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Fungal Disease in Cotton Leaf Detection and Classification using Neural Networks and Support Vector Machine

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Abstract*: Agriculture productivity is the main factor for improving economic status of India. Reduction in production rate is mainly due to various diseases in plants. Identification of plant disease in early stage is the main challenge for improving the production rate as well as economic status. This paper presents automatic disease detection in cotton crop for three types of diseases Alternaria Leaf Spot Fungal Disease (ALSFD), Grey Mildew Cotton Disease (GMCD), and Rust Foliar Fungal Disease (RFFD). The K-means clustering algorithm is used for disease segmentation for cotton leaf. The diseased cluster is segmented into three clusters. From cluster 2 the features Mean , Contrast, Energy, Correlation, Standard Deviation, Variance , Entropy, and Kurtosis are extracted. The extracted features for 30 samples are given to Artificial Neural Network (ANN) and Support Vector Machine (SVM) classifiers for disease classification. The performance of these classifiers are compared. The ALSF disease is classified 77.4% for ANN and 84.3% for SVM, GMC disease is 87.8% for ANN and 98.7% in SVM, RFF disease is 90.1%for ANN and 93.2% for SVM. The overall average accuracy of ANN classifier is 85.1% for three diseases and overall average accuracy for SVM is 92.06% for three diseases. It is clearly observed from the analysis SVM classifier gives accurate disease detection compared to ANN.

***Keywords*: Image segmentation, K-means clustering, Alternaria Leaf Spot Fungal Disease, Grey-Mildew-Cotton Disease and Rust Foliar Fungal Disease, ANN, SVM**

I. INTRODUCTION

Agriculture is the key parameter to improve the Indian economy. Indian economy can be raised by increasing the agriculture production. The damage caused due to diseases in plants has to be reduced to increase production [1][10][11]. As diseases are quite natural in plants so early detection of disease is required to improve production and quality. Continuous monitoring of large fields with naked eye is time consuming and highly costly process. It is suitable only for small farms[12][13]. So the aim of this research is to automatically detect the leaf disease in early stage using image processing techniques. This detection technique greatly helps the farmers and increases the production.

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The commonly seen disease in plants are leaf spots, viral and bacterial diseases [14][15]. This paper focuses on the leaf disease Alternaria leaf spot, grey-mildew and Rust diseases. Alternaria is most commonly seen fungal leaf spot foliar disease. This disease occurs to the cotton fields [2] [3]. This disease suppresses the plant growth and reduces the production.

The diseased leaf turns pale brown color with round spots and irregular spots as shown in Fig:1. As the severity increase the infection spreads leaves become dry and fall down [4], [5].

Fig.1 Alternaria Leaf Spot Disease

Grey-mildew is a fungal disease mostly seen in cotton farms in India. This disease appears in crop at the end of the season. This is seen on older leaves. White powder type substance appear on lower side and upper side of leaf as shown in Fig:2. Both sides covers with white fungus. The severely affected leaves turns dry and curly later fall down[6][7]. This makes the plants weak and low productivity. Using image processing techniques young leaves in the initial stage can detected.

Fig.2 Grey-Mildew Cotton Disease

Rust disease is foliar fungus disease commonly seen in cotton crops. This appears as small yellowish spots on leaves as shown in Fig:3. These enlarge to orange to reddish at the centre. As the disease severity increases weakens stalks and stems thereby causes breakage[8]. In this paper these three diseases Alternaria, Grey-mildew and Rust disease are detected using image segmentation and classified using Artificial Neural Networks and Support Vector Machine [16].

Fig.3 Rust Foliar Fungal Disease

II. METHODOLOGY

Diseases in cotton farms are seen on different parts of plant like stem, roots, cotton bud, leaves and fiber [9][10]. The plant disease data is collected from plant village data base which is available publicly. Research is carried out by taking three different types of diseases most commonly occurs in cotton leaf. The three diseases detected and classified are Alternaria Leaf Spot Fungal Disease (ALSFD), Grey-Mildew-Cotton Disease (GMCD) and Rust Foliar Fungal Disease (RFFD). For experimentation purpose ALSFD of 1332 images, GMCD of 1025 images and RFFD of 1132 are used for detection and classification. The images shown in Figs: 1, 2 & 3 are examples of three diseases. Apart from the diseased leafs, healthy leafs of 1075 images are also taken for testing, validation and experimentation.

The approach followed for automatic leaf disease detection and classification in cotton farms is shown step by step.

1. Acquiring leaf images from data base
2. Input image segmentation using K-means clustering.
3. Extracting features Contrast, Correlation, Energy, Mean, Standard Deviation, Entropy, Variance and Kurtosis from the cotton leaf.
4. Based on extracted features the type of disease is detected and classified using ANN and SVM classifiers.
5. Comparing the classification results for three different diseases using ANN and SVM

A. Image Segmentation

The proposed block diagram is shown in Fig: 4 for classification of diseases. In this paper using K-means clustering the image is partitioned into three clusters. The green pixels are masked in the diseased cluster. Texture and colour of the image is considered for extracting features of the diseased leaf..

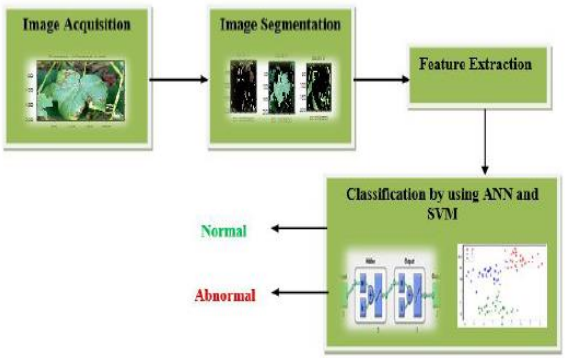

Fig.4 Proposed Methodology for Disease Classification

III. RESULTS AND DISCUSSIONS

The experiments are performed in Matlab. The input leaf considered is cotton leaf with Alternaria Leaf Spot Fungal Disease (ALSFD), Grey Mildew Cotton Disease (GMCD), and Rust Foliar Fungal Disease (RFFD). The original image is segmented into three clusters. Fig: 5 shows the segmented clusters for ALSFD, GMCD and RFFD diseases. Fig 5(a) is for ALSFD and the disease is detected in cluster2. Fig 5 (b) is for GMCD and disease is detected in cluster2. Fig 5 (c) is RFFD and disease is detected in cluster 2. So the features such as Contrast, Correlation, Energy, Mean, Standard Deviation, Entropy, Variance and Kurtosis are extracted from cluster 2 for three disease which is shown in Table: 1.

Table- I: Features Extracted from Diseased Clusters

Features	Alternaria Leaf Spot Fungal Disease (ALSFD)	Grey-Mildew Cotton Disease(GMCD)	Rust Foliar Fungal Disease(RFFD)
Contrast	0.241187825	0.4295461	0.63732097
Correlation	0.898955824	0.8383667	0.8924959
Energy	0.784876	0.7957764	0.4945214
Mean	12.21319	13.564893	2.0560009
Standard Deviation	39.463444	40.286323	62.048908
Entropy	1.2980843	2.3965831	3.0200073
Variance	1428.2129	1481.1106	3535.5449
Kurtosis	15.13307	12.996019	5.3858371

Table: 2 and 3 shows the classification results for ANN & SVM. In ANN classifier the samples considered for three diseases are 3492. ALSFD is correctly classified for 1032 samples, misclassified for 98 as GMCD and 202 for RFFD. The accuracy ALSFD is 77.4%. GMCD is correctly classified for 900 samples, misclassified for 59 samples as ALSFD and 69 as RFFD. The accuracy is 87.8% for GMCD. RFFD is correctly classified for 1021 samples, misclassified 63 samples for GMCD and 48 samples for ALSFD. The accuracy is 90.1% for for RFFD. The overall average accuracy for ANN is 85.1%.

Table- II: Classification Results for ANN Classifier

ANN Classifier	Alternaria Leaf Spot Fungal Disease (ALSFD)	Grey-Mildew Cotton Disease (GMCD)	Rust Foliar Fungal Disease (RFFD)	Accuracy in %
ALSFD	1032	98	202	77.4%
GMCD	59	900	69	87.8%
RFFD	48	63	1021	90.1%

For SVM classifier the samples considered is 3490. ALSFD is correctly classified for 1123 samples, misclassified for 74 samples in GMCD and 135 for RFFD. The accuracy ALSFD is 84.3%. GMCD is correctly classified for 1012 samples, misclassified for 4 samples as ALSFD, 9 samples as RFFD. The accuracy is 98,7% for GMCD. RFFD is correctly classified for 1056 samples and misclassified for 32 samples as ALSFD, 45 samples as GMCD. The accuracy is 93.2% for RFFD. The overall average accuracy is 92.06%.

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Table- III: Classification Results for SVM Classifier

SVM Classifier	Alternaria Leaf Spot Fungal Disease (ALSFD)	Grey-Mildew Cotton Disease (GMCD)	Rust Foliar Fungal Disease (RFFD)	Accuracy in %
ALSFD	1123	74	135	84.3 %
GMCD	4	1012	9	98.7 %
RFFD	32	45	1056	93.2 %

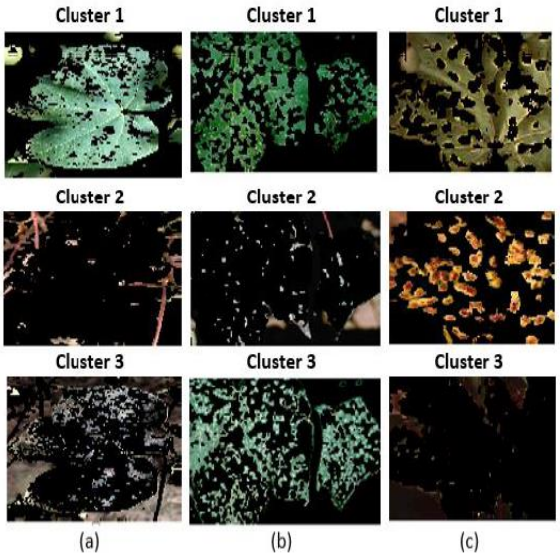

Fig.5. Image Segmentation using K-Means Clustering for three Fungal Disease (a) Alternaria Leaf Spot Fungal Disease (ALSFD) (b) Grey Mildew Cotton Disease (GMCD) (c) Rust Foliar Fungal Disease (RFFD)

IV. CONCLUSIONS

In this research automatic disease detection using image processing based approach is followed. This method gives accurate detection of leaf diseases. Three different diseases Alternaria Leaf Spot Fungal Disease (ALSFD), Grey Mildew Cotton Disease (GMCD), and Rust Foliar Fungal Disease (RFFD) are tested using this approach. K-means clustering is implemented for segmenting leaf images into clusters and for feature extraction from the diseased cluster. The features extracted from diseased cluster are Contrast, Correlation, Energy, Mean, Standard Deviation, Entropy, Variance and Kurtosis. In the later stage these extracted features are given to ANN and SVM classifiers. The classification results show that the SVM classifier gives accurate disease detection compared to ANN. The overall average accuracy of ANN classifier is 85.1% and overall average accuracy for SVM is 92.06%.

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