

A Study on Leaf Disease Detection Using Machine Learning

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Abstract - India is an agricultural nation, hence the rate of crop output there is cause for concern. Lower crop yields result in higher food prices and a hunger problem for people. Deep learning models so seek to raise crop yield rates and decrease plant disease infections. They might even help farmers with technology in the process. Food security may be compromised by a number of diseases that significantly reduce agricultural output. Accurately detecting plant ailments is so essential and crucial. The subjective, labor-intensive laboratory testing and visual observation that characterize conventional classification systems have many disadvantages. Plant pathologists use optical methods to observe diseased leaves in plants in order to diagnose illnesses in plants, which is the current acknowledged method. This is so that most plant diseases may be identified by their outward symptoms. The difficulty of the disease diagnosis process when done manually plus the fact that the pathologist's skill level determines how successful the diagnosis will be making this a good problem for computer-aided diagnostic systems. Plant diseases cause an annual loss of thirty-five percent of India's crop yield. Due to inadequate lab equipment and comprehension, early plant disease identification is still challenging. Our study delves into the potential use of computer vision methods for early and scalable detection of plant diseases. When productivity is prioritized over the ecological effects of input resources, the environment deteriorates. Pesticides and fertilizers are the primary source of production expenses and environmental degradation. By keeping a check on leaf area, leaf disease, and chlorophyll content, it is possible to effectively utilize that contribution. Different diseases that harm plants through their leaves can have a detrimental effect on agricultural productivity and lead to losses in money. Reduction of both the amount and quality crucial accelerating plant growth increasing crop harvests. It can be challenging for researchers and farmers alike to recognize diseases in plant leaves. Both the economy and public health are negatively impacted by the pesticides that farmers now use on their crops. To identify these plant diseases, a few approaches applied. In this paper we studied a number of plant diseases and new techniques for diagnosing them.

Keywords: Plant leaf disease, Artificial Intelligence, Diagnosis, Machine Learning, Accuracy, Image Processing.

I. INTRODUCTION

Plant diseases in agriculture are mostly caused by climatic changes and regional variations in weather patterns. Climate change, which includes too much or too little rainfall cause of crop illnesses by viruses, fungus, and bacteria. A disease of the plants providing discoveries continuously impede plant growth and crop yield. By facilitating the adoption of preventative measures, early detection of chronic disorders can reduce costs and lost productivity. To produce the best-quality crop possible, disease must be contained and kept from spreading across the farm. It is necessary to recognize diseases by their symptoms, investigate their causes, and implement preventative actions to lessen their spread. According to Patil, Rutuja Rajendra, and Sumit Kumar (2020) a plant infections may cause harm to both underground and above-ground plants. In crops like rice, wheat, oats, potatoes, tomatoes, pomegranates, etc., you can stop leaf disease from occurring in the future if you wish to control it. Spotting, brown dots, yellow spots, and other signs might be utilized to determine the condition.

We can identify the type of disease and whether it is caused by a fungus, bacteria, or virus by observing the unique characteristics that each plant exhibits. The exact sickness and its cause are ascertained by using the symptoms of the illness. The figure 1 shows the major types of leaf diseases.

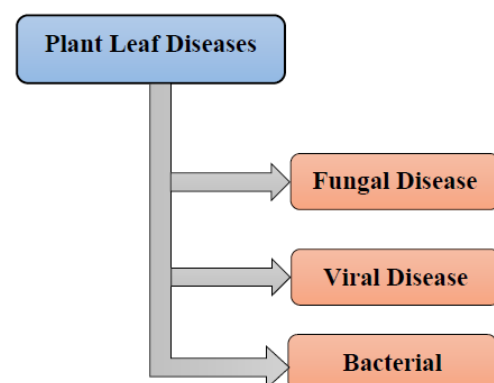


Figure 1: Types of Leaf Disease

Farmers in the agricultural sector frequently used their unaided eyes to identify diseases; however this approach is inaccurate and labor-intensive. Farmers occasionally require the expertise of specialists in order to diagnose a sickness. Causes disruptions to normal activity, development, and structure of plants. The classification of a plant disease depends on whether the primary agent is infectious or noninfectious. Plant diseases can hinder a wide range of processes, such as photosynthesis, the development of flowers and fruits, cell division and enlargement, plant growth and development, and the absorption and transport of nutrients and water. Plant diseases caused by several types of nematodes, bacteria, viruses, viroids, phytoplasma, and fungi said by Dhaka, Vijaypal Singh, et al. (2021).

Bacterial Diseases

Bacteria cause a wide range of diseases, such as rot, scab, bacterial wilt, and bacterial blight. Fungi that can cause some diseases include,

- Bacterial spot
- Bacterial blight
- Bacterial wilt
- Scab
- Rot
- Powdery mildew
- Cyclocladium

Fungal Diseases

Fungi are the parasites that afflict plants most often. Due to its small size, it can only be seen under a microscope. Fungal spores are usually discharged, and once within a plant, they can cause an infection. Fungal spores can only start new infections in environments with the right temperature and moisture content. Numerous illnesses are more common in humid, moist climates.

- Grey mold
- Aphid
- Powdery mildew
- Cyllindrocladium
- Mealybugs

Viral Diseases

The leaf curls inward or outward and spreads very slowly when sick with a virus. The leaves are thicker than usual and have a texture similar to leather. The juvenile leaves have a tint of yellow. They seem cupped and have a thick, rubbery look.

- Mosaic
- Spotted Wilt

- Curly top

Identification Steps

Crop productivity and quality are generally decreased by plant diseases. Plant disease management disease diagnosis is a three-phase process:

1. Image acquisition
2. Image pre-processing
3. Image segmentation
4. Feature extraction
5. Image classification

Image Acquisition

The act of taking a digital photo and saving it to digital media is known as loading a digital image. We can shoot both healthy and sick photos with this type of camera. Efficiency is impacted by the quality of the images. A webcam, smartphone, or smart camera that is either mobile or fixed at a specific distance is used to take images for image analysis.

Image Pre-processing

The main objective of picture pre-processing is to improve the image and eliminate unwanted aberrations. Noise used a range of techniques to increase contrast in images, including noise filtration, dynamic image size and form, image conversion, and morphological processes. It also converted RGB to HSI and grayscale. After being taken and having the noise removed, whether a leaf has a disease based on its color, shape, and texture.

Image Segmentation

A method for splitting a digital image into multiple segments is called image segmentation. The picture is divided into discrete parts in order to form a cluster. The K-means cluster approach is commonly employed for clustering photos. There is a minimum of one image in every cluster that contains a significant amount of the harmful area. Items are categorized into K distinct groups for every set of features using the k-means cluster algorithmic process.

Feature Extraction

The process of extracting features, which shows feature extraction an image's by counting the number of times pairs of pixels with specific values exist in the image and in a particular spatial relationship. A matrix is produced by this method, from which statistical measures are subsequently taken.

Classification of Image

This help in training and testing of the datasets. For categorization, use the random forest classifier. Plants with healthy and diseased leaves are tested using this procedure, and the findings are shown. The images go through this process following feature extraction. To stop a disease from coming back later, it needs to be treated properly as soon as it is identified. Some of these actions include planting seeds that are clear of the disease, avoiding overhead watering, increasing air circulation, etc.

II. LITERATURE REVIEW

Automatic disease detection on crop leaves is an important subject of study in agricultural science therefore, illness it arises "disease" usually when killed. Detecting crop leaf diseases automatically is a smart technique to improve agricultural output. In this study of the literature, various techniques for detecting crop leaf diseases are investigated. The following is a list of articles for agricultural disease detection. The survey for the creation of new techniques is carried out using these papers.

An author Ngugi, Lawrence C et al (2021) diagnose a leaf disease, multiple steps are necessary in order to use the hue component for further analysis. The next stage of the procedure is to mask the green color by setting the background value of the green pixel to zero in the area of interest that is not it. Consequently, segmentation yields useful segments that include a significant quantity of information. To apply the color co-occurrence approach for texture feature analysis,

SGDM properties for hue content are computed. During pre-processing, true color photos become intensity images. Pixels are regarded as objects if, at any point throughout the thresholding process, their value exceeds the threshold. Once we have this thresholded image, we equalize its histogram.

Lu, Jinzhu, (2021) designed to detect infections so they could take the necessary measures as soon as possible, they trained their model with 30880 pictures, and for testing, they used 1225 original shots. To improve the accuracy of their assessment of the Bacterial Leaf Blight. For the diseases, the model has a classification accuracy of over 81%. A higher accuracy was found the resulted in the creation of a CNN-based model for plant disease detection. This method used to identify 13 different forms of plant diseases. Final accuracy with this model was 96.3%. In another Raina, Sakshi, and Abhishek Gupta (2021) study, after utilizing K-means clustering to separate the classifying features in the SVM training of the model.

Orchi, Houda et al (2021) claim an accuracy of 82.33% for their work. The automation of disease identification in the agriculture industry is a topic of great interest to people all around the world. To pinpoint those ailments, a large team of researchers is at work. A survey regarding the most prevalent plant disease has been carried out. Sethy, Prabira Kumar, et al (2020) describes impact of illness symptoms on product yield is investigated in this study. It also discusses how to increase accuracy through testing and training data volume. The figure 2 shows some common diseases affected leaf like cedar apple rust, black measles, etc.

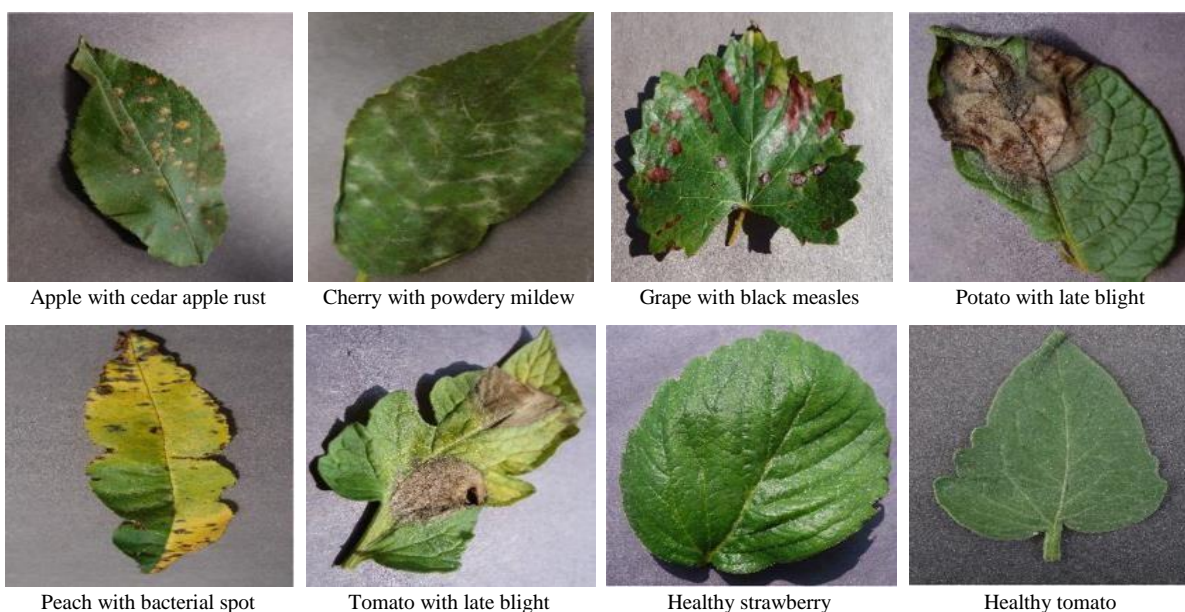


Figure 2: Some Common Diseases Affected Leaf

Vasavi, Pallepati et al (2022), a mobile client-server architecture that diagnoses leaf diseases with the Gabor wavelet technique (GWT). Originally, this method transformed colors from a color model that depended on the device to a color space model. Mobile pre-processing can begin when the leaf has been obtained and the color space transformed. With consideration for the human visual system, the human perception^a*^b color space was developed. Modifying a, b components' output curves to increase the accuracy of the human perception of lightness. The leaf image was analyzed using the K-means unsupervised approach. It is recommended that taken leaf images be processed efficiently in the future against a complicated background using a variety of leaf image.

In a similar work, Applalanaidu, Majji V., and G. Kumaravelan (2021) employed a combination of texture features (homogeneity, correlation, and inertia) and color extraction, obtained from the computation to identify disease in maize leaves. Three different species of legumes have been found through recent neural network research based on the structural properties of the veins on leaves. Many more recent articles have explored versions CNN for disease diagnosis using photos of plant leaves. The fact that these initiatives are crop-specific is one of their main drawbacks.

Fan, Xijian, et al (2022) looked into the method of hybrid clustering. Leaf segmentation is essential for plant disease diagnosis since plant diseases can affect the precision of feature extraction. The author utilized a technique called super pixel clustering, which organizes neighboring pixels with a particular attribute like brightness, texture, or color into smooth patches. Images can be made less complex by adding extra pixels. The author suggests that one possible effective technique for segmenting color images is the expectation maximization (EM) algorithm.

Hassan, SkMahmudul, et al (2021) demonstrate how two distinct fungus can be distinguished from one another on the leaves of cucumber plants. Two *P. cucurbitae* and one *S. fuliginea* infection were identified using a three-layer artificial neural network (ANN). After three days at a temperature of C, the author took pictures of real-time germination of cucumber seeds on moist paper. Further research is necessary to enhance farmers' assistance robots' ability to identify fungal and viral illnesses in real time.

Waldamichael, FraolGelana, et al (2022) used a DL method to occlusion was also proposed to help identify and comprehend the areas affected by the sickness. A number of journals, including Bengio and Good Fellow, have published datasets that the author uses. To make deep models smaller

and less complex for little devices like smartphones, more research is needed.

Bhagat, Monu, et al. (2020) was recommended to classify and detect plant diseases automatically. In this scenario, pixels are sorted into a total of k classes according to a set of features. Multiple illnesses in a leaf emerge as a result of several clusters. ANN is used for both disease detection and categorization. To increase detection accuracy, more research is required.

Bi, Chongke, et al. (2022) was talk on genetic algorithms and BP neural networks with various properties. We utilized the Otsu technique for both segmentation and extraction. Using a mobile client, tobacco sickness can be virtually diagnosed in real time, and illnesses uploaded by users can be tested by a server. Genetic algorithms allow for faster training times as well as more accurate recognition. More research is needed in order to improve accuracy and characterize the characteristics of tobacco disease.

Vishnoi, Vibhor Kumar (2022) a plant leaf image segmentation algorithm was presented. The author proposed a method for identifying and splitting up photos. A variety of tools were first used to capture different types of photographs, and those photos were subsequently processed using specific segmentation methods. R, G, and B components are present in every pixel in the author's m*n-sized image. Color co-occurrence was exploited in the feature extraction procedure. For the aforementioned tests, the MATLAB software was utilized. For banana, lemon, and bean leaves, the author only gives the results. Additional research is necessary for each type of leaf.

Islam, MdAshiqul, et al (2021) identify and monitor the features of peripheral diseases, they suggested a vision-based approach. Rotted leaf area disease identification is based on color features. The betel vine types chosen by the author are Bangla desi variants. To detect things, they employed a Canon scanner with a 300 PPI resolution. Leaf total area and % infected area can be used to determine the severity of a leaf disease. To segment diseases caused by leaf rot, the author employed the Otsu thresholding method.

Chouhan, Siddharth Singh et al (2022) used a deep convolution network technique as a classification method for leaf disease identification. Studies have elucidated the ways in which climate change can impact pathogen development pace and stage. Learned to distinguish between the leaf's surrounds using a deep neural network. We manually crop all of the photographs, highlighting the area of focus by drawing a square around the leaves. This research introduced the Caffe deep neural network framework.

Jana, S., A et al (2020) created state-of-the-art techniques for diagnosing illnesses in photos using a web application. This technique reduces the size of the original image sent to the portal and retrieves its attributes, such as morphology and color. The author uses SVM for classification and K-means clustering. To quickly diagnose diseases, farmers must upload plant leaves to this paper. The proposed framework for sickness detection maintains two picture databases current the author described and portrayed the shape of the area. The first, second, and third stages are the divisions made by the author for infections. The article's topic was the bacterial blight illness that affects pomegranates research is being done to increase system performance datasets.

Bhagat, Monu, et al (2020) described techniques for employing the Gabor wavelet transform to extract information from tomato leaves. Powdery mildew and early blight. In the preparation phase, images are resized to 512*512 resolutions in order estimate processing eliminated the image's background by using the background subtraction technique. The kernel function was utilized to train and assess the SVM for classification purposes. The below table 1 explain about the Comparison between Different Classifier in existing system.

Table 1: Comparison between Different Classifier

Article	Crop	Disease	Pre-processing technique	Classifier	Result	Year
J. Chen,et al	Rice plant, maize	Rice disease like Stackburn, Scald, Smut, White Tip, Streak, Phaeosphaeria Spot, Maize Eyespot, Goss's Bacterial Wilt Gray Leaf Spot	Grey transformation, image filtering, image sharpening and resizing,	INC-VGGN	82%	2020
S Hernández and J.L. López	Apple, grape, tomato, cherry, Peach, strawberry, blueberry, black paper, Raspberry Soybean	26 diseases, 38 classes	Stochastic Gradient Descent	Bayesian fine-tuning VGG16	86%	2020
A Waheed, et al	Maize	Common rust, Healthy crop, Cercospora, spot Gray, spot, Northern blight	data augmentation	Optimized DenseNet, VGG19, NasNet,XceptionNet EfficientNet	83%	2020
J. Sun etal	Maize	Northern leaf blight	high-pass filter reduces the reflection of the image	Generalized intersection over union (GIoU), RetinaNet DSSD, RelationNet SNIP	85%	2020

Deep Learning

As a branch of machine learning, deep learning (DL) has three main uses: object detection, image classification, and natural language processing.

Neural network-based deep learning (DL) is a method for automatically selecting features from data. It's not too important to use artificial feature engineering. Combining allows for the discovery of scattered features and attributes

within sample data. It achieves higher accuracy and better generalization than traditional methods in target identification and picture recognition. These days there are three main types of networks: the most widely used tool for classifying plant leaf diseases. Meshram, Vishal, et al. (2021) tells about Deconvolutional and Cully Convolutional Networks (FCNs) are two types of DL networks that aren't utilized for classifying plant leaf diseases. Typically, medical diagnosis or image segmentation are the uses of these networks. By using

local correlation of the image's data, the convolutional layer extracts features. It shows a kernel in the upper-left corner of the picture.

K-Means

The K-means algorithm was among first used multiple extensions in the literature and a wealth of research, K-means has been applied to many substantive topics.

Trivedi, Jay et al(2020) Super pixel clustering-based leaf segmentation was suggested using a combination of the PHOG and K-means clustering methods. Our method worked remarkably well for segmenting and identifying the diseased leaf picture of the plant. Meshram, Vishal, et al. (2021) recommended using machine learning and image processing to diagnose brinjal leaf disease. By dividing, this method demonstrated remarkable success in diagnosing leaf ailments.

Yogeshwari, M., and G. Thailambal (2023) proposed using image processing methods to detect leaf spots. This process involved four steps: segmentation, acquisition, algorithm calculate the target spot for cotton leaf disease and bacterial leaf spot had accuracy rates of up to 80% and 70%, respectively. Sinha, Bam Bahadur, and R. Dhanalakshmi (2022) advised using which collects texture and color features and feeds more than 85% of classifications were correctly classified on average using SVM.

Support Vector Machine (SVM)

It may effectively balance the complexity of the model and the ability to classify even with few samples. Superior to other machine learning methods, SVM has several advantages, such as the capacity to operate in the absence of any previous knowledge and to reduce noise.

The detection of agricultural diseases makes use of numerous cutting-edge models that include SVM classifiers. Gargade, Appasaheb, and Shridhar Khandekar (2021) recommended using SVM and image processing to diagnose cotton leaf disease.

The experiment's results show that good performance was achieved. Zamani, Abu Sarwar, et al (2022) created help in the detection and categorization of diseases affecting grape leaves by the use of an SVM classifier; following the identification of the afflicted area for KNN segmentation, they retrieved attributes pertaining to the color and texture of the grape leaves. In the end, they classified the different types of leaf diseases using these methods. 78.89% was the accuracy of this system on the test set.

Challenges and Problem Statement in Leaf Disease Analysis

Different plants and their ailments has been the subject of extensive investigation, which has also produced various diagnostic techniques. Collecting input data from multiple sources is a necessary step in the process of automated disease detection. In this review, we are considering the following major issues, challenges associated with disease, and approaches:

- Fine-quality photograph of foliage.
- Consideration of the data set must be extensive.
- Background information and noise have an impact on acquired photos.
- Dividing a leaf's precise location into significant diseases. Training and testing samples are created from the input image.
- Classification helps identify segmented spots into diseases that are meaningful.
- When the climate changes, plant leaf color, size, and texture change.
- There are certain plants that require regular inspection.
- It can be difficult to diagnose illnesses in diverse plant leaves.
- There needs to be improvement in the current research because reviews indicate ML techniques have greater potential to identify diseases.

To address the strategies used to go above these barriers, the literature study is examined in light of this.

III. CONCLUSION

Crop failure scenarios are exceedingly prevalent. Crop failure exposes farmers to significant losses. Choosing a person to carefully inspect the plants and treat leaf diseases is another issue that farmers face. It is important to identify the source of the plant disease as doing so would increase yield and quality while reducing the need for pesticides and the expense of field harvesting. Among the important characteristics and features of the leaf that are taken into consideration for order are size, shape, and surface. The primary cause of the decline in fruit and vegetable output in the leaves is illness. To solve the problem, deep learning and image processing methods were applied. Different approaches and different datasets were used by multiple authors to produce accurate results. Based on an analysis of approaches, we can infer that there are several techniques for diagnosing plant illnesses. All have advantages and disadvantages. As demonstrated, deep learning methods have outperformed shallow classifiers trained with manually generated features. With adequate data available for training, deep learning

algorithms can be able to diagnose diseases and pests with high accuracy.

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