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Leaf Disease Detection Using Deep Learning

[1]Jayapradha J., [2]Divey Khandewal, [3]Abhishek Anand, [4]M.Prakash

[1,2,3,4]Computer Science and Engineering, SRM Institute of Science and Technology, Chennai, India
[1]jayapraj@srmist.edu.in, [2]diveykhandelwal_ramakant@srmuniv.edu.in
[3]anandabhishek129@gmail.com, [4]prakashm2@srmist.edu.in

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Abstract
Agriculture contributes to an excessive amount of centrality in the Indian economy. An enormous number of business openings are given by farming. This paper presents leaf qualities examination utilizing some image processing procedures utilized in the agriculture field for the discovery of maladies. The primary target of this model is to distinguish the malady in the leaves and tell to the ranchers so they can give the comparing pesticides to that leaves. In rural research, programmed leaf illness attributes recognition is significant in checking enormous fields of yields, and in this manner all alone identifies side effects of leaf malady qualities when they show up on leaves of plants. The proposed dynamic framework uses image content portrayal and administered classifier kind of neural system. Picture handling methods for this sort of choice investigation includes data collection, pre-processing of images, and feature extraction through GLCM.

Keywords: *Image Preprocessing, feature, Classification, Neural networks, standard deviation, leaf disease*

1. Introduction

In this paper, we discuss the different methods we are using for plant disease detection. Diseases can cause a high return of yields getting squandered. Research reveals that depending on unadulterated unaided eye perceptions of specialists to discover and group illnesses can be tedious and profoundly expensive, particularly in creating territories and provincial states. So we are attempting to make a quick, programmed, modest and precise picture preparing based arrangement for detection.The process comprises four important phases; In Processing[9], an input image of a leaf is to be taken and resized and region of interest(ROI)is selected[4] if required. Here, features involving color and texture are being taken from[5][6] an image at input using GLCM [6]for the training of network[8]and classification by the model. Color features for example mean and standard deviation from HSV color and texture features such as energy, contrast, homogeneity, and correlation is calculated[6]. This model is mobilized to test images and automatically characteristics leaf diseases. For this, automatic trained classification NN[8][11] model is mobilized for classifying disease, depending on training with some training samples of that same category. The model will be using the tangent sigmoid function as an activation function. This model detects 4 diseases which are Cercospora, Cercosporidium Personatum, Personata Phaeoisariopsis, Alternaris and normal leaf using Feedforward Backpropagation Neural Network [11][8]. Finally, the result is this model classifier predicates disease in plant leaves with the least error at training and has the best accuracy for classifying than other counterparts.

2. State of the Art (Literature Survey)

• C.V.Aravinda proposed that for the best harvest creation, precisely distinguishing and sorting of the leaf malady is important and it very well may be finished through leaf picture preparing procedure. As per him, various techniques are considered for picture division and include extractions and characterizing strategies for tainted plant leaf pictures are utilized. Back proliferation technique, SVMs is viably utilized for discoveries of unhealthy leaves. Utilizing picture handling methods, the sick plant leaves can be successfully distinguished and fix different plant diseases. [2]

• Dhiman Mondal proposed that the order and identification method can be utilized for plant leaf infection arrangement. Here preprocess is done before highlight extraction. RGB pictures are changed over into

white and afterward changed over into dim level pictures to extricate the picture of vein from each leaf. At that point, essential Morphological capacities are applied to the picture. The picture is changed over into a parallel picture. After that, if parallel pixel esteem is 0 it's changed over to relating RGB picture esteem. At last, by utilizing the Pearson relationship and dominating the list of capabilities and Naïve Bayesian classifier illness is detected. [3]

• Prashant Jain proposed for consequently identifying the leaf plant just as for leaf ailment location, Machine Vision Technology is of incredible use. These frameworks will be useful for agriculturist since it is productive than the manual method. The proposed framework uses the Euclidean separation strategy and K-means clustering procedure for the division of picture to segment the leaf zone, illness zone and background area of the info leaf picture to ascertain the percentage contamination of the sickness in the leaf and to grade them into different classes. These frameworks can be utilized to supplant the manual leaf acknowledgment system and can be used by farming specialists in recognizing correct pesticide and its amount to defeat the problem proficiently and successfully. [4]

• Khan Walid's proposed picture division with multiclass SVM is used to build up a computerized and effectively open framework. The most noteworthy illnesses in potato, late scourge, and early curse, are related to a little computational exertion. Our methodology will offer ranchers a practical, productive and timesaving method for malady distinguishing proof. We are intending to coordinate progressively several sicknesses of different types of the plant into the framework. We will commit our future deals with consequently assessing the seriousness of the identified ailment. Besides, a cell phone helped the framework will be created in the future to mechanize the discovery procedure.[5]

•Shijin Kumar P.S proposed the techniques utilized for highlight extraction are Gray Level Co-event Matrix (GLCM) used for taking out features and Connected Regions. The first one is an MRI with benign tumor (grade I and grade II) normal grade, the second one is an MRI with a dangerous tumor (grade III and grade IV) which could be deadly and the third one is an ordinary MRI (without tumor). Each picture is trained and the Gray Level Co-event Matrix (GLCM) is made from each of them. From the GLCM, surface features are taken out and associated spots are utilized to remove shape features.[6]

• V.Ramya proposed approach comprises 4 stages. Exactness is improved by the utilization of various picture preparing strategies, for example, picture examination, preprocessing, highlight extraction and arrangement. Speed and precision are the two primary qualities of plant infection recognition utilizing AI strategies that must be accomplished. Utilizing the proposed technique, the exactness up to 92% can be accomplished. The exactness of identification can be expanded when utilizing the SVM classifier with a progressive number of highlights. This methodology can be utilized for the applications, for example, a grouping of ailments of plant parts like a leaf with a reasonable classifier. [7]

• John William ORILLO proposed the advancement of a program that decides the illnesses present in rice leaf through picture preparing combined with back propagation neural system was effectively actualized utilizing MATLAB. The undertaking was effectively done and demonstrated to give precise outcomes; in any case, the scientists propose the accompanying suggestions to additionally improve the task: (1) include more sort of infections that can be recognized utilizing the program; (2) think about the seriousness of the sickness and assortment of rice (3) gather more pictures for the dataset of the neural system which could yield increasingly exact outcomes. [8]

•ChaowalitKhitthuk proposed a plant leaf sickness conclusion framework utilizing shading symbolism with infection highlight investigation. The co-preparing of I and h segments permits the element appears to be proficiently notable. Dim level co-event grid and surface element condition are utilized as factual information for streamlined fluffy ARTMAP to adequately characterize 4 grape leaf illness picture types. The results are alluring which can be reasonably applied to true plant leaf ailment recognition and grouping. [9]

• SPMohanty proposed that end to end supervised learning using neural networks is possible even for problems with high no of classes from dataset of 54306 images they were able to they were able to come up with accuracy of 99.35%.One of its limitation being right now we are always compelled to the grouping of single leaves, looking up, on a homogeneous foundation. While these are clear conditions, a certifiable application ought to have the option to group pictures of an ailment as it introduces itself legitimately on the plant. In fact, numerous infections don't present themselves on the upper side of leaves just (or by any means), however on a wide range of parts of the plant. In this manner, new picture assortment endeavors should attempt to get pictures from various points of view and in a perfect world from settings that are as reasonable as would be prudent. [10]

•N.Krithika proposed that most huge systems used for identification and looking at of the plant leaf illnesses are advanced picture preparing calculations. These days, diverse picture securing gadgets and information transmission advances are produced for catching the agronomical harvest pictures and are transmitting to the data community. Leaf recognizable proof is the most essential procedure for picking up the data about leaves. Recognizing the leaf isn't just a difficult undertaking, dissecting the leaf illnesses is additionally a monotonous procedure in rural field. When the kind of leaves is recognized then the distinguishing proof of leaf illnesses

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is adequately gotten. Something else, the recognizable proof of the leaf infection is mind boggling the most challenging job is to identify the leaves individually. Here; the skeletons of the leaves are used for choosing the position and direction of the leaves. Tangential direction based segmentation is used. On the off chance that the grape leaf pictures are grouped, at that point the histograms of H and shading channels are created and the pixels esteems are seen to recognize the sound and unhealthy tissues. At that point, separate the highlights and group by utilizing the KNN arrangement calculation so as to discover the leaf illnesses. [11]

3. Methodologies

a. Pre-processing

Pre-processing is a method for actions with images at the lowest level of abstraction. The objective of pre-processing is a betterment of the image that suppresses not wanted distortion or enhancing some signal features important for further processing.

In this, we take an image of a leaf as input as shown in figure 2. The input must be in RGB format. Then input image is resized according to 256*256 dimensions as seen from fig (2) and (3).

Architectural Diagram

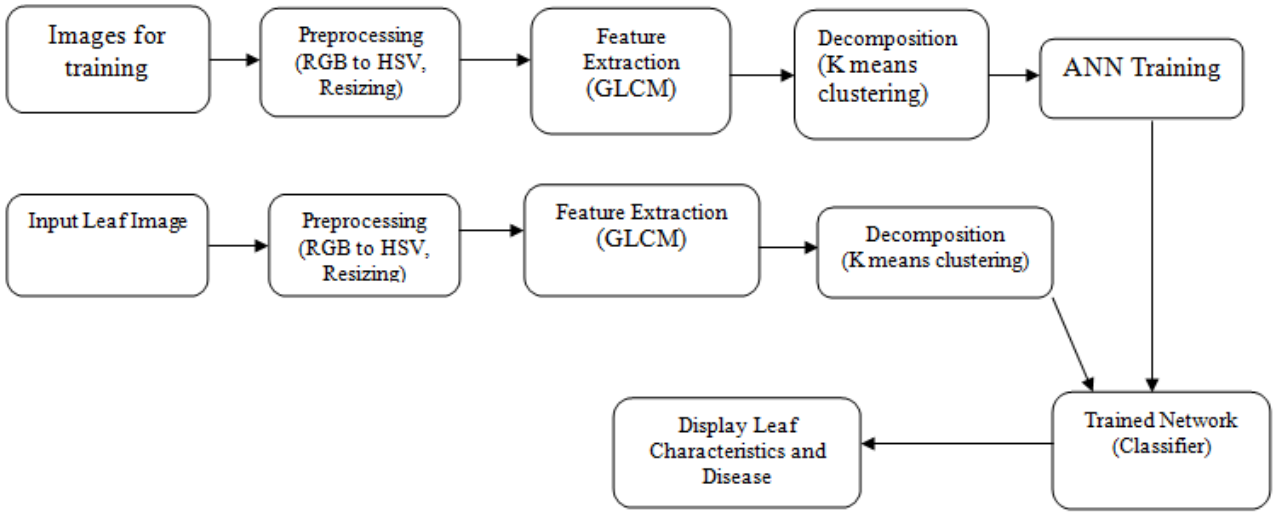

Figure 1: Architectural Diagram

Then we take an input image and convert it to HSV (hue saturation, value)as shown in fig 3 so that we can separate colour information as it is not easy to do in RGB. Various parameters like mean, standard deviation can be calculated from HSV. Then we convert image into grayscale as shown in fig 4. It helps generate cluster and in wavelet decomposition and further helpful in extracting colour features by histogram analysis.

b. Feature Extraction

Feature extraction, the best dimensionality compacting process efficiently shows needed image parts as a compact feature vector.

In these various types of features are calculated such as colour information and various parameters from HSV instance of an image. Firstly, colours features are extracted from the HSV instance. Then we calculate mean standard deviation, kurtosis, and skewness. Then we store these set of extracted quantities. Skewness is used to measure symmetry and kurtosis is used to study the distribution of the image matrix. Then we do level 2 decomposition (as shown in fig 5) using the gray scale image of the leaf by finding Daubechies Wavelet coefficients. They're used by implementing cascaded filter where low pass and high pass filters satisfy certain specific constraints.

The GLCM function calculates the texture features of an image by estimating how frequently pairs of the pixel with target values and how a specified spatial relationship occur within an image, thus building a GLCM, and then taking out statistical features from GLCM matrix. We are using GLCM matrix to extract entropy, contrast, correlation and homogeneity features. We store these texture features in a set. So, a total of 55 features are derived from 2 sets are calculated for training.

c. Decomposition

K-means Clustering is making clusters of images to extract features by making k different clusters. The K-means is a approach for partitioning an image into K clusters. The method is:

1. Choose K cluster centres, randomly.
2. Allocate each pixel to cluster in image from where its distance is least.
3. Re-calculate the centre of cluster by calculating average of the values presenting cluster
4. Run above steps till convergence is accomplished.

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Here, distance is selected as the difference of a pixel and a centre of cluster seen from fig 6 to fig 9. The differences can be in colour of pixel, intensities, texture features, or an averagedsum of these features. Kis selected by choice. In this we take value of k as 4.2 clusters are taken and then Histogram analysis is done to extract various types of color present (as shown in fig 12 and fig 13) and then is used as a input in feature set. No of bins used in analysis is equal to 16. Then this set is feed for training.

d. Training using Neural Networks

In this, we used photos of leaf to train our neural network, so that it can learn itself effectively and efficiently. Some photos of each leaf disease were taken for training. A total of 4diseases can be detected using this trained model. Every disease is identified by a integer value given to it in output file used for training.

A Feed-Forward neural network is used for training model with Back propagation algorithm as seen in fig 12.

In a feed forward neural network, images are presented as input and then various textures and colour features are extracted and then after following various methodologies, disease is categorised using Euclidian distance formula and then compared to correct output.

Then error is calculated and then back-propagated to correct the weights and bias present in various layers. This is how training is done using Feed forward neural network.

Fig 12 shows a total of 55 features (colour and texture) for each image were stored in .mat file. This serves as a input for training for feeding into neural network and getting 55 outputs where each output tells us the class to which leaf disease might belongs to. So we take mean of all values and predict the class of disease (fig 14). In this we are using tangent sigmoid function as activation function.

The training will stop if model meets one of the following conditions as seen in fig 15:

1) Highest number of iteration is accomplished.
2) Least gradient descent value is accomplished.
3) Highest number of validation checks is reached.

4. Results Discussed

Figure 2: Resized Input image in form of RGB (Red, Green, blue) colour space

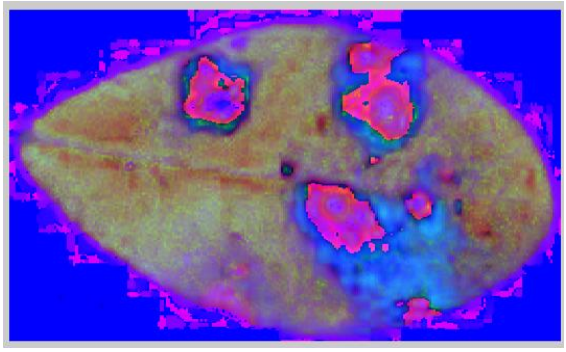

Figure 3: HSV conversion of input image for Enhancement of different areas

Figure 4: RGB to greyscale conversion

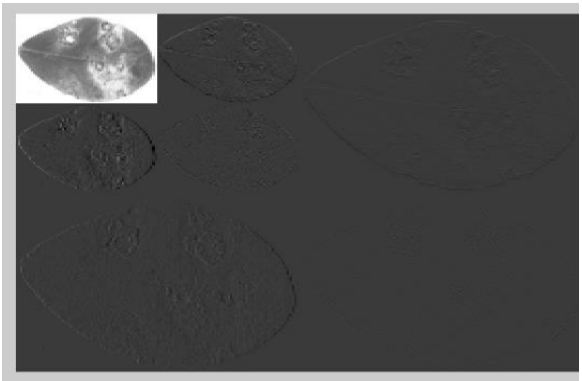

Figure 5: Wavelet decomposition of leaf image also called level 2 decomposition

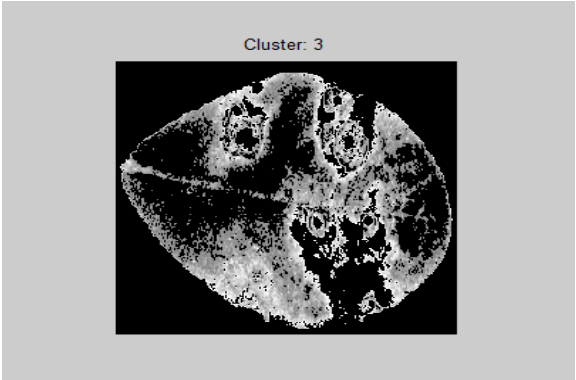

Figure 6: 3rd clusters generated using k means clustering.

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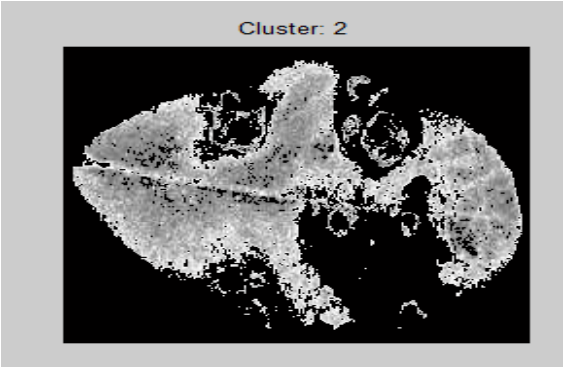

Figure 7: 2nd cluster generated using k means clustering.

Figure 8: 4th cluster generated using k means clustering.

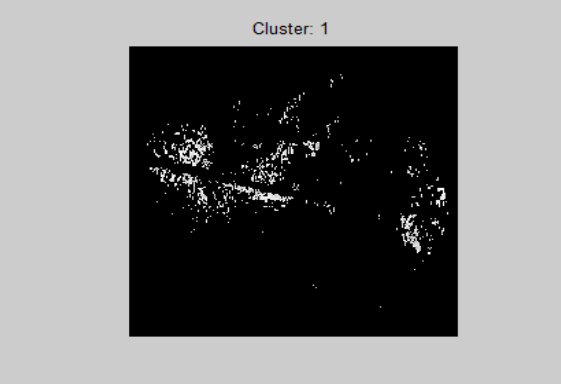

Figure 9: 1st cluster generated using k means clustering.

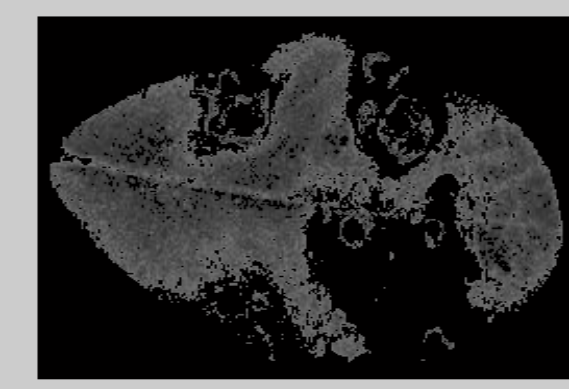

Figure 10: after removing noise (cluster 2)

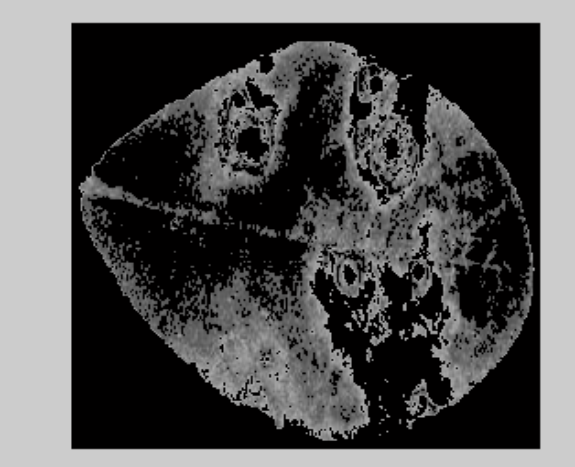

Figure 11: after removing noise (cluster 3)

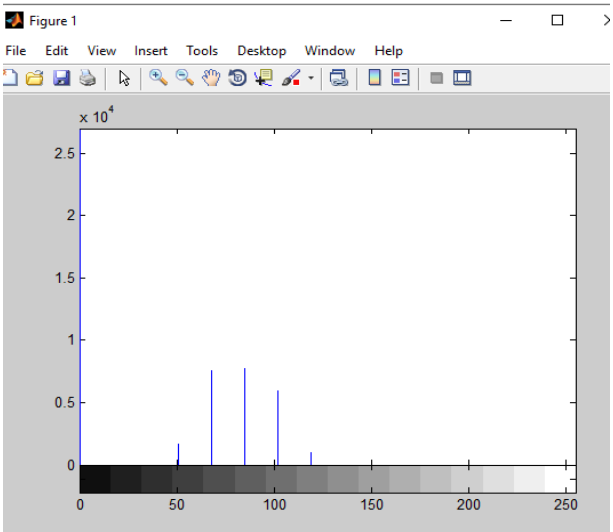

Figure 12: Histogram analysis of segmented images (cluster2)

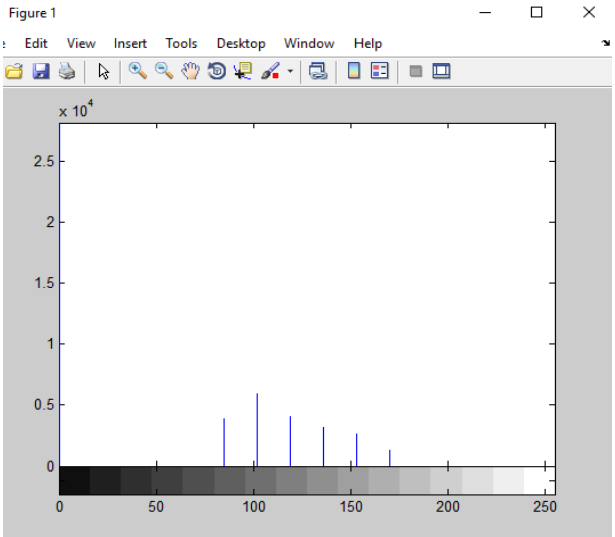

Figure 13: Histogram analysis of segmented images (cluster3)

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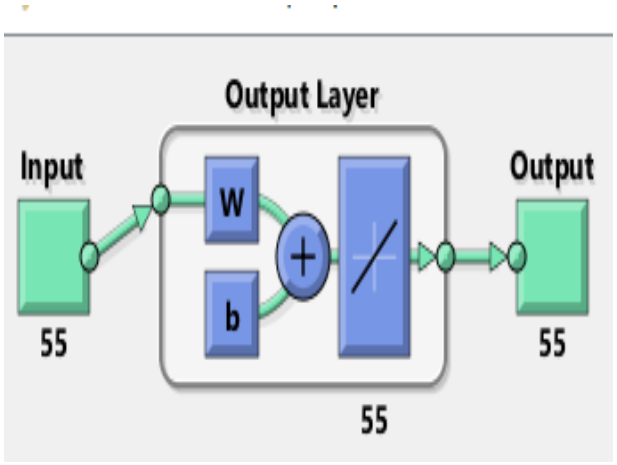
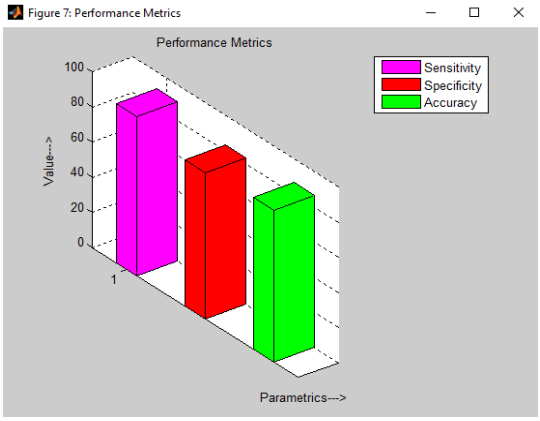


Figure 14: Feed forward neural network

Number of input features for training is 55.For each feature, model detects to which disease class, leaf belongs to.

Op(x) = (I(x)*We(x)) +Bi(x).
I(x) = x th input feature.
We(x) = weight for xth feature.
Bi(x) = Bias for xth feature.
Op= tansig (sum of all (Op(x)).
Where 0<x<=55.
Op(x) = output for xth feature.
Op = Final output layer.



Accuracy = 86.5
Specificity = 83.33
Sensitivity = 90.90

Figure 15: Shows performance of model

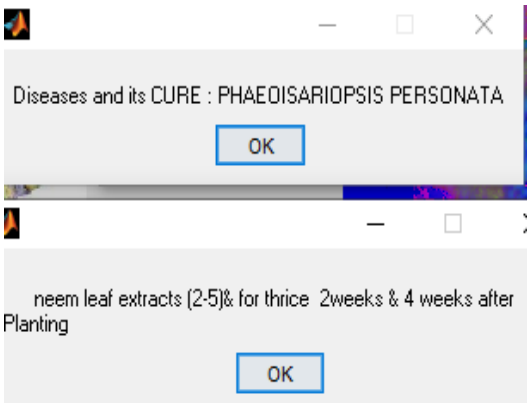


Figure 16: Final output name of disease infecting the plant leaf and its way to cure

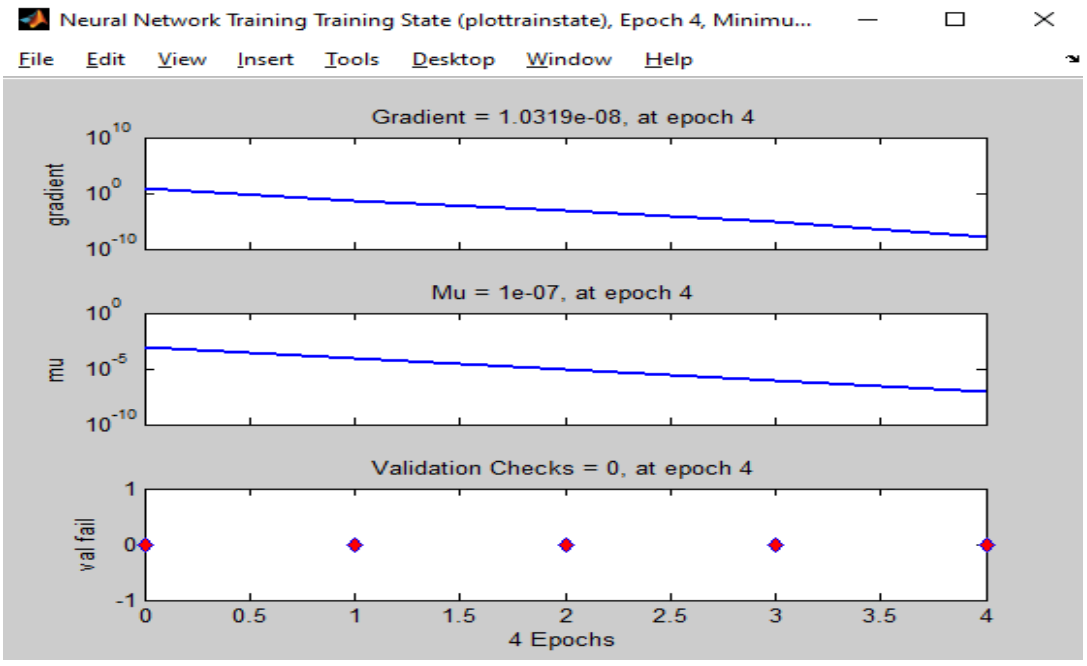


Figure 17: various changes in parameters during Training using feed forward Back propagation Neural Network.

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SNO	Author	Title	Year	Techniques Used	CONCEPT
1	C.V. Aravinda	Classification and Clustering of Infected Leaf Plant Using K-Means Algorithm	2018	NN, SVM, transfer learning methods	For the best harvest creation, precisely distinguishing and sorting of the leaf malady is important and it very well may be finished through leaf picture preparing procedure. Various techniques are considered for picture division and furthermore include extractions and characterizing strategies for tainted plant leaf pictures are utilized.
2	DhimanMondal	Detection and classification technique of yellow vein mosaic virus disease in okra leaf images using leaf vein extraction and naive Bayesian classifier	2017	Pearson correlation, Naive Bayesian	Here pre-process is done before highlight extraction. RGB pictures are changed over into white and afterward changed over into dim level picture to extricate the picture of vein from each leaf. After that if parallel pixel esteem is 0 it's changed over to relating RGB picture esteem. At last by utilizing Pearson relationship and dominating list of capabilities and Naïve Bayesian classifier illness is detected.
3	Prashant Jain	K-Means Segmentation Method for Automatic Leaf Disease Detection	2016	Euclidean distance, k-means clustering	The proposed framework uses Euclidean separation strategy and K-means clustering procedure for division of picture to segment the leaf zone, illness zone and background area of the info leaf picture so as to ascertain the percentage contamination of the sickness in the leaf and to grade them into different classes.
4	Khan Walid	Detection of Potato Diseases Using Image Segmentation and Multiclass Support Vector Machine	2017	SVM, Neural networks	Methodology will offer ranchers a practical, productive and timesaving method for malady distinguishing proof. We are intending to coordinate progressively number of sicknesses of different types of plant into the framework
5	ShijinKumar P.S	Extraction of Texture Features using GLCM and Shape Features using Connected Regions	2017	GLCM, histogram matching	Each picture is trained and the Gray Level Co-event Matrix (GLCM) is made from each of them. From the GLCM, surface features are taken out and associated spots are utilized to remove shape features. The component esteems acquired from every picture are appeared.
6	V.Ramya	Leaf Disease Detection and Classification using Neural Networks	2017	SVM, bayes theorem	Comprises of 4 stages. Picture examination, pre-processing, highlight extraction and arrangement. Speed and precision are the two primary qualities of plant infection recognition. Utilizing the proposed technique, the exactness up to 92% can be accomplished.
7	John William ORILLO	Identification of Diseases in Rice Plant (Oryza Sativa) using Back Propagation Artificial Neural Network	2017	RGB to HSV conversion, back propagation neural network	Proposed the advancement of a program which decides the illnesses present in rice leaf through picture preparing combined with back propagation neural system was effectively actualized utilizing MATLAB. The undertaking was effectively done and demonstrated to give precise outcomes
8	Chaowalit Khitthuk	Plant Leaf Disease Diagnosis from Color Imagery Using Co-Occurrence Matrix and Artificial Intelligence System	2018	GLCM, fuzzy logic	The co-preparing of I and h segments permits the element appearance to be proficiently notable. Dim level co-event grid and surface element condition are utilized as factual information for streamlined fluffy ARTMAP to adequately characterize 4 grape leaf illness picture types.

5. Conclusion

This research includes detection of leaf disease which are Cercospora, Cercosporidium Personatum, Personata Phaeoisariopsis, Alternaris and normal leaf. In this, methods which are used for plant leaf disease detection and image segmentation are mentioned for automated detection and classification of diseases and further suggestion of methods for curing it. Therefore, similar images for these diseases were obtained for detection and feature extraction. Results were calculated with very less

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computational values, which demonstrated the efficiency of the proposed algorithm in identifying and classifying leaf diseases. The benefit of using this method is that it is possible to identify the diseases of leaves at an early stage and so can be helpful for the farmer in their crop management as they can cure it or remove the plant.

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