Disease Detection System: A Technology-Based Approach to Plant Disease Management

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I. Abstract-Disease Detection

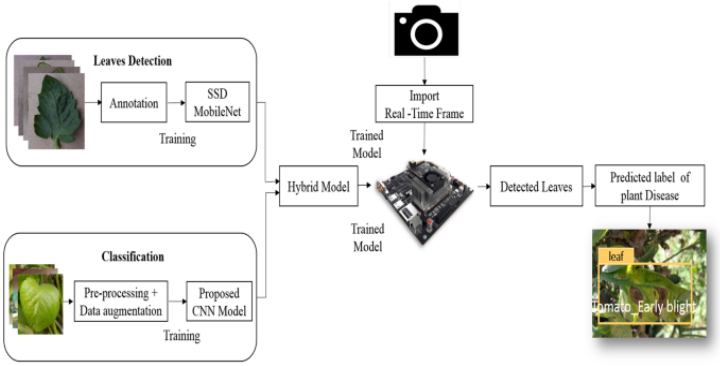
System is a technology-based system designed to recognize and detect diseases in plants using advanced computer vision techniques and convolutional neural networks (CNNs). This system is primarily developed to improve the detection and management of plant diseases in farms and greenhouses. In this paper, we present the design and implementation of the Disease Detection System, including its two main components: the disease recognition component and the disease interpretation component. We also discuss the potential benefits and applications of this system in improving plant disease management.

II. Introduction

Plant diseases can have a significant impact on crop yields and food security. Early detection and management of plant diseases is crucial to prevent their spread and minimize their impact. However, traditional methods of disease detection, such as visual inspection by experts, can be time-consuming and may not always be accurate.

The Disease Detection System is a technology-based approach to plant disease management that aims to improve the detection and management of plant diseases in farms and greenhouses. The system uses advanced computer vision techniques and CNNs to accurately recognize and detect various plant diseases. In this paper, we present the design and implementation of the Disease Detection System, including its two main components: the disease recognition component and the disease interpretation component. We also discuss the potential benefits and applications of this system in improving plant disease management.

III. System Design



The Disease Detection System comprises one main component: the disease recognition component. The recognition component is responsible for recognizing and detecting diseases in plants.

Disease Recognition Component The recognition component of the system uses a Jetson Nano as the computer of choice, utilising its CUDA cores to run advanced CNNs such as ResNet50. The system is trained on a large dataset of plant images to enable it to accurately recognize and detect various plant diseases.

The recognition process begins with the acquisition of images of plants using a camera attached to the Jetson Nano. These images are then pre-processed to enhance their quality and fed into the CNN for disease recognition. The CNN analyzes the images and outputs a prediction of whether or not a disease is present in the plant.

IV. Literature Review

a. Introduction

Research was carried out to evaluate the current applications for detecting plant diseases in agriculture, given the various detection methods employed across a diverse range of crops. Additionally, an examination was conducted on tools used for detecting nutritional deficiencies, which also fall within this category.

b. Related work

- Michelle Horton's article discusses how airborne sensors can accurately monitor crops in real-time, providing quicker and more cost-effective methods of monitoring agricultural nutrients compared to traditional leaf tissue analysis. Sheng Wang, an associate professor and research scientist at the University of Illinois Urbana-Champaign, believes that this immediate and high-resolution crop nitrogen information will be highly useful to producers in diagnosing crop development and guiding adaptive management. Kaiyu Guan, Blue Waters Associate Professor at the same university, suggests that precision agriculture that depends on sophisticated sensing technology and aerial satellite platforms to monitor crops might be the solution.

  To overcome constraints, the researchers presented a hybrid strategy based on hyperspectral imaging and machine-learning algorithms. Hyperspectral imaging uses a spectrometer to divide a pixel into hundreds of pictures at various wavelengths, delivering additional information on the acquired image. The researchers constructed deep learning models based on aerial reflectance data using Radiative Transfer Modeling and a data-driven Partial-Least Squares Regression (PLSR) technique. According to the research, PLSR requires a little amount of label data for model training.

  The researchers used cuDNN and NVIDIA V100 GPUs to develop deep learning models to predict crop nitrogen, chlorophyll, and photosynthetic capacity at the leaf and canopy levels. The models were around 85% accurate when tested against ground-truth data. The method is quick, scanning fields in a matter of seconds per acre. According to Wang, such technology can be extremely beneficial in determining crop nitrogen condition and production potential.
- Marcos A. de Oliveira Jr. has developed an application using Jetson Nano for plant stress detection and on-field spray decision. Due to limited processing capability, edge and fog devices are designed to deal with a single problem. Precision agriculture

has seen an increase in research in edge and fog computing, with IoT devices being used for Smart Farms to provide farmers with real-time data on farm conditions. Artificial Intelligence (AI) tactics have been incorporated into the Smart Farm idea, with Jetson Nano being considered as a possibility due to its low-power system and hardware resources like GPU designed for machine learning applications. This research focuses on detecting stress levels in bean plants using AI algorithms on the edge device Jetson Nano, building upon the findings of de Toledo (2019) who used neural networks and machine learning for plant stress state categorization approaches. The study validates an application model using Jetson Nano for detecting stress in bean plants, enabling real-time decision-making in the spraying of agricultural goods in the field.

- The paper "Real-time detection and identification of plant leaf diseases using convolutional neural networks on an embedded platform" by Ruchi Gajjar et al. proposes a real-time system to identify the type of disease present in a crop based on leaf images using machine learning. A deep convolutional neural network architecture is proposed to classify the crop disease, and a single shot detector is used for identification and localization of the leaf1. These models are deployed on an embedded hardware, Nvidia Jetson TX1, for real-time in-field plant disease detection and identification1. The disease classification accuracy achieved is around 96.88%, and the classification results are compared with existing convolutional neural network architectures. Also, the high success rate of the proposed system in the actual field test makes the proposed system a completely deployable system.

V. Potential Benefits and Applications

The Disease Detection System has several potential benefits for improving plant disease management in farms and greenhouses. By accurately recognizing and detecting various plant diseases, this system can help farmers identify diseased plants early on, allowing them to take appropriate action to prevent their spread.

In addition to improving disease detection, this system can also provide valuable information about detected diseases, including their symptoms, causes, and possible treatment options. This information can help farmers make informed decisions about how to manage diseased plants.

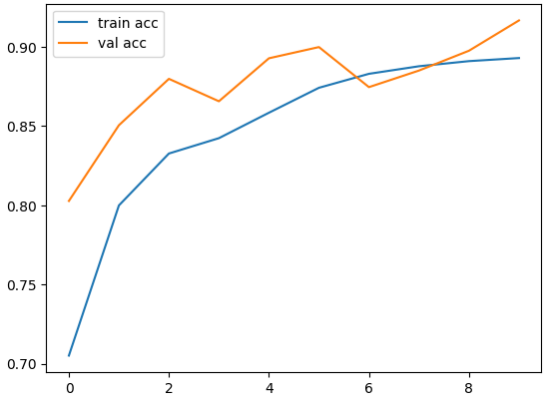
Overall, the Disease Detection System has the potential to significantly improve plant disease management in farms and greenhouses by providing accurate disease detection and valuable information about detected diseases.

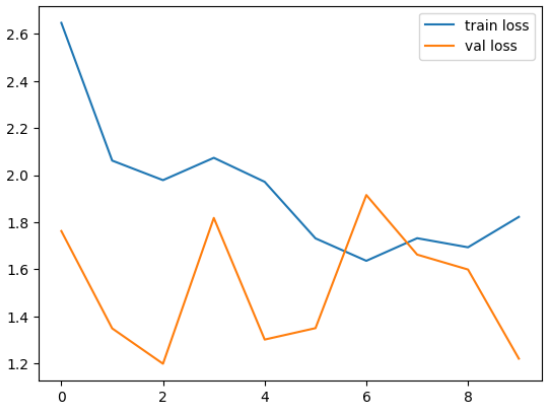
VI. Discussion

One important aspect of any disease detection system is its accuracy. The accuracy of a system refers to how well it can correctly identify whether or not a disease is present in a given plant. A high-accuracy system will correctly identify diseased plants most of the time while minimizing false positives (i.e., incorrectly identifying healthy plants as diseased).

The expected accuracy of the Disease Detection System will depend on several factors, including:

The quality of the training data used to train the CNNs
The architecture of the CNNs used for disease recognition
The quality of the images acquired by the camera attached to the Jetson Nano
The pre-processing techniques used to enhance image quality before feeding them into the CNNs
By carefully selecting high-quality training data and using well-designed CNN architectures, it should be possible to achieve high levels of accuracy with this system. Additionally, using high-quality cameras for image acquisition and applying appropriate pre-processing techniques can further improve accuracy.





VII. Conclusion

The Disease Detection System is a technology-based approach to plant disease management that has the potential to significantly improve the detection and management of plant diseases in farms and greenhouses. The system's use of advanced computer vision techniques and CNNs enables it to accurately recognize and detect various plant diseases, while its interpretation component provides valuable information about the detected diseases and suggests possible treatment options. With its potential benefits for improving plant disease management, this system represents an important step forward in leveraging technology for sustainable agriculture.

VIII. References

1 Oliveira Jr., M.A. (n.d.). An Application with Jetson Nano for Plant Stress Detection and On-field Spray Decision 1. 2 Gajjar, R., Gajjar N., Thakor V.J., Patel N.P., Ruparelia S. (2021). Real-time detection and identification of plant leaf diseases using convolutional neural networks on an embedded platform 2. 3 Horton M., (2022). Airborne Sensors Accurately Monitor Crops in Real Time 3.