Cotton Leaf Disease Detection Using Texture and Gradient Features

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***Abstract:** The detection of cotton leaf disease is a very important factor to prevent serious outbreak. Most cotton diseases are caused by fungi, bacteria, and insects. A new method is proposed for careful detection of diseases and timely handling to prevent the crops from heavy losses. A disease due to bacteria, insects and fungus occurs in the cotton leaves in the range of about 80-95%. In the proposed work, first the group of infected leaves and normal leaves are collected and the image preprocessing is done using Adaptive histogram equalization for enhancing the contrast. In feature extraction phase, texture and gradient feature are extracted using Local Binary Pattern (LBP), Histogram of Oriented Gradient (HOG) and Differential of Gaussian (DOG). K- Nearest neighbor classifier is applied to classify the leaf image as a unaffected or an affected leaf. A cotton leaf database is internally created to evaluate the efficacy of our algorithm. The validate results show that the proposed method achieved higher classification accuracy in lower computational time.*

***Keywords:** cotton leaf diseases, adaptive histogram, Texture feature, Gradient feature, KNN classifier.*

I. INTRODUCTION

The Cash crop in India is the cotton crop which plays major role. It is also known as "White Gold" or "The King of fibers". India is a 2nd largest cotton producing country in the world. In India, cotton is cultivated in around 9 states. Cotton is highly cultivated in Tamilnadu, Orissa, Karnataka, Andhra Pradesh, Punjab, Haryana, and Maharashtra. Cotton harvesting starts in July in the southern states and may extended to November in the north and will be ready to harvest over time for about 6weeks. The proposed work gives the brief description of the method used for leaf disease identification. It is not possible to manually identify the disease status of each and every cotton leaves. Thus the image processing based disease detection on cotton leaves is developed which is very simple and accurate. To widen the life time of the cotton leaves, it is necessary thing to perceive the cotton leaf disease in bud stage. From the literature survey, it may be noted that various image processing based leaf disease detection methods have been developed. But it could not provide higher accuracy and the computational time is also high. To solve these issues, the proposed work implements simple machine learning approach which yields higher accuracy and less computational time. There are three types of cotton leaf diseases viz., bacterial disease, fungal diseases, and diseases due to insects. A dots like in a leaf immersed in water are surrounded by the root of the leaf veins and gives a look in raw bounding. When these regions grow and grow in size, the color changes in to black. leaves drop from the plant. Also they fall from the plant. This phase is called s blackarm stage. The blackarm is indicated as

(a) (b) (c)

Fig.1 (a) Bacterial cotton leaf images (b) Fungal cotton leaf images (c) Insect cotton leaf images

the stem is stunted. The defected portion is noticed on bolls and when it is larger and changes to brown color. **Fig.1** shows three different types of cotton leaf diseases. Fig. 1 (a) shows cotton leaf with bacteria disease. These kind of leaf consists of brown patches, in turn develops circular pattern. When the wet condition dries out, it drops out from the plant. Fig. 1 (b) shows the fungal affected cotton leaf images. The leaves are inferred with minimal size insects below the leaves and usually in yellow color and sometimes pink in color. The color depends on the type of the plant. Fig. 1 (c) shows the insect affected cotton leaf diseased images.

II. RELATED WORKS

In the recent research, lot of methods has been developed for image processing based leaf disease detection. Chandrakant and D Kokane et.al [1] proposed a pattern recognition technique for disease detection. In this work, the author discussed about the classification of diseased cotton leaf images based on Error Back propagation neural network. The training involves the derivation of seven invariant moments and the experimental value in terms of average accuracy is found to be 85.52 percent. Vijay S.bhong et.al [2] proposed a Euclidean distance based K-means clustering approach for detecting the disease on the cotton leaves. This method attains almost 89.56% of accuracy. The k-means clustering algorithm initially segments the objects and classified the segmented parts K no. of classes. Naik D Manikra et.al [3] provided the comparative study of ANN (Artificial Neural Network) and SVM

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(Support Vector Machine). In this work, the author included segmentation algorithm as K-means clustering technique. Finally the features are extracted and the trained neural network is used to recognize the particular disease. The experimental results showed the accuracy as 94%. Sushma S.patil et.al [4] also proposed combined SVM and K-mean clustering algorithm. In this work, they used the mobile captured image. Initially the image was pre-processed and then the edges are detected. Finally K-means clustering algorithm segments the image and SVM identify the type of disease occurred in a leaf. Reena Tigare et al., [5] proposed an Artificial Neural Network (ANN) classifiers based approach in which the texture features are selected using LBP. The experimental results shows that the developed classifier yields better accuracy of 80%.

III. PROPOSED METHODOLOGY

The various process involved in the recognition of disease in leaves are depicted in Fig2.

Initially the various datasets of leaf are unruffled and grouped in different category for further processes. Then in pre-processing step, the adaptive histogram equalization is used to normalize the intensity of the image. Then different features such as texture features and gradient feature are extracted for classification. Then the K-NN (K-Nearest Neighbor) classifier classifies the leaf as affected or unaffected leaves based on the extracted features.

A. Pre-Processing

Preprocessing is mainly used to reduce the noises present in an image and improve the original quality of the image. In this proposed work, adaptive histogram equalization is used as preprocessing.

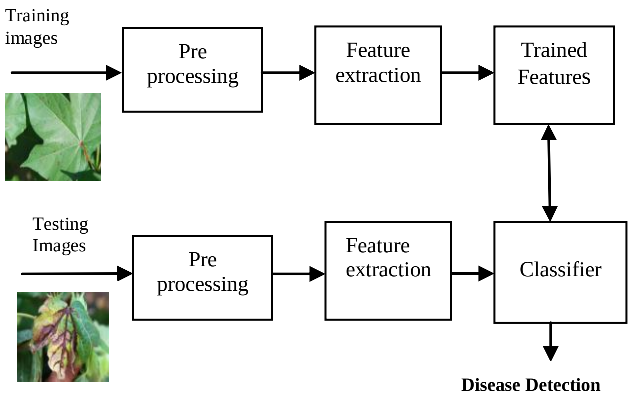

Fig.2. Overall illustration of proposed methodology

- ***Adaptive histogram equalization (AHE)*** Adaptive histogram equalization (AHE) [6] is a very simple method used in image processing techniques for enhancing the contrast of the images. The way in which it differs from the normal histogram method is that , adaptive method estimates the prominent section of the image in terms of histogram bins. Based on the gray level distribution, it rearrange the lightness values of the image. **Fig.3** shows the output of adaptive histogram equalization of the input cotton leaf image.
- ***Differential of Gaussian*** Difference of Gaussians (DoG) [7] is one of the feature extraction technique. It estimates the blurred version of the original image and removes the same from the another. In order to reproduce the blurred images from the gray scale images, the gray scale images are convolved with Gaussian kernels having contrary standard deviations. **Fig.4** shows the output of Differential of Gaussian (DoG) method for the given input cotton leaf Image. When Laplace is to estimated, the image is sharpened by convolving the image with the Gaussian kernel of assured girth.

The Gaussian convolutional kernel for DoG is shown in equation 1.

$$G_{\sigma 1}(x,y)=\frac{1}{\sqrt{2\pi\sigma_1^{\,2}}}\exp\left(-\frac{x^2+y^2}{2\sigma_1^{\,2}}\right) \qquad (1)$$

The DoG as an operator or convolution kernel is shown in equation 2.

$$DoG\overset{\Delta}{=}G_{\sigma 1}-G_{\sigma 2}=\frac{1}{\sqrt{2\pi}}\left(\frac{1}{\sigma_1}e^{-\left(\frac{x^2+y^2}{2\sigma_1^{\,2}}\right)}-\frac{1}{\sigma_2}e^{-\left(\frac{x^2+y^2}{2\sigma_2^{\,2}}\right)}\right) \qquad (2)$$

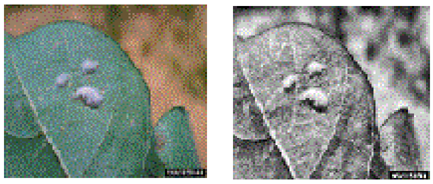

Fig.3 Result of Adaptive Histogram equalization of Cotton Leaf Images

Fig.4. Result of Differential of Gaussian (DoG) Cotton Leaf Images

B. Feature extraction

The foremost features are derived from the input images and given as input to the classifier for classification purpose. Various methods are available in feature methods. Some of the most important methods are feature extraction depending on intensity, feature extraction depending on texture and shape based feature extraction. In the proposed work, texture based feature extraction called Local Binary Pattern and feature extraction based on gradient values called Histogram of Gradient (HoG) is used.

- ***Local Binary Pattern*** [8] is an operative parameter based on texture. The method defines a thresholding value and points the label by comparing with the nearby pixel and produces the value as a binary number. This algorithm is suitable for two dimensional images for texture feature analysis. The comparison is between the present pixel with the nearby pixel to produce local structure. Define a centre pixel and compare it with the neighbourhood pixel based on the threshold value. The first LBP operator is a fixed 3x3 neighborhood which is shown in **Fig. 5.** The output of LBP of input cotton leaf images is shown in **Fig.6.**

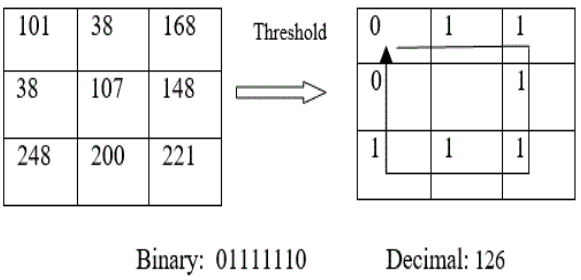

Fig.5. Computation of LBP texture value

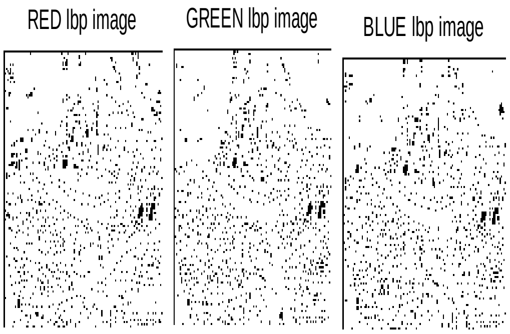

Fig.6. Result of the LBP in Cotton Leaf Images

- ***Histogram of oriented gradient (HoG)*** The histogram of oriented gradients (HoG**)** [9] is used for object detection in image processing applications based on the features. This method is based on the gradient location. So this counts the incident of the gradient reference points. HoG is compared to edge orientation histograms, scale invariant feature transform descriptor, and shape contexts. Normally the difference is the calculation of grouped grid in the equally distributed cells and also depends on the enhancement in the contrast regions.Due to this, accuracy is improved.

IV. CLASSIFICATION

In the proposed work, K-NN classifier [3] is used to classify the cotton leaf images into affected or unaffected leaves. K nearest neighbors is used for classification purpose. The algorithm uses a new parameter called as similarity measure which is defined based on the distance functions. The classifier is used for mathematical analysis. From the features that are extracted, the classifier classifies the input test image as affected or unaffected images. If it is affected images, it is classified as bacterial affected or fungal affected or insect affected leaves.

V. EXPERIMENTAL RESULTS

A. Database Collection

The cotton leaf images are collected through the internet. Totally 185 images are collected in which 50 images are unaffected leaves and remaining 135 images are disease affected leaves. In the collected 135 diseased leaves, 35 leaf images belong to bacterial disease, 50 leaf images belong to fungal disease and 50 leaf images are insect caused diseases.

B. Results and Discussion

In KNN, the value of k varies from 1 to 5. By varying the value of k, KNN classifier achieves different accuracy values.

The accuracy of the proposed KNN classifier for different values of k is summarized in **table1** and is shown in **Fig.7**. From this figure, it is noted that the KNN attains maximum accuracy of 99.6% for small k value (k=1). The accuracy of proposed method for different number of test images are tabulated in **table 2** and the corresponding comparison is shown in **Fig.8.** From this comparison, it is concluded that the proposed method shows its potential for classifying cotton leaf images as its yield 100% of accuracy for different sets of test images

Table. I. Recognition accuracy

S.NO	K value	Accuracy of KNN (%)
1.	K=1	99.6
2.	K=2	98.4
3.	K=3	80.2
4.	K=4	67.2
5.	K=5	68

Table II. Detection rate (%) of the proposed method for various training and testing value

S.No	Test images	Accuracy (%)	Time consumption (in sec)
1.	72	100	8.04
2.	72	100	8.02
3.	107	100	8.11

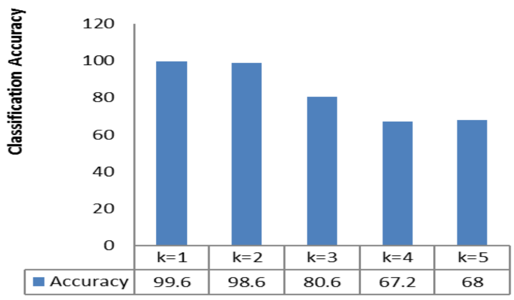

Fig.7. Graphical representation of accuracy for various K values

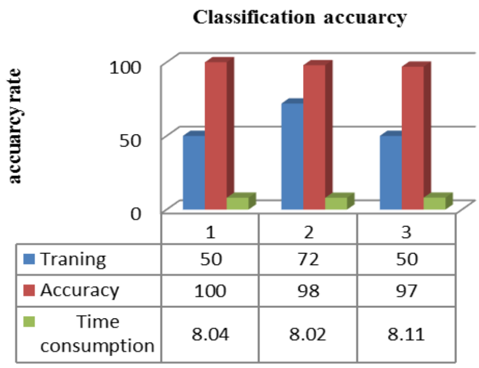

Fig.8. Detection rate (%) of the proposed method for various training and testing set

VI. CONCLUSION

The detection of cotton leaf disease is very important factor which prevents the heavy production loss.

This paper presented an image processing based approach for accurate detection of cotton leaf diseases. For this project implementation, the cotton leaf images (with and without disease attack) are internally collected from the website. Firstly, the images are preprocessed using adaptive histogram equalization. For normalization, difference of Gaussian (DoG) algorithm is applied on equalized image. More discriminative gradient and texture feature have been extracted using LBP and HoG algorithm respectively. Finally, KNN classifier is applied to detect the cotton leaf diseases accurately. So from the experimental result, our algorithm achieves 100% classification accuracy for 50 training images in a very lower computational time (T= 8.04 seconds). In future large set of database can be used to validate the efficiency of our algorithm. This project can be very helpful to farmers to increase the cotton production.

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