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A Review on Crop Disease Detection Using Neural Networks and SVM

Prathamesh Nagargoje[1], Omkar kadam[2], Pratik Patil[3], Prof.Santosh Javheri[4]

[123]B.E (Computer Engineering), Rajarshi Shahu College of Engineering, Pune.

[4]Associate Professor (Computer Engineering), RSCOE, Pune.
[1]prathameshnagargoje@gmail.com, [2]omkarkadam9966@gmail.com,
[3]prspatil.11111@gmail.com, [4]sbjavheri@gmail.com

Abstract

Crop disease identification is that the key to forestall the losses within the yield and quantity of the agricultural product. The studies of the crop diseases mean the studies of visibly observable patterns seen on the crops. For sustainable agriculture health monitoring and disease detection on crops are very critical. It's very difficult to observe crop diseases manually. It requires an incredible amount of labor, expertise in the crops diseases, and also requires excessive processing time. Hence, image processing is employed for the detection of crops diseases. This paper reviewed different techniques of image processing for the detection of crop diseases using their leaf images. It includes ANN, CNN, SVM techniques for disease detection and pre-processing techniques. We found that CNN is the best among them. It needs less pre-processing tasks.

Keywords: *ANN, SVM, CNN.*

1. Introduction

India is an agricultural country and about 58% [12] of the employment subject to agriculture/Farming. Farmers have large variety of crops and pesticides. “Disease on crops results in a major reduction in both the standard and quantity of agricultural products. The studies of disease seek advice from the studies of visually observable patterns on the crops. Observing of health and disease on crop plays a crucial role within the successful cultivation of crops on the farm in early days , the observing and analysis of crop dis-eases were done manually by the expertise person in that field this needs an incredible amount of labour and also requires excessive time interval . The image processing techniques are often utilized in disease detection. In most cases, disease symptoms are seen on the leaves, stem, and fruit. The crop leaf for the detection of disease is taken into ac-count which shows the disease symptoms. This paper gives the introduction to image processing technique used for disease detection” [9].

“The crops are prone to various types of diseases and symptoms of the diseases are visible on leaf, fruit and stem in most of the cases” [1][5][8]. Sachin D. Khirade “proposed basic steps crop disease detection which includes steps like Image Acquisition, Image Pre-processing, Image Segmentation, Feature Extraction, Classification” [9]. Kashif Javed [10] also proposed image segmentation and classification in crop disease identification. After basic steps of image we can proceed to classification, in that we surveyed ANN, SVM and CNN and we introduced those methods in our paper.

2. Steps for Disease Classification

In this stage, the steps for crop disease classification using image processing in general are shown Fig.1.

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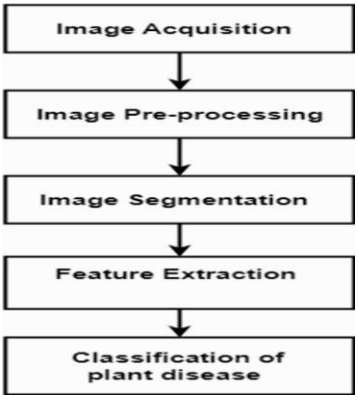

Figure 1. Steps for Crop Disease Classification

2.1. Image Acquisition

Crop leaf images are taken using camera or smartphone. Generally, structure of an image is in RGB (Red, Green, Blue) format. For the RGB leaf image Color transformation structure is formed, and later, for the color transformation structure the device-independent color space transformation is applied [4].

2.2. Image Pre-processing

"To remove noise in an image or another object removal, different pre-processing procedures are considered. Image clipping i.e. to urge the interested image region, cropping of the leaf image is completed. Image smoothing is completed using the smoothing filter. Image amplification is administered for increasing the contrast" [9].

"Then the histogram equalization which distributes the intensities of the images is applied on the image to amplify the crop disease images. The cumulative distribution function is used to scatter intensity values" [2].

2.3. Image Segmentation

"Segmentation is used for getting same features or some similarity in the images. Segmentation is a process of partitioning of an image into several parts. Using several methods like otsu's method, k-means clustering, converting an RGB image into HIS model, the segmentation is done" [9].

2.4. Feature Extraction

Feature extraction plays a crucial role within the identification of an object. Feature extraction is utilized in many applications of image processing. Features that will used in crop disease detection are color, morphology, texture, edges, etc.

"Monica Jhuria et al considers color, texture, and morphology as a feature for disease detection. They have found that the morphological result gives a far better result than the other features. Texture means how the color is distributed within the image, the roughness, hardness of the image. It can even be used to disclosure the infected areas of crops" [3].

2.5. Classification

i) Artificial Neural Network (ANN):

The training database images are classified by using a neural network after feature extraction is completed. "These feature vectors are considered as neurons in ANN" [3]. The output of the neuron is the weighted sum of the inputs. The algorithms like BPNN, FFNN, LVQ, RBF algorithms are frequently used. to paper title, aligned center and bold face. Sources and notes appear below the table, aligned left. All tables must be in portrait orientation.

i.i) BackPropagation Neural Networks (BPNN):

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The Backpropagation NN algorithm is a supervised learning technique for multilayer feed-forward networks which is type of Artificial Neural Networks. In a recurrent neural network BPNN (Backpropagation) algorithm is used. "The neural network weights are fixed and may be used to compute output values for new query images that aren't present within the learning database.

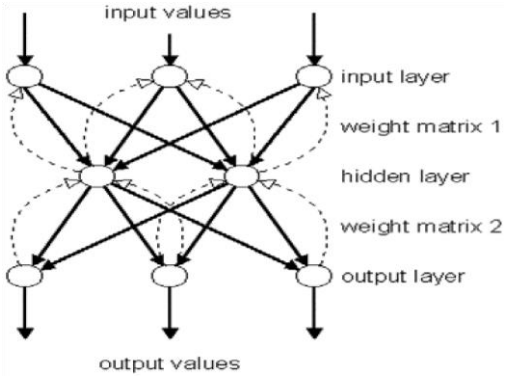

Figure 2. Back Propagation Neural Network

Testing of query images: After getting the load of the training database, then testing of the query image is completed" [9]. The fig. 3 shows the flowchart of working of neural networks for the testing of input image.

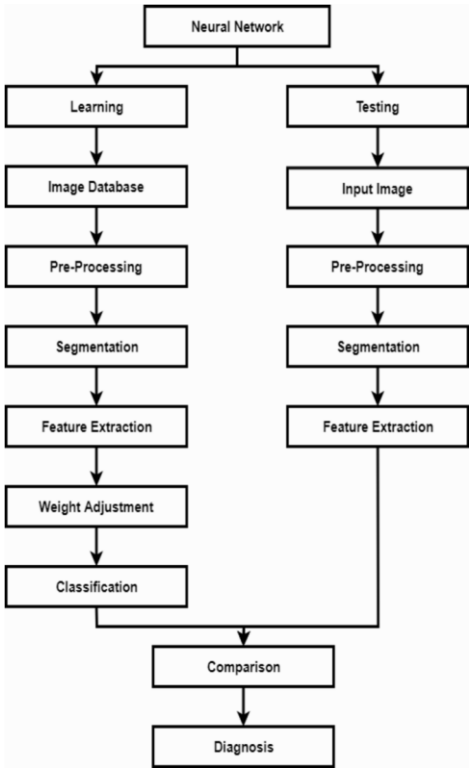

Figure 3. Working principle of ANN

i.ii) Feed-forward neural networks (FFNN):

Feed-forward neural networks (FFNN) is favored architecture among artificial neural networks. Difficult problems are solved by FFNN by modeling difficult relationships of input-output. A feed forward neural network is an artificial neural network wherein connections between the units are in one direction only. The information is transmitted in forward direction without forming a loop by artificial neuron in FFNN. From the input layer, through the hidden layers and to the output layers the knowledge moves in forward direction only.

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"Three types of functions can be used as activation function in FFNN:
1. Threshold function.
2. Piecewise Linear function.
3. Sigmoid function.

Advantages of FFNN:
1. Fixed computation time.
2. Computation Speed is very high.
3. Fault tolerant.
4. Learns general solutions.
5. Can learn from noisy and missing data. 6. Can be taught to recompense for system changes" [15].

i.iii) Linear Vector Quantization (LVQ):

It may be used once we have labelled input data. It's a supervised version of vector quantization. "LVQ is one of the significant case of an ANN. Use of winner-take-all Hebbian learning-based approach is made by LVQ. In this training algorithms, one determines the prototype which is closest to the input per a given distance measure and it's chosen for every data point. The winner is moved closer if it correctly classifies the data point or it's moved away if it classifies the data point incorrectly" [15].

i.iv) Radial basis function (RBF):

"A radial basis function (RBF) is a real-valued function used for activation whose value depends only on the distance from the origin. In RBF, the activation of hidden units is based on the distance from the input vector to a prototype vector. Euclidean distance is used to decide the distance. Then with reference to some objective function it fits a linear model with Coefficients to the hidden layer outputs" [15].

Performance Analysis:
Following parameters are used to check quality of classification of model:
1. Accuracy: Ratio of number of correct predictions to total number of input samples (AC).
2. Precision: Proportion of the predicted positive cases that were actually correct (P).
3. Recall ratio: The proportion of positive cases that were correctly identified is the recall or true positive rate (TP).
4. F1 Score: It is measure of accuracy. If F1 Score is near 1 then it means perfect values of precision and recall.

ii) Convolutional Neural Networks (CNN):
A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm. Convolutional Neural Network takes input image, and is able to differentiate one from the other by assigning importance to numerous aspects/objects within the image. Convolutional Neural Network requires less pre-processing as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, Convolutional Neural Network have the flexibility to learn these filters/characteristics.

A leaf of infected crop is passed to CNN based model [14]. "The architecture of a Convolutional Neural Network is equivalent to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlap to cover the entire visual area" [16].

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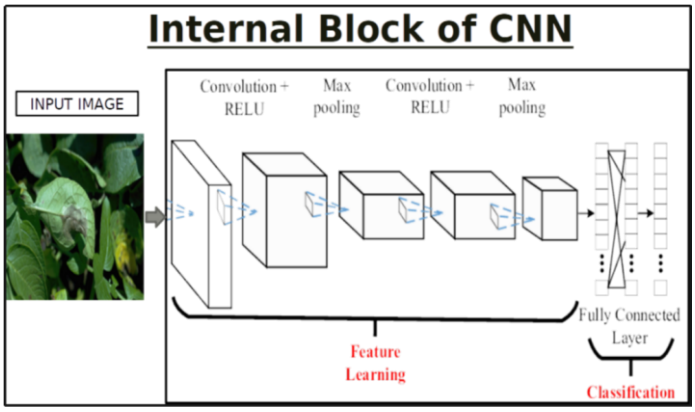

Figure 4. Working of CNN

ii. i) Convolution

Convolution is the major process in CNN's. "The convolution calculation of the two - dimensional image is often mapped to the continual sliding convolution window to get the corresponding convolution value. In mathematics convolution is a mathematical operation on two functions that produces a third function expressing how the shape of one is modified by the other" [11].

ii. ii) Activate Function

"The Relu activation function is an unsaturated nonlinear function which will receive signals by simulating brain neurons. Saturated nonlinear function, like Sigmoid and Tanh, has worse performance than unsaturated nonlinear functions when training a network" [17].

ii. iii) Pooling "As the number of convolutional layers increases, the parameters of the network will increase exponentially. The pooling operation can effectively reduce the amount of network parameters. To scale back the parameters in all regions, the pooling operation is performed by calculating the statistical characteristics of a region to represent the complete region's characteristics" [17].

ii. iv) Dropout Srivastava et al. proposed that "dropout can alleviate the case of fewer training samples in neural networks by pre-venting the synergies of certain features. For every input sample, the corresponding network structure is different, but all of those different network structures share a load of hidden nodes at a similar time, so different samples correspond to different models" [6].

To stop the overfitting of model and improve accuracy of model dropout function is added in training model.

ii. v) Loss Function

Loss function is used to optimize parameters of our convolutional neural network model. Loss function calculates the set parameter values how well the network is in-tended to do. Loss function mostly measures the absolute errors between actual output and desired output. If your predictions are totally off, your loss function will output a higher number. If they're pretty good, it'll output a lower number.

iii) Support Vector Machine (SVM):

Given categorized training data, SVM outputs an ideal separating hyperplane. This hyperplane classifies new data point into classes. "To improve the accuracy of SVM, some parameters of the SVM classifier must be adjusted. One of the parameters is the kernel which defines whether parting should be linear or nonlinear. Another parameter is regularization which defines the extent to which misclassification of a training sample must be avoided. Linear kernel and regularization parameter with value 1000 is used in this system. a bigger value of regularization chooses small mar-gin of hyperplane if it ensures minimum misclassification of training examples" [18].

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"Panchal et al. presented a method using SVM classifier to identify the diseases in pomegranate leaf" [13]. Images are converted into grey scaled images and contrast enhancement applied and feature extraction is done and identified regions are stored in vector. Then SVM applied to classify the images.

The developer also want to secure the communication from database to application. Santosh Javheri proposed [14] the privacy preservation data classification using ma-chine learning technique. They implemented BGV encrypted scheme to encrypt the data.

Table 1. Comparison between ANN, CNN, SVM

Parameter	ANN	CNN	SVM
Success Rate	High	relatively greater than ANN	Low
Scalability	Lower	Higher	Higher
Classifier Type	Non-linear	Non-linear	Linear
Neuron Connectivity	Fully connected	Partially connected	Partially connected
Computational Cost	Low	High	Low
Model Complexity	Less than CNN and High then SVM	High	Less
Amount of training data required	Depends upon problem statement complexity	Large	comparatively less than NN

3. Performance of Classifiers for Crop Disease

Table 2. Overall performance of classification algorithms for crop leaf disease detection [7].

First Author, Year	Classification Algorithms	Reported Accuracy	Pros	Constraints
John William Orillo, 2013	Back Propagation ANN	93.33%	Color based characterization of leaf can be extracted properly.	High computational Cost
Pooja Pawar, 2016	Artificial Neural Network	80.45%	Works well for more than one crop of different types.	Feature Selection is difficult.
Kaur, 2016	Support Vector Machine with Ant Colony Optimization	96.77% to 98.42%	Detects fungal and bacterial diseases	Memory Intensive
Bin Liu, 2017	Deep Convolution Neural Network	97.62%	Accurate, robust, prevents over fitting of the CNN model, high feature extraction capability	Difficulty in identifying the structure of the model

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John William Orillo, 2013	Back Propagation ANN	93.33%	Color based characterization of leaf can be extracted properly.	High computational Cost

4. Conclusion And Future Work

The precise classification and detection of crops disease are very significant in order to effective farming of crops. Methods like image processing are used to detect diseases. This paper discussed various techniques to identify diseases on plants. This paper discussed image processing techniques are ANN, CNN, SVM and we can conclude that the CNN gives most accurate classifications in image processing. Also CNN needs less image pre-processing. CNN is best for future implementation of crop disease detection models.

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