Leaf Disease Detection Using Artificial Neural Network

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Abstract — *Most of Indian population depends on agriculture productivity. Major population of India depends on agriculture. Many diseases in leaves like fungal, bacteria and viruses may cost great loss to farmers. Disease in leaf destroys the quality of leaf. There are many types of leaf disease but we worked on leaf spot disease by using Artificial Neural Network. Automatic detection techniques can be used for disease detection in plants is efficient and time saving and accuracy. The automation of plant disease identification has gained attention in last few years. So, with the improvement in ANN, its families and Machine learning techniques there is a significant scope of improvement in the pre-existing methodologies for leaf disease detection, segmentation and identification. With the help of modern sensors and imaging techniques the efficiency and accuracy of ANN model have significantly improved, as we know that the process is highly dependent on qualityof data sets and the algorithm we use to process these datasets. This study focuses on various implementations of these ANN's and their benefits such that they deal out optimal or near optimal solutions.*

Keywords: *Artificial neural network, Plant pathology, K-mean , Accuracy, Classification*

I. INTRODUCTION

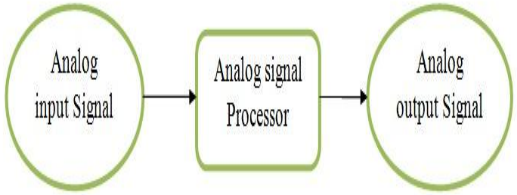
Image processing is a technique to enhance raw images received from cameras/sensors placed on satellites, space probes and aircrafts or pictures taken in normal life for various applications. In last four and five decades various techniques have been developed in image processing. Most of the techniques are developed for enhancing images obtained unmannered spacecrafts. Advanced picture preparing is the utilization of PC calculations to perform picture handling on computerized pictures. As a subcategory or field of advanced flag handling, computerized picture preparing has numerous favorable circumstances over simple picture handling. It permits a considerably more extensive scope of calculations to be connected to the information and can maintaining a strategic distance from issues, for example, the development of commotion and flag contortion amid handling. Since pictures are characterized more than two measurements (maybe more) advanced picture preparing might be displayed as multidimensional frameworks. Image processing is used in various applications such as:

1. Remote sensing
2. Medical Imaging
3. Non-destructive Evaluation
4. Military
5. Film Industry
6. Graphics arts
7. Material science

A. Methods of image processing

Analog Image Processing

Analog Image Processing refers to the alteration of image through electrical means. Simple picture preparing is any picture handling undertaking directed on two-dimensional simple flags by simple means (instead of advanced picture preparing). Fundamentally any information can be spoken to in two kinds named as Analog and Digital if the pictorial portrayal of the information spoke to in simple wave arranges that can be named as simple picture. Example TV broadcasting in more established today era, through the dish radio wire frameworks. Whereas the advanced portrayal or putting away the information in computerized frame is named as an advanced picture preparing. The diagram of analog image processing is shown below.

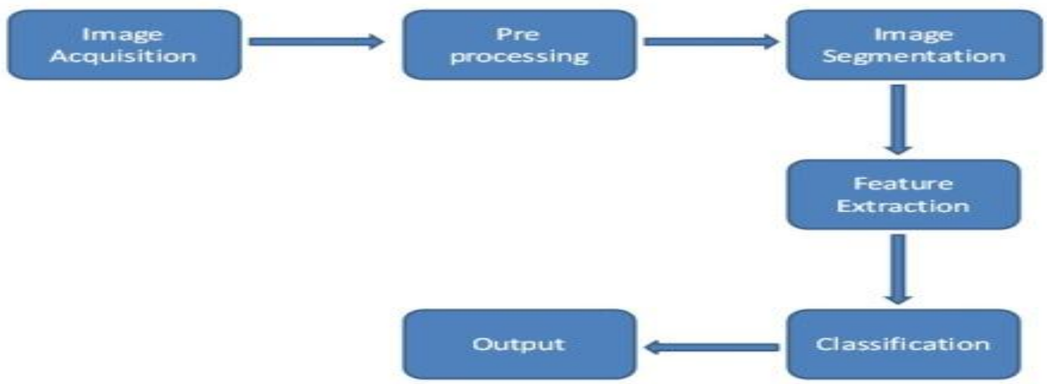


Digital image processing

Digital computers are used to process image in this case. The image will be converted to digital form using a scanner and then process it. Computerized picture preparing is the utilization of PC calculations

to perform picture handling on advanced pictures. As a subcategory or field of advanced flag preparing, computerized picture handling has numerous favorable circumstances over simple picture handling. It permits a considerably more extensive scope of calculations to be connected to the information and can keep away from issues, for example, the development of clamor and flag twisting amid preparing. Since pictures are characterized more than two measurements (maybe more) computerized picture preparing might be displayed as multidimensional frameworks. Advanced picture handling permits the utilization of significantly more mind boggling calculations, and henceforth, can offer both more modern execution at basic undertakings, and the usage of techniques which would be incomprehensible by simple means. The diagram below shows steps in digital image processing.

B. Image processing steps



Artificial Neural Network

Artificial Intelligence and Machine learning plays a very important role in Plant Pathology. With the help of artificial intelligence techniques farmers can easily identify and detect the diseases in plants. Farmers can easily understand the cause of disease in early stage. India is an agriculture country. Most of the India population depends upon agriculture growth but diseases caused to plants may cause great loss to farmers and Indian economy growth. With the help of artificial techniques farmers can easily identify the disease in early stage. Some of artificial techniques in plant pathology are-Agriculture robotics, Soil and Crop monitoring and Predictive Analysis .In early stages farmers suffers from diseases caused by chemicals during the spraying in fields but with the help of AI it can be done by Automatic machines which helps farmers to stay away from diseases. Neural network recently have been applied successfully in many disease detection in plants. Network parameters are used to train networks in order to improve mapping in training process.

Artificial Neural Networks (ANN) is based on BNN which is used for computation. ANN are basically the electronic models based on the structure of brain(mind). Mind learns from the experiences and that is how ANN works. ANN comprises of various nodes which are connected to each other and one of them performs a certain mathematical operation. ANN is basically inspired implementation that are used to perform certain tasks such as clustering, classification, pattern-recognition etc. on computer. ANN has many advantages but the most important advantage is that it can learn from observing data sets. ANN has three layers that are interconnected to transfer information. A simple ANN structure as shown below.

C. Benefits of ANN

There are basically four benefits of ANN. They are

1) Neural networks can learn organically which means an artificial neural network's outputs aren't limited entirely by inputs .This ability is valuable for robotics and pattern recognition systems.
2) These Non-linear systems have the capability to reach the computationally expensive solutions using shortcuts. This nonlinear short-cut mechanism is fed into

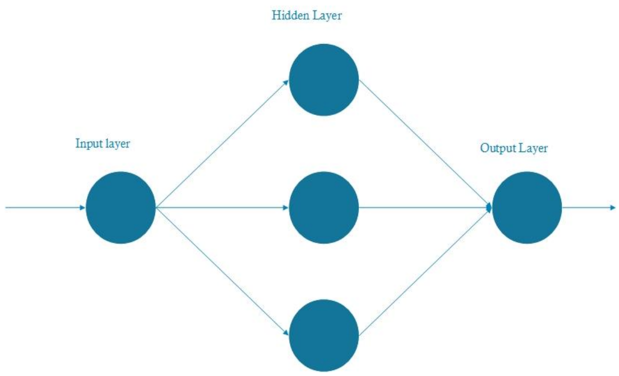


Fig 1 View of Artificial neural network

II. Problem Identification

There are number of approaches used for the purpose of classification of disease present on the leaf of plant. But not such method has been developed till now to classify them accurately. Number of author have work on identification of disease from plants like- cucumber leaves, Cercospora leaves, groundnut leaves, grape leaves, rice leaves etc using number of methods including Support Vector Machine, Artificial Neural network, K-means Clustering, Fusion Classification Technique etc. Pranjali B. Padol and S. D. Sawant in [6] author have present a fusion of Artificial Neural network, K-means Clustering, SVM for the identification of Downy mildew disease and powdery mildew disease from the leaf of grapes with accuracy of 100% while classification result for SVM found to be 93.3% and 83.33% where as for ANN result found to be 86.67% and 91.67% for classification of Downy mildew and powdery mildew disease separately. In our present work we try to emphasis on improving the performance of Artificial Neural Network and Support Vector Machine separately.

III. Proposed algorithm

In this proposed work we consist of four fundamental stages: Image acquisition of grape and bay laurel leaf image, pre processing of image, feature extraction and classification of images in leaf spot disease

F Semantic view of Artificial Neural Network

artificial neural networking, which makes it valuable in commercial big-data analysis.

3) Artificial neural networks have the potential for high fault tolerance.

4) Artificial neural networks can results in a self-debugging and diagnosing network, asked for finding out specific data that is no longer communicating, these artificial neural networks can regenerate large amounts of data by inference and help in determining the node that is not working.

These benefits can be seen in some popular applications of ANN such as:-

- Speech Recognition
- Character Recognition
- Signature Verification Application
- Human Face Detection

IV. Dataset

We have collected about 200 images that we choose randomly from Google suffering from leaf spot diseases.

V. Flow chart of proposed technique

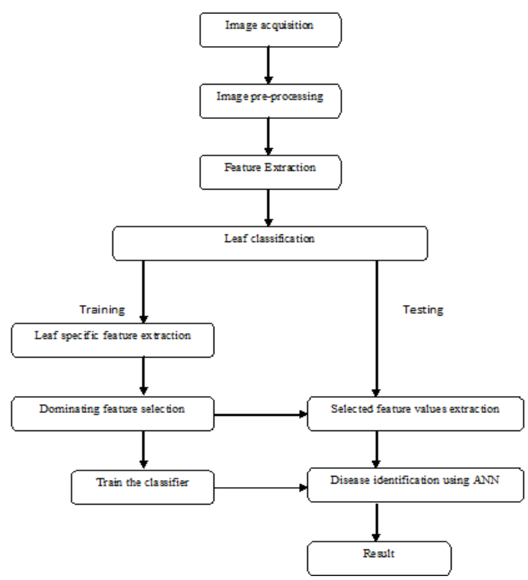


Fig 2 proposed algorithm

A. Material Used

We have been using grape leaves and bay laurel leaves with black spot disease. In this work add up to 115 grape leaf pictures (containing both starting stage and in addition last stage pictures) are utilized which are influenced by dark spot disease. We have been using 115 images for training phase and testing phase. In this work we are using 115 bay laurel leaf images (containing both starting stage and in addition last stage pictures) are used which are affected by black spot disease. We have been using 115 images for training phase and testing phase. In India grape productivity is more as compared to other countries. Grape trade from India is around 53,910 tons esteemed at 48,505 (1000US$) that makes an offer of almost 1.54% of aggregate fare of grapes in world. Grape is an imperative organic product edit in India. Because of sickness on grape plant there is loss of around 10-30 % of product. It is important to perceive the sicknesses at an underlying stage and give legitimate arrangements so greatest inconvenience can be kept away from in order to upgrade the benefit. Farmers utilize manual perception technique to judge the illnesses. But sometimes this may be an inaccurate way. An early recognition of sicknesses is the significant test in a horticulture field. Types of leaf disease are classified into bacterial, viral, fungal etc. Grape suffers from enormous loss due to the various leaf diseases like: Black spot, Downy Mildew, Powdery Mildew and Anthracnose etc. For grape leaf the fungal diseases found in India are Downy Mildew, Powdery Mildew, Anthracnose, Grey Mold, and Black spot etc.

B. Evaluation parameters

Segment accuracy $SA=\sum_{k=1}^{k} \frac{Ak \cap Ck}{\sum_{i=1}^{k} Ci}$

Where k =number of clusters

A_k = pixel belonging to the K_{th} cluster

C_k = the pixel in the K_{th} cluster in the ground

U_{ik} = membership value of pixel i belonging to K_{th} cluster

N is the total number of pixel

The best clustering result is achieved when SA $= 1$

Dice similarity coefficient (DSC)

Given two sets, X and Y, it is defined as

$$DSC = \frac{2|X \cap Y|}{|X| + |Y|}$$

Where $|X|$ and $|Y|$ are the cardinalities of the two sets.

When applied to boolean data, using the definition of true positive (TP), false positive (FP), and false negative (FN), it can be written as

$$DSC = \frac{2TP}{2TP+FP+FN}$$

DSC is the quotient of similarity and ranges between 0 and 1.

Jaccard coefficient (JC)

In jaccard coefficient, the set operations can be expressed in terms of vector operations over binary vectors a and b:

$$\$\upsilon = \frac{2|a.b|}{|a|^2 + |b|^2}$$

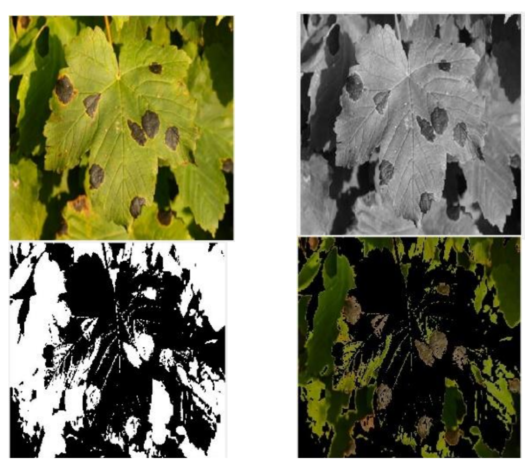
which gives the same outcome over binary vectors and also gives a more general similarity metric over vectors in general terms.

VI. Results

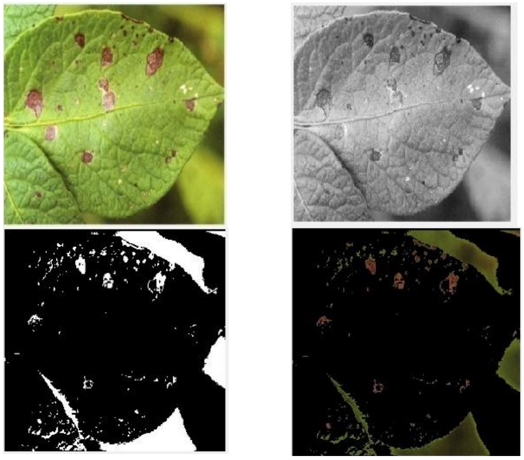
The results have been validated on three quantitative evaluation parameters are Accuracy, Dice Similarity Coefficient (DSC), Jaccards Coefficient (JC) and the comparision of the proposed ANN has been done with another classification algorithm used as K-mean.

For the result we have consideres 5 figures choosen randomly from the dataset.

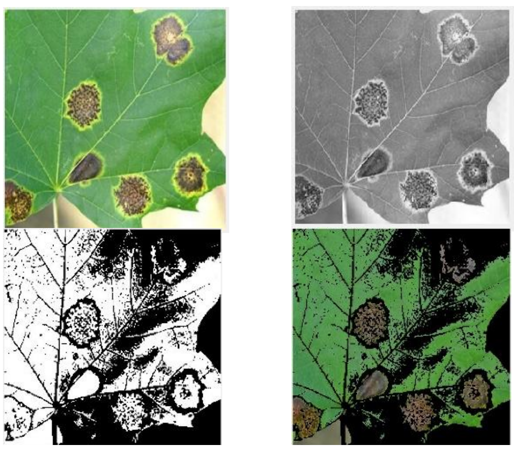
The segmentation results have been given in below



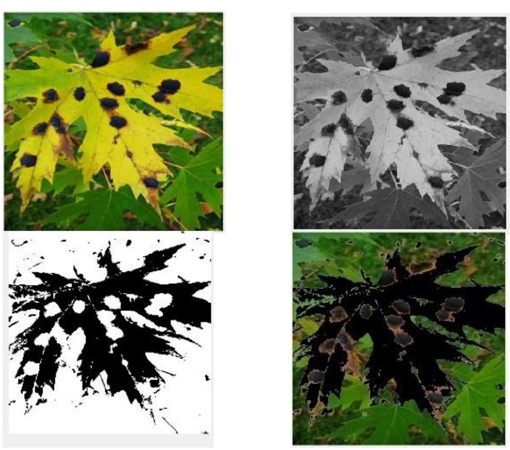
1. Maple leaf



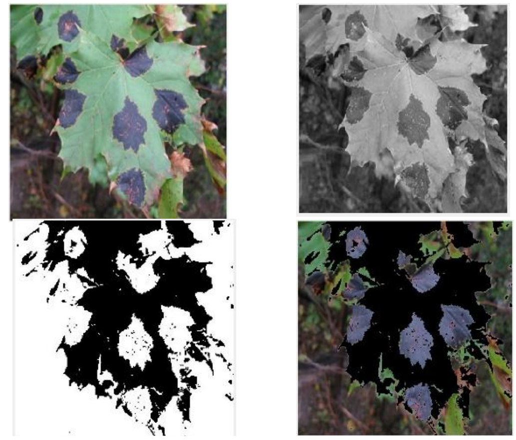
2. Potato leaf



3.Maple leaf

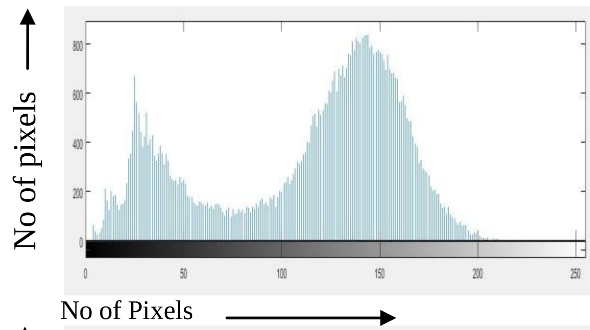


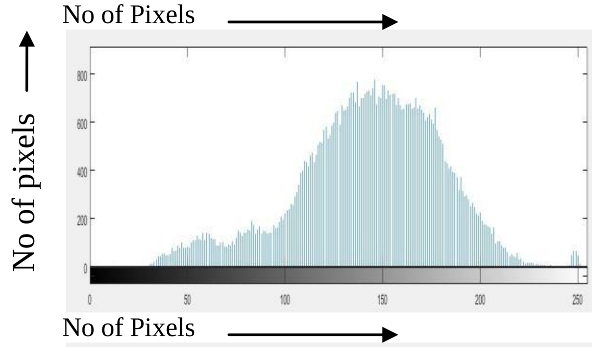
4. Ohio leaf

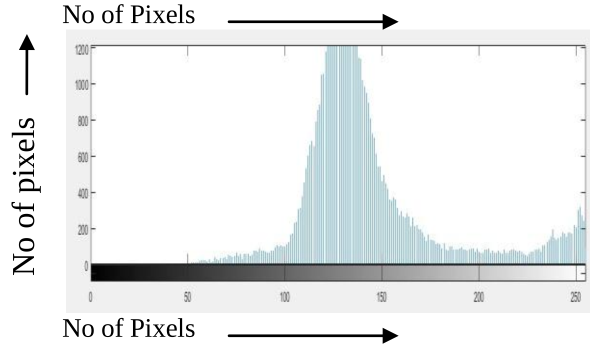


5. Sugar Maple leaf

A. Results for segmentation







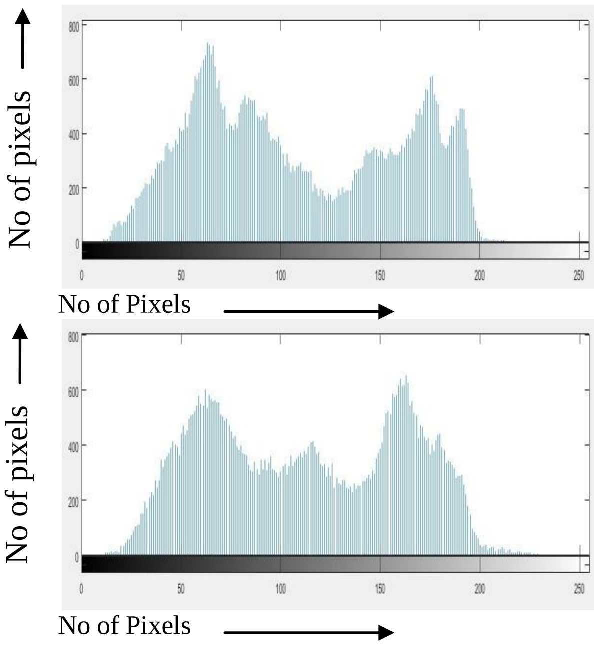


Fig 3. Histogram of segmented images

The accuracy for image 1for the K-mean algorithm was evaluated to be 0.7314 and for proposed ANN the accuracy was found to be 0.7700.The accuracy for image 2 for the K-mean algorithm was evaluated to be 0.7496 and for proposed ANN the accuracy was found to be 0.8124.The accuracy for image 3 for the K-mean algorithm was evaluated to be 0.7784 and for proposed ANN the accuracy was found to be 0.7947. The accuracy for image 4 for the K-mean algorithm was evaluated to be 0.7108 and for proposed ANN the accuracy was found to be 0.7536.The accuracy for image 5 for the K-mean algorithm was evaluated to be 0.7542 and for proposed ANN the accuracy was found to be 0.8099.

The Jaccards Coefficient for the image 1for the K-mean algorithm was evaluated to be 0.7133 and for proposed ANN the Jaccards Coefficient was found to be 0.7411. The Jaccards Coefficient for the image 2 for the K-mean algorithm was evaluated to be 0.7421 and for proposed ANN the Jaccards Coefficient was found to be 0.7776. The Jaccards Coefficient for the image 3 for the K-mean algorithm was evaluated to be 0.7637 and for proposed ANN the Jaccards Coefficient was found to be 0.8009. The Jaccards Coefficient for the image 4 for the K-mean algorithm was evaluated to be 0.7266 and for proposed ANN the Jaccards Coefficient was found to be 0.7601. The Jaccards Coefficient for the image 5 for the K-mean algorithm was evaluated to be 0.7513 and for proposed ANN the Jaccards Coefficient was found to be 0.7925.

The Dice Similarity Coefficient for the image 1 for the K-mean algorithm was evaluated to be 0.7012 and for proposed ANN the Dice Similarity Coefficient was found to be 0.7599. The Dice Similarity Coefficient for the image 2 for the K-mean algorithm was evaluated to be 0.7502 and for proposed ANN the Dice Similarity Coefficient was found to be 0.7874. The Dice Similarity Coefficient for the image 2 for the K-mean algorithm was evaluated to be 0.7502 and for proposed ANN the Dice Similarity Coefficient was found to be 0.7874. The Dice Similarity Coefficient for the image 3 for the K-mean algorithm was evaluated to be 0.7402 and for proposed ANN the Dice Similarity Coefficient was found to be 0.7896. The Dice Similarity Coefficient for the image 4 for the K-mean algorithm was evaluated to be 0.7139 and for proposed ANN the Dice Similarity Coefficient was found to be 0.7614. The Dice Similarity Coefficient for the image 5 for the K-mean algorithm was evaluated to be 0.7619 and for proposed ANN the Dice Similarity Coefficient was found to be 0.7878.

The average accuracy, Jaccards Coefficient and Dice Similarity Coefficient for the K-mean algorithm was evaluated to be (0.7449, 0.7394, 0.7338). The average accuracy, Jaccards Coefficient and Dice Similarity Coefficient for proposed algorithm was evaluated to be (0.7881, 0.7744, 0.7772). The comparison of K-Mean Algorithm and proposed ANN clearly shows that the proposed ANN has more average value accuracy, JC and DSC. In figure 16 there is a comparative graph for k-mean and proposed ANN.

The result for the segmentation has been given in the table 4 and 5.

B. Results for k-means

Measures	Image1	Image2	Image3	Image4	Image5	Average
Accuracy	0.7314	0.7496	0.7784	0.7108	0.7542	0.7449
JC	0.7133	0.7421	0.7637	0.7266	0.7513	0.7394
DSC	0.7012	0.7502	0.742	0.7139	0.7619	0.7338

Fig 4 Results for proposed ANN

Measures	Image1	Image2	Image3	Image4	Image5	Average
Accuracy	0.7700	0.8124	0.7947	0.7536	0.8099	0.7881
JC	0.7411	0.7776	0.8009	0.7601	0.7925	0.7744
DSC	0.7599	0.7874	0.7896	0.7614	0.7878	0.7772

C. Dataset

We have collected about 200 images that we choose randomly from Google suffering from leaf spot diseases.

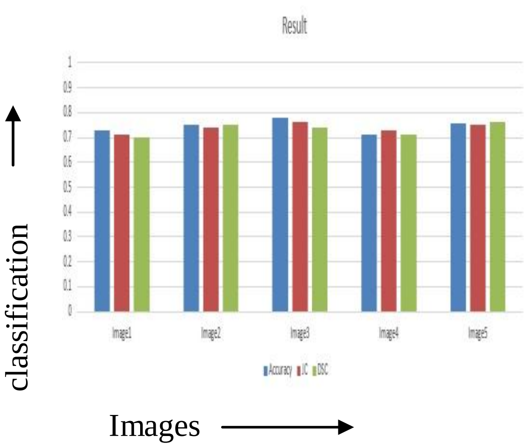


Fig 4 Results for proposed ANN

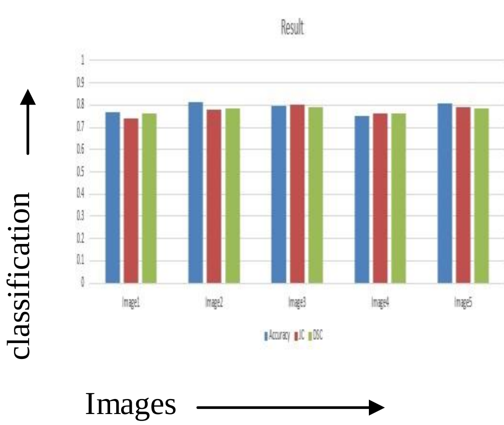


Fig 5 Result for proposed k-means

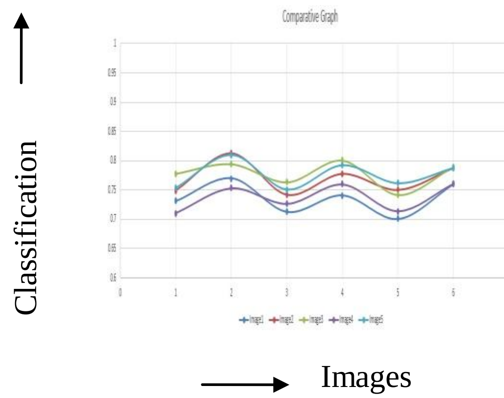


Fig 6. Comparative graph for k-means and proposed ANN

VII. CONCLUSION

Based on the different diseases, the different approaches were used by authors to detect the fruit diseases under image processing. The main focuses were on how to collect or take the images. The images were taken under the precise and static environment so that the accuracy and performance thus obtained is vital and viable. We have proposed a ANN for the classification of diseases from the leaf image. With the help of modern sensors and imaging techniques the efficiency and accuracy of ANN model have significantly improved, as we know that the process is highly dependent on quality of data sets and the algorithm we use to process these datasets.

This study focuses on various implementations of these ANN's and their benefits such that they deal out optimal or near optimal solutions. The ANN with its learning capabilities achieves higher performance when compare with other classification algorithm named as K-mean. The average accuracy, JC and DSC for ANN was measured to be (0.7881, 0.7744, 0.7772) when compared with that of K-mean with average (0.7449, 0.7394, 0.7338).

VIII. FUTURE WORK

We have worked with leaf spot disease on the proposed work, in future we will take forward this task to classify other diseases like leaf curl, leaf rust, powdery mildew etc.

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