Adaptive Neuro-Fuzzy Inference System for Recognition of Cotton Leaf Diseases

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***Abstract*—Image processing fascinated the many researchers in the area of pattern recognition and the image processing techniques are interminably applied to agricultural science, and it has great perspective, particularly in the plant protection field, which ultimately leads to the crop management. The purpose of this notion is to develop and to evaluate Adaptive Neuro-fuzzy Inference System as the methodology to recognize the cotton leaf's diseases. This project presents automatic system for classification of three cotton leaf's diseases namely Bacterial Blight, Myrothecium and Alternaria. The k-means algorithm is used for segmentation of images and Color Layout Descriptors is used to extract as features to train the Adaptive Fuzzy Inference System, which is applied to trace out the leaf spots from the of plant leaves, which assists in diagnosing the cotton leaf spot diseases accurately.**

***Keywords*— Cotton leaf diseases, Color Layout Descriptors (CLD), k-means clustering, Image segmentation, Zigzag coefficient, Image classification.**

I. INTRODUCTION

The plants existence is pervasive on the earth and in the environment where we live and also including the places beyond our reach. Plants contribute a lot for the human development by providing, breathable air, food, fuel, medicine etc. Plants also help to regulate the climate, provide habitats, food, and a natural way to regulate flooding. Now a day, it is highly desirable to maintain proper databases to keep track of different diseases of plants' leaves because many plants are on the verge of extinction. Automatic plant leaf's diseases identification is also of great interest to public because it gives a direction to common person's curiosity. Particularly in countries like India have diverse salutary plant species but proper databases and software are unavailable for automatic recognition of plant leaf's diseases useful for educational purposes as well as for curing deadly diseases [1].

The Indian agriculture area is also considered as the main source of income and rural livelihood. The cotton crop has crucial impact on our nation's economy, so cultivating the healthy cotton in the fruitful environment also plays the important role. The cotton has been contributing more than 14% to the industrial production, 4% to the Global Domestic Product, and more than 14 % to the earnings of our nation's export as per the data of 2011. To revive the productivity and quality of the cotton, our nation embarked the plan called 'technology mission' on cotton in 2000 [2].

The cotton plants are affected by many diseases that can rapidly impact on the productivity and the standard of crop. Normally, the cotton leaves' diseases are detected and diagnosed by the farmers' naked eye observation with high perception and it may lead to the wrong and inaccurate diagnosis as the farmers identify symptoms by their perspectives and perception. This may also lead to the useless and more use of the expensive pesticides. Hence, the automatic detection of the diseases is significant which will assist in premature and precise identification of the cotton leaf's diseases. This notion is the automatic disease detection and identification of the cotton leaf's diseases using adaptive neuro fuzzy inference system, in this once the disease affected leaf's image is given as an input, the system will process the image and classify the image for namely three diseases such as Myrothesium, Bacteria blight, or Alternaria[2]. The observation of the human eye is not so strong that the infected part of image that minute variation pattern of color can be a different disease present on the leaf of cotton[2] . This type project can exactly differentiate the color present on these leaves and database-stored image features, related to the color using adaptive neuro-fuzzy inference system as methodology to identify the leaf diseases on cotton depending upon that difference and further comparisons.

II. DISEASES OF THE COTTON LEAF

i. Bacterial Blight

Figure1. Bacterial Blight

Disease affecting the cotton plant resulting from infection by Xanthomonas citri pathovar malvacearum. It is the most significant bacterial disease of cotton which infects all aerial parts of the host. The different cultivars given that loss due to this disease were estimated for about 10 to 30%. Initially many minute water soaked angular spots scattered on the ventral surface of leaves appeared in Bacteria Blight disease as shown in the figure1. These spots turn brown and then converted into black dead lesions on both sides of the leaf; and The spots on the infected leaves may spread along the major veins of the leaf and turn them brown or black [2]. This symptom is called as “Black vein”.

ii. Myrothecium

Figure2. Myrothecium

This leaf spot is caused by Myrothecium roridum Tode ex Fr. was observed on cotton fields in Maranhao State, Brazil, causing crop reduction of up to 60%. Disease indications are lesions with concentric necrotic rings, with salient structures (sporodochia) irregularly distributed [3]. Initially circular to semicircular light brown to tan colored spots appear, having violet to reddish brown borders. Shield shaped small fruiting bodies are developed in the central part of the disease’s spot. When the center gets dry holes appear in the leaves, eventually the leaves fall [2].

iii. Alternaria

Figure3. Alternaria

Alternaria leaf spot is primarily a leaf’s disease but symptoms may also develop on cotyledons and bolls. Infection is favored by wet weather and temperature of about 27^{o}C. Plants are most susceptible at the seedling stage and late in the season when the crop begins. Symptom’s development is favored by any physiological or nutritional stress. To control or minimize leaf‘s spot problems, destroy residues from previous crops prior to planting. Older spots may combine generating irregular dead areas. Alternaria leaf’s spot may be confounded with those of bacterial blight which are angular in shape. Under favorable conditions the disease is most severe on lower leaves and least acute on upper leaves, unless leaves are affected by premature senescence [4]. Initially small circular brown, grey-brown to tan colored spots of size varying from 1-10mm appear on leaves. In the later stages, these spots enlarge and concentric rings and cracked centre widens. Severe infection leads drying and falling of leaves [2].

III. LITERATURE SURVEY

The k-means clustering algorithm is used for segmentation of different plants' leaves to identify the diseases affected to them, the leaves of plants such as Rice, Cotton, Sugarcane and Grape and Apple etc. The automatic system for recognition and classification of plants' diseases was projected before using k-means clustering method for segmentation and back propagation algorithm for classification to obtain the expected efficiency. The system for recognition of Ramularia disease, Bacterial Blight, Ascochyta Blight on cotton crop was developed in which input image is divided in various color channels like R, G, B, H, S, V, I3a, I3b, and grey levels then DWT is applied to each color channel and the wavelet energy is calculated for each sub-band and compose the feature vectors [2].

Using edge features and RGB pixel counting features the detection and classification of grey mildew, bacterial leaf blight, leaf curl, alternaria leaf's diseases on cotton was performed. An image recognition system for identification of diseases like Rice blast, Ricesheath blight and Brown spot in paddy fields of Sri Lanka was proposed in which Sobel method is used to detect the edges of the image and Texture, shape and color feature disease spot are extracted which are used for classification and accuracy of the system was 80% for Rice blast, 60% for Rice sheath blight and 85% for Brown spot. The color and texture features of diseased apple leaf were extracted. The Kernel Principal Component Analysis (KPCA) based trait selection is carried out to identify the best characteristics. The classification model based KPCA and GA-SVM has found to have higher classification efficiency than the model based on PCA and GA-SVM [2].

A proliferation of literature is available in plant leaf's disease detection and some of the key contributions of k-means clustering are highlighted. In Cercospora Leaf Spot (CLS) rater the goal of Codebook Generation Module (CGM) is to model the representative colors in three different types of regions. In CGM, the diverse sets of superpixels into each of the three regions is manually labeled, to which k-means clustering is applied independently for generating the codewords of these three regions. In Rating Estimation Module (REM), superpixels are extracted from a set of images at four scales, where at each scale a novel feature representation is used to describe both the local and global image characteristics. Features at all scales are then fused and a regressor is earned from the selected features and the k-means clustering will extract codewords of each category for an Automated System for Plant-level Disease Rating in Real Fields [5].

An example shown [6] while developing an Automated System for Plant-level Disease Rating in Real Fields that, k-means clustering is used to detect citrus anthracnose disease infected a citrus leaf; and basic clustering k-means algorithm is used for segmentation in textured images creating device independent color space conversion in which coordinates used to specify the color. The k-means clustering algorithm used to classify pixels based on a set of features. The classification achieved by minimizes the sum of squares of distances of the objects and the corresponding cluster. However, k- means clustering is used to separate the leaf image into different clusters if a leaf contains more than one disease and the suitable color group numbers lead to the better color extraction.

IV. PROPOSED SYSTEM

i. *Overview of the proposed system*

An estimated seventy percent of Indian economy depends on agriculture. Since there is increasing Indian population, which is more and more dependent on the agricultural yield, production of the crops must be improved. In order to raise more, the diseases must be investigated well before. Diseases are analyzed using different image processing techniques and one such technique is projected here.

The proposed agenda is implemented in three phases. First, image segmentation is done using k-means clustering to identify the diseased region area. In the next step using feature extraction techniques, the Color Layout Descriptor (CLD) is used to extract the features from segmented regions. The classification of disease affected type is performed based on these color features.

ii. *Challenges of the proposed system*

The critical concern is how to extract the discriminative and firm features for classification of test image. It is found that k-means clustering is used for segmentation of images and Color Layout Descriptors to extract the features to train the Adaptive-Neuro Fuzzy Inference System [2] and introduced into cotton leaf's disease classification. Now challenge is to differentiate the diseased and non diseased images of the cotton leaf; and discrimination of features with efficiency and accuracy are most important.

Image detection has attracted many researchers in the area of pattern recognition, analogous flow of ideas are applied to the field of pattern recognition of plants' leaves, that is used in diagnosing the cotton leaves' diseases; and there are abundant methods have been proposed in the last two decades, which are not fully solved [7].

There are two main important traits of plant's disease detection machine-learning methods that must be maintained, they are: speed and accuracy.

V. IMPLEMENTATION

i. Work Process of the System

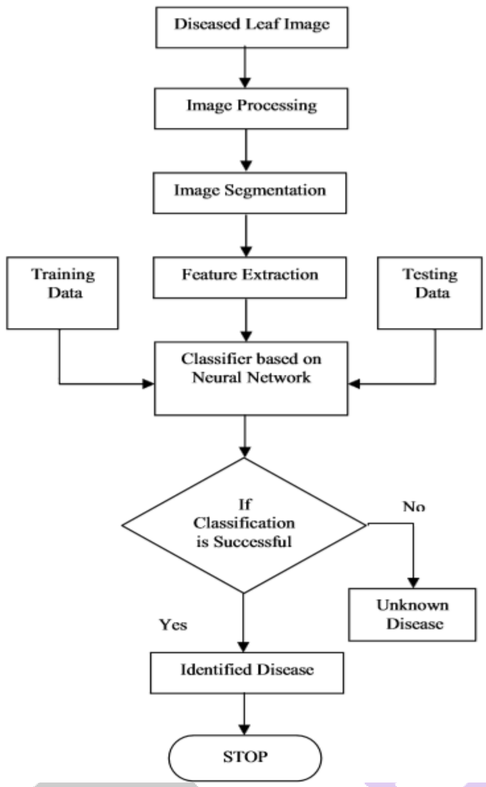

Figure 4. Proposed approach's flowchart

ii. Image Enhancement

The acquired images are enhanced by using unsharp filter, by subtracting an unsharp version of an image from the original image; it enhances edges (and other high frequency components in an image [2]. The method is as shown below.

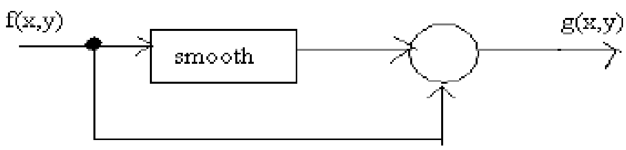

Figure5. Image augmentation using unsharp filter

The unsharp filter is created from the negative of the Laplacian filter with parameter alpha and the selected value for alpha is 0.2, by the function 'fspecial'. These images are segmented using K-means Method [2].

iii. Image Segmentation

The k-means algorithm is an algorithm to cluster n objects based on the attributes into k partitions where k less than n. An algorithm for clustering N data points into k disjoint subsets/clusters , S_j containing data points so as to minimize sum-of-squares error criterion, and is defined as follows,

$$J = \sum_{j=1}^{K} \sum_{n \in S_j} |x_n - \mu_j|^2$$

Where J is the sum of square –error for all objects in the database, x_n is a vector representing the the n^{th} data point (object) and μ_j is the mean of the data points in S_j. Basically speaking k-means clustering is an algorithm to classify or to group the objects based on attributes/features into k number of group.

The k is positive integer number. The grouping is done by minimizing the sum of squares of distances between the corresponding cluster's centroid and data. The k-means clustering is used to partition the input image into three clusters. It is used to minimize the sqEuclidean distance between point and centroid of a cluster. The empty clusters are removed by using parameters ‘emptyaction’ and ‘drop’. The maximum numbers of iterations are set to default value of one hundred. Then k-means ssegmentation is performed to isolate disease spot using Radial Basis Function (RBF) kernel [2].

iv. Feature Extraction

The Color Layout Descriptor is extremely compact and resolution invariant representation of color. The spatial distribution of colors is efficiently represented by Color Layout Descriptor and therefore CLD is used for a wide variety of similarity-based retrieval. The extraction process of color descriptor consists of four stages: Image partitioning, Representative color selection, DCT transformation and Zigzag scanning [2].

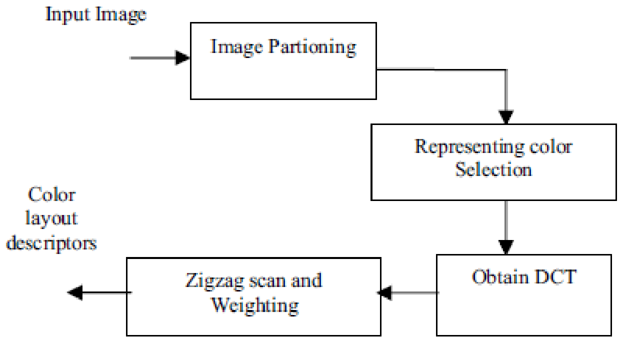

Figure 6. Feature extraction

In the image partitioning stage, the input picture in RGB color space is divided into 64 blocks. Then the average of the pixel color in the block is chosen as the representative color for that block. The color space conversion is applied to convert the resultant image of size 8×8 to from RGB to YcbCr color space. Next the three sets of 64 coefficient for luminenceY, crominance for blue and red color each are obtained by applying 8×8 DCT. The result is three matrices of size 8×8 representing 64 coefficients for Discrete Cosine Transform Y, Discrete Cosine Transforms Cb, and Discrete Cosine Transforms Cr. A zigzag scanning is performed with these three sets of 64 DCT coefficients and low frequency coefficients of the 8x8 matrix are grouped, these three set of zigzag scanned matrices correspond to the color layout descriptor of the input image [2].

v.Classification

Adaptive Neuro-Fuzzy Inference System is used for classification. It combines the principles of neural network and fuzzy logic; therefore it provides advantages of both in a single structure. The gradient decent method is used to update the premise parameters which define membership function and consequent parameters are identified by using least square method. It has a network consisting of nodes and directional links. Since, the nodes have the parameters which can affect the output of nodes it is referred as adaptive network. The architecture of ANFIS is shown in Figure7.

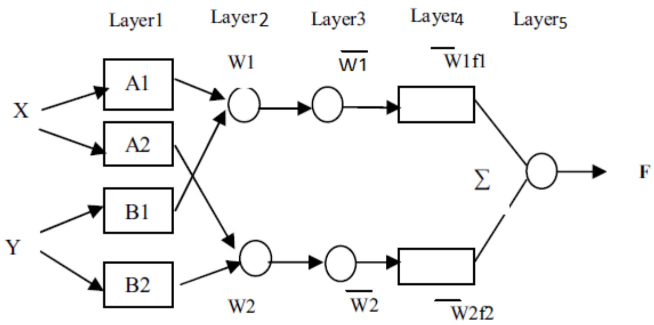

Figure7. ANFIS architecture

The circular nodes are fixed while the square nodes have parameters to learn.

Layer1: Output of each node.

Layer2: Every node in this layer is fixed. The t-norm is used to ‘AND’ the membership grades.

Layer3: This layer contains the fixed nodes. These nodes calculate the ratio of the firing strengths of the rules.

Layer4: This layer consists of the adaptive nodes that execute the consequent part of the rules.

Layer5: It consists of a single node that determines the overall output/ class of the test image.

The network is trained by using forward and backward pass. In [2] the input vector gets proliferated through the network layer by layer in the forward pass. In the backward pass the error is sent back through the network similar to the backpropagation algorithm. The Sugeno –type fuzzy inference system is used as FIS. The FIS using fuzzy subtractive clustering is generated using genfis2. The combination of least square method and gradient method is applied for training of membership function.

VI. RESULTS AND DISCUSSION

The following steps and snapshots show the actual working scenario and outcomes of this system.

i. ***Myrothecium disease is correctly recognized for the test image is as shown in the below figure8.***

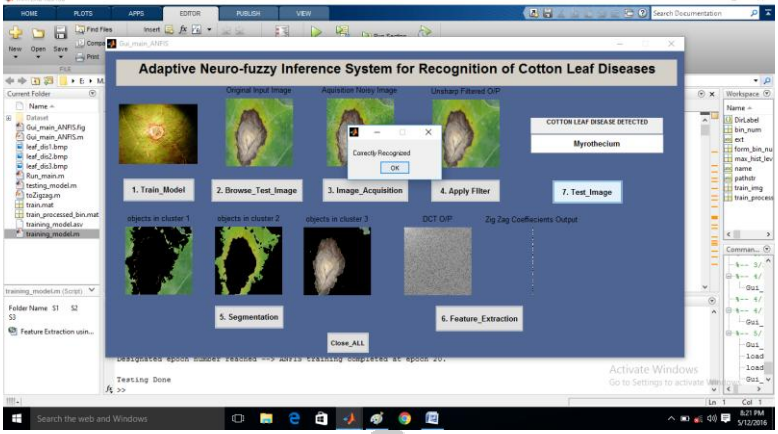

Figure8. Recognition of Myrothecium disease

ii. ***Bacterial Blight disease is correctly recognized for the test image is as shown in the below figure9***

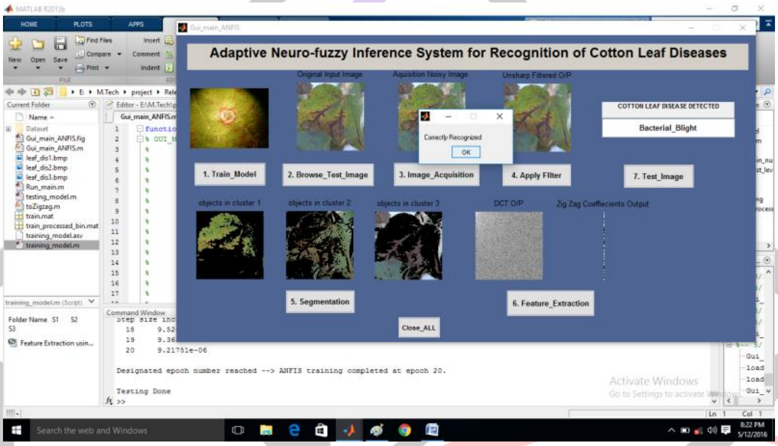

Figure9. Recognition of Bacterial Blight disease

iii. ***Aternaria disease is correctly recognized for the test image is as shown in the below figure10.***

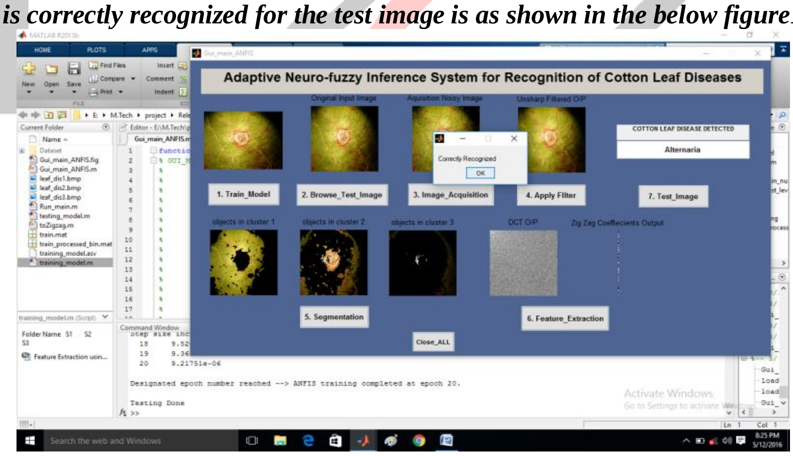

Figure10. Recognition of Aternaria disease

VII. CONCLUSION

The product quality control is essentially required to acquire the more value added products, as many studies show that superiority of agriculture products may be abridged from many diseases. Therefore, to improve the yield and quality of the product of the cotton, the diseases affect to it must be responsibly recognized and reduced. The results which are obtained will show that the successful recognition of cotton leaf's diseases, Bacterial Blight, Myrothecium and Alternaria.

VIII. FUTURE WORK

This fruitful notion can also be used to detect, diagnose and classify the diseases of different plants' leaves. The speed and accuracy of this system can be still improved by using different methods from image processing stage to classification stage of the disease; and by adding more features such as shape and texture etc.; the accuracy of classifier may be improved. Results can be analyzed by checking True Positive, True Negative, False Positive and False Negative output values of classifier.

IX. ACKNOWLEDGMENT

I am very much thankful to Dr. Venkatesh R. Kulkarni, Scientist (Plant pathology), Agriculture Research Station, Dharwad Farm, Karnataka, India, for providing the dataset of disease-affected leaves for mentioned three diseases of cotton needed for the successful completion of this project.

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