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# A Survey Paper on Crop Disease Detection

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**A B S T R A C T**

Crop disease detection is the process of identifying and classifying plant diseases from images or other data. This can be done manually or using automated methods. Manual methods typically involve a human expert visually inspecting the plant and identifying the disease. Automated methods use computer vision algorithms to identify the disease from images or other data. Crop diseases pose a significant threat to global food security by causing substantial yield losses and reduced quality in agricultural production. Timely and accurate detection of crop diseases is crucial to mitigate these losses and ensure sustainable agricultural practices. In recent years, advancements in sensor technology, data analysis techniques, and machine learning algorithms have enabled the development of various methods for crop disease detection. This survey paper aims to provide a comprehensive overview of the state-of-the-art techniques, methodologies, and challenges in the field of crop disease detection. The paper begins by introducing the importance of crop disease detection in modern agriculture and its impact on both economic and environmental aspects. It then categorizes the existing detection methods into several key approaches, including visual inspection, spectroscopy, image analysis, and sensor-based techniques. For each approach, the paper discusses its underlying principles, advantages, limitations, and representative studies.

Keywords: Plant diseases, Deep learning, Precision agriculture, Generalization, Review, Survey

## Introduction

Crop diseases have become a significant challenge for farmers, leading to substantial crop losses and financial setbacks. In recent times, deep learning has shown promising results in various computer vision tasks, including crop disease detection. The survey delves into the role of machine learning and artificial intelligence in crop disease detection. It examines how convolutional neural networks (CNNs), recurrent neural networks (RNNs), and other deep learning architectures have been applied to analyze crop images and sensor data. The paper highlights the pivotal role of annotated datasets in training these models and emphasizes the importance of transfer learning in overcoming limited data challenges. The survey paper addresses the integration of emerging technologies such as Cloud Computing, Deep learning, unmanned aerial vehicles (UAVs) and satellite imagery in large-scale crop disease monitoring. It discusses the potential benefits and drawbacks of these technologies, along with their contributions to precision agriculture and early disease detection. As the field evolves, various challenges and open research areas are identified. These challenges include dataset standardization, model interpretability, real-time disease monitoring, and the need for robustness across different environmental conditions. The paper concludes by summarizing the key findings, discussing potential future trends, and encouraging interdisciplinary collaborations among researchers, agronomists, and technologists to collectively address the complex challenges in crop disease detection. This paper aims to leverage the power of deep ResNet or InceptionV3 and propose methods to enhance the accuracy of crop disease detection systems. Plant diseases are responsible for yield losses that directly impact national and global food production systems, resulting in economic losses. According to the Food and Agriculture Organization (FAO), plant diseases and pests are responsible for 20% to 40% loss in global food production (Food and Agriculture Organization of the United Nations International Plant Protection Convention, 2017). Plant diseases are responsible for an estimated 13% of global crop yield loss. These statistics highlight the importance of identifying plant diseases to mitigate yield losses. However, first, it is crucial to understand the factors responsible for plant diseases.

## There are Several Objectives for Crop Disease Detection. These Include:

**Early detection**: Early detection of crop diseases is important to prevent the spread of the disease and to minimize crop losses. Early detection of crop diseases is important for several reasons. First, it allows farmers to take action to prevent the spread of the disease and to minimize crop losses. Second, it allows farmers to choose the correct treatment for the disease, which can improve the chances of a successful outcome. Third, early detection can help farmers to save time and money, as they will not have to wait until the disease has progressed to a more advanced stage before taking action. There are a number of ways to detect crop diseases early. One way is to visually inspect the plants regularly. This can be done by farmers themselves, or by trained professionals. Another way to detect crop diseases early is to use diagnostic tools, such as laboratory tests or molecular tests. These tools can be used to identify the presence of a disease even before the symptoms are visible. Early detection of crop diseases is an important part of integrated pest management

(IPM). IPM is a holistic approach to pest management that combines a variety of methods to control pests, including crop rotation, biological control, and chemical control. Early detection of crop diseases can help to make IPM more effective by allowing farmers to take action before the disease has a chance to spread.

**Accurate identification**: Accurate identification of crop diseases is important for several reasons. First, it allows farmers to choose the correct treatment for the disease, which can improve the chances of a successful outcome. Second, accurate identification can help farmers to save time and money, as they will not have to waste resources on treatments that are not effective. Third, accurate identification can help farmers to track the spread of diseases and to take steps to prevent them from spreading further. There are a number of ways to accurately identify crop diseases. One way is to visually inspect the plants and compare the symptoms to known diseases. This can be done by farmers themselves, or by trained professionals. Another way to accurately identify crop diseases is to use diagnostic tools, such as laboratory tests or molecular tests. These tools can be used to identify the specific pathogen that is causing the disease. Accurate identification of crop diseases is an important part of integrated pest management (IPM). IPM is a holistic approach to pest management that combines a variety of methods to control pests, including crop rotation, biological control, and chemical control. Accurate identification of crop diseases can help to make IPM more effective by allowing farmers to choose the correct treatment for the disease.

**Scalability**: The ability to scale the crop disease detection system to large numbers of plants is important for commercial applications. Capability in crop disease detection is the ability to accurately detect diseases in a large number of plants. This is an important consideration for commercial applications, where it is necessary to be able to quickly and efficiently identify diseases in order to prevent them from spreading and causing crop losses.

There are a number of factors that can affect the scalability of crop disease detection systems. These include:

- **The size of the dataset:** The larger the dataset, the more difficult it is to train a model that can accurately identify diseases in a large number of plants.
- **The complexity of the diseases:** Some diseases are more difficult to identify than others. For example, diseases that because similar symptoms can be difficult to distinguish from each other.
- **The availability of computing resources:** Scalable crop disease detection systems require significant computing resources. This can be a challenge for small farmers or businesses that do not have access to these resources.

There are a number of ways to improve the scalability of crop disease detection systems. These include:

- **Using cloud computing:** Cloud computing can provide the scalability and computing resources needed to train and deploy large-scale crop disease detection models.
- **Using transfer learning:** Transfer learning is a technique that can be used to train a model that can be used to identify a variety of diseases. This can help to reduce the size of the dataset that needs to be trained.
- **Using ensemble models:** Ensemble models are made up of multiple models that are trained on different datasets. This can help to improve the accuracy of the model and make it more robust to changes in the data.

**There are several methods that can be used for crop disease detection. These include:**

- **Visual inspection:** This is the most traditional method for crop disease detection. A human expert visually inspects the plant and identifies the disease.
- **Microscopic inspection:** This method uses a microscope to examine the plant tissue and identify the disease.
- **Molecular methods:** These methods use molecular techniques to identify the disease.
- **Computer vision:** This method uses computer vision algorithms to identify the disease from images or other data. Computer vision is a rapidly developing field, and there have been significant advances in recent years in the use of computer vision for crop disease detection. Deep learning models have shown promising results in accurately identifying crop diseases from images. The best model for plant disease detection depends on the specific application. For example, if the application requires high accuracy, then a deep learning model may be the best option. However, if the application requires scalability, then a simpler model may be more appropriate.

**Here are some of the benefits of crop disease detection:**

- **Reduced crop losses:** Early detection and treatment of crop diseases can help to reduce crop losses.
- **Improved crop yields:** By preventing the spread of diseases, crop yields can be improved.
- **Increased food security:** Crop disease detection can help to increase food security by ensuring that crops are healthy and productive.

**Here are some of the challenges of crop disease detection:**

- **Variety of diseases:** There are a wide variety of crop diseases, and each disease can have a different appearance. This can make it difficult to identify diseases accurately.

- **Variable symptoms:** The symptoms of a disease can vary depending on the crop, the environment, and the stage of the disease. This can make it even more difficult to identify diseases accurately.
- **Limited data:** There is often limited data available for training crop disease detection models. This can make it difficult to achieve high accuracy. Despite the challenges, crop disease detection is an important tool for improving crop health and productivity. As the field of computer vision continues to develop, it is likely that crop disease detection will become even more accurate and scalable.

## Survey of crop detection

In this paper, a lightweight CNN model has been proposed for the knowing of 9 types of diseases in tomato plants. The proposed CNN system don't use a large network structure of pre-trained models having a huge number of hidden layers and parameters and has the advantage of less storage capacity and quick response while maintaining the same level of accuracy as reported in the literature.[1]. In this model. We consider an input image 416X416 with seventy-five layers design of Improved-detect with three residual blocks. Mainly it uses the features from yolo v2 and extending to residual units for up sampling process. Improved-Detect model results in good accuracy. In this paper, based on deep residual learning methodology, a CNN architecture was suggested to apply to tomato disease classification task. The results show that the proposed model can compete with VGG networks pre-trained on the ImageNet dataset, with the advantage of lighter training time on a PC with regular hardware abilities. This paper also confirms the usefulness and effectiveness of Transfer Learning on the task of tomato plant disease identification. [3]. Several reliable automated procedures are used for leaf pattern recognition. This paper mainly reviews the advantages of each classifier and compares their compatibility with different leaf features recognition process. A computer vision approach which can completely neglect the background of the image is speeding up the recognition process and it is suitable for highly complex plant leaf samples. [4], The database used in the experiments is freely available and contains almost 50,000 images of 171 diseases affecting 21 plant species. However, only images of corn diseases were used in the context of this work. [5], In this paper they have used public dataset for plant leaf disease detection called PlantVillage curated by Sharada P. Mohanty et Al.[6].

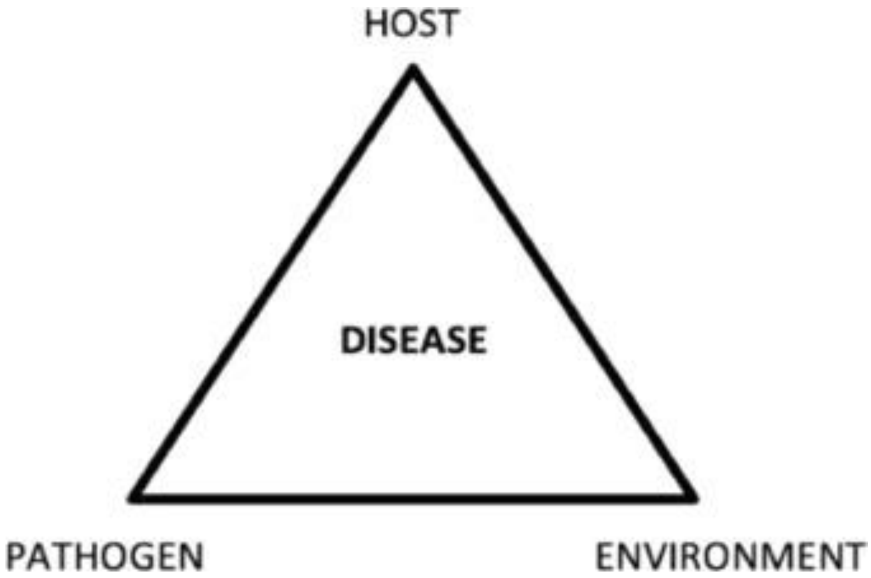


Fig. 1. Plant Disease Triangle

In 2015, S. Khirade et Al. tackled the problem of plant disease detection using digital image processing techniques and back propagation neural network (BPNN) [7]. Proposed a method to detect pomegranate plant disease and observed using 40 images with accuracy of 90%. C. KNN Classifier K-Nearest Neighbours has been used for pattern recognition, statistical estimation and classification in Machine Learning. We made a survey on plant disease detection using KNN classifier as follows.[8]. V Srinidhi,Apoorva Sahay and K. Deeba's project uses Deep Convolutional Neural Networks models namely Efficient Net and Dense Net to detect Apple plant diseases from Images of apple plant leaves and accurately classify them into 4 classes. The categories include "healthy", "scab", "rust and "multiple diseases". In this project, the apple leaf disease dataset is improved using data augmentation and image annotation techniques, namely Canny Edge Detection, Blurring and Flipping. Based on augmented dataset, models using EfficientNetB7 and Dense Net are proposed providing accuracy of 99.8% and 99.75% respectively and overcoming known shortcomings of convolutional neural networks. [9].

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