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A Survey on Plant Leaf Disease Detection

Sneha Patel[1] | Dr. U.K. Jaliya[1] | Pranay Patel[1]

[1] Department of Computer Engineering, Birla Vishvakarma Mahavidyalaya, Vallabh Vidyanagar, Gujarat, India

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ABSTRACT

Deep learning constitutes a recent, modern technique for image processing with accurate results. Many techniques of deep learning and image processing are used for leaf disease detection and classification. Deep learning techniques such as CNN, Fast RCNN, Faster RCNN, and Mask RCNN, and image processing techniques such as image preprocessing, segmentation, feature extraction etc. are used for disease detection. As per the survey, deep learning technique provides high accuracy than image processing technique. Plant leaf disease detection has wide range of applications available in various fields such as Biological Research and in Agriculture Institute. Agricultural productivity is something on which economy highly depends. This paper provides an overview of various techniques that are used for Plant Leaf Disease Detection. It also covers survey on different diseases classification techniques that can be used for plant leaf disease detection. Some authors are describing to find leaf diseases using various methods and to recommend the various implementations.

KEYWORDS: *Leaf Disease Detection, Deep Learning, Image Processing, Feature Extraction, Convolutional Neural Network*

I. INTRODUCTION

Agriculture is the most important sector of the Indian Economy because India is an agricultural country. More than 80% of people's income depends on agriculture. Leaf disease detection is an important task here because various types of diseases in the crop reduces the overall yield. And for farmers, it is difficult to identify particular disease. We have surveyed various types of vegetable and fruit leaf disease and their detection techniques. There are two main approaches for leaf disease detection: Image processing and Deep Learning. In figure1.1 we can notice vegetable and fruit leaves like potato, tomato, apple, a grape with the diseased part. This disease can be easily detected using various deep learning techniques and image processing techniques. Image processing follows steps like Image Acquisition, Image Preprocessing,

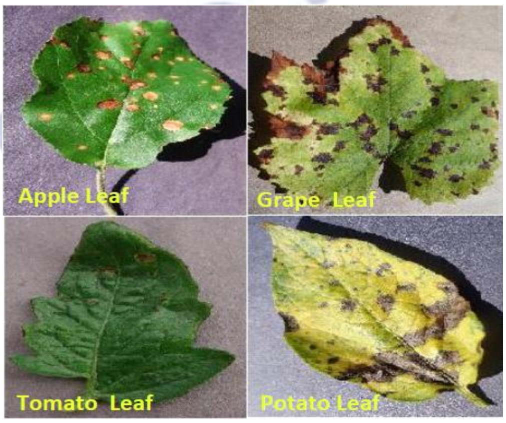

Figure 1.1 leaves with diseased part [12]

Image Segmentation, Feature extraction, and Classification. There are also many deep learning methods available to detect different types of leaf disease detection and classify into various categories of leaf disease, such as Bacterial spot, Early blight, Late blight, Mold, Septoria leaf spot, Spider mites, Two spotted spider mite, Target Spot, Mosaic virus, Yellow Curl Virus, and Healthy. The main aim of this paper is to provide survey on various leaf disease detection systems which can improve agricultural production.

II. LEAF DISEASE DETECTION AND CLASSIFICATION

Deep learning is the sub-part of the broader family of the Machine Learning techniques. It consists of various techniques such as CNN, RNN, LSTM etc. Here, a general block diagram of CNN is shown that performs classification on images of vegetab

le and fruit leaves. Images are divided into two parts, training and testing. The ratio of the train test split is 80-20 (80% of the whole dataset used for the training and 20% for the testing)

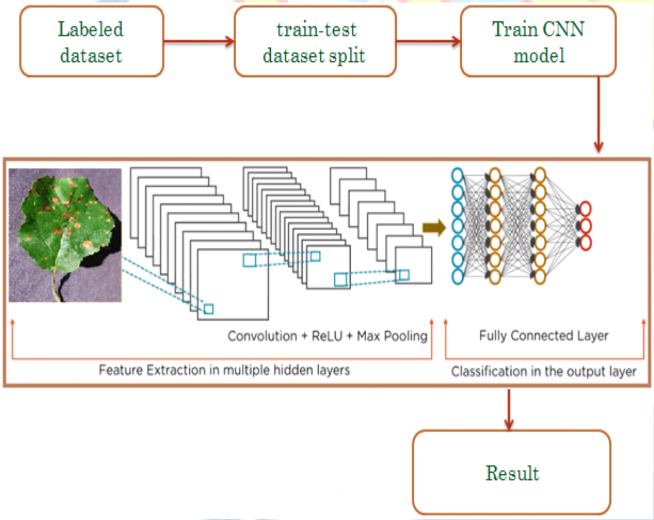

Figure 1.2 General Block Diagram of CNN Approach [13]

Normally, CNN model consists of convolutional, Relu, pooling and fully connected layers. The architecture used for the classification of the leaf diseases is a variation of the LeNet model. It consists of an additional block of convolutional, activation and pooling layers in comparison to the original LeNet architecture. The model used in this paper been shown in Fig. 1.2 Three such blocks followed by fully connected layers and softmax activation are used in this architecture. Convolutional and pooling layers are used for feature extraction whereas the fully connected layers are used for classification. Relu is the activation function that extracts the feature that performs an element-wise operation and set all negative pixel to 0 and output rectified feature map.

The convolutional layer applies convolution operation for the extraction of features. The size of the filter is fixed to 3 × 3 whereas the number of filters is increased progressively as we move from one block to another.

This increase in the number of filters is necessary to compensate for the reduction in the size of the feature maps caused by the use of pooling layers in each of the blocks. The max-pooling layer is used for a reduction in the size of the feature maps, speeding up the training process, and making the model less variant to minor changes in input. The kernel size for max-pooling is 2×2. The ReLU activation layer is used in each of the blocks for the introduction of non-linearity.

Also, the Dropout regularization technique has been used with a keep probability of 0.4 to avoid over fitting the train set. Dropout regularization randomly drops neurons in the network during each iteration of training in order to reduce the variance of the model and simplify the network which aids in the prevention of over fitting. flattening is the converting pooled feature map into a single long continues linear vector that linear vector feed into a fully connected layer. fully-connected neural network layers each with 500 and 10 neurons respectively. The second dense layer is followed by a soft-max activation function to compute. The overall accuracy score will be used for performance evaluation.

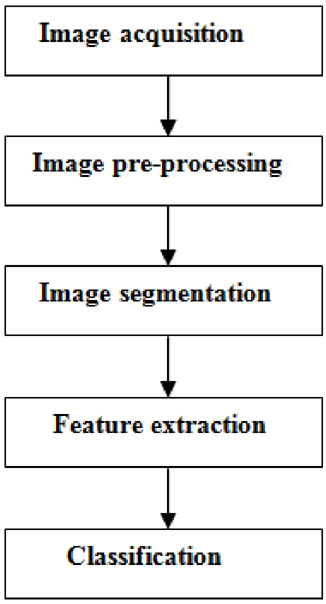

Figure 1.3 General Block Diagram of Feature

Based ApproachFeature Extraction is the existing technology that follows steps in image Acquisition, Image Pre-processing, Image Segmentation, Feature extraction, and classification. Here general block diagram of image processing is as above fig 1.3.

1. Image Acquisition:

The first step of system is the image acquisition. Loading of an image is that digital picture process and it's represented as capturing the image through digital camera and stores it in digital media using the camera we tend to captured healthy and diseased pictures. The efficiency depends upon the quality of images.

2. Image Pre-processing:

The main motive of image pre-processing is to enhance the image and remove unwanted distortions noise used various techniques for image enhancement contrast and RGB to grayscale conversion, RGB TO HSI conversion and use other various techniques like dynamic image size and form, filtering of noise, image conversion and morphological operations.

3. Image Segmentation:

Segmentation of image is the technique for the conversion of a digital picture into many segments. Image is divided into different parts to make cluster. We tend to use the K-means cluster technique for the partitioning of pictures into clusters during which a minimum of one part of the cluster contains an image with a major space of the unhealthy part. The k-means cluster algorithmic rule is applied to classify the objects into K variety of categories per set of features.

4. Feature Extraction:

GLCM (Gray-Level Co-occurrence Matrix) technique used for feature extraction which represents spatial arrangement and distance matrix. The GLCM functions explain the texture of an image by calculating how frequently the pairs of pixels with specific values occur and in a specified spatial relationship occur in an image, creating a matrix and then extracts statistical measures from it. The statistical features extracted are mean, standard deviation, variance, skewness, kurtosis, contrast, energy, homogeneity, area, perimeter, centroid, aspect ratio, eccentricity, entropy and sum of entropy.

5. Classification:

Classifiers are used for the training and testing of the datasets. Classification is done by the random forest classifier. This technique is used to test healthy and diseased plants leaves and show the result.

III. SURVEY ON DEEP LEARNING TECHNIQUES

Many authors have used different techniques of deep learning for leaf disease detection. Robert G. de Luna et al.[1]has developed the Convolution Neural Network to identify which of the tomato diseases is present on the monitored tomato plants and compare CNN with F-RCNN, and use Transfer Learning for disease recognition of the tomato plant leaf diseases. Geetharamani G et al.[3]has applied Deep CNN model is trained using an open dataset with 39 different classes of plant leaves and background images and Six types of data augmentation methods that were used for image flipping, gamma correction, noise injection, principal component analysis (PCA) color augmentation, rotation, and scaling and observed that using data augmentation can increase the performance of the model and Compared with popular transfer learning approaches. Transfer learning is a knowledge- sharing method that reduces the size of the training data, the time and the computational costs when building deep learning models [7] . Transfer learning helps to transfer the learning of a pre-trained model to a new model. Transfer learning has been used in various applications, such as plant classification, software defect prediction, activity recognition and sentiment classification. In this research, the performance of the proposed Deep CNN model has been compared with popular transfer learning approaches, such as AlexNet, VGG16, Inception-v3 and ResNet. Balakrishna K et al.[9]In the first stage, the tomato leaf is classified as healthy or unhealthy using the KNN approach. and the second stage, they classify the unhealthy tomato leaf using PNN and the KNN approach. The features are like GLCM, Gabor, and color are used for classification purposes. Omkar Kulkarni et al.[4] has developed Deep Convolutional Neural Networks that have been formulated with the goal of classifying both crop species and the identity of disease on images. The proposed methodology was tested on five classes of crops and three types of crop diseases for each class. The experimental results show that the InceptionV3 model performs better than the MobileNet model in terms of accuracy and validation loss.

Peng Jiang et al.[2] has performed convolution neural networks (CNNs) for the real-time detection of apple leaf diseases and use the apple leaf disease dataset (ALDD), deep-CNNs is proposed by introducing the Google Net Inception structure and Rainbow concatenation. Alternaria leaf spot, Brown spot, Mosaic, Grey spot, and Rust are five common types of apple leaf diseases that severely affect apple yield.

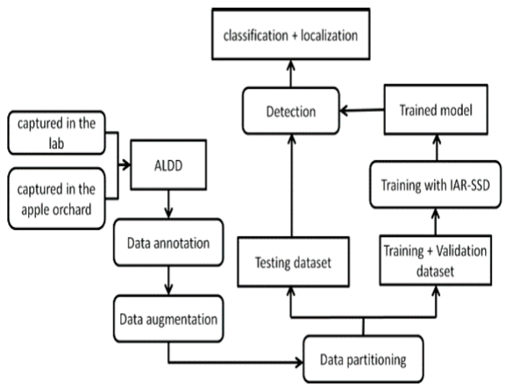

Figure 1.4 Real-Time Detection Flow Chart Of Apple Leaf Disease [2].

Adedamola Adedoja et al.[5] has developed deep learning based on NASNet architecture. The model was fine-tuned using techniques like differential learning rates, cyclical learning rates and test-time augmentation (TTA) to improve model accuracy without a reduction in training efficiency. The different categories of plant leave images as either diseased or healthy despite the complex inter and intraclass variations seem promising. Suma V R Among Shetty et al.[6]has developed a Convolution neural network to detect and classify plant diseases. This shows the ability of CNN to extract important features in the natural environment which is required for plant disease classification. Image classification, Image Categories, Feature Extraction, and Training Data is carried out. The whole development of the algorithm is done in the Python tool. Using several toolboxes like Statistics and Machine Learning Toolbox, Neural Network Toolbox and Image Processing Toolbox the outputs as of now are the training data in form of image categories, image classification using K-Means clustering and moisture content along with predicting of withstanding. The algorithm is implemented with training data and classification of the given image dataset. The test input image is compared with the trained data for detection and prediction analysis. From the results, it is clear that the model provides reliable results.

IV. SURVEY ON FEATURE EXTRACTION TECHNIQUES

Many researchers have used different techniques of image processing to detect the leaf disease and that follows steps: Image Acquisition, Image Pre-processing, Image Segmentation, Feature extraction, and classification. Abirami Devaraj et al.[7]has worked as a disease of Alternaria, Alternate, Anthracnose, Bacterial Blight and Cercospora Leaf Spot this disease is detected using image processing techniques that involve loading an image, image preprocessing, image segmentation, feature extraction, and classification. Velamakanni Sahithya et al.[8]is a ladies' finger plant leaves that are chosen and examined to find an early stage of various diseases such as a yellow mosaic vein, leaf spot, powdery mildew. Leaf images are captured, processed, segmented, features extracted, and classified and show the healthy or unhealthy. kMeans clustering is used for segmentation and for classification, SVM and ANN are used. This work uses PCA to reduce the Feature set. Priyanka Soni et al.[10]This paper is defined specifically for leaf disease identification. The work is here divided into two major stages. In the first stage, the ring project-based segmentation model is defined to explore the features of leaf images. Once the features are identified, the next work is to apply the PNN classifier to identify the existence of a disease. The work is about to identify the health and infected disease based on featured region identification. The work is applied to randomly collect leaf images from the web for different plants. The simulation results show a clear and accurate identification of diseased leaf. Sujatha R et al.[11] image processing used for the identification of leaf diseases. This is used k-means clustering and SVM. There are five steps for the leaf disease identification which are said to be image acquisition, image pre-processing, segmentation, feature extraction, classification. This approach by using different algorithms for segmentation, classification. By using this concept the disease identification is done for all kinds of leaves and also the user can know the affected area of leaf in percentage by identifying the disease properly the user can rectify the problem very easily and with less cost.

V. DATASET DETAILS AND RESULT

Robert G. de Luna et al.[1] Used dataset of 4,923 images of diseased and healthy tomato plant leaves that consist of diseases namely Phoma Rot, Leaf Miner, and Target Spot. The F-RCNN trained anomaly detection model produced a confidence score of 80% while the Transfer Learning disease recognition model achieves an accuracy of 95.75%. The automated image capturing system was implemented in actual and registered 91.67% accuracy in the recognition of the tomato plant leaf diseases. Geetharamani G et al.[3] used an open dataset with 39 different classes of plant leaves and background images. The data augmentation increases the amount of training data from 49,598 to 55,636. The most successful Deep CNN model was trained and tested with using an augmented dataset with 61,486 images and 30 0 0 training epochs. The model achieves 96.46% classification accuracy of the testing set plant leaf images, and between 92% and 100% for the individual class. Peng Jiang et al.[2] used the apple leaf disease dataset (ALDD). that consist of 26,377 images of apple leaves which contain Alternaria leaf spot, Brown spot, Mosaic, Grey spot, and Rust are 5 common types of apple leaf diseases. The experimental results show that the INARSSD model realizes a detection performance of 78.80% map on ALDD.

TABLE 1: Test accuracies of nine pre-networks [2]

Pre-network model	Input size	Recognization accurancy (%)
Alex Net	227	95.78
Google Net	224	94.85
Inception v3	232	95.49
Resnet-101	224	95.16
Resnet-50	224	95.43
Resnet-34	224	95.17
Resnet-18	224	95.64
Resnet-16	224	95.10
VGG-INCP	244	95.14

Omkar Kulkarni et al.[4] Transfer learning is used to build deep learning model using MobileNet and InceptionV3 pre-trained models. These models are fine-tuned by using image dataset of 5 different types of crops with 5277 images. Dataset is preprocessed and divided into 80%-20% training and testing data with 99.74% accuracy. Adedamola Adedoja et al.[5] The PlantVillage consists of 54,306 images with sizes 256 x 256 with labels of 38 individual classes assigned to them e.g. apple scab, apple healthy, grape black rot, etc. There are three different versions of this dataset, color, greyscale and segmented. Experiments are run on all three versions of the dataset. Using the model, an accuracy rate of 93.82% was achieved. Velamakanni Sahithya et al.[8] practical limitations in climatic conditions and other terrain regions, noisy image data sets are also created and taken into consideration. the average accuracy of detection in SVM and ANN is 85% and 97% respectively. Without noise, they are observed to be 92% and 98% respectively. The Performance Comparison shown in below table.

TABLE 2: Performance Comparison [8]

	Without noise	*With Gaussian noise*	*With Poisson noise*
Data set	Training: 32 Testing: 54	Training: 64 Testing: 108	Training: 64 Testing :108
PSNR	infinity	20.1891	26.9913
SSIM	infinity	0.9882	0.9352
Accuracy	SVM : 92 ANN : 98	SVM : 77.9 ANN : 99.8	SVM : 82 ANN : 95

Balakrishna K et al.[9] Experimentation is conducted on the author's own dataset of 600 healthy and unhealthy leaves. This paper discusses various techniques for like GLCM, KNN for leaves classification and further HSV format, Sobel edge detection, Morphological operation, Gabor filter, KNN and PNN for infected leaves classification, PNN classification performance better compared to KNN. Abirami Devaraj, Karunya Rathan, Sarvepalli Jaahnavi and K Indira et. al.[7] The present study deals with Alternaria Alternata, Antracnose, Bacterial Blight and Cercospora Leaf Spot these automatic illness detection using image processing techniques in MATLAB. It involves loading an image, image preprocessing, image segmentation, feature extraction and classification. Priyanka Soni et al.[10] In this paper, a hybrid method is defined to identify the existence of disease in plant disease. Leaf is considered here as the primary component of images on which the observation is applied. The recognition results applied on random dataset are presented. The work is applied on three different datasets. The trained dataset properties are shown in Table 3.

TABLE 3: Dataset Property [10]

Property	Value
Number of Images	20
Format	JPG
Resolution	Random
Type	Color
Variation	Color/Brightness/Background/Object
Training Images	20
Test Images	20
Correctly Recognized	18
In Correctly Recognized	2
Recognition Rate	90

Suma V R Among Shetty et al.[6] the source of data is collected from the PlantVillage website. The images thus collated are labeled with four different categories-bacterial spots, yellow leaf curl virus, late blight and healthy (in order to differentiate healthy leaves from affected ones). The dataset is divided into 70% for the training, 10% for validation and 20% for testing.

TABLE 4: Results of testing and validation accuracy [6]

Model	Validation accuracy	Test accuracy
Base model and dropout	99.21%	99.32%
Base model and L2 regularization	98.62%	98.73%

Sujatha R*, Y Sravan Kumar and Garine Uma Akhil et al.[11] This study summarizes major image processing used for identification of leaf diseases are k-means clustering, SVM. This approach can significantly support an accurate detection of leaf disease. There are five steps for the leaf disease identification which are said to be image acquisition, image pre-processing, segmentation, feature extraction, classification. By computing amount of disease present in the leaf, we can use sufficient amount of pesticides to effectively control the pests in turn the crop yield will be increased. We can extend this approach by using different algorithms for segmentation, classification.

V. CONCLUSION

In this paper, survey on various techniques for Leaf Disease Detection is done. In the leaves, disease is the main reason for less production of vegetables and fruits. To overcome that issue using Deep Learning and Image Processing techniques. Different author used that techniques and different datasets for accurate result. After reviewing techniques we can conclude that there are number of ways by which we can detect disease of plants. Each has some advantages and limitations. According to survey Deep Learning Techniques is more accurate than Image Processing Techniques.

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