Crop Disease Detection Using Artificial Intelligence and Machine Learning

Mohit Samota
B.Tech Student, Global Institute of Technology, Jaipur, Rajasthan, India
21egjcs082@gitjaipur.com

Munesh Purohit
B.Tech Student, Global Institute of Technology, Jaipur, Rajasthan, India
21egjcs083@gitjaipur.com

Muskan Sah
B.Tech Student, Global Institute of Technology, Jaipur, Rajasthan, India
21egjcs084@gitjaipur.com

Naman Jain
B.Tech Student, Global Institute of Technology, Jaipur, Rajasthan, India
21egjcs085@gitjaipur.com

Pranay Sharma
Assistant Professor, Global Institute of Technology, Jaipur, Rajasthan, India
pranay.sharma@gitjaipur.com

ABSTRACT: Crop diseases pose a serious threat to agricultural productivity and food security worldwide. Early and accurate detection of crop diseases is essential to minimize yield losses and ensure sustainable farming practices. Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have enabled the development of automated crop disease detection systems that analyze plant images and environmental data with high accuracy. This paper presents a brief overview of AI- and ML-based approaches for crop disease detection, highlighting commonly used techniques, applications, and associated challenges. The study demonstrates how intelligent models support early diagnosis, reduce dependency on manual inspection, and enhance decision-making in modern agriculture.

KEYWORDS: Crop Disease Detection, Artificial Intelligence, Machine Learning, Deep Learning, Precision Agriculture.

1. INTRODUCTION

Agriculture is the backbone of the global economy and plays a vital role in ensuring food security. However, crop diseases significantly affect agricultural productivity by reducing yield and crop quality. Traditional disease detection methods rely on visual inspection by farmers or agricultural experts, which is time-consuming, subjective, and often impractical for large-scale farming.

With the rapid growth of digital technologies, AI and ML have emerged as effective solutions for automated crop disease detection. These technologies enable real-time monitoring and accurate identification of disease symptoms by analyzing images of plant leaves and stems. Automated detection systems help farmers take timely preventive measures, thereby reducing economic losses and improving crop health management.

2. MACHINE LEARNING AND DEEP LEARNING TECHNIQUES

Machine learning techniques such as Support Vector Machines (SVM), Random Forest (RF), and k-Nearest Neighbors (k-NN) have been widely used for crop disease classification. These methods rely on handcrafted features extracted from plant images, including color, texture, and shape.

Deep learning approaches, particularly Convolutional Neural Networks (CNNs), have shown superior performance in crop disease detection. CNNs automatically learn discriminative features from raw images, enabling accurate classification of multiple disease types under varying environmental conditions. Transfer learning models such as VGG, ResNet, and MobileNet further enhance detection accuracy while reducing training time.

3. APPLICATIONS OF CROP DISEASE DETECTION SYSTEMS

AI-based crop disease detection systems are used in various agricultural applications, including early disease diagnosis, large-scale crop monitoring, and smart farming solutions. These systems can be integrated with mobile applications, drones, and IoT devices to provide real-time alerts and recommendations to farmers.

Early detection enables targeted pesticide application, reducing chemical usage and promoting sustainable agriculture. Additionally, cloud-based platforms allow farmers to store and analyze historical data for improved disease prediction and crop management.

4. BENEFITS AND CHALLENGES

The key benefits of AI- and ML-based crop disease detection include high detection accuracy, reduced manual effort, and timely decision-making. Automated systems help farmers identify diseases at early stages, minimizing crop damage and increasing productivity.

However, challenges such as limited labeled datasets, variations in lighting and background conditions, and high computational requirements remain. Addressing these issues is crucial for deploying robust and scalable crop disease detection systems.

5. CONCLUSION

AI and ML have significantly improved the accuracy and efficiency of crop disease detection systems. Deep learning models, particularly CNNs, have demonstrated strong potential in identifying plant diseases with minimal human intervention. Despite existing challenges, continued advancements in data collection, model optimization, and computing resources are expected to further enhance the reliability and adoption of intelligent crop disease detection systems, contributing to sustainable agricultural development.

REFERENCES

[1] P. Jha, D. Dembla and W. Dubey, “Deep learning models for enhancing potato leaf disease prediction: Implementation of transfer learning based stacking ensemble model”, Multimedia Tools and Applications, Vol. 83, pp. 37839–37858, 2024.

[2] P. Upadhyay, K. K. Sharma, R. Dwivedi and P. Jha, "A Statistical Machine Learning Approach to Optimize Workload in Cloud Data Centre," 2023 7th International Conference on Computing Methodologies and Communication (ICCMC), pp. 276-280, 2023.

[3] Pradeep Jha, Deepak Dembla, Widhi Dubey, "Implementation of Machine Learning Classification Algorithm Based on Ensemble Learning for Detection of Vegetable Crops Disease", International Journal of Advanced Computer Science & Applications, Vol. 15, Issue. 1, 2024.

[4] Pradeep Jha, Deepak Dembla, Widhi Dubey, "Implementation of Transfer Learning Based Ensemble Model using Image Processing for Detection of Potato and Bell Pepper Leaf Diseases", International Journal of Intelligent Systems and Applications in Engineering, Vol. 12, pp. 69-80, 2024.

[5] Dr. Neeraj Sharma, "Cloud Computing Architecture: Models, Services, and Deployment Strategies", International Journal of Recent Research and Review, Vol. 18, Issue. 1, pp. 209-216, 2025.

[6] G. Sharma, N. Hemrajani, S. Sharma, A. Upadhyay, Y. Bhardwaj, and A. Kumar, "Data management framework for IoT edge-cloud architecture for resource-constrained IoT application," Journal of Discrete Mathematical Sciences and Cryptography, vol. 25, no. 4, pp. 1093–1103, 2022.

[7] I. Yadav, V. Shekhawat, K. Gautam, G. Kumar Soni and R. Yadav, "Artificial Intelligence for Cybersecurity: Emerging Techniques, Challenges, and Future Trends," 2025 3rd International Conference on Sustainable Computing and Data Communication Systems (ICSCDS), Epp. 1176-1180, 2025.

[8] M. Kumar, R. Ajmera, and D. Kumar, "Statistical analysis and accuracy assessment of improved machine learning based opinion mining framework," Advances in Nonlinear Variational Inequalities, vol. 27, no. 1, 2024.

[9] Neeraj Sharma, "An Analytical Study of Distributed Data Store Using Big Data Analysis Technique", Research Methods,Imparc, 2019.

[10] Dr. Neeraj Sharma, "Advancements in Machine Learning: A Comprehensive Survey of Emerging Trends and Applications", International Journal of Recent Research and Review, Vol. 18, Issue. 1, pp. 187-197, 2025.

[11] H. Sharma and R. Ajmera, "Comprehensive review and analysis of elderly fall detection system using machine learning," Tuijin Jishu/Journal of Propulsion Technology, vol. 44, no. 5, 2023.

[12] P. Jha, D. Dembla and W. Dubey, "Comparative Analysis of Crop Diseases Detection Using Machine Learning Algorithm," 2023 Third International Conference on Artificial Intelligence and Smart Energy (ICAIS), pp. 569-574, 2023.

[13] P. Jha, D. Dembla and W. Dubey, "Crop Disease Detection and Classification Using Deep Learning-Based Classifier Algorithm", Emerging Trends in Expert Applications and Security. ICETEAS 2023. Lecture Notes in Networks and Systems, Vol 682. 2023.