International Journal of Research in Computer & Information Technology (IJRCIT),
Vol.6, Issue 4, Sept 2021
E-ISSN: 2455-3743
Available online at www.ircit.co.in

Study of Plant Diseases Detection & Classification Using Image Processing Techniques

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Abstract— Agriculture is one of the important sources of livelihood in the world. Nowadays the agriculture sector also providing employment opportunities to the village people on large scale in developing countries like India. In India, many crops are cultivating and according to the survey, nearly 75% population is dependent on agriculture. Most of the Indian farmers are adopting manual cultivation due to a lack of technical knowledge and are unaware of what kind of crops grows well on their land. When plants are affected by a number of diseases through their leaves that will directly affect the production of agriculture and profitable loss with the reduction in quality of crops. So that healthy plant leaves are very important for the fast growth of plants and to increase the production of crops. Identification of proper diseases in plants leaves is challenging for farmers and also for researchers. Nowadays farmers are spraying pesticides on the plants without knowing the proper disease of the plant and it also affects humans directly or indirectly by health and economically also. Therefore, to detect these plant diseases many techniques need to be adopted. In this paper, we have done a survey on different plants disease and various available advanced techniques to detect proper plant diseases.

Keywords— Plant Diseases Identification, Image Processing, Classification Mechanism

I. Introduction

Indian economy is dependent of agricultural productivity. Over 70% of rural homes depend on agriculture. Agriculture pays about 17% to the total GDP and provides employment to over 60% of the population. Therefore, detection of plant diseases plays a vital key role in the arena of agriculture. Indian agriculture is composed of many crops like rice, wheat. Indian farmers also grow sugarcane, oilseeds, potatoes and non-food items like coffee, tea, cotton, rubber. All these crops grow based on strength of leaves and roots. There are things that lead to different disease for the plant leaves, which spoiled crops and finally it will affect on economy of the country. These big losses can be avoided by early identification of plant diseases. Accurate detection of plant disease is needed to strengthen the field of agriculture and economy of our country. Various types of Disease kill leaves in a plant. Farmers get more difficulties in identifying these diseases, they are unable to take precaution on those plants due to lack of knowledge on those diseases. Biomedical is one of the fields to detect plant diseases. In current day among this field, the image processing methods are suitable, efficient and reliable field for disease detection with help of plant leaf images. Farmers need fast and efficient techniques to detect all types of diseases of plants that can save time. These systems that can reduce efforts and use of pesticides. For measurement of yields in agriculture different ideas are proposed by scientists with the help of laboratory and systems for efficient identification of plant leaf diseases. The paper we presented here is survey of various types of plant diseases and techniques for detection of disease by different researchers.

A. Key Issues and Challenges in The Field of Disease Analysis

Many researchers have done research on various plants and their diseases also they suggested some techniques for identification of diseases. Automation of identifying disease entails the input date collected from different sources. In this review, considering all available different research papers and we are identifying and discussing key issues, challenges on diseases and techniques are as follows.

- Quality image of plant leaves
- Data set need to be considered in large amount.
- Acquired images are affected by background data and noises.
- Segmenting the exact spot in a leaf into meaningful disease.
- Preparation of training and testing samples from input image.
- Classification in recognizing segmented spot to meaningful disease.
- Color of plant leaf, size and texture are varying when climate changed.
- Regular observation is needed for particular plants. Identifying diseases for different plant leaves is challenging.
- Reviews suggest that image processing, machine learning and artificial intelligence techniques have

Manuscript Received August 12, 2021; Revised 28 August, 2021 and Published on Sept 09, 2021

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more potential to find diseases so, there has to be improving in existing research.

Keeping all these in mind and to discuss the techniques used to accomplish these challenges, the literature survey is discussed.

II. Types of Plant Disease

Many researchers done research on various plants diseases and they had given some techniques to identify the disease. To get knowledge of this studies area, we perform a take a look at on numerous styles of plant life with diseases. This survey will assist to suggest novel concept for identity of diseases.

The cause for this segment is that researchers can recognize sort of photo processing operation and sort of function that we need to be taken into consideration through staring at unhealthy plant Disease to the plant life that takes area while a virus, micro-organism infects a plant and issues its ordinary growth. Effect on plant leaves can range from discoloration to death. Disease reasons because of inclusive of fungi, microbes, viruses, nematodes. Here we're discussing a few not unusual place sicknesses in Maize, arecanut, coconut trees, Papaya, Cotton, Chilly, Tomato, Brinjal. The snap shots of plant disorder are proven in Fig.1. Several variations of Diseases are defined further.

A. Rust

It is usually found on leaves lower surfaces of mature plants. Initially raised spots on the undersides of leaves. As time passes these spots become reddish- orange spore masses. Later, leaf postules turn to yellow- green and eventually black. Severe infestations will bend and yellow leaves and cause leaf drop [16].

B. Kole Roga

It is a main disease of areca nut. The pathogen is a fungus Phytophthora palmivora [17].

C. Yellow leaf disease

This disease caused by pathogen Phytoplasma in arecanut where green leaves tuning into yellow that gradually decline in yield.

D. Leaf rot

It is caused in coconut tree. It is caused by fungi or bacteria. Leaf spot vary in size, shape and colors [18].

E. Leaf curl

Disease is characterized by leaf curl. It can cause by fungus, genus Taphrina or virus [19].

F. Angular leaf spot

Most of cotton plants die due to this disease because it appears on leaves first then water soaked. Finally turn black and form holes in leaves [20].

G. Leaf spot

It is serious bacterial disease found in chili spread by Xanthomonas campestris pv vesicatoria [21]. The symptoms like small yellow green legions and patches on leaves.

H. Late Blight

Late Blight spreads rapidly. The development of the fungus due to Cool and wet weather. It forms irregularly shaped ashen spots signs on leaves. Around the spots there will be a ring of white mold [22].

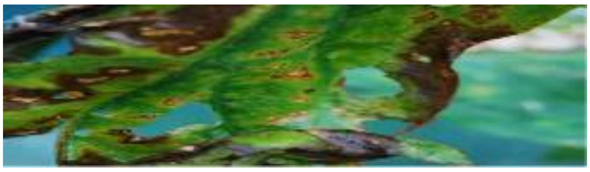
I. Bacterial wilt

Brinjal cultivation yield drops due to bacterial wilt. Entire plant has fall down due to wilting of the foliage [23].

Leaf Rot: Coconut

Papay Leaves Curl

Angular Leaf spot: Cotton



Leaf Spot: Chilli

Tomato Late Blight

Bacterial wilt: Brinjal
Figure 1: Types of Plant Diseases

III. Plant Disease Identification and Classification Process

The process of plant disease detection system basically consists of four phases as shown in Fig.2. The first phase involves acquisition of images either through digital camera and mobile phone or from web. The second phase converts the image into various numbers of clusters for which different techniques can be applied. Next phase contains feature extraction methods and the last phase is about the classification of diseases.

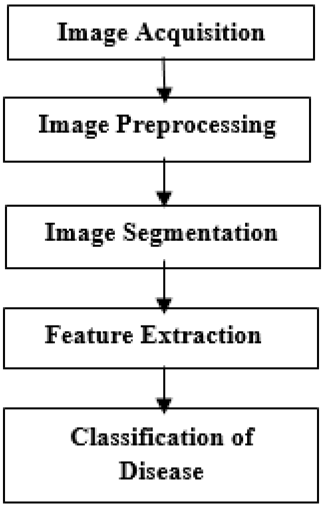


Figure 2: Processes in plant disease detection

A. Image Acquisition

Plant leaf images are taken by using digital camera. These images are in RGB color form so the color transformation structure is applied.

B. Image Pre-processing

Different preprocessing techniques are used for removing unwanted noise from the image. To get interested image region image clipping i.e., cropping is used. Smoothing filters are used for image smoothing. For increment in contrast image enhancement is carried out. By using colour conversion equation, RGB image is converted into grey image.

C. Image segmentation

Segmentation is nothing but the partitioning of image into various parts of same features. So, it can be done using various techniques like OSTU method, k-means clustering, converting RGB image into HIS model etc.

1. Using Boundary and spot detection algorithm: The RGB image is converted into the HIS model for segmenting. This algorithm helps to find the infected part of the leaf. For boundary detection the 8 connectivity of pixels is consider and boundary detection algorithm is applied.
2. K-means clustering: The K-means clustering is used for classification of object based on a set of features into K number of classes. The classification of object is done by minimizing the sum of the squares of the distance between the object and the corresponding cluster.

The algorithm for K –means Clustering

a) Pick center of K cluster, either randomly or based on some heuristic.
b) Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center.
c) Again, compute the cluster centers by averaging all of the pixels in the cluster. Repeat steps 2 and 3 until convergence is attained.

3] Otsu Threshold Algorithm: Binary images from grey-level images are created by using this algorithm, by setting all pixels below some threshold to zero and all pixels above that threshold to one. The Otsu algorithm defined in is as follows:

a) According to the threshold, separate pixels into two clusters

b) Then find the mean of each cluster.

c) Square the difference between the means.

d) Multiply the number of pixels in one cluster times the number in the other

D. Feature Extraction

Feature extraction is used in many applications in image processing hence plays an important role in identification of plant leaf disease. Color, texture, morphology, edges these features can be used in plant disease detection. Texture means how the color is distributed in the image, the roughness, hardness of the image. It can also be used for the detection of infected plant areas.

a) Color co-occurrence Method: In this method both color and texture are taken into account to get a unique feature for that image. RGB image is converted into the HSI translation.

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b) Leaf color extraction using H and B components: The input image is enhanced by using isotropic diffusion technique to preserve the information of the affected pixels before separating the color from the background. To distinguish between grape leaf and the non-grape leaf part, H and B components from HIS and LAB color space is used. A SOFM with back propagation neural network is implemented to recognize colors of disease leaf.

E. Classification

After extraction, the learning database images are classified by using neural network. The Back-Propagation algorithm modified SOM; Multiclass Support vector machines can be used.

IV. Review of Literature

In the past, several researchers have focused their work to enhance the accuracy of an automatic detection system for plant leaf diseases. This section discusses different techniques used for the classification of plant disease by using various classifiers such as Convolution Neural Network, Support Vector Machine, K-Nearest Neighbors, etc.

A. Convolutional Neural Network (CNN)

Convolution Neural Networks are a class of deep feed forward neural networks that have the ability of processing multidimensional data. The aim of CNN is to reduce images into an easier-to-process form, without compromising the features that are essential for getting a good prediction. There are various available architectures for CNN such as AlexNet, GoogLeNet, VGGNet etc. Due to its growth has generated a lot of interest among researchers in various fields of computer science [9]. In agriculture, it has been used for the classification of diseases in plants.

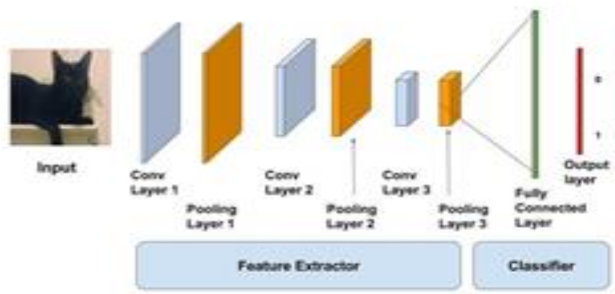

Figure 3 CNN Classifier

As shown in Fig.3, the CNN model comprises of an input layer, convolution layer, pooling layer, a fully connected layer and an output layer. To classify the disease in plants in a precise manner the images are provided as input. The convolution layer is used for extracting the features from the images. The pooling layer computes the feature values from the extracted features. Depending on complexity of images, the convolution and pooling layer can be further increased for obtaining more details. Fully connected layer uses the output of previous layers and transforms them into a single vector that can be used as an input for next layer. The output layer finally classifies the plant disease. The following work has been done in plant leaf detection using the CNN approach.

Mohanty et al. in 2016 [10] have focused mainly on two CNN architectures i.e., AlexNet and GoogLeNet and the training mechanisms that have been used for transfer learning and training from scratch. The images used from Plant Village dataset and about 54,306 images of different plants with 38 classes of diseases were taken. All the images in the dataset were downscaled into 256 × 256 pixels, and model optimization and predictions were performed on the resized images.

Lu et al. in 2017 [11] have proposed a model for disease detection of rice crop using deep convolution neural network. They have used 500 images captured with a camera from a field and 10 common diseases in rice plants have been detected. The results have been compared for different pooling (mean, max and stochastic pooling), different convolution filter sizes (5X5, 9X9, 16X16, 32X32) and for different algorithms (CNN, BP, SVM, PSO).

Gandhi et al. in 2018 [12] proposed a system based on two different CNN architectures i.e., Inception v3 and MobileNets. They have used 56,000 images with 38 classes of crops from the PlantVillage dataset. A deep convolutional generative adversarial network (DCGAN) has been used for the augmentation of limited images in the dataset.

Ferentinos, K. P. in 2018 [13] have used different architectures of CNN, such as AlexNetOWTBn, Overfeat, AlexNet, VGG, and GoogLeNet that were trained using various parameters. The training and testing of these models were implemented using Torch7, which is a computational framework for machine learning. Around 87,848 images of PlantVillage dataset having 25 plant species in 58 distinct classes of disease were used in this work. VGG and AlexNetOWTBn architectures had the highest success rates as compared to others.

Khamparia et al. 2019 [14] have integrated convolutional neural networks (CNN) with autoencoders for detection of diseases in crops. The authors have utilized a dataset with 900 images of three crops with five different types of diseases such as early blight and late blight for potato, leaf curl and yellow leaf curl for tomato and rust disease for maize crop. The convolution filters of size 2 X 2 and 3 X 3 have been used and analyzed accuracy varies for different convolution filters for different number of epochs. For loss reduction and improved accuracy while training, Adam optimizer has been used.

Kamal et al. in 2019 [15] proposed two models namely Modified MobileNet and Reduced MobileNet by using the depthwise separable convolution architecture and their

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results were compared with MobileNet, AlexNet and VGG. Various optimizers like SGD, Adam and Nadam were also used. Nadam performed better and with a faster convergence rate than the other two optimizers. In this work 82,161 images having 55 distinct classes of healthy and diseased plants were used from publicly available Plant Village dataset for the training and testing of the model.

Geetharamani, G., & Pandian, A. in 2019 [16] presented a plant leaf disease identification approach by using a deep convolutional neural network (Deep CNN). The Deep CNN framework is trained and tested on an open access data that the authors have downloaded from Plant Village dataset. About 54,448 images of 13 different plant leaves have been used in this work. Augmented image dataset and a non-augmented image dataset have been used to train the model. The augmented images have been created using techniques such as gamma correction, colour augmentation, noise injection, rotation, principal component analysis (PCA), and image flipping that increase the size of augmented dataset to 61,486 images.

Karthik et al. in 2020 [17] utilized two distinct deep learning mechanisms for the first time to detect the diseases such as late blight, early blight, and leaf mold on tomato leaves. The authors in the first architecture have used residual learning on CNN. In the second approach they have integrated residual learning with attention mechanism on CNN for the efficient learning of features. This task has been done on Plant Village Dataset and about 95,999 images have been used for training their model.

B. Support Vector Machine (SVM)

Support vector machine (SVM) is a type of learning algorithm that is based on structural risk minimization and is also used for classification and regression problems. It is designed in such a way as to maximize the classification boundaries so that two classes are separated as widely as possible.

As shown in fig. 3, to get the appropriate data point, SVM has been applied to this region and it is termed as hyperplane. The adjacent points of hyperplane are recognized from both sides of the plane i.e., support vectors. To make a separation between these vectors a fixed margin that must be maximum is used, through which the SVM can be trained in an effective way.

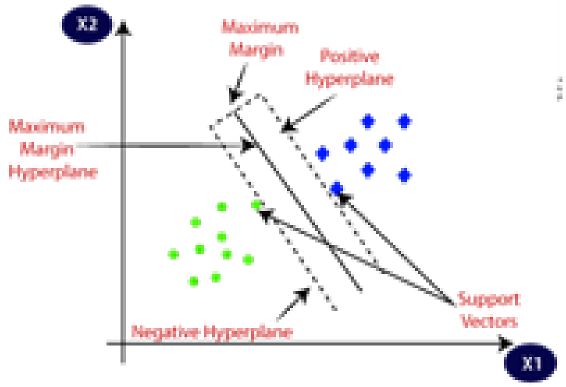

Figure 4: SVM Classifier

The work done using SVM for the classification of diseases in plants is discussed below:

Badol et al. in 2016 [18] have used a Linear Support Vector Machine for the classification of two types of diseases i.e., Downey and Powderly Mildew in grape leaves. The researchers used 137 images of grapes that they captured using a camera. Images are preprocessed to remove the noise using gaussian filter and thresholding is done to remove unwanted components. Then, segmentation of images is done using k-means and later features are extracted and the images are then fed to the SVM classifier.

Singh et al. in 2017 [19] have identified and classified pea rust disease that is caused by a fungus known as Uromyces fabae (Pers.) de Bary. About 500 images of pea plants were used that have been collected from Hill Agricultural Research and Extension Centre in Himachal Pradesh, India. Various steps of image processing were used and at the classification phase, SVM was utilized for disease detection.

Bhimte et al. in 2018 [20] presented a model which detected Bacterial blight and Magnesium Deficiency in cotton plants. The dataset consisted of 130 images that were captured with a camera. Quality of images are improved using preprocessing techniques and then k- means clustering is used for segmentation. The images are then classified using SVM classifier after the features have been extracted using Gray Level Co-occurrence Matrix (GLCM).

Kumar et al. in 2018 [21] introduced a new exponential spider monkey optimization (ESMO) technique of feature selection for identification of disease in plant leaves. For feature extraction subtractive pixel adjacency model (SPAM) technique is used. In this work 1000 images from PlantVillage dataset have been used for detection of disease. To make classification among healthy and diseased leaves KNN, SVM, ZeroR, and LDA classifiers were used. After analysis, SVM classifier performed better than the other classifiers.

Hossain et al. in 2018 [22] proposed a system to identify two classes of diseases namely brown blight and algal in the tea plant. About 300 images of healthy and diseased tea plant were captured using a camera from Bangladesh Tea Research

Institute. After preprocessing and feature extraction the data was fed to the SVM classifier for the accurate prediction of the disease.

Aruraj et al. in 2019 [23] have developed a method to classify the diseases in banana plant. They have used 123 images of banana plant which included both the diseased and healthy images from the PlantVillage dataset. For texture analysis the technique of local binary pattern has been used and the features that have been extracted are fed to the SVM classifier through a 7-fold cross validation. In Table 2, we discussed the work that makes use of the SVM technique to detect plant disease.

C. K-Nearest Neighbor (K-NN)

In this classification scheme, statistical along with non-parametric and the weight is given corresponding to neighbors. Here, the classification is done based on the computed Euclidean distance metric. It is also known as a lazy learner because it simply stores all the training tuples given to it as inputs in its learning phase without performing any calculations and thus prevents it from being used in areas where dynamic classification is needed for large databases.

In fig. 4, a blue star represents the test data point. This test point is bounded through the red circles, and green squares that serve two classes. As shown in figure, there are six points, so six distances need to be calculated.

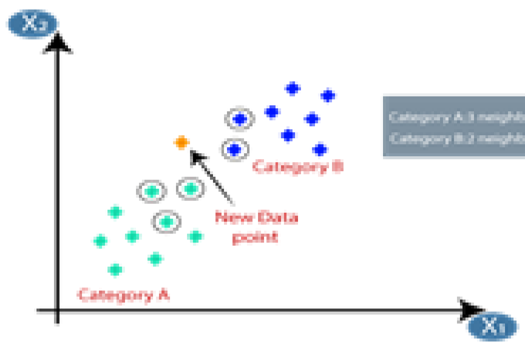

Figure 5: K-NN Classifier

For K-NN classification the three essential aspects are as follows:

- Easy resultant output interpretation
- Short computational time
- High prediction rate

This technique is used widely in areas such as text mining, pattern recognition, forecasting the trends in stock market and in agriculture for classifying various diseases in plants. The following work has been done using the K-NN approach for detecting plant diseases.

Parikh et al. in 2016 [24] proposed a system that uses cascades of KNN classifiers and multiple training sets to successfully detect Grey Mildew, a fungal disease in cotton plants from unconstrained images. The authors have collected 130 images from Sardar Krushi Nagar Dantiwada Agriculture University. The images are segmented, and the features extracted and KNN classifier is then used.

Ramcharan et al. in 2017 [25] utilized transfer learning mechanism on the basis of SVM and KNN, by utilizing the convolutional layers of existing trained Inception v3 model. The classification of the disease has been done in three specific ways; SVM, KNN and original softmax layer of inception v3 model.

Suresha et al. in 2017 [26] presented a system for detecting diseases such as Blast and Brown Spot in paddy plant. About 300 images taken from a camera in paddy fields of Shivamogga district in Karnataka state have been used in this paper. For segmentation Otsu technique have been used along with global threshold. Connected component has been used for feature extraction and classification is done using the KNN technique.

Hossain et al. in 2019 [27] have considered plant diseases such as Alternaria, anthracnose, bacterial blight, leaf spot, and canker of plants and used K-NN to classify them. The dataset comprises of 237 leaf images acquired from the Arkansas plant disease database. The features of plants have been extracted using the GLCM technique. To prevent overfitting, the 5-fold cross validation was applied on the training dataset.

Abdulridha et al. in 2019 [28] developed an automatic early identification of diseases such as laurel wilt, phytophthora root rot (Prr), and deficiency of iron and nitrogen in avocado plants. The images were acquired using cameras and Multilayer perceptron (MLP) and K-nearest neighbor (K-NN) classification techniques were used.

V. Conclusion

Several Severe diseases in plants leads to the annual losses of the agricultural yield. Therefore, detecting the diseases at an early stage in plants is very important and crucial for the prevention of such drastic losses in the future. In this paper, we have discussed the diseases in various plants along with the related methodology encompassing of the image processing steps. Classification techniques that are most widely used for the identification and detection of diseases on plant leaves have been reviewed. The most recent work has been studied. It can be concluded that amongst the techniques that have been used in the existing work done, highest accuracy has been achieved with the help of deep learning concepts and the CNN approach.

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