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Applying image processing technique to detect plant diseases

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ABSTRACT: *The present work proposes a methodology for detecting plant diseases early and accurately, using diverse image processing techniques and artificial neural network (ANN).*
Farmers experience great difficulties in changing from one disease control policy to another. Relying on pure naked-eye observation to detect and classify diseases can be expensive various plant diseases pose a great threat to the agricultural sector by reducing the life of the plants. the present work is aimed to develop a simple disease detection system for plant diseases. The work begins with capturing the images. Filtered and segmented using Gabor filter. Then, texture and color features are extracted from the result of segmentation and Artificial neural network (ANN) is then trained by choosing the feature values that could distinguish the healthy and diseased samples appropriately. Experimental results showed that classification performance by ANN taking feature set is better with an accuracy of 91%.

Keywords: *Artificial Neural Network, Gabor Filter.*

I. INTRODUCTION

Agriculture is the mother of all cultures. It has played a key role in the development of human civilization. Agricultural practices such as irrigation, crop rotation, fertilizers, and pesticides were developed long ago, but have made great strides in the past century. By the early 19th century, agricultural techniques had so improved that yield per land unit was many times that seen in the middle ages. Agricultural production system is an outcome of a complex interaction of soil, seed and agro chemicals (including fertilizers). Therefore, judicious management of all the inputs is essential for the sustainability of a complex system. The focus on enhancing the productivity, without considering the ecological impacts has resulted into environmental degradation. Without any adverse consequences, enhancement of the productivity can be done in a sustainable manner.

Plants exist everywhere we live, as well as places without us. Many of them carry significant information for the development of human society. As diseases of the plants are inevitable, detecting disease plays a major role in the field of Agriculture. Plant disease is one of the crucial causes that reduces quantity and degrades quality of the agricultural products.

Diseases and insect pests are the major problems that threaten pomegranate cultivation. These require careful diagnosis and timely handling to protect the crops from heavy loses [2]. In pomegranate plant, diseases can be found in various parts such as fruit, stem and leaves. Major diseases that affect pomegranate fruit are bacterial blight (*Xanthomonas axonopodis pv punicae*), antracnose (*Colletotrichum gloeosporoides)* and wilt complex (*ceratocystis fimbriata*).

Image samples of these diseases are shown in Figure 1.

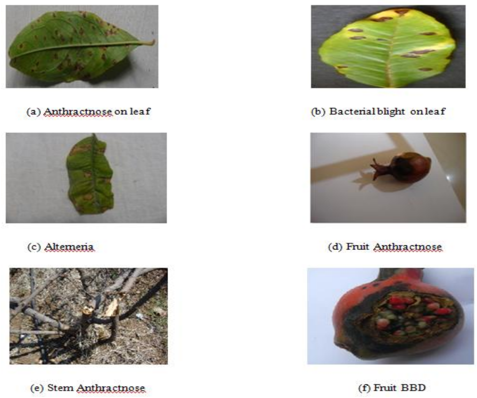

Figure 1: Various diseases affecting pomegranate

Bacterial blight is the most severe disease of the pomegranate. The disease symptoms can be initially found on stem part which gradually pervades to leaves and then to fruits. On leaves, the disease starts with small, irregular, water soaked spots that are 2 to 5 mm in size with necrotic centre of pin head size. Spots are translucent against light. Later, these spots turn light to dark brown and are surrounded by prominent water soaked margins. Numerous spots may coalesce to form bigger patches. Severely infected leaves may drop off. High temperature and high relative humidity favors the disease. The disease spreads to healthy plants through wind splashed rains and in new area through infected cuttings.

In this work we will be focusing on three different diseases which are attacked on pomegranate crop.

1) Alterneria.
2) Bacterial blight.
3) Anthractnose.
4) Fruit Anthractnose.
5) Stem Anthractnose
6) Fruit Bacterial blight.

II. METHODOLGY

The methodological analysis of the present work has been presented pictorially in Figure 1. The work commence with capturing images using cameras or scanners. These images are made to undergo pre-processing steps like filtering and segmentation. Then different texture and colour features are extracted from the processed image. Finally, the feature values are fed as input to the ANN classifier to classify the given image.

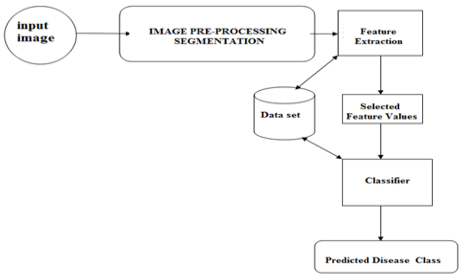

Figure 1: Block Diagram

A. Input Image: The first step in the proposed approach is to capture the sample from the digital camera and extract the features. The sample is captured from the digital camera and the features are then stored in the database.

B. Image Database: The next point in the project is creation of the image database with all the images that would be used for training and testing. The construction of an image database is clearly dependent on the application. The image database in the proposed approach consists of 140 image samples. The image database itself is responsible for the better efficiency of the classifier as it is that which decides the robustness of the algorithm.

C. Image Pre-processing: Image pre-processing is the name for operations on images at the lowest level of abstraction whose aim is an improvement of the image data that suppress undesired distortions or enhances some image features important for further processing and analysis task. It does not increase image information content. Its methods use the considerable redundancy in images. Neighbouring pixels corresponding to one real object have the same or similar brightness value. If a distorted pixel can be picked out from the image, it can be restored as an average value of neighbouring pixels .In the proposed approach image pre-processing methods are applied to the captured image which are stored in image database.

i. *Segmentation*

Image segmentation is process i.e. used to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze[2]. As the premise of feature extraction and pattern recognition, image segmentation is one of the fundamental approaches of digital image processing. Image Segmentation is the process that is used to distinguish object of interest from background. The proposed approach uses CIE L*a*b*, or CIELAB, color scale for use. It was intended to provide a standard, approximately uniform The CIELAB color scale is an approximately uniform color scale. In a uniform color scale, the differences between points plotted in the color space correspond to visual differences between the colors plotted. The CIELAB color space is organized in a cube form. The L* axis runs from top to bottom. The maximum for L* is 100, which represents a perfect reflecting diffuser. The minimum for L* is zero, which represents black. The a* and b* axes have no specific numerical limits. Positive a* is red. Negative a* is green. Positive b* is yellow. Negative b* is blue. Below is a figure representing the CIELAB color space.

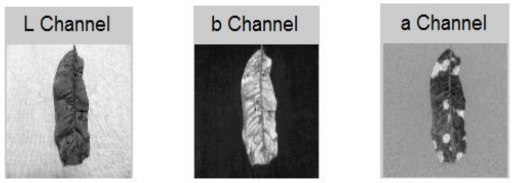

Figure 2: segmentation using CIELAB space color

D. Feature Extraction

The aim of this phase is to find and extract features that can be used to determine the meaning of a given sample. In image processing, image features usually include color, shape and texture features [3].

The proposed approach considers Gabor filter to calculate feature sets

- *Gabor filter*

A set of features are computed from the response of the image samples to the Gabor filters. They are unichannel features given by

$$e_{imn} = \sqrt{\left(\sum_{x,y} h_{imn}^{2}(x,y) \right)}$$

where '*e*' is the energy in the filtered image. The interchannel features between different spectral channels i and j with m and m' denoting the scales of the filters is computed as

$$o_{ijmm'n}^{2} = 2 - 2\sum_{x,y} \underbrace{\frac{h_{imn}(x,y)h_{jm'n}(x,y)}{e_{imn}e_{jm'n}}}_{c_{ijmm'n}}$$

where $C_{ijmm'n}$ is the zero offset normalized crosscorrelation between $h_{imn}(x,y)$ and $h_{jm'n}(x,y)$.

D. Recognition & Classification:

The recognition process consists of two phases, training and classification. Classification of image is done ANN (Artificial Neural Network)

i. Artificial Neural Network

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process the information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. A trained neural network can be thought of as an "expert" in the category of information it has been given to analyze [4].

III. EXPIREMENTAL ANALYSIS & RESULTS

EXPIREMENTAL ANALYSIS

- *Experimental Analysis WRT Number of Hidden Neurons v/s Neural Network efficiency.*

Number of Hidden Neurons	Recognition Rate for Alterneria (%)	Recognition Rate for BBD (%)	Recognition Rate for Anthractnose. (%)	Overall Neural Network Efficiency (%)
10	78	72	81	77
20	77	83.5	96	85.5
30	72.5	82	94.5	83
40	78	86	94	86
50	81.5	94	97.5	91

Table 1: Number of hidden Neurons v/s NN efficiency.

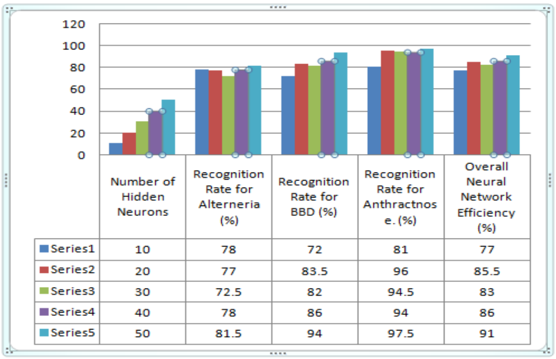

Figure 3: Graphical Analysis for Hidden Neurons v/s NN efficiency.

The table 1 shows the dependency of the efficiency on the number of hidden layers. Number of hidden layer represents number of states of the neurons in the network. The efficiency of the network is optimum when there are at least n x n numbers of hidden layers. The n here represents number of features per training set. The figure 3 shows the graphical representation of analysis with respect to Number of Hidden Neurons v/s Neural Network Efficiency which shows the network is optimum when 50 hidden neurons are considered.

- Experimental Analysis WRT Termination error rate v/s Neural Network efficiency

Termination Error rate (ms)	Recognition Rate for Alterneria (%)	Recognition Rate for BBD (%)	Recognition Rate for Anthractnose. (%)	Overall Neural Network Efficiency (%)
0.1	78.5	73	81.5	79
0.01	76.5	83.5	96	85
0.001	73	82.5	94.5	84
0.0001	77	86	93	84
0.00001	81.5	94	97.5	91

Table 2: Termination error rate v/s Neural Network efficiency

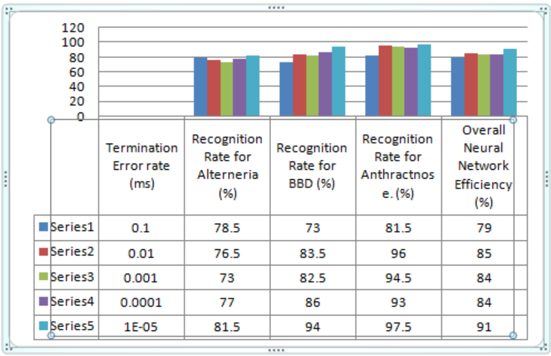

Figure 4: Graphical Analysis for Termination error rate v/s ANN efficiency

The table 2 shows the dependency of the efficiency on the termination error rate. Termination error rate represents the maximum tolerable error in classifying the values in a neural network. The efficiency of the network is optimum for more termination rate, better is the performance of the neural network. The figure 4 shows the graphical representation of analysis with respect to Termination Error Rate v/s Neural Network Efficiency which shows the network is optimum when termination error is set to 0.00001.

IV. RESULTS

In this approach, the network is trained on 140 samples from which 8 samples are alterneria, 26 samples are BBD and 89 samples are Anthractnose are used for training and testing. The Below table 3 shows the recognition rate for diseases by setting the parameters as specified in table 4.

Diseases	Recognized Samples	Misclassified samples	Recognition Rate (%)
Alterneria	6	2	75
BBD	21	5	80.76
Anthractnose	86	3	96

Table 3: Recognition rate of the diseases with uniform background

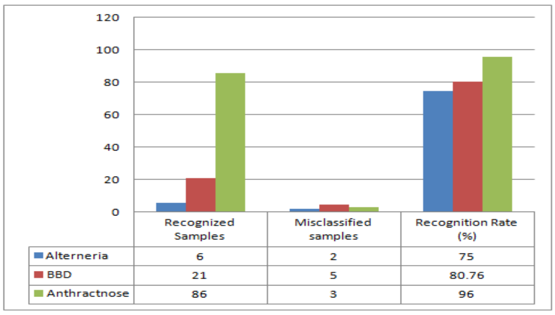

Figure 5.2.1: Recognition rate of the diseases with uniform background

Structure of Neural Network for proposed approach

Number of Input Neurons	168
Number of output Neurons	4
Hidden Layers	50
Iterations	4500
Termination Error Rate (ms)	.00001
Gradient	0.02
Recognition Rate of Neural Network (%)	91

Table 4: Neural Network Design

From the above conducted analysis the table 4 clearly shows that the performance of neural network is not only depending upon the number features; number of hidden neurons and the termination error rate but also depends on the quality of sample image. Hence an optimization must be tested with number of feature values, number of hidden neurons and the termination error rate in various different input conditions in order to correctly classify samples to their corresponding classes. The system performance can be evaluated based on its ability to correctly classify samples to their corresponding classes. Hence the above shown experimental analysis shows that the efficiency of the network is better when number of features are 168 for an image, number of hidden neurons are 50, termination error rate is .00001 and images with uniform background in light environment with minimum distance of 1 or 2 feet between the input image and the camera.

V. CONCLUSION

In this project work the area of plant diseases recognition is introduced. The system developed here is for plant diseases recognition, the development of good classification methods and precise features is very important in order to run the system in real time. Therefore proposed approach which is based on Gabor filter for feature extraction and ANN classifier for classification got a better results and recognition rate up to 91%.

An ANN based classifier is adopted which uses the combination of color and texture features to recognize and classify different plant diseases. The results are encouraging and promise the development of a good machine vision system in the area of recognition and classification of plant diseases. The proposed approach can significantly support in recognizing normal and affected produce.

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