Neural Network for Papaya Leaf Disease Detection

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Abstract

The scientific name of papaya is Carica papaya which is an herbaceous perennial in the family Caricaceae grown for its edible fruit. The papaya plant is tree-like,usually unbranched and has hollow stems and petioles. Its origin is Costa Rica, Mexico and USA. The common names of papaya is pawpaw and tree melon. In East Indies and Southern Asia, it is known as tapaya, kepaya, lapaya and kapaya. In Brazil,it is known as Mamao. Papayas are a soft, fleshy fruit that can be used in a wide variety of culinary ways. The possible health benefits of consuming papaya include a reduced risk of heart disease, diabetes, cancer, aiding in digestion, improving blood glucose control in people with diabetes, lowering blood pressure, and improving wound healing.

Disease identification in early stage can increase crop productivity and hence lead to economical growth. This work deals with leaf rather than fruit. Images of papaya leaf samples, image compression and image filtering and several image generation techniques are used to obtain several trained data image sets and then hence providing a better product. This paper focus on the power of neural network for detecting diseases in the papaya. Image segmentation is done with the help of k-medoid clustering algorithm which is a partitioning based clustering method.

Key Terms: Disease, neural network, k-medoid clustering, Multi-Layer Perceptron, Support Vector Machine, Artificial.

1. Introduction

Papaya is an evergreen herb, having tree-like appearance, 2-10 m tall and usually unbranched. It contains white latex. Its stem is cylindrical having 10-30 cm diameter. It comes into fruiting in 5 months and it leaves for 4-5 years. Leaves are arranged spirally, clustered close to apex of trunk,petiole upto 1m long. Flowers are yellow and tiny,funnel shaped. There are three types of flowers namely-Male, Female and Hermaphrodite.Papaya is a tropical plant. Papaya can be grown in light,well-drainage soils having pH between 5.5 and 6.5. Trees are very sensitive to flooding,water-logged soils and windy areas. Papaya seedling are very susceptible to weeds. Several diseases like black rot,black spot, powdery mildew, Ringspot,Stem Rot, Mealybug etc. can damage this crop and hence decrease its productivity.

Papaya has wide role in medicine industry which is used to cure many diseases. Carica papaya leaf juice have potential activity of increasing platelets against dengue fever. An extract made from dried papaya leaves was reported to slow down the tumour growths in various types of cancers like cervix, lungs, breast, pancreas etc. Hence, it provides a anti-cancer effect. It also provides an anti-oxidant and anti ulcer effect. Papaya serves as a good therapeutic agent against gastric ulcer and oxidative stress. The latex papaya formulated in Carbopol gel, based on hydroxyproline

content found effective in treatment of burns. Various extract of fresh and dried leaves of papaya against bacteria and fungi of medical importance.

Due to the diseases affecting the agricultural products, the productivity is reduced and in turn it decreases economical growth of the country. Various biotic factors such as fungal,bacterial etc. and abiotic factors such as weather, soil, rain etc. affect the growth of agricultural products. So, for getting a sustainable agriculture, crop should be monitored properly and the cause of diseases in that crop should be detected. Close examination, and laboratory culture and analysis are required for proper diagnosis of the causal agent of disease. Generally fungal diseases cause the obvious symptoms with irregular growth, pattern & colour (except viruses), however abiotic problems cause regular, uniform symptoms.

In this paper, Artificial Neural Networks is used to identify the disease affecting Papaya. The proposed system focuses on images of three diseases namely black spot, mealybugs and ring spot affecting papaya taken with the help of smartphones and various digital cameras of various resolutions. Various types of diseases like black rot, black spot, powdery mildew etc. are associated with this crop. Some diseases may be caused by deficiency of nutrients and others are caused by some viral or fungal activities. Through visual images of diseases, the control strategies can be easily implemented.

The evolution of artificial neural networks made image recognition and classification easier through their different types of segmentation techniques. **Section 2** of the paper illustrates the literature review of related works. **Section 3** deals with images of healthy leaf and three different types of diseased leaf images. This section also includes description about these three diseases affecting papaya. **Section 4** deals with the methods including image segmentation using k-medoid clustering and the proposed algorithm used in disease detection of the mentioned three diseases. **Section 5** deals with Conclusion and future enhancements done in this technique.

2. Literature Review related to works

Computer vision helped in quick and accurate identification of plant diseases. Li [1] focussed on image segmentation of grape downy mildew and grape powdery mildew using k-means clustering. In this study, fifty images of grape drowny mildew were obtained and thirty-five images of grape powdery mildew were obtained. This included both binary segmentation and color segmentation for extracting shape features, color and texture features. Support Vector Machine(SVM)Classifier designed in MATLAB was used for diseased image recognition.

Ayobami [2] proposed a method for identifying lesion spots on citrus fruits which badly affect the growth of citrus fruits.In this lesion segmentation was based on Chi-square distance and threshold function. In this,color feature extraction done by using five types of color features namely enhanced RGB, HSV, LUV, LAB and HSI. This study also proved that SVM classifier is a better than KNN.

Alexie [3] which focussed on Pulse Coupled Neural Network (PCNN) for image preprocessing of heterogeneous materials. It helps in image denoising and image segmentation. Geometric Filtering Algorithm is applied after segmentation for evaluating material structure.

In 2005, [4] used color-cooccurence method (CCM) for texture analysis for various images of healthy and diseased citrus leaves. This study was done on four different types of classes. Three types of classification algorithms were used namely a stastical classifier using Mahalanobis minimum distance,a neural network classifier using back-propagation and a neural network classifier using radial basis functions. Finally, it was concluded that mahalanobis statistical classifier and neural network classifier using back-propagation are suitable for texture analysis in an outdoor scene.

Liu [5] was based on neural network with back propagation. It used MATLAB toolbox for training data. This study developed a prediction system for fruit tree diseases and insect pests. Back propagation usually allows quick convergence on local minima for error. This work focussed on Ring spot disease found on fruits.Comparision of Predicted vale with Actual value made. Eight fruit tree diseases and insect pests were chosen as research objects and four weather factors were selected in every month for using as condition for prediction.

In 2007, [6] introduced Rough sets approach for plant disease detection and intrusion detection for reducing the inputs in these neural network based applications. This study also revealed better results using Multi-Layer Perceptron than those of whole feature vector. The main goal of Rough Set Analysis is the induction of approximations of concepts.

The study [7] focussed on different types of automation techniques used in agriculture for various purposes.There are various types of probems faced in agriculture like weed management, pest detection, crop disease detection, irrigation control etc. These problems can be solved by implementation of various automation practices like IOT, Artificial Intelligence, Wireless Communication, Machine Learning and Deep Learning. This paper also developed a proposed model for flower and leaf identification and watering using IOT.

[8] developed different types of algorithms and image segmentation and soft computing techniques for identifying different diseases occurring in different crops and fruits.This study helps in early identification of diseases which would help in eco friendly approach by limiting the use of pesticides.

The study [9] developed an automated method to detect and count grape berries. This detection method uses both visual and texture. Three different grape varieties were used namely Gewurztraminer, Traminette and Riesling for generating the result. Multiple flashes were used to detect depth discontinuities in the image.

In 2014, [10] developed methods to accurately detect intact tomato using machine learning techniques. X-means clustering was used for image segmentation. In this study, image segmentation involves three steps which are pixel-based segmentation, blob based segmentation and individual fruit detection. A digital single lens camera is used for capturing images. Fruit detection was done part by part such as young, immatured and matured fruits.

[11] The paper proposed various image segmentation methods-Thresholding method, Edge Based Method, Region Based Method, Clustering Method, WaterShed Method, PDE Based Method and ANN Based Method. The study included comparison among these techniques, their merits and demerits. All of these methods are used for various applications like medical image processing, disease detection in plants etc.

[12] focussed on Artificial Neural Networks used in image segmentation using Otsu method and filtering for identifying nutrient deficieny in plants. Several parameters like RL, QNHL, input types, quantities and noise were analysed. This study also revealed that the system with one optimized ANN is better than system with two ANNs. Thw whole experiment were performed using MATLAB.

In 2015, [13] focussed on various image processing methods for leaf disease detection. In this study, Region Based Segmentation Technique for identifying diseased region on the leaf. Region Based Segmentation includes three methods which are Region Growing,Region Splitting and Region Merging. In this work, Region Growing is proved as the best method for Region Segmentation.

In 2016, [14] reported classification of 26 diseases in 14 crops using architectures AlexNet and GoogLeNet. [15] focussed on training on healthy sample and diseased samples of tomato leaf and developed an algorithm for classification of disease using segmentation and feature extraction. K-medoid clustering algorithm is used for segmentation. Feature Extraction is done by using CCM method

which uses Spatial Gray-level dependency matrices and for LS-SVM Classifier is used for classification purpose.

The paper [16] describes various partitioning clustering techniques used in image segmentation. It discussed pros and cons of two clustering algorithms namely k-means and k-medoid.k-means is an unsupervised learning algorithm which uses an iterative refinement method to produce its final clustering based on the number of clusters k defined by the user and the dataset.k-centers(mean) are defined, one for each cluster.In k-medoid clustering algorithm,data points are chosen as medoidsIt is considered as the object of a cluster. Its dissimilarity with all other points of cluster is minimal.

[17] is a review paper for detecting disease in plant leaf. This study focussed on k-medoid clustering method for image segmentation and neural network with feed forward back propagation was used for classification purpose.

[18] which developed agro-medical expert system for disease detection and classification with help of K-means clustering And SVM classifiers. Feature Extraction for detecting diseases deals with statistical and Gray-level co-occurence matrix (GLCM).

In 2019, [19] focussed on classification of five fruits namely Apple, Mango, Orange, Tomato and Pomegranate using MSVM and detects the common defects.This work used k-means clustering algorithm for segmentation. Feature extraction is done by GLCM technique. MSVM classifier is used for classification. Fruits are identified with the accuracy of 94.02%.

[20] The proposed system developed a web based tool for farmers to detect disease in pomegranate fruit. K-means clustering algorithm was used for image segmentation and Support Vector Machine classifier was used for classifying whether the input image of fruit is infected or not. The system was provided with two logins-Superuser and user. User can use the system for detecting diseases with intent search and without intent search and SuperUser is responsible for adding,deleting and updating the images of fruit.

[21] which focused on expert systems using CLIPS and Delphi languages for identifying some diseases in Papaya Plant. The system helps farmer in choosing symptoms of the plant and then these symptoms are analysed and output will be the disease name that the plant got infected. This work contains description of some papaya diseases namely Foot rot, Anthracnose, Powdery Mildews, Papaya RingSpot, Papaya Mosaic disease, Papaya leaf curl disease, their symptoms and favourable conditions for each disease.

[22] focussed on detection of three apple fruit diseases-apple rot, apple blotch and apple scab. K-means clustering was used for image segmentation and MSVM classifier was used for classification. For feature extraction of the fruit - Global Color Histogram, Color Coherence Vector, Local Binary Pattern, and Completed Local Binary Pattern techniques are used.

[23] focussed region based segmentation, textual feature analysis and KNN algorithm for image classification. MATLAB is used for implementating the system and result analysis is done on the basis of execution time and accuracy. K-means clustering was used for image segmentation and K-Nearest Neighbour classifier was used for classification.

[24] provided a survey of various types of image processing techniques including Image enhancement, Image Restoration, Image Compression, Image Segmentation, Image Recognizing and Image Smoothing. The study includes brief description of all these techniques. It also provided brief details of aaplications in image processing.

[25]proposed system used to detect leaf spot disease found on brinjal leaves. K-means clustering algorithm is used for image segmentation. Feature extraction is done by using CCM method and Artifical Neural Network is used as classifier. CCM method is

used for extracting color and texture features of an image.

Yang [26] developed a back propagation artificial neural network model to distinguish corn crops from weeds. This study included forty images of corn and forty images of weeds. Thus, a total of eighty images were used for training and twenty images for testing. The output of the work resulted in 80 to 100% success rate for identifying crop and 60 to 80% success rate for identifying weeds. The Neural Network toolbox v2.0 for MATLAB v5.0 was used for building the proposed model.

Dubey [27] developed method for leaf classification using color,shape and texture features. Geometric features like slimness, roundness etc. and Fourier descriptors were used for extracting shape features. For extracting color features, color moments like mean, standard deviation and skewness were used. Texture features are extracted using fractal measure called lacunarity.

Sonal [28] developed an automated system which focussed on detection of plant leaf diseases using k-means clustering for image segmentation and artificial neural network model for recognizing the infected leaf. Probabilistic Neural Network, GLCM and SGLDM were used for texture feature extraction of an input image.

Malti [29] proposed an automated disease detection system for plant leaf of *Phaseolus vulgaris* (Beans) and *Camellia assamica* (Tea). This study involved image acquisition, image pre-processing, image segmentation, feature extraction and classification. Image segmentation was done by using k-means clustering. Color Co-occurence method was used for extracting color and texture features of an image.

Zulkifli [30] proposed a software for identifying diseases in chilli plant leaf. In this study, various types of images of chilli leaves were collected which are different in shape and color. Images of chilli leaf were captured by camera using LABVIEW software as a Graphical User Interface and image processing techniques wereimplemented by MATLAB software tools.

Sanjay [31] This work focussed on brown spot which is a fungal disease found on sugarcane. Images of brown spot diseased leaves were taken for this study. Two types of image segmentation were used. Simple Threshold segmentation was used for finding out area of leaf and triangle thresholding methods were used for finding out lesion region area. This experiment provided average accuracy of 98.60%.

Abdul [32] study developed a method for leaf classification. Shape features were extracted with Fourier descriptors, Slimness ratio, dispersion and roundness ratio. Color features were extracted with help of color moments like mean, standard deviation and skewness. Vein features were extracted using Morphology. Texture features were extracted using lacunarity. This method used Probabilistic Neural Network (PNN) as classifier.

Newsam [33] proposed a comparison of shape features and texture features for recognising pattern in simulating data. Three texture features namely Wavelets, Gabor Filters and Gray level Co-occurence matrices and two shape features namely geometric moments and angular radial transforms were compared. In this study, Angular Radial Transform was considered as best shape feature and Gabor filters considered as best texture feature.

Fang [34] proposed a new multiple route protocol using adaptive route selection policy based on back propagation neural networks. In this study, Gradient ascent algorithm was used to find out the relationships between different optimum route selection methods. This proposal was evaluated using Omnet simulator.

Misigo [35] proposed a Apple Classification System. MATLAB R2015a development platform environment was used to build Apple Classification System Prototype. This study dealt with performance of Naive Bayes algorithm for classifying different varieties of Apple fruits. This study focussed on three

different types of apple fruits: Golden delicious, Pink lady and Honey Crisp.

Changqi [36] study focussed on identification of three types of diseases namely Powdery Mildew, shrinkage and uneven ripening. This paper involves image pre-processing for removing noise and application of top-hat transform for eliminating uneven illumination effects. Image segmentation is done by using gray morphology, OTSU algorithm, the mean shift segmentation algorithm. Back Propagation Neural Network and Support Vector Mahine were used for classifying and recognising diseases of strawberry.

A. Nasirahmadi [37] proposed method for identification of bean varieties using color features. Ten varieties of Bean were selected. Out of these varieties, six color features of the bean and six color features of the spot were extracted. These features were given as input for Multilayer Perceptron-Artificial Neural Network Classifier. In this research, ANN was considered as a rapid and an effective method for bean classification.

Yousef [38] proposed a working prototype of a date fruit grading and sorting system. The hardware portion of the model included conveyer, camera and helm control systems. The software system included various images of date fruits and classified them. Image pre-processing was done by binarization threshold. Some essential features like flabbiness, size, shape, intensity and defects were extracted. Image classification was done by Back Propagation Neural Network. This system provided accuracy of 80%.

Devrim [39] proposed a system for detecting defects in apple and its quality classification. This study included two varieties of apple: Jonagold and Golden Delicious. Color, Texture and Wavelet features of apple images were extracted using Principal Component Analysis and classification was performed using MLP-Neural Networks.

3. Disease Description

Many diseases affecting papaya are-Powdery Mildew (Odium Indicum, Odium caricae), Leaf-Blight (*Corynespora cassiicola*), Damping-off (*Rhizoctonia Solani*), Foot Rot (*Pythium aphanidermatum*), Anthracnose (*Colletotrichum gloeosporioides*), Papaya Mosaic, Black Spot

Fig. A
Healthy Leaf

Fig. B. 1
Foliar Symptoms of Papaya Ringspot

Fig. B. 2

Fig. C
MealyBug

Fig. D. 1
Black Spot On
Upper Leaf Surface

Fig. D. 2
Black Spot On
Lower Leaf Surface

(*Asperisporium caricae)*, Ring Spot (Papaya RingSpot Virus-PRSV*)*, Mealybugs (Paracoccus marginatus) etc. These diseases are caused by fungus, virus, insects and pests.

The popular Plant Village dataset is used for collecting this dataset.The dataset contains images of one healthy papaya plant leaf and five images of five infected plant leaves with diseases papaya ringspot,blackspot, and mealybugs .

This study includes description of following three diseases infecting papaya leaves:

1) Black Spot (*Asperisporium caricae*)

The Fig. D.1 and D.2 illustrates Black Spot On Upper Leaf Surface and Lower Leaf Surface respectively. It is a fungal disease. Its scientific name is Asperisporium Caricae. Previously it was known as Cercospora caricae.

Symptoms:
1. Round to irregular leave spots with 3-6mm in diameter.
2. Dark Brown or Black Spots.If the leaves are severely infected,they die.
3. The spores from the underside of the leaves are spread.

Detection & Inspection

Look for the dark brown to black spots on the fruit and on the underside of the leaves where the spores are produced; on the top surface the spots are light brown with yellow margins, and fade in colour as they age. Look for spots mostly on the older leaves. Look to see if the leaves dry and die early when the spotting is severe. Look for the spots on the leaves from below, up into the crown of the tree.

2) Ring Spot (Papaya RingSpot Virus-PRSV)

It is a pathogenic plant viral disease. Virus is transmitted by severe aphid species. Pathogen belongs to Potyvirus group of Potyviridae family. Fig. B.1 and B.2 illustrates foliar symptoms of ring spot on papaya leaves.

Symptoms:
1. Papaya exhibits yellowing,leaf distortion and severe mosaic.
2. Oily or water soaked spots and streaks appear on the trunks and petioles.
3. Dark-green streaks and rings appear on the leaf stalks

Transmission and favourable conditions

1. Aphid transmits this disease.
2. PRSV is typically not seed transmitted

Detection and Inspection

Symptoms of the disease are very characteristic and easily visible on plants infected in the field. During the early stage of infection PRSV can be identified by the presence of oily stains in the base of the petioles and in the stem.

3) Papaya MealyBug (*Paracoccus marginatus*)

MealyBug is a small sap sucking insect in MealyBug Family, Pseudococcidae. Fig. C illustrates papaya mealybug which are seen as cotton like masses on leaves.

Symptoms:
1. Papaya mealy bug is polyphagous pest. Symtopms can be observed on ground parts of leaves, stem and fruits as clusters of cotton like masses.
2. The mealy bug affected portion is cholotic initially. Later it will be changed to brown and dry away.
3. Deformation or curling of leaves.
4. Excretion of honey dew by these bugs results in growth of dense black soothy moulds on leaves which reduces photosynthesis efficiency of plants.

Natural enemies of papaya mealybugs

Some parasitoids like Acerophagus papaya, Phygadium spp. and predators like Spalgis

epius, Rodolia fumida and Cryptolaemus montrouzieri are considered as natural enemies of papaya mealybugs. The entomogenous fungus Beauveria bassiana is also considered as one of the enemy.

Favourable conditions

1. Papaya mealybug prefers tropical climate.
2. Higher reproductive potential.
3. Its developmental period is short.
4. It can survive in adverse climates due to presence of thick wax coating around the body.
5. Spreading of mealybugs with the symbiosis association of ants.

4. Methodology

The proposed system is to build a model that can classify whether an input plant leaf image is diseased or healthy. This work includes collection of various papaya leaf images including one healthy leaf and three types of diseased papaya plant leaf namely black spot infected leaf, papaya mealybug infected leaf and papaya ring spot infected leaf. Image enhancement is done on these images. Feature extraction is done for finding out color feature which is important for detecting infected parts of the leaf. Image segmentation is done using k-medoid clustering algorithm for finding out the diseased region. Finally, algorithm is developed using artificial neural network for classification of healthy and infected leaves.

4.1 Architecture Used

This System deal with identification of three main diseases-Black Spot,Mealy Bugs and Ring Spot affecting papaya.Images of respective leaf is captured and then k-medoid clustering is used for segmenting images.k-medoid is not prone to noise and outliers.Pair-wise distance measure makes it more flexible and then two layer perceptron activation function is applied for identifying the disease.

4.1.1 k-medoid algorithm for image segmentation

k-medoid is a classical partitioning technique of clustering, which clusters the data set of *n* objects into *k* clusters, with the number *k* of clusters assumed known *a priori* (which implies that the programmer must specify k before the execution of the algorithm).The basic idea of this algorithm is to first compute K representative objects which are known as medoids. Then each object of the data set is assigned to its nearest medoid.

The dissimilarity of the medoid(Ci) and object(Pi) is calculated by using E = |Pi - Ci|

A medoid can be defined as the object of a cluster whose average dissimilarity to all the objects in the cluster is minimal, that is, it is a most centrally located point in the cluster.

Initially select k random points as the medoids from the given n data points of the data set.

1. Associate each data point to the closest medoid by using any of the most common distance metrics.
2. For each pair of non-selected object h and selected object i, calculate the total swapping cost $TC_{ih.}$ **if** $TC_{ih} < 0$, i is replaced by h.
3. Repeat the steps 2-3 until there is no change of the medoids.

Merits of k-medoid algorithm are as follows:
1. It is easy to implement.
2. It is fast and converges in a fixed number of steps.
3. It is simple to understand.
4. It is less sensitive to noise and outliers.

4.1.2 MultiLayerPerceptron

Multi Layer perceptron (MLP) is a feedforward neural network with one or more layers between input and output layer. Feedforward means that data flows in one direction from input to output layer (forward). This type of network is trained with the backpropagation learning algorithm. MLPs are widely used for

pattern classification, recognition, prediction and approximation. Multi Layer Perceptron can solve problems which are not linearly separable.

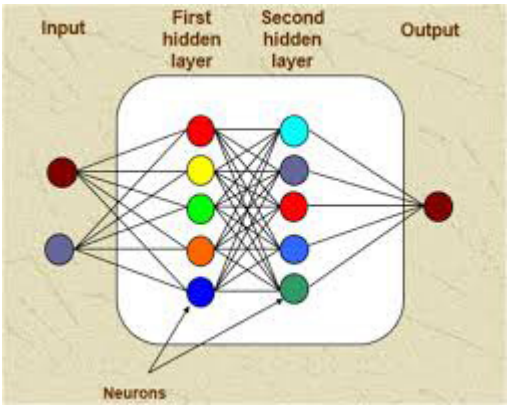

Fig. A Two layer MLP Model

Feed Forward Network, is the most typical neural network model. Its goal is to approximate some function f (). Suppose a classifier y = f ∗ (x) that maps an input x to an output class y, the MLP find the best approximation to that classifier by defining a mapping, y = f(x; θ) and learning the best parameters θ for it. The MLP networks are composed of many functions that are chained together. Each of these layers is composed of units that perform an affine transformation of a linear sum of inputs. Each layer is represented as y = f(WxT + b). Where f is the activation function, W is the set of parameter, or weights, in the layer, x is the input vector, which can also be the output of the previous layer, and b is the bias vector. The layers of an MLP consists of several fully connected layers because each unit in a layer is connected to all the units in the previous layer. In a fully connected layer, the parameters of each unit are independent of the rest of the units in the layer, that means each unit possess a unique set of weights.

Backpropagation Algorithm

It is a supervised algorithm for training Neural Networks. Backpropagation is used to calculate the gradient of the error of the network with respect to the network's modifiable weights. The training algorithm of back propagation involves four steps:

- Initialization of weights-Some small random values are assigned.

- Feed Forward-Each input unit (X) receives an input signal and transmits this signal to each of the hidden units Z_1, Z_2, ..., Zn. Each hidden unit then calculates the activation function and send it signal Z_i to each output unit. The output unit calculates the activation function to form the response of the given input pattern.

- Back propagation of errors-Each output unit compares activation Y_k with its target value T_k to determine the associated error for that unit. Based on the error, the factor ∂_k(k = 1, ..., m) is computed and is used to distribute the error at output unit Y_k back to all units in the previous layer.Similarly, the factor ∂_j(j = 1, ..., p) is compared for each hidden unit Z_j.

- Updation of the weights and biases.

Activation Function

Activation functions are used to convert a input signal of a node in a artificial neural network to an output signal which can be used as input to the next layer.A neural network without a activation function is simply a Linear Regression Model which has limited power. The activation function is a mathematical "gate" in between the input feeding the current neuron and its output going to the next layer. It can be as simple as a step function that turns the neuron output on and off, depending on a rule or threshold.The most common types of Activation Functions are:

1) Sigmoid Function
2) Tanh-Hyperbolic Tangents
3) ReLu-Rectified Linear Units

This work deals with a variation of ReLU function which is known as Leaky ReLU which enables back propagation for negative values. Backpropagation suggests an optimal weight for each neuron which results in the most accurate prediction.

Leaky ReLU activation function is an improved version of ReLU function. Instead of defining the ReLu function as 0 for negative values of x, we define it as an extremely small linear component of x. Here is the mathematical expression-

$f(x) = 0.01x, x < 0$

$= x, x >= 0$

4.1.3 Proposed System Algorithm

1) **Algorithm for detecting Black Spot(*Asperisporium caricae*)**
- Input a GrayScale Image
- K-medoid clustering technique is used for segmenting image.
- Classify black(0, 0, 0, Gray scaled value).
- Black region is identified as black spot which is a fungal disease.

2) **Algorithm for detecting MealyBugs(Paracoccus marginatus)**
- Input a GrayScale Image.
- K-medoid clustering technique is used for segmenting image.
- Classify white(255,255,255,Gray scaled value).
- White region is identified as white spot which is a fungal disease.

3) **Algorithm for detecting RingSpot (PapayaRingSpotVirus-PRSV)**
- Input a GrayScale Image
- K-medoid clustering technique is used for segmenting image.
- Circular region is identified which is a viral disease.

5. Results and Discussion

In this section, analysis of various papaya leaf diseases like Ring Spot, Black Spot, Mealy Bug (under leaf) is done based on the various samples of papaya leaves collected. K-medoid clustering technique is used for grouping them into clusters by setting a threshold value which is then followed by a segmentation process.

Fig A indicates that K-medoid clustering is selected as an effective method in this case study.

Fig B indicates the comparative study of various classifiers used for detecting papaya ring spot disease.

Fig C indicates the detection of mealy bug disease identification under papaya leaf by setting the threshold value where values in the specified range will be indicated as white colour which in turn indicates the presence of mealy bug.

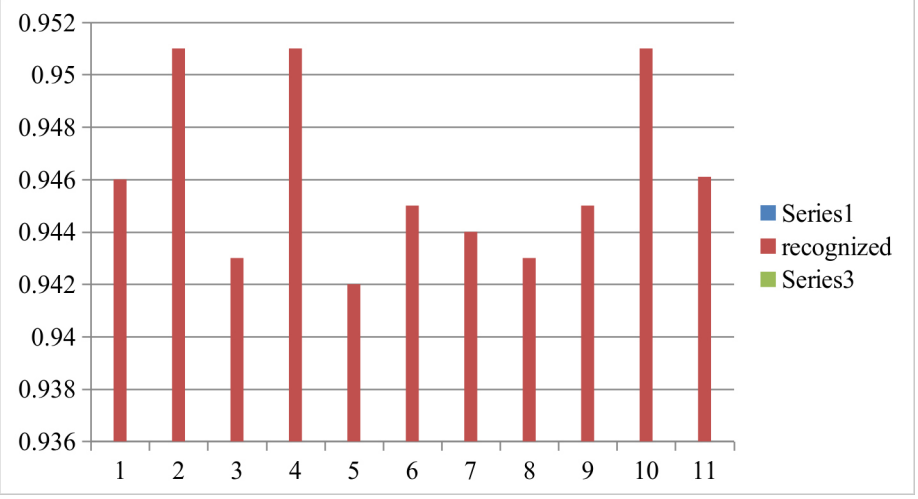

Fig. A Samples recognized with an average of 94.61%. Samples are plotted in the x-axis

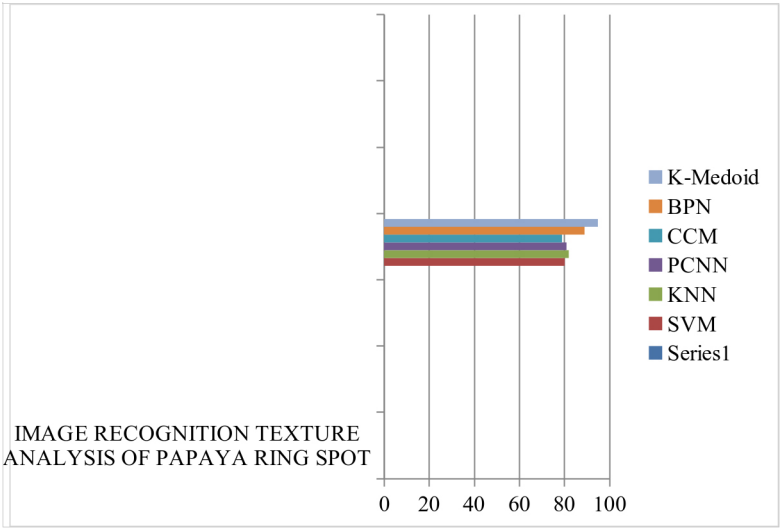

Fig. B For ring spot RGB in the range(249, 249, 7) to (151, 151, 69) recognised

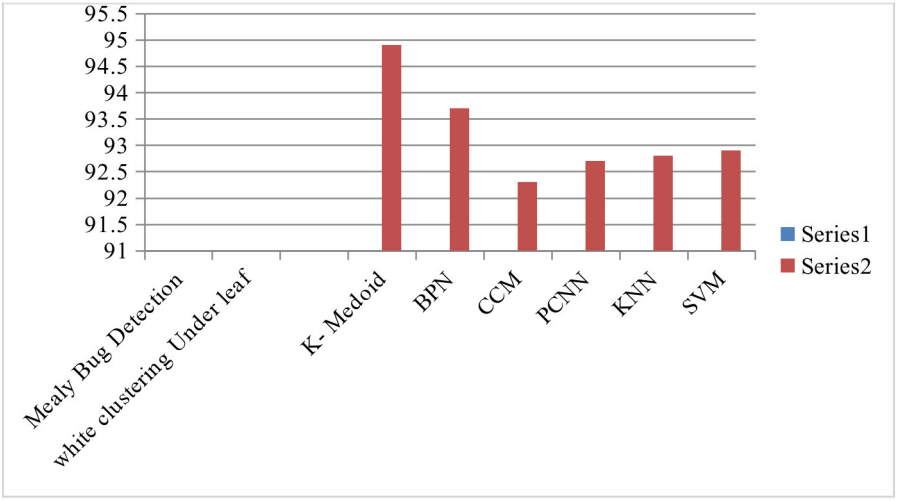

Fig. C RGB tested in the range (240, 240, 240) to (255, 255, 255)

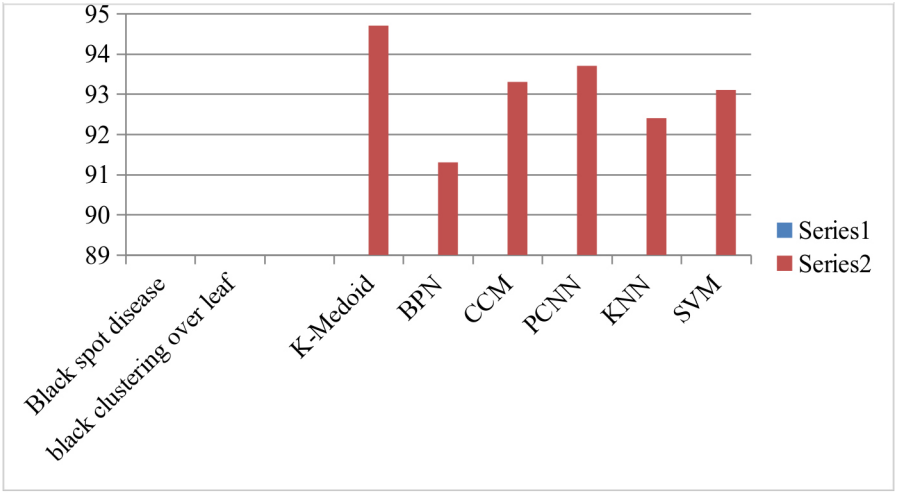

Fig. D RGB tested in the range (0, 0, 0) to (101, 101, 61)

Fig D indicates the detection of black spot over leaf by setting the threshold value where values in the specified range will be indicated as black colour.For converting color image into gray scale value following formula is used.

Gray[i,j]=(R[i,j]+G[i,j]+B[i,j])/3

6. Conclusion and Future Enhancements

This proposed system deals with detection of three main diseases affecting papaya leaves namely Black Spot(Asperisporium caricae), RingSpot(PRSV) and MealyBugs. Blackspot is a fungal disease. RingSpot is a viral disease and Papaya MealyBug is caused by insects. In this work, images of various papaya leaves are collected. Then image enhancement is done. K-medoid clustering algorithm is used for segmentation of images. Feature extraction is done for extracting color features. Multilayer Perceptron is used for classification of images. New algorithm is proposed for identifying the mentioned three diseases-Black Spot, Ring Spot and MealyBugs.

This work can be extended in future to identify all types of diseases affecting papaya leaves. It can be further enhanced to detect diseases in papaya fruit and stem. Future scope of this work can be extended to other plant leaves and fruits and more data set can be added for enhancing the overall performance and accuracy of neural network based detection mechanism.

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