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BIOTIC LEAVES DISEASE CLASSIFICATION AND DETECTION USING DIFFERENT CLASSIFIER ANALYSIS IN AGRICULTURE

S. Nithiya and K. Annapurani

Department of CSE, SRM Institute of Science and Technology, India.

Abstract

Disease identification plays a crucial role in agricultural productivity and will be beneficial to farmers. A lot of research work is put into identifying the disease of the plant based on the leaves. Production of yield might be improved if the diseases through leaves are identified in proper time and care taken to manage the disease of the plants. In the olden days, the checking and investigation of the malady in leaves were done physically by the skilled individual in that field. This requires a huge measure of work and furthermore over the top handling time. This expertise knowledge can be fed into the system and trained in such a way to identify and classify the diseases that would finally lead to higher productivity. Due to which the process of identifying the diseases can be automated. The diseases in leaves might be due to bacteria, fungi, and viruses. Once the disease is identified it has to be properly classified in order to provide medicinal care. This paper is used for understanding of existing machine learning techniques which is used for leaf diseases classification and identification. The performance analysis and pros and cons of different machine learning techniques used for leaf disease identification are discussed. Also, the leaf disease datasets available for identification are discussed. Improvement that may be considered in machine learning algorithms for classification of leaf diseases is discussed.

Key words: Leaf diseases, classification, identification, machine learning algorithm, bacteria, fungi

Introduction

The requirement for food will constantly increment for the next 40 years because of the human growth (Godfray, H.C.J, *et al.,* 2010) The less production in crop yield because of pathogen assumes an important job in crop losses all through the world and its contamination extends somewhere in the range of 20% and 40% on average. (Savary, S., *et al.,* 2012) Pathogen affects the maize, grain, rice, and soybean are assessed to be around 12%, groundnuts and potatoes are evaluated to be around 24% and wheat and cotton are evaluated to be around 50% (Oerke, E.-C, 2006) To limit harm in crops during development, reap and postharvest preparing just as to augment the profitability and guarantee horticultural maintainability early forecast of sickness is a needful one. The diseases are affected in leaf, fruit, and stem of the plant determined by brown and yellow, early, and late scorch. The method should need automated disease identification which follows image acquisition, image preprocessing, image segmentation of an image. This paper provides an overview of various leaf diseases of different plants discussed by many researchers and suggested the consideration that is feasible for early identification of leaf diseases.

Type of plant diseases based on leaf infection

Plant diseases are classified into two types biotic (Husin ZB, *et al.,* 2012) and abiotic (Kennelly, Megan, *et al.,* 2012) Biotic caused by fungi, bacteria, and viruses. Abiotic, interestingly, are delivered by non-living biological conditions, for example, hail, spring ices, climate conditions, consuming of synthetic compounds. There are different types of symptoms in different plants based on the infections on the leaves. The color of the leaf may change, spots will be there on the leaf, knots, a white coating, rust-like reddish orange color may be in the leaves. Based on these parameters the leaf disease can be identified. table 1 gives the symptoms in leaves of different plants to identify the diseases.

Plant Disease Detection System

The framework of a simple plant disease detection system included with the following modules: acquisition,

***Author for correspondence :** E-mail : nithiyas@srmist.edu.in, annapook@srmist.edu.in

Table 1: Disease of the plant with symptoms.

Leaf Spot-Symptoms	brownish and irregular spots appear on the leaf surface.Leaves get yellow and shrink off as illness gets serious.
Powdery Mildew Symptoms	White powdery diseases occurred at the lower surface of the leaf. Very soon leaves affected as yellow, coarse, and lose their nutritive as the disease becomes severe
Leaf Rust Symptoms	Initially, circular pinhead-sized brown eruptive lesions appear on the leaves, and later leaves become yellow and wither off.
Sooty mold Symptoms	Thick dark covering creates on the upper surface of the leaves.
Root-knot Symptoms	Formation of bunches/nerves on roots is the principle pointer of the sickness manifestation.
Rust Symptoms	It generally appears on leaves lower surfaces of developed plants. At first raised spots on the undersides of leaves. the disease becomes severe when the spots tuns to reddish-orange
Yellow leaf disease Symptoms	Green leaf turns into yellow.
Leaf rot symptoms	It is affected majorly in the coconut tree. The reason for this disease is caused by fungi or bacteria.
Leaf curl Symptoms	The disease is identified by leaf curl. The reason for this disease is caused by a fungus, genus Taphrina or virus
Angular leaf spot Symptoms	The vast majority of the cotton plants die because of this sickness since it shows up on leaves first at that point water-doused. At long last, turn dark and holes in leaves
Leaf spot Symptoms	It is a severe bacterial illness found in chili. The side effects like little yellow-green armies and patches on leaves.
Late Blight Symptoms	Late Blight spread very fast the advancement of the disease growth because of Cool and wet climate. It frames sporadically formed colorless spots signs on leaves.
Bacterial wilt Symptoms	Brinjal development yield drops because of bacterial wither. The whole plant has passed on because of the withering of the foliage

In table1 discussed different symptoms of plant disease at different plants

preprocessing, segmentation, feature extraction, and classification

Fig. 1 gives the details about various steps of image classification with its functionality

Image Acquisition

Images are acquired from the real-time environment using a digital camera, cell phones or the images are collected from reliable website eg.data.gov.in

Preprocessing

Acquired images are preprocessed by removing the noise of an image, morphology, smoothing the edges of an image.

Segmentation

In a digital image, processing images are segmented as objects. Deep learning-based image processing images are segmented by pixel.

Feature Extraction

Feature extraction is very useful for making difference between one object to others. Feature extraction is based on color, shape and texture of an object.

Classification

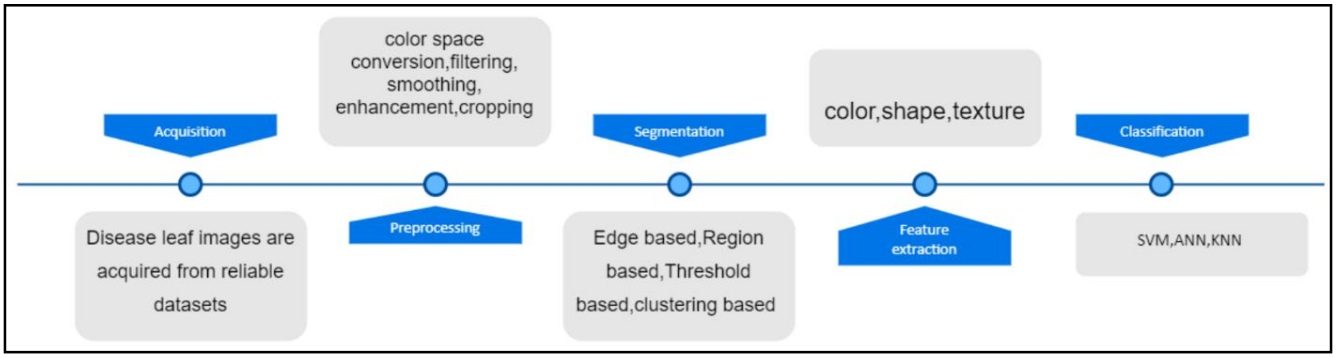

Fig. 1: Block diagram of Leaf disease detection in plants.

Classification occurred at feature extracted images. It classifies the images into different classes. Many types of classification are used in this stage.

Plant leaf disease classification

This section discusses the different methods of classifiers used for the proper identification of diseases in plants based on the symptoms in leaf. The performance of the classifiers on different plant diseases is discussed according to the analysis done by various researchers.

Sparse representation classifier

Shanwen zhang (2017), Discussed cucumber leaf disease. Every diseased leaf image is preprocessed by smoothing, enhancing, denoising, alignment. The author used K mean clustering algorithm for segmentation using Euclidean distance. In segmentation, the pixel is classified into k classes. Each pixel of the leaf image labeled by K mean clustering algorithm by cluster index. Index value varied by color variation of a leaf. Segmented color images are converted in L*A*B to obtain histogram for lesion images. The classification was proposed by spare representation (SR).

CNN classification

Yang Lu (2017), presented about disease identification in rice. The author discussed 10 common rice disease known as rice brown spot, false smut, rice blast, rice, rice, etc. disease is identified using deep CNN which consist of three types convolutional layer known as stochastic pooling layer, and a SoftMax layer. Images are compressed from 5760*3840 to 512*512 to make run-time efficiency. Image features are extracted from that image. The first part of the convolutional layer extract different low-level features from the input image, such as edges, lines, and corners. The other two-part can be used to obtain high-level features. Stochastic-pooling layer provides the combination of MIN and MAX pooling layer.

Multilayer CNN classification

Uday Pratap Singh (2019), the author found out fungal disease infection at the mongo leaves. Proposed work is based on the multilayer convolutional neural network which is inspired by AlexNet architecture. Preprocessing of an image involves contrast enhancement and the rescaling of an image by the method of histogram equalization and central square crop. In this proposed work author used four types of CNN layers named convolution, max-pooling, fully-connected and output layer. In this CNN architecture, multiple steps are involved to make the architecture as an efficient one.

The first two layers consist of 128 filters and ReLU activation function. Also, the third layer added with the max-pooling layer used for the reduction of convoluted image size by {2, 2}. After that two more convolutional layers added with 384 filters and ReLU activation function. Finally, the dropout rate is rate 0.2 is assigned for max-pooling layer. This layer also included the flattening process in the output function. The output of the flattening model has given the feature set of images. A fully connected layer is used to classifying an image based on the feature. A dense layer is the next layer of the fully connected layer having 512 hidden layers and ReLU activation function. One more fully connected layer is used to generate the 3 output neuron and max pooling. It is used to compute the maximum variance and reduce the variance of a particular image area. SoftMax layer is applied in multi-class problem.

Feature based classifier

Muhammad Attique Khan (2019), the author presented about various apple diseases such as healthy leaves, Blackrot, Rust, and Scab. This paper mainly used to contribute contrast enhancement at preprocessing time after that segmentation of an image, and feature selection of an image. The author is mainly concentrating on enhancing image quality by implementing Three preprocessing stages is involved as applying 3D-Box filtering, implementing De-correlation step, and including of a 3D-Gaussian and 3D-Median filter. For making Smoothing of the lesion region, the 3D-Box filtering operation is performed. For making the color variance of an image De-correlation is used. combination 3D-Gaussian and the 3D-Median filter are used to removing the noise factor. The segmentation method includes two types of techniques as Strong Correlated Pixels (SCP) and Expectation-Maximization (EM) algorithm. The feature of images is extracted by color, color histogram. Images ate classified using feature extraction, selection methods

Deep convolutional neural network classifier

Xihai Zhang (2018), the author discussed eight different kinds of maize leaf diseases. Maize is one of the major crops in India. The author implemented with three convolution layers such as two fully connected layers and a loss layer. The pooling layer is attached for ReLU operation. In between two fully connected layers, Dropout and ReLU were attached for improving identification accuracy. Over-fitting of CNN can be prevented by dropout operation.

SVM classifier

Megha S. (2017), the author discussed different leaf diseases that were caused by bacteria. Preprocessing steps involved RGB to grayscale, Resizing of an image,

Image filtration. FCM clustering technique is used for segmentation. SVM is used for the detection and classification of disease. Compare with other image segmentation techniques FCM is fast and flexible. FCM is an iterative clustering method that provides an optimal partition.

Pairwise based classifier

Jayme Garcia Arnal Barbedo (2016), This paper author discussed 12 different plant disease which was identified using the pairwise based classification system. The author discussed three major parts in this paper as processing, training, and core function. In basic processing, the lesion part was isolated by removing the unwanted part of the leaf. In the first phase of training, a histogram is used to capture the characteristics of each disease by referring to the color channel. The second step involved leaf segmentation by calculating the pixel value of Red, Green, and Blue. The lesions part of the diseases is in the RGB format which was transformed to the HSV, L*a*b* and CMYK color spaces. Segmented lesion part is given to the training phase. The final step in the training phase is a consistency value calculation. Cross correlation of each histogram with corresponding images in the training set was calculated and then it gets averaged.

Pattern recognition classifier

P. R. Rothe (2015), In this paper author, discussed three types of cotton leaf diseases such as Bacterial Blight, Myrothecium, and Alternariol. A low pass filter is used for Image enhanced by removing noise. Segmentation performed by the active contour model by the segregation of the lesion pixel by leaf background. The active contour model is an energy minimization model. The back-propagation network model is used of the classification process. Backpropagation network model rules are based on gradient descent. Input, output, and the hidden layer is used in the training phase of the feed-forward backpropagation network. The input and output layer has 7 node and the output layer has only one node. Backpropagation is used to adjust the weights of The Network model. The error was estimated during the training phase of the network model.

Table 2: Performance analysis.

Authors and years	Types of algorithm	Species	Disease	Disease (Detection accuracy)
Shanwen Zhang ,2017	Classification using sparse representation-mean clustering	Cucumber leaf	Downy mildew, gray mould, corynespora cassiico, bacterial angular,scab, anthraconse	91.25
yang lu ,2017	CNN	Rise leaf	rice blast, rice false smut, rice brown spot,etc	95
Muhammad Attique Khan, 2019	Segmentation method based on Strong Correlated Pixels (SCP) and Expectation-Maximization (EM) algorithm. genetic algorithm	Apple disease	healthy leaves, Blackrot, Rust, and Scab	97.20
Uday pratap singh, 2019	multilayer convolutional neural network	Mongo leaf	fungal disease	97.13
Xihai Zhang, 2018	CNN	Maize leaf	Curvularia leaf spot, dwarf mosaic, gray leaf spot, northern leaf blight, brown spot, round spot, rust, and southern leaf blight	98.8
Lin Yuan, 2017	FLDA	Wheat leaf	Healthy and unhealthy leaf	85
Megha .S,2017	FCM clustering, adaptive approach	Plant disease	bacterial, fungal affected leaf	85
Jayme Garcia Arnal Barbedo, 2016	Digital image processing	Common bean, Cassava,citrus, Coconut tree,etc.	Angular mosaic,Common bacterial bligh,Rust, Hedylepta indicata ,Target leaf spot	Common bean-50Cassava-46 Citrus-56, etc
P.R. Rothe,2015	Gaussian filter, The feed-forward back propagation network	cotton leaf	Bacterial Blight, Myrothecium and Alternaria	85
Manisha Bhange,2015	Color Coherence Vector,SVM	pomegranate	Bacterial Blight, Myrothecium and Alternaria	88

K-Mean clustering classifier

Manisha Bhange (2015), the author here discussed pomegranate disease detection. The first step input image gets resized at the preprocessing stage. CCV (Color Coherence Vector) feature vectors are used for feature extraction. After that K-means clustering algorithm using Euclidean distance is used for clustering. In Euclidean distance calculation object to each cluster is calculated, and then the image is allotted to the cluster with the smallest Euclidean distance. Classification is performed using SVM. Which is used to classify the disease infected diseased and non-infected disease images.

Performance Analysis of different Classifier

A Performance analysis study is carried out by different types of plant diseases and their accuracy rate. Among this analysis, CNN classifier consists of a high accuracy rate, and also training of image computation time is low compare with other classifiers. In Forthcoming years disease classification technique is made up of decision trees, Naïve Bayes classifier in the sense of helping farmers an automatic detection of all types of diseases in crop to be detected. In table 2 Performance analysis is carried out by 10 different types of plants and different classification algorithm.

Conclusion

In this paper, different methods used to distinguish plant sicknesses are introduced. Every method has its own focal points and impediments. On one hand, visual examination is the most economical and basic technique, however effective and dependable. Image handling strategies are exact and less tedious. When these strategies become shrewd and helpful, it might be progressively effective from these different procedures of image processing, the farmer can increase exact data so they can go for proficient yield in the crop management. Different classification techniques are discussed in this review paper. According to this paper, CNN consist of the highest accuracy than the other classification techniques. CNN can be recommended for future development research work.

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