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Research Article

DISEASED LEAF DETECTION USING K-MEAN CLUSTERING AND TEXTURE FEATURES

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ABSTRACT

The main objective of our study was aimed at quantifying the severity of disease symptoms Cercospora, Anthracnose and *Alternaria alternata* in *Dalbergia sisso*, *Luffa actangula* and *Solanum melongena* leaves. The first step of the proposed algorithm was the capture of the diseased region using digital camera followed by pre-processing stage to remove the unwanted background, noise and poor resolution of image. K- mean clustering algorithm was then applied to divide the image into respective clusters followed by extraction of number of color and texture features using Gray Level Co-occurrence Matrices (GLCMs). These parameters were finally fed to Back Propagation Neural Network (BPNN), which contain a hidden layer between the input and output images which performs the final classification.

INTRODUCTION

The present work has been carried out for the automatic disease detection of plant leaf of *Dalbergia sisso* (Sisam), *Luffa actangula* (Ridge gourd) and *Solanum melongena* (Egg plant) using image processing techniques.

Dalbergia sisso Roxb. is an important timber species with high medicinal value. The leaves possess antibacterial, antiprotozoal and anti-inflammatory activity. It also contains Isoflavone which is used as chemotherapeutic cancer preventive agent (Bhattacharya *et al*., 2014). The leaves of *D. sisso* is affected by various diseases out of which Cercospora leaf spot is of major importance. Symptoms include small to large size light grey spots surrounded by irregular dark brown zonate margin with numerous production of brown to black dot like structures on the upper surface of the leaves (Banerjee *et al*., 2017)

Luffa actangula (L.) Roxb. is one of the important vegetable crop. The leaf gets affected by fungus Anthracnose and disease symptoms appear as small circular, light brown spots which gradually enlarges and turns dark brown with grayish white centre resulting in yellowing and blightening of entire leaf (Bhatt, 2007).

Solanum melongena L. is considered as one of the common vegetable crop grown in india and throughout the world. Due to environmental changes the crops get severely affected and characteristics leaf spot symptoms caused by fungus *Alternaria alternata* occurs. The disease produces small, circular brown spots with purple halo appears on the leaves. The centre gradually turns grey and cracked with enlargement in size resulting in defoliation of leaves.

Basic Steps for Disease Detection

The following are the steps for plant leaf disease detection and classification using image processing:

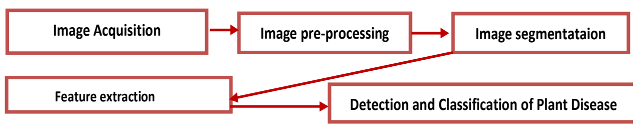

Figure 1 Block diagram for basic steps in image analysis

Image Acquisition

Image acquisition involves capturing the image either as entire region or as a fraction region depending on the analysis. Our

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study focussed on the diseased images of leaf of *Dalbergia sisso*, *Luffa actangula* and *Solanum melongena* which were stored in digital media for further MATLAB operations.

Image Pre- Processing

Image Pre- processing is carried out to improve the quality of the image and remove the unwanted noise in image followed by clipping and smoothing of the image. The image enhancement is carried out to increase the contrast (Khirade and Patil, 2015). The RGB images are converted into grey images using colour conversion by the following formula:

F(x) = 0.2989*R + 0.5870*B + 0.114*B

Then histogram equalization is applied to increase its quality prior to clustering process (Thangadurai and Padmavathi, 2014and Anand and Aravinth, 2016).

Image Segmentation

This method is used for the conversion of digital image into various segments having some similarity. Image segmentation helps in the detection of objects and boundary line of the image. In our study K- mean clustering is done for classification of objects based on a set of features into K number of classes. The classification is done by minimizing sum of squares of distance between data objects and mapping to corresponding clusters centroid (Khirade and Patil, 2015 and Anand and Aravinth, 2016).

$$J = \sum_{p=1}^{k} \sum_{q=1}^{n} \| a_{(p)} - c_{(p)} \|^2$$

Where, j= objective function, p= number of clusters, q= number of cases, a= case q, c= centroid for cluster p.

Feature Extraction

During feature extraction phase a Gray Level Co-occurrence Matrices (GLCMs) is created from the image using the graycomatrix() function of MATLAB. GLCM is created by calculating how often a pixel with gray-level (grayscale intensity) value i occurs horizontally adjacent to a pixel with the value j. Each element (i, j) in GLCMs specifies the number of times that the pixel with value i occurred horizontally adjacent to a pixel with value j.

Now statistical properties i.e. Contrast, Correlation, Energy and Homogeneity of the gray-level co-occurrence matrix are calculated using graycoprops() function.

Contrast

It returns a measure of the intensity contrast between a pixel and its neighbor over the whole image.

Range = [0 (size(GLCM,1)-1)^2]
Contrast is 0 for a constant image.

The property Contrast is also known as *variance* and *inertia*.
Mathematically:

$$\sum_{i,j} |i-j|^2 p(i,j)$$

Correlation

It returns a measure of how correlated a pixel is to its neighbor over the whole image.
Range = [-1 1]

Correlation is 1 or -1 for a perfectly positively or negatively correlated image. Correlation is not a number for a constant image.
Mathematically:

$$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j}$$

Energy

It returns the sum of squared elements in the GLCM.
Range = [0 1]
Energy is 1 for a constant image.
The property Energy is also known as *uniformity*, *uniformity of energy*, and *angular second moment*.
Mathematically:

$$\sum_{i,j} p(i,j)^2$$

Homogeneity

It returns a value that measures the closeness of the distribution of elements in the GLCM to the GLCM diagonal.
Range = [0 1]
Homogeneity is 1 for a diagonal GLCM.
Mathematically:

$$\sum_{i,j} \frac{p(i,j)}{1+|i-j|}$$

Other statistical properties i.e., Mean, standard deviation, skewness and kurtosis are based on geometrical moments of patches of images. Being homogeneous ratios, and generally centered, skewness and kurtosis have the advantage of being invariant to affine luminance changes in images.

These calculated statistical properties construct the test features which will be used for detection and classification of plant disease.

The MATLAB code for Classification is based on MULTISVM (3.0) proposed by (Mishra, 2015) that classifies the class of given training vector according to the given group and gives us result that which class it belongs.

Classification

Classification is used in the interpretation of the extracted diseased region in an image which helps in the identification of the type of disease infection in leaves. In our analysis back propagation neural network (BPNN) is used which build association between known pattern of input and specific output. The input layer analyzes the diseased region while the output layer specifies the disease outcome of the affected region. A hidden layer occurs in between the input and output layer which provides connecting link between the input and output images. It is applied to obtain least error in the classification of disease of the affected region (Prabha and Kumar, 2014).

RESULTS

The results of the leaf disease detection are as follows

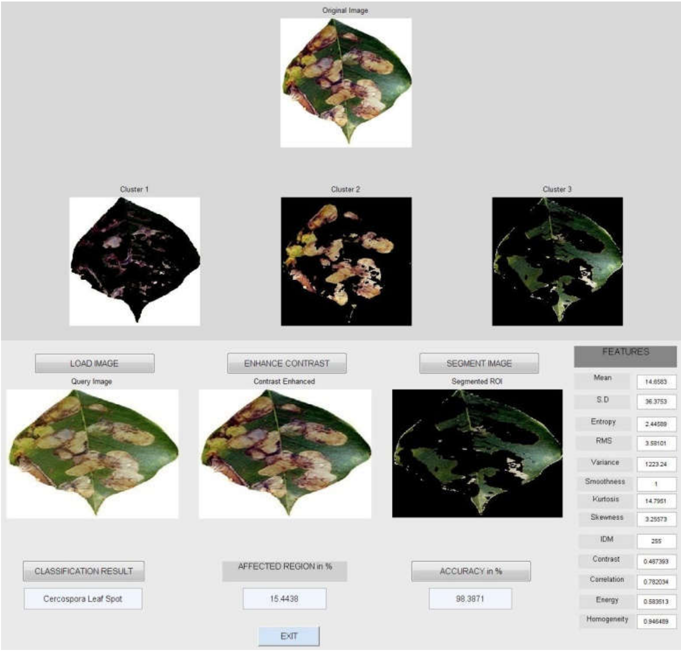


Figure 2 System shows leaf disease detection of *D. sisso* using digital image processing techniques

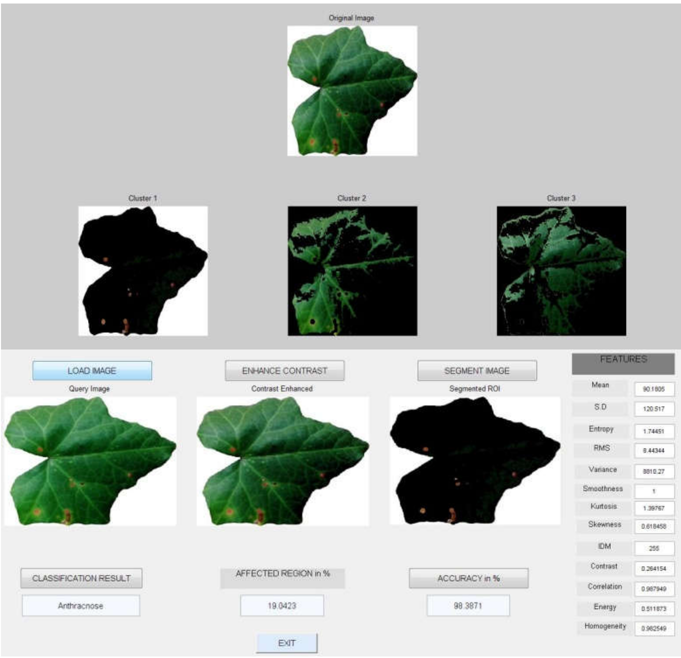
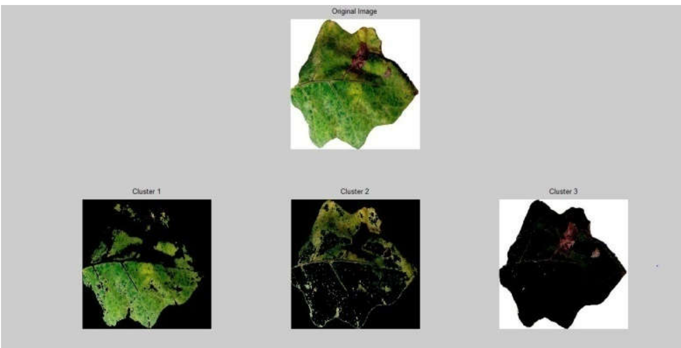


Figure 3 System shows leaf disease detection of *L. actangula* using digital image processing techniques



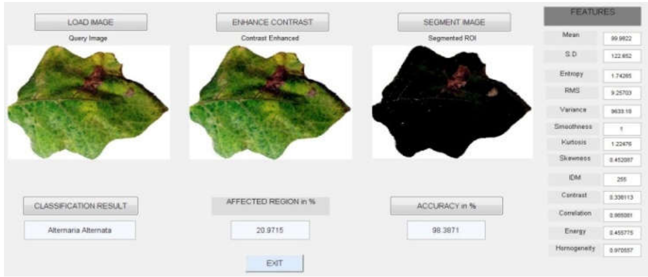


Figure 4 System shows leaf disease detection of *S. melongena* using digital image processing techniques

CONCLUSION

The present study deals with quantifying the severity of disease symptoms of the Cercospora, Anthracnose and *Alternaria alternata* in *Dalbergia sisso*, *Luffa actangula* and *Solanum melongena* leaves using image processing techniques. The basic steps involves image acquisition, image preprocessing, image segmentation, feature extraction and classification. Development of automatic detection system using advanced computer technology such as image processing helps in the proper identification of diseases at an early or initial stage and provide useful information for the prevention of disease in advance. We would like to extend our further work on other plant parts such as root, stem, fruits etc.

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