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Agriculture with Artificial Intelligence for Crop Disease and Pest Identification and Classification

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Agriculture has long been a critical part of human survival, but its challenges have only grown with increasing population demands and the impacts of climate change. Crop diseases and pests continue to pose a significant threat to global food production. Traditional methods of monitoring and addressing these issues are often time-consuming, resource-intensive, and less effective. In this era of rapid technological advancement, artificial intelligence (AI), machine learning (ML), and deep learning (DL) are emerging as transformative tools in the agricultural sector **(Nancy *et al* 2022)**. This article explores the latest developments in the application of AI, ML, and DL for crop disease and pest identification and classification, shedding light on how these technologies are revolutionizing the way we address agricultural challenges.

Artificial intelligence, machine learning, and deep learning have the potential to revolutionize agriculture by providing powerful tools for disease and pest identification and classification. These technologies can process vast amounts of data, including images, sensor readings, and historical information, to make more informed decisions and streamline the management of crop health.

One of the most exciting developments in the field is the use of image recognition and analysis techniques to identify diseases and pests on crops. With the help of machine learning models, these technologies can analyze images of plants and detect subtle signs of damage or infestation that might be missed by the human eye. Recent advances in image recognition, such as Convolutional Neural Networks (CNNs), have significantly improved the accuracy and speed of these systems. AI, ML, and DL systems can integrate various sources of data, creating a comprehensive view of crop health. This includes historical weather data, soil composition, crop type, and past disease and pest incidents. By processing this integrated data, these technologies can predict disease outbreaks and pest infestations, allowing farmers to take preventative measures in a timely manner. Mostly used CNN methods are VGG16, ResNet-50, Inception, MobileNet-V3 and EfficientNet-B0.

Recently the Vision Transformer (ViT) structure has been introduced to improve the classification applications. The idea is based on how humans classify images. When a human observes a picture, he or she focuses on a specific area of the image to detect the instance of interest. The ViT structure follows this approach for image classification **(Borhani *et el.* 2022).**

Disease and Pest Identification

The heart of AI's application in agriculture is disease and pest identification. Researchers and developers have created models that can accurately distinguish between different types of diseases, such as powdery mildew, rust, or blight. Similarly, pests like aphids, spider mites, and whiteflies can be identified and classified. This level of specificity is a game-changer for

farmers as it enables targeted responses and minimizes the need for broad-spectrum chemical treatments **(Gianessi 2014)**. Automated monitoring systems equipped with AI can provide continuous surveillance of crops, scanning for any signs of trouble.

Recent Developments in AI, ML, and DL for Crop Disease and Pest Identification: The application of artificial intelligence (AI), machine learning (ML), and deep learning (DL) in agriculture is continuously evolving, and recent developments in these technologies have brought about significant advancements in crop disease and pest identification for various crops.

Wheat Crop Disease Identification: Wheat is one of the world's most essential staple crops, but it is susceptible to various diseases that can devastate yields. Recent developments in AI and ML have produced innovative solutions for identifying and managing wheat crop diseases.

Image Recognition: Researchers have created AI models that can identify diseases like wheat rust and powdery mildew from images of wheat leaves. These models use deep learning techniques, including convolutional neural networks (CNNs), to analyze microscopic details, enabling accurate and early disease detection. Wheat stripe rust, wheat powdery mildew, and healthy wheat datasets, were evaluated using five lightweight CNN models, namely MobileNetV3, ShuffleNetV2, GhostNet, MnasNet, and EfficientNetV2, were evaluated **(Wen *et al.* 2023)**

Remote Sensing: Satellite and drone-based remote sensing equipped with AI algorithms can monitor large wheat fields for signs of disease. These systems provide real-time data, allowing farmers to take timely actions to prevent disease spread and optimize their management strategies.

Precision Farming: AI-powered precision farming tools have emerged, helping wheat farmers make informed decisions regarding irrigation, fertilization, and disease control. These technologies reduce resource wastage and increase wheat yields.

Rice Crop Disease and Pest Identification: Rice is a staple food for over half of the world's population, and its production faces constant threats from diseases and pests. Recent advancements in AI, ML, and DL have significantly improved rice crop disease and pest identification.

Machine Learning Apps: Smartphone applications equipped with machine learning models have been developed to diagnose rice diseases and pests. These apps allow farmers to take pictures of affected rice plants and receive instant feedback on the issue, helping them decide on appropriate treatments. In the study conducted by **Akshitha *et al*. (2022)**, advanced deep learning techniques were employed for the identification and classification of three different plant diseases, namely Bacterial Leaf Blight, Blast, and Brown Spot. The research involved the utilization of convolutional neural networks (CNN), Vgg19, and DenseNet models.

Sensor-Based Monitoring: Sensor technology, coupled with AI, enables real-time monitoring of rice fields. These sensors can detect changes in humidity, temperature, and other environmental factors that contribute to disease and pest infestations. AI algorithms process this data to provide insights to farmers.

Genetic Resistance: AI and ML are used to analyze rice genetics and develop disease-resistant strains. Researchers are harnessing deep learning techniques to identify genes associated with resistance to specific diseases and pests, leading to the creation of more resilient rice varieties. Rice blast, caused by the fungus *Magnaporthe oryzae*, is a devastating disease. AI and ML used to analyze the genetic makeup of rice plants and identify specific resistance genes **(Fiyaz *et al.* 2022)**.

Conclusion

The recent developments in AI, ML, and DL for crop disease and pest identification are transforming agriculture, benefiting different crops like wheat, rice, tomatoes and more. These technologies are providing farmers with powerful tools to detect and manage diseases and pests more effectively, reducing costs, minimizing environmental impact, and ultimately ensuring food security for a growing global population. As AI, ML, and DL continue to advance, they will play a pivotal role in improving crop health management across a wide range of agricultural commodities.

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