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Disease Identification in Cotton Plants Using Spatial FCM & PNN Classifier

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ABSTRACT: Agricultural crops in India are under constant threat of pests affecting their roots as well as leaves. Plant diseases cause significant damage and economic losses in crops. Subsequently, reduction in plant diseases by early diagnosis results in substantial improvement in quality of the product. Enormous cotton crop yield is lost every year, due to rapid infestation by pests and insects. Infected cotton plants can exhibit a variety of symptoms and making diagnosis was extremely difficult. Common symptoms are includes abnormal leaf growth, color distortion, stunted growth, rots and damaged pods. In this paper, we have used spatial FCM & PNN classifier to identify the pest & type of disease in cotton plant. Image acquisition devices are used to acquire images of plantations at regular intervals. These images are then subjected to pre-processing using median filtering technique. The pre-processed leaf images are then segmented using Spatial FCM clustering method. Then the color features(mean, skewness), texture features such as energy, entropy, correlation, contrast, edges are extracted from diseased leaf image using repeated occurrence of gray level configuration in the texture & then compared with normal cotton leaf image. The Probabilistic Neural Network (PNN) method is used to classify the pest & Disease in cotton crop.

KEYWORDS: cotton plant disease; FCM; median filtering; texture features; Probabilistic neural network;

I. INTRODUCTION

Agriculture is one of the most important sources for human sustenance on Earth. Not only does it provides the much necessary food for human existence and consumption but also plays a major vital role in the economy of the country. But Plant diseases have turned into a dilemma as it can cause significant reduction in both quality and quantity of agricultural products. Nowadays farmers are facing many crucial problems for getting better yield cause of rapid change in climate and unexpected level of insects, in order to get better yield need to reduce the level of pest insect. Several millions of dollars are spent worldwide for the safety of crops, agricultural produce and good, healthy yield[1]. It is a matter of concern to safeguard crops from Bio-aggressors such as pests and insects, which otherwise lead to widespread damage and loss of crops. In a country such as India, approximately 18% of crop yield is lost due to pest attacks every year which is valued around 90,000 million rupees[2]. Conventionally, manual pest monitoring techniques, sticky traps, black light traps are being utilized for pest monitoring and detection in farms. Manual pest monitoring techniques are time consuming and subjective to the availability of a human expert to detect the same.

Disease is caused by pathogen which is any agent causing disease. In most of the cases pests or diseases are seen on the leaves or stems of the plant. Therefore identification of plants, leaves, stems and finding out the pest or diseases, percentage of the pest or disease incidence, symptoms of the pest or disease attack, plays a key role in successful cultivation of crops. In general, there are two types of factors which can bring death and destruction to plants; living (biotic) and nonliving (abiotic) agents [3]. Living agent's including insects, bacteria, fungi and viruses. Nonliving agents include extremes of temperature, excess moisture, poor light, insufficient nutrients, and poor soil pH and air pollutants. Here the segmentation technique used is Spatial FCM & the Neural network (NN) is a mathematical form or computational model based on biological neural networks used to extract the leaf feature as of the database.

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II. RELATED WORK

Ananthi.S, Vishnu Varthini.S[1] studied methods of image pre-processing for recognition of crop diseases. They used cucumber powdery mildew, speckle & downy mildews as study samples & reported comparative study of effect of simple filter and median filter. They stated that Leaves with spots must be pre-processed firstly in order to carry out the intelligent diagnosis to crop based on image processing and appropriate features should be extracted on the basic of this.

A prediction approach based on support vector machines [4] for developing weather based prediction models of plant diseases is proposed by Rakesh & Amar. The performance of conventional multiple regression, artificial neural network (back propagation neural network, generalized regression neural network) and support vector machine (SVM) was compared. Stereomicroscopic method and Image analysis [8] method is compared for usefulness of image analysis as an efficient and precise method to measure fruit traits like size, shape dispersal related structures by Mix & Pico. Brendon J. Woodford, Nikola K. Kasabov and C. Howard Wearing in paper titled **"**Fruit Image Advances in Image Processing for Detection of Plant Diseases" proposed wavelet based image processing technique and neural network to develop a method of on line identification of pest damage in pip fruit in orchards. Three pests that are prevalent in orchards were selected as the candidates for this research: the leaf-roller, codling moth, and apple leaf curling midge.

A novel approach [7] is proposed for integrating image analysis technique into diagnostic expert system. A CLASE (Central Lab. of Agricultural Expert System) diagnostic model is used to manage cucumber crop. The expert system finds out the diseases of user observation. In order to diagnose a disorder from a leaf image, four image processing phases are used: enhancement, segmentation, feature extraction and classification .They tested three different disorders such as Leaf miner, Powdery and Downey and this approach has greatly reduced error prone dialogue between system and user. The morphological features of leaves are analysed for plant classification and in the early diagnosis of certain plant diseases.

Stereomicroscopic method and Image analysis method is compared for usefulness of image analysis as an efficient and precise method to measure fruit traits like size, shape dispersal related structures by Mix & Pico. In general fruit length obtained with image analysis was significantly greater than that recorded with a stereomicroscopic. Only fruit length estimates did not differ between the two methods.

A prediction approach based on support vector machines for developing weather based prediction models of plant diseases is proposed by Rakesh & Amar. The performance of conventional multiple regression, artificial neural network (back propagation neural network, generalized regression neural network) and support vector machine (SVM) was compared.

Santanu &Jaya described a software prototype system in paper for disease detection based on the infected images of various rice plants. They used image growing, image segmentation techniques to detect infected parts of the plants. Zooming algorithm is used to extract features of the images .Self Organize Map (SOM) neural network is used for classifying diseased rise images.

III. PROPOSED ALGORITHM

A. Noise Removal using Median filters

Median filters can be used to reduce impulse noise level from corrupted images. Median filters are used to remove the salt-and-pepper noise. The median filter is a simpler nonlinear smoothing operation that takes a median value of the data inside a moving window of finite length. Median filter can be used to evaluate the averaging value of filter.

$$\hat{f}(x,y) = \underset{(s,t)\in S_{xy}}{\text{median}} \{g(s,t)\} \quad (1)$$

The best known order-statistics filter is the *median filter*, which replaces the value of a pixel by the median of the gray levels in the neighbourhood of that pixel.

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B. Segmentation using Spatial FCM

Clustering is the process of partitioning a group of data points into a small number of clusters. Image analysis can be applied for the following purposes:

i. To detect diseased leaf, stem, fruit.
ii. To quantify affected area by disease.
iii. To find the boundaries of the affected area.
iv. To determine the color of the affected area.
v. To determine size & shape of fruits.

A cluster is usually represented as either grouping of similar data points around a centre i.e., centroid or a prototype data instance nearest to the centroid. Clusters with well-defined boundaries are called crisp clusters, while those without such feature are called fuzzy clusters. In this paper Spatial FCM clustering is used for segmentation of leaf images.

A conventional FCM algorithm does not fully utilize the spatial information in the image. In this paper, we present a fuzzy c-means (FCM) algorithm that incorporates spatial information into the membership function for clustering. The spatial function is the summation of the membership function in the neighbourhood of each pixel under consideration.

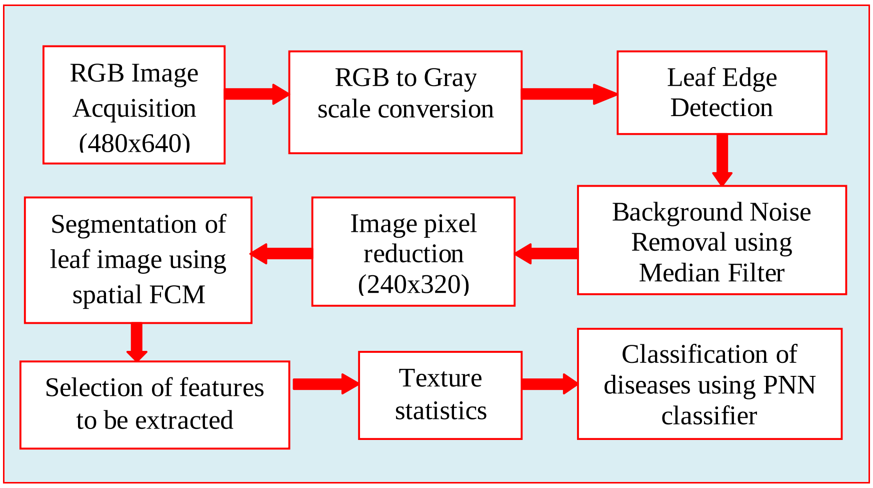

Fig 1: Block Diagram depicting the proposed model

The advantages of the new method are the following: it yields regions more homogeneous than those of other methods, it reduces the spurious blobs, it removes noisy spots, and it is less sensitive to noise than other techniques.

Let $X = \{x_1, x_2, x_3 ..., x_n\}$ be the set of data points and $C = \{c_1, c_2, c_3 ..., c_n\}$ be the set of centers. The following equations explain the membership and cluster centre updation for each iteration respectively.

$$\mu_{ij} = \frac{1}{\sum_{k=1}^{c} (d_{ij}/d_{ik})^{(2/m-1)}}$$

$$c_j = \sum_{i=1}^{n} \left(\frac{((\mu_{ij})^{m} x_i)}{(\mu_{ij})^{m}} \right) \qquad (2)$$

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where,

d_{ij} represents the distance between i^{th} data and j^{th} cluster centre.

c represents the number of cluster

m is the fuzziness index

μ_{ij} represents the membership of i^{th} data to j^{th} cluster centre.

n is the number of data points.

c_j represents the j^{th} cluster centre

Spatial fuzzy c-means, the spatial domain are updated based on the membership values of neighbouring pixels. The distance between clusters and the data points assigned to them should be minimized and the distance between clusters should to be maximized.

C. Advantages of spatial FCM

The advantages of the new method are the following:

- it yields regions more homogeneous than those of other methods,
- it reduces the spurious blobs,
- it removes noisy spots, and
- it is less sensitive to noise than other techniques
- it is a powerful method for noisy image segmentation and works for both single and multiple featured data with spatial information.

IV. PROBABILISTIC NEURAL NETWORK

After image feature extraction using fuzzy entropy, the next step is image classification. In this research we use Probabilistic Neural Network (PNN) as paddy diseases classifier. Probabilistic Neural Network (PNN) proposed by Donald Specht in 1990 as an alternative back-propagation neural network. PNN has several advantages i.e., its training speed is many times faster than a back-propagation network. PNN is robust to noise examples, it also for its simple structure and training manner, it is that training is easy and instantaneous. PNN consists of four layers, input layer, pattern layer, summation layer and output layer. The layers that make up the PNN is as:

(i) Input layer

Input layer is input x consisting of k value to be classified in one class of n classes.

(ii) Pattern layer

Pattern layer performs dot product between input and weight x_{Ai} or $Z_A = x.x_{Ai}$, then divided by a certain bias σ then inserted into the radial basis functions, that is *radbas* (n) = exp(-n) . Thus, the equation used in pattern layer is computed as:

$$f(x) = \exp(-(x - x_{Ai})^T (x - x_{Ai}) / 2\sigma^2) \tag{3}$$

with x_{Ai} express training vector class A order i .

(iii) Summation layer

In this layer, each pattern in each class are summed to produce a population density function for each class. The equation used at this layer is:

$$p(x) = \frac{1}{(2\pi)^{\frac{k}{2}} \sigma^k t} \sum_{i=1}^{t} \exp\left(- \frac{(x - x_{Ai})^T (x - x_{Ai})}{2\sigma^2} \right) \tag{4}$$

with x_{Ai} express training vector class A order i , k is length of vector, and σ is smoothing parameter.

(iv)Output layer

At the decision layer input x will be classified into class Y if the value p_y (x) is larger than any other class.

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V. SIMULATION RESULTS

The features extracted for leaf image analysis are:

(i) Color

(ii) Texture

Energy, Entropy, Homogeneity, uniformity, correlation, contrast

(iii) Shape Of The Leaf

Leaf area

(iv) Edge& Skeleton

(a).**INFECTED COTTON LEAF**

(b). COTTON BOLLWORM

(c). COTTON LEAF BLIGHT

Fig 2: Disease affected Cotton leaves

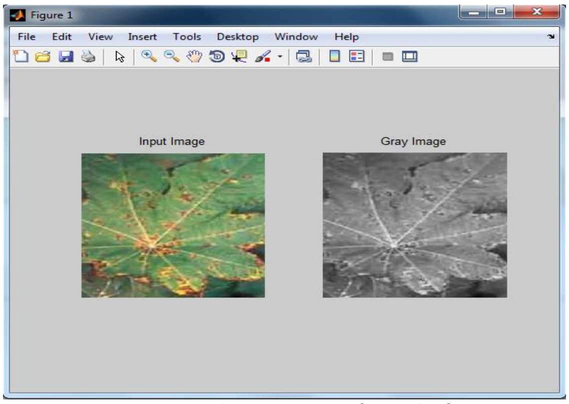

Fig 3: Gray scale conversion of input leaf image

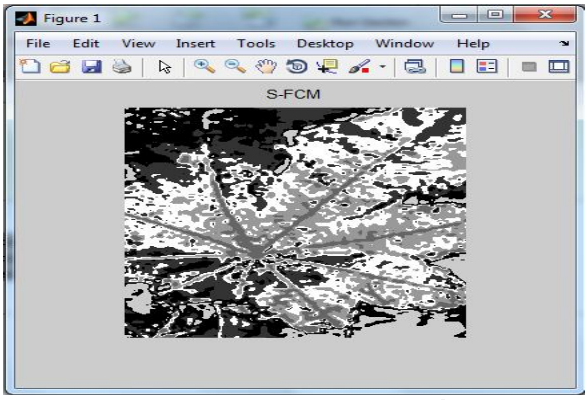

Fig 4: Segmentation using Spatial FCM

First the input image is converted into gray scale image by extracting the RGB components form color image.Then the noises present in the converted gray scale image is removed by using median filter.

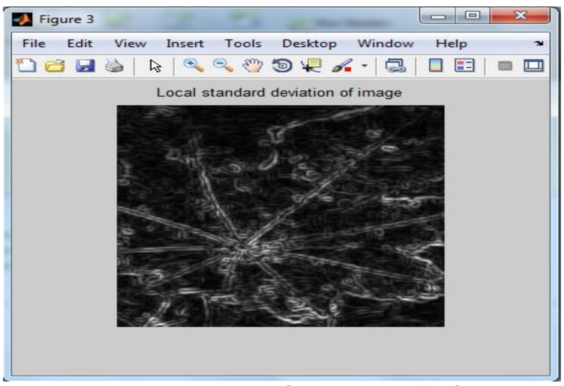

Fig 5: Feature extraction from segmented leaf image

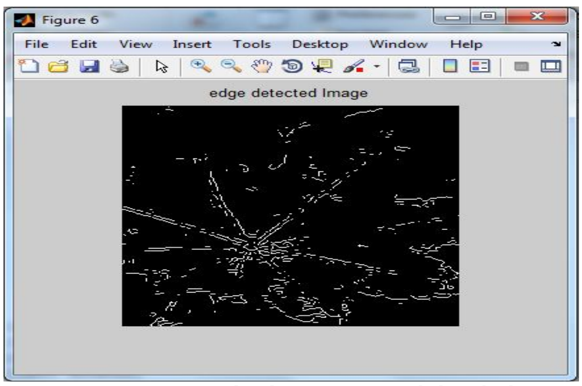

Fig 6: Edge detection using sobel method

Shape based image retrieval is the measuring of similarity between shapes represented by their features. Shape is an important visual feature and it is one of the primitive features for image content description. Shape content description is difficult to define because measuring the similarity between shapes is difficult. Texture is a powerful regional descriptor that helps in the retrieval process. Texture, on its own does not have the capability of finding similar images, but it can be used to classify textured images from non-textured ones and then be combined with another visual attribute like color to make the retrieval more effective.

Here the texture features such as standard deviation, energy, entropy, etc are extracted using CBIR (Content-Based Image Retrieval) method. The contours & edges having the information are detected using sobel edge detection method.

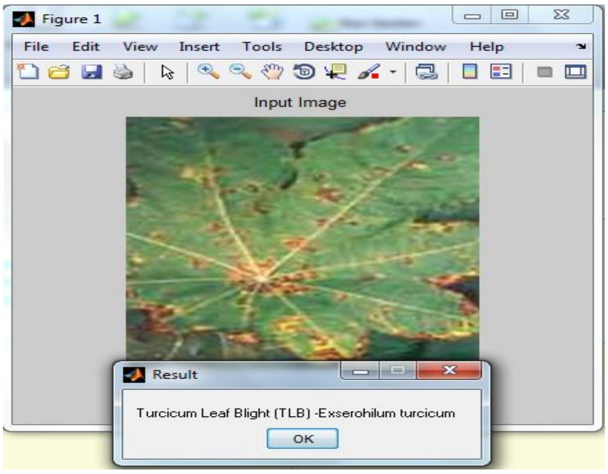

Fig 7: Identification of disease using PNN Classifier

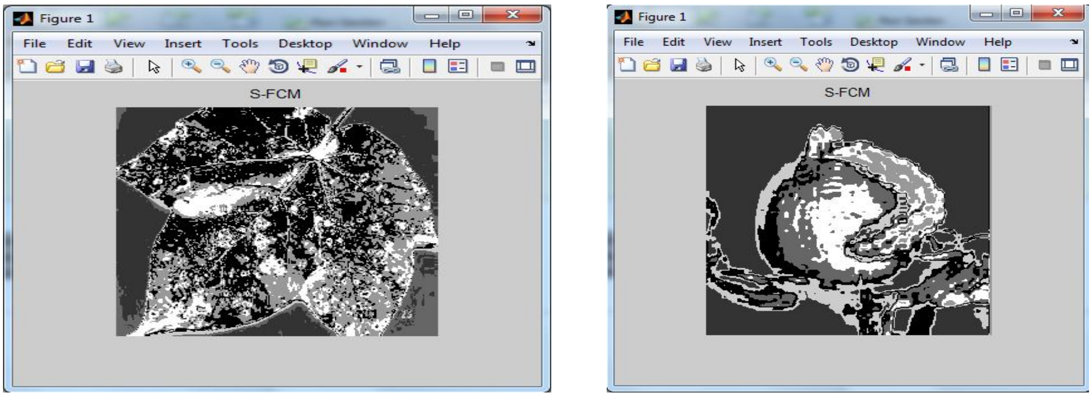

Fig 8: Segmented cotton leaves using spatial FCM

From above discussions, it was evident that the time consumed for clustering process is less in K-Means but it is very high in FCM techniques. Thus accuracy is very high in FCM techniques but time complexity is very high. It is analysed that in K-means clustering when the no. of clusters increases, the computational time gets decreased. Thus it shows that no. of clusters is inversely proportional to the computational time. And also computational complexity is also less.

VI. Conclusion and Future Work

The simulation results showed that the proposed algorithm performs better with spatial FCM for segmentation of Cotton leaf image & PNN for classification of disease in cotton plant.The spatial FCM provides the more accurate clustered results. From discussion, it is evident that all the evaluation parameters are high in our proposed technique

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(SFCM) when compared to other clustering techniques. Spatial FCM is a powerful method for noisy image segmentation and works for both single and multiple featured data with spatial information.

This work can be extended for image classification using ant colony or any other optimisation techniques in order to detect the pests and classify the disease in crops. Also it can be further modified for finding the diseased areas in the crops by using sophisticated software and better image acquisition devices.

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