Crop Disease Detection Using ML Health Assistance Chatbot

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Abstract:
Agriculture is one of the most important sectors, but crop diseases often cause heavy losses for farmers. Many farmers struggle to identify plant diseases at an early stage because it requires expert knowledge and regular monitoring, which is not always available. To solve this problem, we propose a smart system that uses deep learning, specifically a Convolutional Neural Network (CNN), to automatically detect crop diseases from images.In this system, farmers can easily upload a picture of the affected crop through a mobile or web application. The CNN model then analyzes the image and predicts whether the crop is healthy or infected. If a disease is detected, the system provides detailed information about the disease, its symptoms, preventive measures, and the right products (like pesticides or fertilizers) that can help in controlling it. This helps farmers take quick action before the disease spreads further.To make the solution more interactive and farmer-friendly, the system also includes a chatbot. The chatbot allows farmers to ask questions in simple language about crop care, diseases, or best farming practices, and receive instant guidance. By combining image-based disease detection with an AI-powered chatbot, the system not only diagnoses crop health problems but also becomes a 24/7 virtual assistant for farmers.

Key Words: Crop Disease Detection Convolutional Neural Network (CNN) Deep Learning Image Classification Precision Agriculture Chatbot Assistance Smart Farming.

INTRODUCTION

Farming is the backbone of our country, but farmers often face big challenges when their crops get affected by diseases. Identifying these diseases at the right time is very important because even a small delay can lead to huge losses in crop yield and income. Most farmers depend on manual observation or advice from experts, but this process is time-consuming, costly, and not always reliable.

With the help of modern technology, especially Artificial Intelligence (AI), we can make this process faster and easier. In this project, we use a Convolutional Neural Network (CNN) model to detect crop diseases automatically from images. Farmers just need to take a picture of their plant and upload it to the system. The system will then analyze the image, identify if there is any disease, and give useful suggestions such as precautions and recommended products to control it.

To make the solution more helpful, we also include a chatbot where farmers can ask questions in simple language about their crops, diseases, or farming practices. This makes the system act like a virtual farming assistant that is available anytime.

By combining AI-powered image analysis with an interactive chatbot, this system aims to reduce crop damage, save farmers' time, and increase overall productivity in agriculture.

LITERATURE SURVEY

Mohammad Anwar Hossain, Newaz Ibrahim Khan, Noshin Un Noor, Fazle Rabby, Ashiqur Rahman and Hridoy Chandra Shill, "Crop health analysis system: Integrating machine learning for disease detection in agricultural images", International Journal of Computing and Artificial Intelligence 2025. This project introduces an innovative approach to detecting plant diseases using the latest technology in artificial

intelligence. By combining Convolutional Neural Networks (CNNs) for extracting important image features and the ResNet-50 model for classifying those features, the system can accurately identify crop diseases from images. Through a structured image classification process that includes collecting, processing, and enhancing data, the model achieves high accuracy and efficiency in disease detection. A key highlight of the project is the integration of this advanced machine learning model with a user-friendly web application built using Streamlit. This allows farmers to easily upload images and receive instant disease diagnoses online. When compared to the standard ResNet-50 model, the optimized version used in this project shows improved performance, reaching an impressive 98.72% accuracy. This system not only matches but surpasses traditional methods in terms of speed, accuracy, and scalability. The project also takes into account both technical requirements (like reliable datasets) and broader qualities such as ease of use, resilience, and the ability to adapt to various agricultural conditions. What sets this solution apart is its ability to serve both small and large-scale farms, adapt to changing environments, and support sustainable farming. By helping farmers detect diseases early, this system can lead to higher crop yields, reduce the need for pesticides, and contribute to global food security. It's a strong example of how machine learning can transform agriculture and create real-world impact.[1]

Chatla Subbarayudu and Mohan Kubendiran, "A Comprehensive Survey on Machine Learning and Deep Learning Techniques for Crop Disease Prediction in Smart Agriculture", Nature Environment and Pollution Technology An International Quarterly Scientific Journal 2024. This paper presents a detailed review of various AI-based methods used for predicting crop diseases. It explores and compares a wide range of research studies, focusing on the techniques used, key parameters, and performance outcomes. The review also identifies the strengths and limitations of each approach. To demonstrate the practical impact of these technologies, a case study is included that shows how a shift towards deep learning can lead to the development of a more accurate and efficient disease prediction model. The study also highlights current research gaps and suggests directions for future work. Based on the survey, deep learning methods have been found to outperform traditional machine learning approaches in terms of accuracy and reliability, showing strong potential in reducing crop loss and improving agricultural productivity.[2]

Dr.Sonali Kothari, Dr. Pooja Bagane, Manasvi Mishra, Saloni Kulshrestha, Yashika Asrani, Vrinda Maheswari, "CropGuard : Empowering Agriculture with AI driven Plant Disease Detection Chatbot", International Journal of Intelligent Systems And Applications In Engineering 2024. Crop diseases, mostly caused by bacteria and fungi, continue to be a major threat to crop quality and food production around the world. For many farmers, especially in developing countries, spotting these diseases early is a real challenge. It often requires trained experts, which can be both expensive and time-consuming. However, with the rise of smart devices and AI, there's now a real opportunity to automate disease detection, making it faster, more affordable, and more accessible. In today's world—where climate change, shifting disease patterns, and increasing food demand are putting more pressure on agriculture—farmers need smarter tools to stay ahead. Unfortunately, many of the tools currently available are either too complex or out of reach. That's why we created CropGuard. It's an AI-powered chatbot designed to help detect plant diseases quickly and easily. The system brings together a user-friendly interface built with Streamlit, powerful deep learning models for analyzing plant images, and GPT-3.5 Turbo to allow natural, helpful conversations with users. What makes CropGuard truly stand out is its ability to learn and improve over time. By using feedback from users and new data, the chatbot gets better with each interaction—becoming more accurate and more useful as it goes. Our goal is to give farmers a smart, evolving tool that helps them protect their crops, improve yields, and adapt to the ever-changing world of agriculture. [3]

Pitchayagan Temniranrat , Kantip Kiratiratanapruk , Apichon Kitvimonrat, Wasin Sinthupinyo , Sujin Patarapuwadol , "A System for Automatic Rice Disease Detection from Rice Paddy Images Serviced via a Chatbot", arXiv:2011.10823v2 [eess.SY] 23 Jun 2021. In this study, developed and presented a LINE Bot system designed to diagnose rice diseases using real images captured directly from paddy fields—without the need for any special sample preparation. The goal was to create an easy-to-use, fully automated tool that could help rice farmers improve both the yield and quality of their crops. We applied deep learning techniques, specifically neural networks, to detect diseases in rice plants from these images. To improve upon our previous

work on rice leaf disease detection, we implemented a refined training process for our object detection model. This involved analyzing the model's predictions and using those insights to enhance the quality of the training dataset for future iterations. Among the techniques tested, YOLOv3 emerged as the most effective, and we used it to build the deployment model for the LINE Bot. Trained on the refined dataset, the model's performance improved significantly, with the Average True Positive Point increasing from 91.1% in our earlier research to 95.6% in this study. The deployed LINE Bot provided real-time disease diagnosis suggestions within LINE groups that included both rice farmers and agricultural specialists, allowing for quick communication and expert feedback. In actual use, the system achieved an average accuracy of 78.86% and was able to deliver results in just 2–3 seconds, making it both fast and practical for everyday farming use. [4]

Moshiur Rahman Tonmoy , Md. Mithun Hossain , Nilanjan Dey, "MobilePlantViT: A Mobile-friendly Hybrid ViT for Generalized Plant Disease Image Classification", arXiv:2503.16628v1 [cs.CV] 20 Mar 2025. lant diseases pose a serious threat to global food security by lowering crop yields and impacting sustainable farming practices. Ths paper introduce MobilePlantViT—a lightweight yet powerful hybrid Vision Transformer (ViT) model designed specifically for plant disease classification. Our goal was to build a model that is both efficient and accurate, making it suitable for real-world smart agriculture applications, even in low-resource settings. We tested MobilePlantViT across a wide range of plant disease datasets and found it to be highly effective and generalizable, achieving test accuracies from 80% to over 99%. What's particularly noteworthy is that our model has only 0.69 million parameters, yet it outperforms the smaller versions of MobileViTv1 and MobileViTv2, both of which have more parameters. This highlights the strength of our design in balancing performance with efficiency. We believe MobilePlantViT offers a practical and scalable solution for AI-powered plant disease detection, especially in sustainable and resource-constrained agricultural environments. [5]

Konstantinos I. Roumeliotis, Ranjan Sapkota, Manoj Karkee, Nikolaos D. Tselikas, and Dimitrios K. Nasiopoulos, "Plant Disease Detection through Multimodal Large Language Models and Convolutional Neural Networks", IEEE Transactions, Automation in agriculture is becoming increasingly important, especially for tackling challenges like crop monitoring and early disease detection. In this study, explore how combining advanced AI tools—specifically multimodal Large Language Models (LLMs) like GPT-4o—with Convolutional Neural Networks (CNNs) can improve plant disease identification using leaf images. Using the well-known PlantVillage dataset, we tested how well these models performed under different training scenarios, including zero-shot (no prior examples), few-shot (a handful of examples), and progressive fine-tuning. We focused on two plant species—apple and corn—and tested image resolutions of 100, 150, and 256 pixels to simulate different quality levels. When comparing GPT-4o to the popular ResNet-50 CNN model, we found that the fine-tuned GPT-4o slightly outperformed ResNet-50, reaching up to 98.12% accuracy on apple leaf images, compared to 96.88% for ResNet-50. GPT-4o also showed better generalization and minimal training loss. However, its performance in zero-shot settings was much lower, highlighting the importance of even minimal training to unlock its full potential. We also examined how well the models could adapt across different resolutions and plant types. These tests revealed both the strengths and limitations of the models when applied outside their original training conditions.[6]

Maruti Saisurya Rajanala1, Muppirisetti Sivakiran, Manduva Sai Revanth, Ms. S. Subbulakshimi, Ms. Priyanka G, Dr Anand M, " Agricultural Chatbot Voice Assistant Using NLP Techniques", International Journal on Science and Technology (IJSAT)2025. This paper presents the Agriculture Chatbot Voice Assistant (ACVA)—an innovative virtual advisor powered by Multi-Layer Perceptron (MLP) neural networks and Natural Language Processing (NLP) techniques. ACVA is designed to provide farmers with real-time insights and personalized recommendations, helping them make informed decisions across various aspects of farming. By leveraging MLP, the system can analyze complex agricultural data, including soil health, weather conditions, and crop characteristics, to offer tailored guidance on crop management, pest control, and market trends. With built-in NLP capabilities, ACVA understands and responds to farmers' questions in natural, conversational language. The addition of voice recognition technology makes the system even more accessible, allowing farmers to engage with it seamlessly—even in remote or hands-free

environments. Overall, ACVA has the potential to transform agricultural decision-making by promoting sustainable practices and improving farm productivity through intelligent, user-friendly support.[7]

Shima Ramesh, Mr. Ramachandra Hebbar, Niveditha M, Pooja R, Prasad Bhat N, Shashank N, Mr. P V Vinod, "Plant Disease Detection Using Machine Learning", 2018 International Conference on Design Innovations for 3Cs Compute Communicate Control. Crop diseases pose a significant threat to global food security, yet rapid and accurate identification remains a challenge in many regions due to the lack of proper infrastructure. This paper explores the use of a Random Forest classifier to distinguish between healthy and diseased leaves using custom-created datasets. Our approach involves several key stages: dataset creation, feature extraction, classifier training, and image classification. For feature extraction, we employ the Histogram of Oriented Gradients (HOG) method to capture relevant visual patterns in the leaf images. The compiled dataset—comprising both healthy and diseased leaf samples—is used to train the Random Forest model, enabling it to accurately classify new inputs. By leveraging machine learning on large, publicly available datasets, this study presents a scalable and effective method for detecting plant diseases, potentially transforming disease management in agriculture at scale.[8]

Deepkiran Munjal, Laxman Singh, Mrinal Pandey, Sachin Lakra, "A Systematic Review on the Detection and Classification of Plant Diseases Using Machine Learning", International Journal of Software Innovation. In this study, review and evaluate the latest state-of-the-art machine and deep learning methods for plant disease detection. Additionally, we highlight the limitations and challenges these technologies face, aiming to shed light on areas where future improvements can enhance their practical usability in agriculture. These modern approaches have even outperformed traditional image processing methods and, in some cases, human experts in accuracy and efficiency. Over the years, many researchers have applied various ML and DL techniques to diagnose a wide range of plant ailments, offering new hope to farmers and landowners for timely intervention.[9]

Pallepati Vasavi, Arumugam Punitha, Thota Venkat Narayana Rao, "Chili Crop Disease Prediction Using Machine Learning Algorithms", Revue d'Intelligence Artificielle Vol. 37, No. 3, June, 2023. This study evaluates the performance of several machine learning algorithms—including Random Forest (RF), AdaBoost, Gradient Boosting (GB), and Multi-Layer Perceptron (MLP)—for predicting diseases in chili crops using image data. We utilize a novel dataset, the Real Chili Crop Field Image Dataset, containing approximately 1,157 images categorized into five distinct disease classes. Experimental results show that the Random Forest and Gradient Boosting algorithms achieve the highest accuracies, at 96% and 94% respectively. Notably, this dataset was collected under natural, uncontrolled field conditions, enhancing the real-world applicability of the findings. To improve classification performance, the study incorporates diverse and widely-used feature extraction methods, such as Haralick and Hu moments, combined with the Random Forest classifier. Overall, this work highlights effective machine learning strategies for practical, field-based disease detection in chili crops.[10]

Sharvari V. Patil, Anjali K. Sharma, Bhagyashree R. Kamble, Kajal B. Jadhav, "Cotton Leaf Disease Detection Using Deep Learning", International Journal of Creative Research Thoughts (IJCRT) Volume 10, Issue 5 May 2022. This project aims to develop an end-to-end web application that can analyze diseases on cotton plants using deep learning algorithms. Beyond detection, the application will also provide farmers with tailored recommendations for products to control or eliminate the diseases effectively. To achieve this, we first gathered a dataset of approximately 1,752 images—around 440 images per category—covering three major cotton diseases: sucking and chewing pest damage, bacterial blight, and curl virus disease. The model will be trained and developed using tools available in the Anaconda environment, such as Jupyter Notebook and Spyder. This project demonstrates the feasibility of deploying AI-driven solutions for real-time disease diagnosis in cotton cultivation and highlights the growing importance of IT-based support systems to complement traditional manual methods of disease and pest identification.[11]

Ruchi Rani, Jayakrushna Sahoo, Sivaiah Bellamkonda, Sumit Kumar, "Role of Artificial Intelligence in Agriculture: An Analysis and Advancements with Focus on Plant Diseases", IEEE Access 2023. This paper presents a comprehensive multi-faceted survey and analysis of recent AI techniques aimed at combating plant

diseases. It explores the challenges farmers encounter and how AI-driven solutions can help overcome them. Additionally, it reviews various AI applications in agriculture, highlighting current trends and innovations such as Identification Model Improvement (IMI), Few-Shot Learning (FSL), Generative Adversarial Networks (GANs), and Self-Supervised Learning (SSL). The article also discusses key challenges in implementing AI for plant disease detection. This survey serves as a valuable resource for researchers seeking to advance AI applications in agriculture and address farmers' pressing issues.[12]

Pallepati Vasavi, Arumugam Punitha, T. Venkat Narayana Rao, "Crop leaf disease detection and classification using machine learning and deep learning algorithms by visual symptoms: a review", International Journal of Electrical and Computer Engineering 2022. This paper provides a comprehensive overview of recent research on crop leaf disease prediction using image processing (IP), machine learning (ML), and deep learning (DL) techniques. These approaches have achieved remarkable accuracy in identifying diseases. We survey various studies, analyzing them based on dataset size, number of images, disease classes, algorithms employed, convolutional neural network (CNN) models used, and overall performance. Based on this analysis, we offer recommendations on the most suitable algorithms for deployment across different platforms, including standard computers, mobile and embedded systems, drones, robots, and unmanned aerial vehicles (UAVs).[13]

Vaishnavi Monigari, G. Khyathi Sri, T. Prathima, "Plant Leaf Disease Prediction", International Journal for Research in Applied Science & Engineering Technology (IJRASET)2021. Agriculture plays a vital role in the Indian economy, and plant diseases pose a serious threat by causing significant losses in crop yield, quality, and economic value. Early and accurate detection of plant diseases is essential to prevent these losses and ensure sustainable agricultural productivity. Monitoring large crop areas manually is both labor-intensive and requires specialized expertise, making it impractical at scale. To address this, image processing techniques have become an effective approach for plant disease detection. These techniques involve stages such as image acquisition, filtering, segmentation, feature extraction, and classification, enabling timely and efficient identification of diseases to support better crop management.[14]

Ersin Elbasi, Chamseddine Zaki, Ahmet E. Topcu, Wiem Abdelbaki, Aymen I. Zreikat , Elda Cina, Ahmed Shdefat and Louai Saker, "Crop Prediction Model Using Machine Learning Algorithms", Appl. Sci. 2023. This research explores the potential benefits of integrating machine learning algorithms into modern agriculture to optimize crop production and reduce waste through informed decisions about planting, watering, and harvesting. The paper reviews the current state of machine learning applications in agriculture, discusses key challenges and opportunities, and presents experimental results demonstrating how label changes affect the accuracy of data analysis algorithms. By analyzing diverse farm data—including real-time online IoT sensor inputs—farmers can make better decisions that influence crop growth positively. We evaluated fifteen different algorithms to identify the most suitable ones for agricultural applications and proposed a new feature combination-enhanced algorithm. Our results show classification accuracies of up to 99.59% with the Bayes Net algorithm and 99.46% with Naïve Bayes and Hoeffding Tree classifiers. These findings suggest that integrating machine learning can boost crop yields, reduce farming costs, and promote more resilient and sustainable agricultural systems. Ultimately, this study's insights can help farmers detect diseases early, improve crop efficiency, and alleviate food shortages worldwide.[15]

Madhuri Shripathi Rao, Arushi Singh, N.V. Subba Reddy and Dinesh UAcharya, "Crop prediction using machine learning", Journal of Physics: Conference Series 2021. This paper aims to identify the best predictive model to assist farmers in selecting the most suitable crops based on climatic conditions and soil nutrient content. We compare popular machine learning algorithms—K-Nearest Neighbor (KNN), Decision Tree, and Random Forest Classifier—using two different criteria: Gini and Entropy. Our results show that the Random Forest algorithm achieves the highest accuracy among the three, making it a promising tool for crop prediction and decision-making in agriculture.[16]

Siddhi Jain, Rahul Sahni, Tuneer Khargonkar, Himanshu Gupta, Om Prakash Verma,Tarun Kumar Sharma , Tushar Bhardwaj, Saurabh Agarwal, and Hyunsung Kim, "Automatic Rice Disease Detection and Assistance

Framework Using Deep Learning and a Chatbot", Electronics 2022. Agriculture not only provides food but also serves as a primary source of income for a large portion of the global population. Among staple crops, rice plays a vital role in ensuring food security, particularly for nearly half the world's people. Paddy plants produce a brown husk-covered seed, which, after de-husking and processing, yields edible rice. However, the rising impact of climate change and global warming has severely affected rice production and quality, primarily due to common bacterial and fungal diseases such as sheath rot, leaf blast, leaf smut, brown spot, and bacterial blight. Early and accurate detection of these diseases is therefore critical. In response, this work proposes an automated smartphone application called E-Crop Doctor, designed to detect rice leaf diseases and recommend appropriate pesticides. The app also includes a 24/7 chatbot assistant named docCrop, offering real-time support and guidance to farmers. The study evaluates the performance of two lightweight object detection algorithms—YOLOv3 Tiny and YOLOv4 Tiny—for their suitability in mobile-based disease detection. Results show that YOLOv4 Tiny outperforms YOLOv3 Tiny, achieving a mean Average Precision (mAP) of 97.36%, which is 17.59% higher than its counterpart. Based on this, YOLOv4 Tiny is deployed within the mobile application for effective, real-time use in the field.[17]

P. Uma, M. Gomathi, K.P. Gokulkumar, T. Monika & P. Preethika, "Empowering agriculture with AI: The smart agrohub initiative", Challenges in Information, Communication and Computing Technology 2025. The proposed model, "Smart AgroHub: Integrating AI for Precision Farming and Agricultural Sustainability," is a comprehensive project leveraging Artificial Intelligence (AI) and Machine Learning (ML) to drive innovation in modern agriculture. The system is composed of multiple integrated modules that work together to enhance farming practices. For crop recommendation, advanced ML algorithms such as Decision Trees and Support Vector Machines analyze seasonal weather data to optimize crop selection. The fertilizer recommendation module employs K-Means Clustering to provide personalized suggestions based on soil composition. Crop disease detection utilizes Convolutional Neural Networks (CNNs) to identify plant diseases through leaf image analysis. The pest control recommendation module applies the Apriori algorithm for association rule mining to suggest effective treatments. Additionally, crop price forecasting is achieved through Linear Regression models that predict market trends. To ensure ease of use, the system includes a farmer-assistance chatbot powered by Natural Language Processing (NLP), enabling real-time, user-friendly interactions. Together, these components offer a holistic, data-driven approach to precision agriculture, aiming to increase productivity, reduce resource waste, and promote sustainable farming practices.[18]

Jonathan Omara, Estefania Talavera, Daniel Otim, Dan Turcza, Emmanuel Ofumbi4 and Godliver Owomugisha, "A field-based recommender system for crop disease detection using machine learning", ORIGINAL RESEARCH article Front. Artif. Intell., 26 April 2023 Sec. This study investigates real-time crop disease monitoring and feedback systems designed to support smallholder farmers. Accurate crop disease diagnosis tools and timely access to agricultural information are essential for sustainable growth in the agricultural sector. The research was piloted in a rural farming community, involving 100 smallholder farmers using a system developed for cassava disease diagnosis and advisory recommendation services. We present a field-based recommendation system that delivers real-time feedback on crop disease identification. The system operates on a question–answer framework, developed using machine learning and natural language processing (NLP) techniques. Several state-of-the-art algorithms were tested, with the Sentence-BERT model (RetBERT) delivering the best performance, achieving a BLEU score of 50.8%. This performance is considered promising, although constrained by the limited size of the training dataset. To ensure accessibility in remote regions with poor internet connectivity, the system supports both online and offline functionality. The encouraging results from this pilot study pave the way for a larger-scale trial aimed at validating the solution's effectiveness in improving agricultural outcomes and addressing food security challenges in sub-Saharan Africa.[19]

Ratna Patil, Yogita Sinkar, Ashish Ruke, Harshvardhan Kulkarni, Om Kadam, "Smart Agri-Advisor: Integrating Chatbot Technology with CNN-Based Crop Disease Classification for Enhanced Agricultural Decision-Making", International Journal of Engineering Trends and Technology 2024. The proposed CNN model demonstrates strong performance, achieving an overall classification accuracy of 91%, and an 82% accuracy in correctly predicting specific disease classes in test samples. The model maintains a low loss value

of 0.2238, indicating stable performance and suitability for real-world agricultural applications. In addition to disease detection, the system features a conversational chatbot developed using React and Natural Language Processing (NLP), enabling intuitive user interactions and efficient query handling. To encourage collaboration and knowledge sharing, a community login and registration system powered by MySQL has been integrated, allowing users to engage with one another through a shared platform. By combining machine learning, intelligent assistance, and community-driven features, Smart Agri-Advisor offers a comprehensive and accessible tool for plant disease diagnosis, decision-making support, and information dissemination in agricultural communities.[20]

Pravalika H V, P Jayavardhini, Pallavi S Gowda, J Tanuja4, Ms. Mamatha A, "AgriAI: An Integrated Web Platform for Plant Disease Detection, Prevention Strategies, Virtual Assistance, and Feedback", International Journal of Research Publication and Reviews 2024. This paper presents an AI-based web platform designed for the detection and prevention of plant diseases through the analysis of leaf images. By applying advanced machine learning algorithms, the system accurately diagnoses potential plant diseases based on visible symptoms on the leaves. In addition to diagnosis, the platform provides actionable prevention strategies, enabling users to take timely crop protection measures to minimize further damage. A standout feature of the system is its integrated chatbot, which offers real-time guidance by answering user queries and recommending treatments for specific plant diseases. To foster user engagement and continuous improvement, the platform also includes a review system where users can share their experiences, providing valuable feedback on the effectiveness of treatments and the system's performance. This AI-powered tool supports farmers, researchers, and horticulturists by delivering accurate, accessible, and real-time diagnostic and prevention solutions—ultimately enhancing agricultural productivity and promoting sustainable farming practices.[21]

Sanskruti Magdum, Chaitanya Vibhute, Mr. Amol Rindhe, "Use of Machine Learning Algorithms for Detecting Crop Disease", Sanskruti Magdum, 2023. This paper presents a machine learning-based approach utilizing neural networks to detect plant diseases from images. By automating the identification process, the system aims to reduce the reliance on manual inspection, minimize human error, and enable timely intervention. While some level of manual oversight is still necessary, advancements in automated monitoring significantly improve the efficiency and accuracy of pest detection. The proposed system offers a simple, fast, and effective method for identifying pests in rice fields, contributing to better crop management and increased productivity, while also supporting the goal of reducing excessive pesticide use.[22]

Amanullah Ansari, Shrejal Singh, Dr. Nikhat Akhtar, "AI-Driven Crop Disease Detection and Management in Smart Agriculture", International Journal of Scientific Research in Science and Technology 2025. Traditional methods used by farmers for diagnosing and classifying plant leaf diseases are often labor-intensive, time-consuming, and prone to inaccuracies. The inability to detect and classify diseases promptly can result in widespread crop damage and significant yield reduction. To address these challenges, the application of computerized image processing techniques has emerged as a powerful solution in modern agriculture. In particular, Convolutional Neural Networks (CNNs) have proven highly effective in image recognition tasks due to their ability to autonomously extract relevant features and understand spatial hierarchies within images. This research leverages CNN-based deep learning methods to detect and classify plant diseases using leaf imagery. By utilizing large datasets and computational power, this approach demonstrates superior performance in disease identification, leading to improved productivity, reduced crop losses, and the promotion of sustainable farming practices through automated and data-driven disease management.[23]

Shikha Choudhary and Bhawna Saxena, "Image-Based Crop Disease Detection using Machine Learning Approaches: A Survey", International Journal of Performability Engineering 2023. In this context, machine learning (ML) has emerged as a powerful tool, capable of enabling early disease detection and facilitating timely preventive measures. By leveraging large datasets and advanced algorithms, ML-based systems can significantly reduce crop losses and improve yield quality. This paper provides a comprehensive review of recent advancements in machine learning approaches for crop disease detection. It explores and evaluates

various methodologies, highlighting their strengths, limitations, and real-world applicability—offering insights into how these technologies can shape the future of smart, sustainable agriculture. [24]

Denis Mamba Kabala , Adel Hafiane , Laurent Bobelin and Raphaël Canals, "Image-based crop disease detection with federated learning", Scientific reports. Nature Portfolio 2023. This study explores the use of federated learning for crop disease classification through image analysis. By leveraging the open-source PlantVillage dataset, we trained and evaluated both Convolutional Neural Networks (CNNs) and Vision Transformer (ViT) architectures in a federated setting—where data remains decentralized across multiple devices or nodes. Our findings indicate that the performance of federated learning models depends heavily on factors such as the number of participating clients, communication rounds, local training iterations, and overall data quality. Among the CNN models tested, ResNet50 consistently outperformed others, proving to be a robust and efficient choice for federated learning scenarios. In contrast, ViT models like ViT_B16 and ViT_B32 demonstrated strong classification capabilities but required significantly more computational resources, making them less ideal in distributed environments where latency and communication efficiency are critical. This paper presents a state-of-the-art analysis of federated learning in the agricultural domain, detailing our methodology, experimental results, and insights. We conclude with recommendations for future research aimed at optimizing federated learning frameworks for real-world crop disease detection and sustainable agriculture.[25]
Maurizio Pintus, Felice Colucci and Fabio Maggio, "Emerging Developments in Real-Time Edge AIoT for Agricultural Image Classification", IoT 2025. This paper enables real-time image classification directly at the edge, allowing for autonomous crop monitoring, localized decision-making, early detection of emergencies like disease or pest outbreaks, and targeted application of chemicals. As a result, farmers can reduce operational costs while minimizing environmental and health impacts. The workflow of an edge-based AIoT system typically involves two main stages: first, deep learning models are trained and fine-tuned on high-performance computing systems, and second, these models are customized for deployment on resource-constrained edge devices. However, there are several key challenges to address. These include the limited availability of agricultural image data—often due to seasonality—which is being mitigated through public datasets and synthetic image generation. Choosing the right computer vision algorithms that offer high accuracy while being efficient enough for low-power devices is another major concern. Furthermore, deploying these models efficiently requires algorithmic optimization and the use of hardware accelerators to support deep learning inference. Although many cutting-edge AI models are not yet fully deployable in edge environments, they show great promise for improving performance and functionality in the near future. This review highlights these challenges and explores the growing potential of edge-based AIoT systems to make agriculture more intelligent, sustainable, and responsive.[26]

Karamjeet Kaur, Priyanshi sharma, Ankit Chaubey, Aman Kumar Mishra4 Priyanka Pathak, "Leaf Disease Prediction", International Journal of Novel Research and Development 2023. Agricultural productivity plays a critical role in supporting the economy, and the early detection of plant diseases is essential to maintaining both crop quality and yield. If left undetected, plant diseases can significantly harm plant health, reduce output, and negatively impact the overall quality of agricultural products. One such disease, little leaf disease, poses a serious threat to pine trees in the United States. To address challenges in large-scale crop monitoring, this study proposes an automated approach for detecting and classifying plant leaf diseases. The method relies on image segmentation techniques, specifically utilizing genetic algorithms, to identify disease symptoms in their early stages. Additionally, the paper explores various classification methods for diagnosing plant diseases and highlights the effectiveness of genetic algorithm-based segmentation in enhancing accuracy. By automating disease detection, the proposed approach aims to reduce manual labor and support more efficient and timely agricultural decision-making.[27]

Prof.(Mrs) Jyotsna V. Barpute1, Ashwini B. Phadatre, Gauri S. Honrao, "Leaf Disease Detection Using Image Processing and ML", International Research Journal of Engineering and Technology 2022. In this paper One such innovation is the Internet of Things (IoT), which plays a key role in smart farming. IoT-enabled sensors can deliver real-time insights into various aspects of agricultural landscapes. When paired with deep learning techniques like Convolutional Neural Networks (CNNs), these technologies can greatly enhance agricultural

productivity. CNNs, which excel in machine vision tasks, are particularly effective in detecting plant diseases by analyzing leaf images. Image processing techniques are used to enhance these images and extract meaningful features, acting as a bridge between raw data and actionable insights. This integration of deep learning, image processing, and IoT paves the way for more efficient, data-driven agricultural practices.[28]

S. Nandhini _and K. Ashokkumar, "Machine Learning Technique for Crop Disease Prediction Through Crop Leaf Image", Applied Mathematics & Information Sciences an International Journal 2022. In this study, a deep convolutional neural network (CNN) was trained to identify 25 different plant diseases across 16 crop types using a publicly available dataset consisting of 64,412 images of both healthy and diseased leaf tissue captured under controlled conditions. The trained model achieved an impressive accuracy of 99.35% on a separate test set, demonstrating the effectiveness and real-world potential of this approach. With this level of performance and the widespread use of smartphones, the study highlights a clear and promising path toward scalable, smartphone-based plant disease detection that could benefit farmers across the globe.[29]

Dr.S. Geethaa, Dr. S. Balajia, Santhiya. Ab, Subashri. Cb, and Subicsha. Sb, "Farm's Smart BOT", Turkish Journal of Computer and Mathematics Education 2021. This paper introduces a smart bot designed to help farmers increase productivity by offering tailored agricultural advice. The bot integrates multiple advanced algorithms, with an emphasis on those best suited for different tasks. Built to be platform-independent, it functions seamlessly across various operating systems. Leveraging Natural Language Processing (NLP) for text classification and YOLOv3 for object detection, the Farm's Smart BOT provides an interactive conversational system. It combines several predictive modules, including crop detection, soil analysis, crop disease identification, crop rotation suggestions, and weather forecasting—offering farmers a comprehensive tool for smarter decision-making.[30]

Banupriya. N, "Plant Disease Detection Using Image Processing and Machine Learning Algorithm", Journal of Xidian University 2020. This paper also explores the use of binding segmentation and retrieval functions to analyze two different plant diseases. Identifying plant diseases is essential for achieving good crop yields and maintaining the quality and quantity of agricultural products. Detecting plant diseases involves considering many farming factors such as organic practices, continuous monitoring, and accurate recognition of various illnesses. In farms with diverse crops, manually tracking diseases becomes impractical due to the extensive labor, specialized knowledge, and time required. To address this, image processing techniques combined with K-means clustering and convolutional neural networks can be used for precise disease prediction. The detection process typically involves image segmentation, data preprocessing, image fragmentation, and feature detection and recognition.[31]

Fatma M. Talaat, "Leveraging Machine Learning for Real-Time Plant Disease Detection in the Green Aid System", Kafrelsheikh University, Kafrelsheikh 33516, Egypt. This paper presents GreenAid, an AI-driven system that leverages advanced deep learning and computer vision techniques to provide a scalable, precise, and efficient solution for plant disease detection and diagnosis. At the core of GreenAid is a powerful Convolutional Neural Network (CNN) optimized via transfer learning on large agricultural image datasets, enabling automated and highly accurate identification of plant diseases. The system includes a user-friendly mobile app for capturing and analyzing images directly in the field, alongside a web-based platform for detailed data visualization and historical analysis. An interactive chatbot further enhances user experience by offering timely assistance and guidance. Evaluation results demonstrate GreenAid's effectiveness in improving crop health management, reducing dependence on expert knowledge, and empowering farmers with actionable insights to combat diseases and adopt sustainable practices. By integrating cutting-edge technology with practical agricultural solutions, GreenAid contributes significantly to global efforts in advancing food security and promoting sustainable farming.[33]

Ganesha Srinivas Damaraju, Sai Siddharth Cilamkoti, Lekshmi Venugopal, Vaishnavi Warrier, Devi S Ashok, "PlantHealthAI: An Integrated System for Plant Disease Detection, Severity Prediction with Knowledgebase Chatbot Support", 2023 3rd International Conference on Smart Generation Computing, Communication and Networking. Detecting plant diseases and estimating their severity are critical steps in minimizing the negative

impact on crop yields. This research presents a deep learning-based model designed to detect early leaf spot disease in groundnut crops and assess its incidence level. To evaluate the approach, a real-world dataset was created by inducing early leaf spot disease on susceptible plants in a controlled environment. The model achieved high performance with precision and recall rates of 98% and 95%, respectively. Additionally, the severity estimation model demonstrated promising accuracy, with a maximum absolute difference of 0.5 between predicted and actual severity measures. To enhance usability, a user query feedback system supported by a comprehensive knowledge base was incorporated, providing farmers with detailed information about the detected disease. This system empowers users to make informed decisions for effective disease management, promoting sustainable crop protection practices and positively impacting the agricultural sector.[34]

Md. Manowarul Islam, Md Abdul Ahad Adil, Md. Alamin Talukder, Md. Khabir Uddin Ahamed, "Deep Crop: Deep learning-based crop disease prediction with web application", Journal of Agriculture and Food Research 2023. Agriculture plays a vital role in the economy of every nation by producing essential crops. Timely and accurate identification of plant diseases is crucial to maintaining a healthy and productive agricultural sector, helping to avoid unnecessary resource wastage. Plant diseases cause significant annual losses for crop farmers worldwide. Deep learning techniques offer a promising solution for early disease detection in plant leaves, thereby preventing crop failure. In this study, we evaluated several models—CNN, VGG-16, VGG-19, and ResNet-50—using the PlantVillage dataset containing 10,000 images to detect crop infections. The models achieved accuracy rates of 98.60%, 92.39%, 96.15%, and 98.98%, respectively, with ResNet-50 outperforming the others. Based on these results, the ResNet-50 model was selected for development into a smart web application aimed at real-life crop disease prediction. This application helps farmers identify plant diseases by analyzing leaf images and classifying the disease present using transfer learning. Ultimately, the goal is to empower farmers to detect diseases early, save resources, and minimize economic losses through timely and appropriate treatments.[35]

Peng Jiang, Yuehan Chen, Bin Liu, Dongjian He, And Chunquan Liang, "Real-Time Detection of Apple Leaf Diseases Using Deep Learning Approach Based on Improved Convolutional Neural Networks", Special Section on Advanced Optical Imaging For Extreme Environments 2019. This paper proposes a deep learning approach using an improved convolutional neural network (CNN) model for real-time detection of apple leaf diseases. To achieve this, an Apple Leaf Disease Dataset (ALDD) was constructed, combining laboratory images and complex real-field images, enhanced through data augmentation and image annotation. Building on this dataset, a novel detection model named INAR-SSD was developed by integrating the GoogLeNet Inception structure with Rainbow concatenation. The model was trained on 26,377 images from the ALDD and evaluated on a hold-out test set, achieving a mean Average Precision (mAP) of 78.80% and a high detection speed of 23.13 frames per second (FPS). These results demonstrate that the INAR-SSD model offers a high-performance, real-time solution for early diagnosis of apple leaf diseases, surpassing previous methods in both accuracy and speed.[36]

Bharati Patel, Aakanksha Sharaff, "Rice Crop Disease Prediction Using Machine Learning Technique", International Journal of Agricultural and Environmental Information Systems 2021. Crop yields are severely impacted by the widespread occurrence of unchecked diseases, which spread in a manner similar to cancer in the human body. However, unlike cancer, these plant diseases can be detected early through the analysis of plant phenotyping traits. Effective disease identification relies on several steps, including segmentation, feature extraction, feature selection, and classification. Choosing the optimal combination of these methods is challenging due to the large variety available, often resulting in ineffective disease prediction models. This paper proposes a highly effective machine learning-based adaptive learning algorithm that optimizes the classification process, improving the overall accuracy of crop disease detection across datasets with varying dimensionalities and feature sets. The proposed method achieves an impressive accuracy of 99.2%, outperforming traditional techniques such as back-propagation neural networks (BPNN), convolutional neural networks (CNN), and support vector machines (SVM).[37]

Keith D. Shepherd , Mathew A. E. Miller, Bruce Kisitu, Benjamin G. Miles, Kodjo Gbedevi, " Virtual Agronomist – an AI-assisted chatbot for guiding crop management decisions of smallholder farmers in

Africa", International Fertiliser Association. Many smallholder farmers in Africa struggle to get the right farming advice because there aren't enough agricultural experts to go around. To help with this, the Virtual Agronomist was created—a digital tool that gives farmers personalized, practical advice about soil and crop care throughout the growing season. Farmers use WhatsApp to interact with the system, which is powered by smart technology like ChatGPT to make conversations easy. After farmers register and mark their fields on a map, the system uses soil data and information from the farmers themselves to suggest the best ways to manage their crops and improve yields. Throughout the season, farmers receive simple questions about how their crops are doing—like checking for pests or weeds—and the system responds with helpful tips based on their answers. To make sure even farmers without smartphones or those who speak different languages can benefit, the program trains lead farmers who share advice with their communities, supported by incentives. This mix of technology and local support has led to rapid growth, with over 100,000 farms signed up and millions of messages exchanged in just a few months. In one county in Kenya, nearly 8 out of 10 farmers started using the system. Surveys show farmers using Virtual Agronomist grew 1.4 to almost 2 times more crops than those who didn't. And all this comes at a low cost—only about $1.50 per farmer each season—making it a promising, affordable way to reach more farmers with better advice than traditional methods.[38]

Jayagopi G, Sumathi C B, "Smart Crop Disease Detection Using IOT and Machine Learning Techniques", International Journal of Novel Research and Development 2025. With the fast growth of Internet of Things (IoT) technology and the increasing need for sustainable farming, this study introduces a smart system to help detect and manage crop diseases early. The system uses a network of IoT devices placed in the fields that monitor important environmental factors like temperature, humidity, and soil moisture, while also capturing images of crop leaves. All this data is sent to a central server where machine learning techniques—like Convolutional Neural Networks (CNNs) and Support Vector Machines (SVMs)—analyze it to accurately identify and classify diseases. Both supervised and unsupervised learning approaches are tested to improve detection accuracy. The goal is to give farmers timely information so they can take early action, leading to healthier crops and better yields.[39]

Lakshmikanth Paleti, Arava Nagasri, P. Sunitha, V Sandya, T. Sumallika5, Prabhakar Kandukuri, K. Kishore Kumar, "Sugar Cane Leaf Disease Classification and Identification Using Deep Machine Learning Algorithms", Journal of Theoretical and Applied Information Technology 2023. Detecting crop diseases is a major challenge in agriculture and related fields like forestry and rural medicine. Identifying and classifying leaf diseases, especially in crops like sugarcane, is crucial for precision farming and managing weeds effectively. This paper presents a new approach for recognizing diseases in sugarcane plants using image classification of their leaves. The method explores a combination of machine learning techniques, starting with k-Nearest Neighbors (k-NN) and Support Vector Machines (SVM) for initial training alongside Artificial Neural Networks (ANN), followed by advanced deep learning using Convolutional Neural Networks (CNNs) for more accurate disease detection.[40]

METHODOLOGY

The first step is to collect images of different crops, including both healthy and diseased leaves. These images are gathered from trusted agricultural datasets and real farm samples. Having a large and diverse dataset helps the system learn to recognize diseases more accurately.

Once the images are collected, they are cleaned and prepared for training. This involves resizing the images, removing noise, and sometimes enhancing the colors to make disease patterns more visible. Preprocessing ensures that the images are consistent and ready to be used by the CNN model.

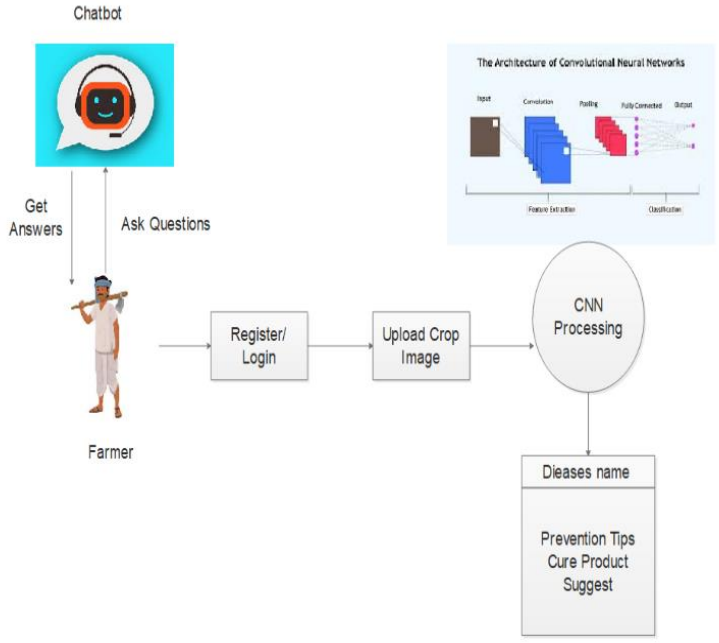
In this step, a Convolutional Neural Network (CNN) model is used to train the system. The CNN automatically learns important features of the crops, such as spots, patches, or discoloration, which are signs of diseases. The model is trained with many images so it can identify patterns and classify crops into categories like "healthy" or "diseased."

After training, the system is ready to predict diseases. Farmers upload an image of their crop leaf, and the trained CNN model analyzes it. The system then predicts whether the crop is healthy or affected by a specific disease.

Along with detection, the system provides practical solutions. It shows precautionary steps that farmers can take to prevent the disease from spreading. It also suggests suitable products, like fertilizers or pesticides, to help control the problem effectively.

To make the system farmer-friendly, a chatbot is included. Farmers can ask questions about crop diseases, remedies, or general farming practices in simple language. The chatbot provides instant answers, acting like a virtual assistant for farmers.

SYSTEM ARCHITECTURE



OBJECTIVE

1. To develop a system that can detect crop diseases accurately using images and a CNN model.
2. To provide farmers with clear information about the detected disease, including symptoms and precautions.
3. To suggest suitable products to control or prevent the disease.
4. To create an interactive chatbot that answers farmers' questions about crops and farming practices.

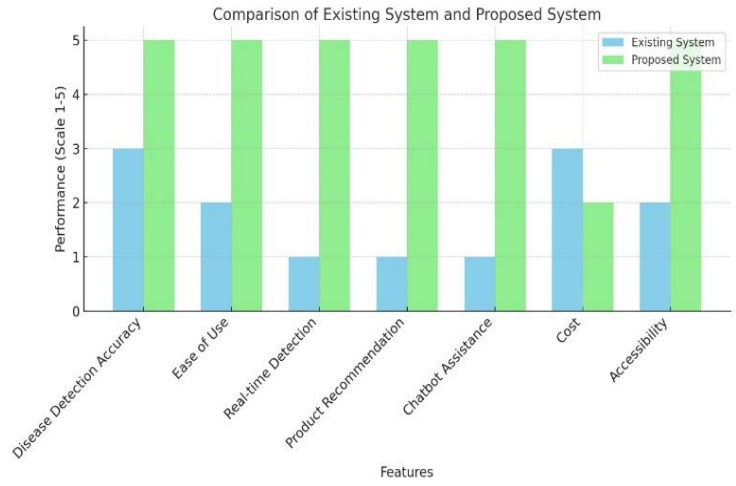
PROBLEM DEFINATIONS

Farmers often face serious problems when crops get infected with diseases. Identifying these diseases early is difficult because it requires expert knowledge and constant monitoring. Many farmers rely on guesswork or expensive expert visits, which can lead to delays in treatment. This delay can cause large losses in crop yield and income.

There is a need for an easy, fast, and reliable solution that can help farmers detect crop diseases at an early stage. The solution should be simple to use, even for farmers with little technical knowledge, and should provide not only disease detection but also guidance on how to treat it.

Our project addresses this problem by developing a smart system that uses a CNN model to detect diseases from crop images and provides farmers with precautionary advice and product recommendations. Additionally, the system includes a chatbot to answer farmers' questions instantly, making disease management faster and more accessible.

COMPARISION OF EXSITING SYSTEM AND PROPOSED SYSTEM



FUCTIONAL REQUIREMENTS

1. Image Upload & Analysis :Allow farmers to upload crop images via a mobile app or web platform.
2. Disease Information: Provide detailed information about the detected disease.
3. Chatbot Assistance:Integrate an AI-powered chatbot to answer farmer queries in simple language.
4. Notification System:Notify users when disease detection is complete.

NON FUCTIONAL REQUIREMENTS

1. Reliability:

The system should operate continuously with minimal downtime, ensuring smooth shopping experience without interruptions.

2. Scalability:

The system should be able to handle a large number of customers simultaneously

3. Security:

The system should ensure data and product details are secure, preventing unauthorized access.

CONCLUSION

In conclusion, this system will make farming easier and more efficient for farmers. By using deep learning and a CNN model, it can quickly identify crop diseases from images, helping farmers take action before the problem spreads. The integrated chatbot makes the system even more useful by giving instant advice in simple language. Overall, this solution will save time, reduce crop losses, and support farmers in growing healthier crops.

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