Artificial Intelligence Based Drone Controlled Detection Of Plant Disease

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Abstract

The rapid advancement of artificial intelligence (AI) and unmanned aerial vehicles, commonly known as drones, has opened new possibilities for precision agriculture. This paper presents a novel approach for the detection of plant diseases using AI-based drone technology. The system leverages high-resolution aerial imagery captured by drones and employs advanced machine learning algorithms to identify and classify various plant diseases in real-time.

The use of unmanned aerial vehicles is revolutionizing the agricultural industry. Cashews are grown by approximately 70% of small and marginal farmers, and the cashew industry plays a critical role in their economic development. Several fungal and algal diseases threaten the cashew tree, resulting in substantial losses in yield. Some cashew-growing regions are particularly susceptible to powdery mildew, damping off, anthracnose, and inflorescence blight. To take timely countermeasures against plant diseases and infections, it is imperative to monitor and detect diseases as early as possible and take suitable measures. Using, such as those that are equipped with artificial intelligence, can assist farmers by providing early detection of crop diseases and precision pesticide application. To facilitate efficient and effective crop monitoring, a equipped with a camera will be deployed to take aerial photographs. An edge computing paradigm of Artificial Intelligence is employed to process this image in order to make decisions with the least amount of latency possible.

This paper discusses the system architecture, including the drone hardware, imaging sensors, and the AI algorithms used for image processing. It also addresses implementation challenges such as varying environmental conditions and the need for large annotated datasets for training the AI models. Preliminary field trials demonstrate the system's effectiveness in detecting common plant diseases, with promising results that suggest significant potential for improving crop management and yield. Future work will focus on expanding the range of detectable diseases, enhancing the robustness of the AI models, and integrating the system with existing agricultural management platforms.

Keywords: deep learning, plant disease, CNN, agriculture, classification, Efficient Net.

I. INTRODUCTION

Plant diseases are one of the major threats to global food production. Efficient monitoring and detection of plant pathogens are instrumental in restricting and effectively managing the spread of the disease and reducing the cost of pesticides. Traditional, molecular, and serological methods that are widely used for plant disease detection are often ineffective if not applied during the initial stages of pathogenesis, when no or very weak symptoms appear. Moreover, they are almost useless in acquiring specialized diagnostic results on plant diseases. On the other hand, remote sensing (RS) techniques utilizing drones are very effective for the rapid identification of plant diseases in their early stages. Currently, drones play a pivotal role in the monitoring of plant pathogen spread, detection, and diagnosis to ensure crops' health status. The advantages of drone technology include high spatial resolution, high efficiency, usage flexibility, and more

significantly, quick detection of plant diseases across a large area with low cost, reliability, and provision of high-resolution data. Drone technology employs an automated procedure that begins with gathering images of diseased plants using various sensors and cameras. After extracting features, image processing approaches use the appropriate traditional machine learning or deep learning algorithms.
One of the essential components of human civilization is agriculture. It helps the economy in addition to supplying food. Plant leaves or crops are vulnerable to different diseases during agricultural cultivation. The diseases halt the growth of their respective species. Early and precise detection and classification of the diseases may reduce the chance of additional damage to the plants. The detection and classification of these diseases have become serious problems. Farmers' typical way of predicting and classifying plant leaf diseases can be boring and erroneous. Problems may arise when attempting to predict the types of diseases manually. The inability to detect and classify plant diseases quickly may result in the destruction of crop plants, resulting in a significant decrease in products. Farmers that use computerized image processing methods in their fields can reduce losses and increase productivity. Numerous techniques have been adopted and applied in the detection and classification of plant diseases based on images of infected leaves or crops.
Plant diseases can have an impact on the growth, function, and structure of plants and crops, affecting the people that rely on them. The majority of farmers still use manual methods to detect and classify plant ailments because it is difficult to do so early on, and this reduces productivity. Agriculture's productivity is a significant economic factor. As a result, disease identification and classification in plants are critical in agricultural industries.

Discussion

The stage of infestation, the crops affected, the method of prevention of spreading the disease, and what type and amount of pesticides need to be applied can be determined. This technology has significant potential to improve the efficiency and profitability of cashew farming. Equipped with sensors detect disease patterns quickly and accurately over large areas. Combined with AI algorithms, these machines can analyse data from a variety of sources such as temperature, humidity, CO2 levels and soil composition. This allows them to recognize disease symptoms before they become visible. Early detection allows for more effective control strategies that can reduce costs caused by lost production due to infestations or crop failure. A standard Plant Village dataset is used for performance evaluation and for standardization. Additionally, samples captured with a drone present a variety of image samples captured in a variety of conditions, which complicates the analysis. According to our analysis, we were able to identify the anthracnose with 95% accuracy and the healthy leaves with 99% accuracy. Introduction A major economic loss in the agricultural sector is caused by plant diseases, both during and after harvest. Globally, pests destroy up to 40 percent of crops each
Computer vision is a sub domain of AI that allows machines to counterfeit the human visual system and precisely draw out, inspect, and recognize real-world images in the same way that humans do. ML techniques have been used to detect and classify plant diseases, but with advancements in a subset of ML, DL, this area of research appears to have considerable potential in terms of increasing accuracy. Many developed DL architectures were used, along with various visualization techniques, to detect and classify plant disease symptoms accordingly.
Medical diagnosis, espionage, satellite images, and agribusiness are just a few of the rapidly increasing industries that have already shown the benefits of computer vision-based technologies. Computer vision-enabled systems can be used in agriculture to detect and classify plant diseases based on different features or symptoms that have been extracted. It uses a well-defined series of steps beginning with image acquisition and continuing with various image-processing tasks such as scaling, filtering, segmentation, feature extraction, and selection, and finally, detection and classification are performed using ML or DL techniques.
Early and accurate detection and diagnosis of plant diseases are key factors in plant production and the reduction of both qualitative and quantitative losses in crop yield. Optical techniques, such as RGB imaging, multi- and hyper spectral sensors, thermograph, or chlorophyll fluorescence, have proven their potential in automated, objective, and reproducible detection systems for the identification and quantification of plant diseases at early time points in epidemics. Recently, 3D scanning has also been added as an optical analysis that supplies additional information on crop plant vitality. Different platforms from proximal to remote sensing are available for multi scale monitoring of single crop organs or entire fields. Accurate and reliable detection of diseases is facilitated by highly sophisticated and innovative methods of data analysis that lead to new insights derived from sensor data for complex plant-pathogen systems. Nondestructive, sensor-based methods support and expand upon visual and/or molecular approaches to plant disease assessment. The most relevant areas of application of sensor-based analyses are precision agriculture and plant phenotyping.

Accurate estimates of disease incidence, disease severity, and the negative effects of diseases on the quality and quantity of agricultural produce are important for field crop, horticulture, plant breeding, and for improving fungicide efficacy as well as for basic and applied plant research. Reliable and timely assessments of plant disease occurrence and spread are, in particular, the basis for planning targeted plant protection activities in field or greenhouse production and to forecast temporal and spatial disease spread in specific growing regions. Common methods for the diagnosis and detection of plant diseases include visual plant disease estimation by human raters, microscopic evaluation of morphology features to identify pathogens, as well as molecular, serological, and microbiological diagnostic techniques.

Future Work

The study concludes that the impact of drone usage is not significant since the rotors in the drone have an impact on the deposition rate of droplets. Additionally, spraying pesticides at a certain height and distance also affects droplet deposition in rice and paddy fields. Furthermore, this study investigates how drones equipped with cameras can be used to identify diseases at an early stage and how advanced image analysis tools can lead to easier decisions. Drones also assist in surveying and mapping the field precisely to determine the vegetation index. The development of AI-based drone-controlled detection systems for plant diseases is a promising field with several avenues for future enhancement. The following are key areas of future work to improve the effectiveness, scalability, and usability of such systems.

Develop more sophisticated machine learning models, including deep learning techniques like Generative Adversarial Networks (GANs) and advanced Convolution Neural Networks (CNNs), to improve the accuracy and reliability of disease detection. Implement algorithms that can handle a wider range of diseases and distinguish between similar symptoms caused by different pathogens or environmental factors. Optimize algorithms and processing pipelines to enable real-time analysis of aerial imagery, providing immediate feedback and allowing for swift corrective actions. Explore edge computing solutions to process data on-board the drone, reducing the need for high-bandwidth data transmission to ground stations. Integrate more advanced imaging technologies, such as multispectral and hyper spectral sensors, to capture a broader spectrum of data. These sensors can detect subtle changes in plant health that are not visible in standard RGB imagery. Develop AI models capable of analyzing multispectral and hyper spectral data to identify disease-specific spectral signatures. Enhance the autonomy of drones to allow for fully automated flight missions, including path planning, obstacle avoidance, and adaptive flight based on real-time analysis. Implement swarm intelligence, where multiple drones coordinate and share data to cover large areas more efficiently and accurately. Focus on reducing the cost of deploying and maintaining drone-based systems to make them accessible to small and medium-sized farms. Develop scalable solutions that can be easily adapted to different crop types, field sizes, and geographic regions. Integrate drone-based detection systems with broader Internet of Things (IoT) networks and precision agriculture platforms. This integration allows for comprehensive monitoring and management of crop health. Enable seamless data exchange and interoperability with existing agricultural management systems to provide farmers with holistic insights and recommendations. Develop intuitive user interfaces and dashboards that present analysis results in a clear and actionable manner. This helps farmers make informed decisions quickly.

Conclusion

By focusing on these areas, future developments can enhance the capability, reliability, and user adoption of AI-based drone-controlled plant disease detection systems, ultimately leading to more sustainable and productive agricultural practices. In current study, a deep learning model was developed to detect multiple crop diseases. The disease detection model is composed of three steps to recognize crops, to determine disease occurrence, and to determine disease types. In each step, the optimal pre-trained CNN model that could be suitable for the data and purpose was selected and configured. To apply this model to the industrial filed, determination of unknown crops using images of crops that have not been used in model construction were added and 'unknown' was defined to prevent false positives. Further studies should add a variety data of crops with and without diseases to create a generally usable disease classification model.

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