilizer recommendation systems because of it's better accuracy compared to other machine learning models.

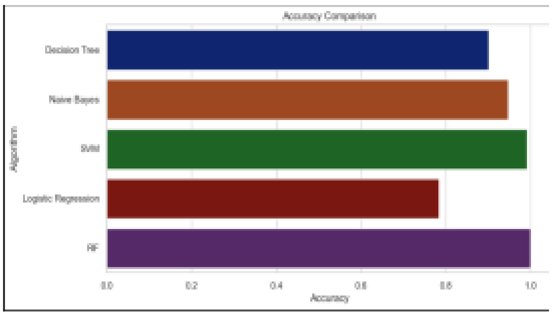

Fig.12.Comparing accuracy of various algorithms

As shown in the accuracy comparison graph, Random Forest Algorithm performs better than Decision Tree, Naïve Bayes, Support Vector Machine (SVM), and Logistic Regression, making it the best choice for classification tasks. Its ability to aggregate multiple decision trees enhances generalization and reduces the risk of overfitting, thereby ensuring more accurate predictions. Additionally, Random Forest efficiently handles complex agricultural data, including soil type, pH value, crop type, and environmental conditions, making it most suitable for recommendation tasks. The model also provides insights into feature importance, helping one to identify key factors influencing crop and fertilizer selection.

V.Conclusion

In conclusion, our agriculture-based platform has successfully integrated crop disease detection, crop and fertilizer recommendations, a chatroom for farmers, and an e-commerce website to help the farmers to the greatest extent we can with the help of technology. The use of Sequential CNN for disease detection and the implementation of the Random Forest Algorithm for accurate crop and fertilizer recommendations, our system has been able to provide a strong, data-driven approach to modern farming. Our project improves agricultural productivity by providing real-time insights, also reducing the dependance on manual expertise. The project ensures timely interventions for proper maintenance and prevents any kind of a loss to the farmer. In addition to that, the integrated e-commerce website provides access to essential agricultural products and services, thereby providing the farmers with a comprehensive solution to all of their requirements and issues. This innovative approach will not only improve decision-making, and resource management but also helps in sustainable agricultural practices. It will provide the farmers the necessary tools to survive in a modern agricultural environment.

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