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An Integrated Image Processing Approach for Diagnosis of Groundnut Plant Leaf Disease using ANN and GLCM

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The plants are highly significiant for human life and animal life. Plants also suffer from illness (i.e., diseases) like humans and animals. Groundnut plant is more prone to diseases in the agriculture sector. Cercospora is the most common leaf disease in the groundnut. Entire plant gets infected by the diseases which include stem, root, flower and leaves. For controlling and managing the diseases human involvement is necessary as it is time consuming for classification and recognition of groundnut leaf diseases. The process is longer and costlier hence an automatic image processing method is adopted. In this paper, the images of groundnut leaves are collected and preprocessed by median filter. The preprocessed images are segmented by multi threshold based color segmentation. These segmented images are fed to feature extraction by Gray Level Co-ocurrance Matrix (GLCM) and feature selection by rough set approach and the leaf diseases are classified by ANN and SVM classifier. Finally the performance measures are made by comparing the accuracy and sensitivity of ANN and SVM classifiers to prove the effectiveness of ANN.

Keywords*:* Cercospora, GLCM, Rough set approach, SVM Classifier, ANN Classifier

Introduction

In the last decade researches related to image processing, evaluation for diseases in plants have found to grown vastly.[1] As number of methods are in use for disease detection in groundnut leaf image processing is significant of all.[2,3] It invigilates the large fields and mechanically identifies the symptoms of diseases. In this work an automatic image processing approach is presented. In the image pixels with dissimilarity is extracted by GLCM technique. By utilizing rough set approach the groundnut leaf with disease is selected for further classification.[4] The comparison of groundnut leaf disease detection with ANN and SVM classifier is done by MATLAB[5] as it is the major tool for image processing.

Methods and materials

In the developed methodology recognition and grouping of groundnut leaf diseases are done by using integrated image processing approach.[6] The collected images are preprocessed by using a filter. The preprocessed image is segmented by multi threshold based color segmentation. The images are segmented by the spots (i.e., red spot, white spot, yellow spots) based on the color. The features of segmented images are extracted by GLCM then extracted features are selected by Rough set Approach. The images received from the above processes are classified by ANN and SVM with high accuracy.[7] Thus the diseased leaves are recognized.

Groundnut Plant and Its Diseases

Groundnut, *Arachis hypogaea*, is an herbaceous plant cultivated for its oil and nuts. Groundnut is generally tiny and erect grown with thin stem and tiny leaves. Groundnut leaves are ordered in alternate pairs. It produces yellow, white and orange flowers. As like humans, peanuts also experience diseases. The portions of the plant which gets attacked by the diseases are leaves, flower, stem and root. It affects the usual growth of the plant and causes drop of flower, leaves, fruit or even death of plant. Hence there is a significant need for exact diagnosis of the diseases in groundnut plant.[8] Disease diagnosis on groundnut plant depends on

1) Unwanted discoloration of leaves and spots appearance.
2) Significant changes in the normal characteristics of groundnut plant
3) Changes in leaf pattern according to the diseases.

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The three major classification of groundnut leaf diseases are bacteria, fungus, virus. Some of the common diseases in groundnut are cercospora, bacterial blight, anthrachose, alternaria etc. For recognition of these diseases image processing technique is used.[9,10]

The developed work focuses on recognition and grouping of groundnut illness by utilizing image processing methodology. By this methodology the input images of groundnut are collected and fed for further analysis. Then preprocessed image is segmented by multi threshold based color segmentation. The segmented image is extracted by GLCM and then the features are selected by rough set approach and ANN and SVM is utilized for further classification. The detailed process of the developed methodology is shown in Fig 1.

Image Acquisition

The input images of groundnut leaf with diseases are collected by digital image processing.[11] For recognition and detection of diseased leaf automatic leaf detection method is utilized for evaluating large fields. These images are fed to processing.

Preprocessing

In image processing the most essential steps are data acquisition and preprocessing. The quality of image is more significant in detection of groundnut leaf diseases. In digital data mining preprocessing is much compulsory particularly in filtering and contrast enhancing phases of diseased leaf. The segmentation of leaf is more likely linked with preprocessing. This operation will permit to gather the best image of groundnut leafs with highest degree of accuracy. Initially images ranging between 0 to 255 pixels are used. Hence it is mandatory to normalize the gray level values from 0 to 1. After normalization the features are extracted for further processing. In preprocessing median filter is utilized in this section.

Median filter

The images obtained are of reduced contrast and noisy nature. Hence denoising of image is highly necessary for enhancing the image quality by noise suppression. Quality of image and feature extraction becomes unreliable due to noise. For denoising, non linear filter is used in this research. Median filter can eliminate or highlight some unique features.

For calculating the output, median filters utilize the pixel window. The pixel windows can be of any size (mostly odd number) and shape. A 5×5 square size is chosen for the proposed work as it is more enough to work properly and less enough to achieve efficiency in an image is experimented. Median filter is the best among all the windowing operators. The basic concept of median filter is to evaluate the sample value of input images and determine whether it is the representative of image.

Multi Threshold Based Color Segmentation

Segmentation of diseased groundnut leaf image is the step by step process of fragmenting an leaf image into any number of segments or fragments and extracting the particular segment for processing of diseased leaf image.[12] This is a method of partitioning a colour image into discrete regions which contains data about diseased portion of leaf. Conventionally for gray image to attain thresholding the range of brightness value can be defined by the real image. Hence the pixels have to be selected within the range which relates to foreground and have to reject the unwanted pixels in the remaining part. Such image is defined as binary two level image.

In color images all the pixels in the image is characterized by multi variables which leads to multi thresholdings. All the pixels in color images are characterized by multiple values of RGB in order to get most reliable threshold values for the range of selection. This methodology specifies the thresholding intensities for RGB range.

For identification of groundnut diseased leaf, RGB pixel properties are analyzed to gain the significant features of image. Based on the information attained from the image thresholding algorithms have to extract the green pixels in a separate manner and evaluate the other pixels with dissimilar colors in separate manner.

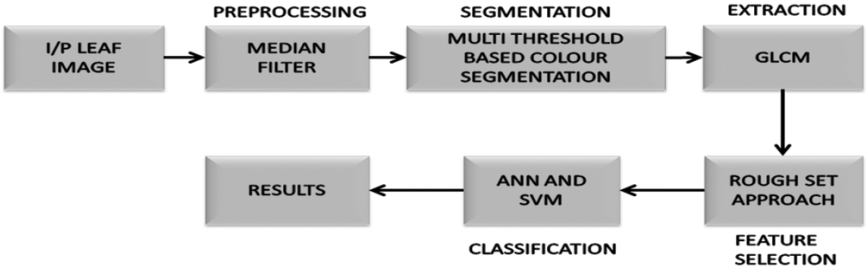

Fig. 1 — Block diagram of proposed method

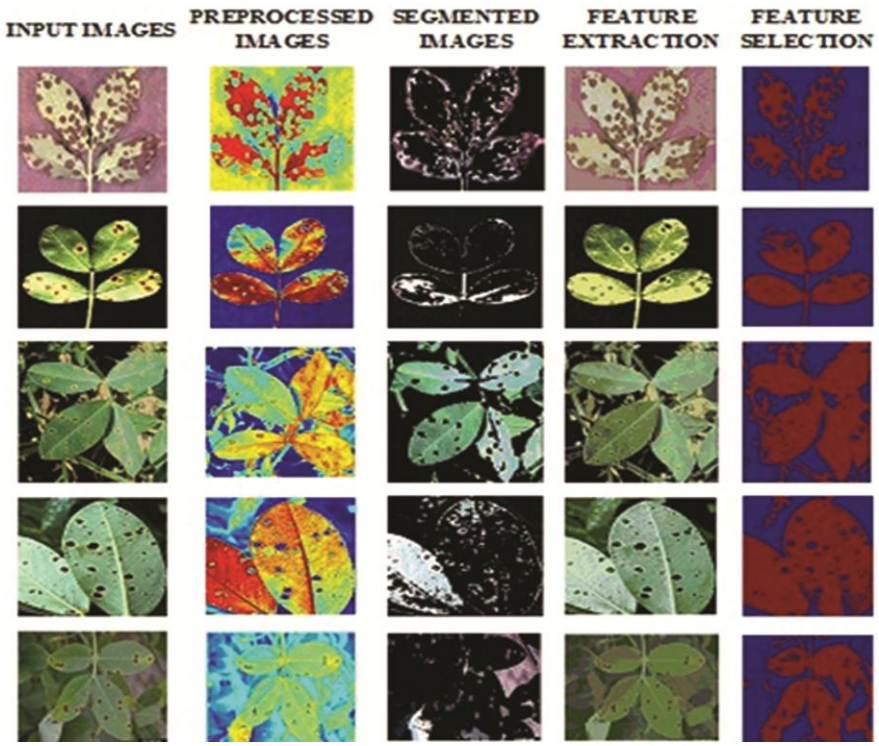

Fig. 2 — Shows the feature extracted and feature selected image of input image

In this work the original images from groundnut plant is utilized and it is more appropriate to concentrate on green color as green color indicates the healthy leaves. RGB intensify range is calculated for green and other colored leaves with diseases and finally thresholding is applied as exhibited in Fig. 2.

If there is more than one thresholding value the equation becomes

$$(x,y)=\begin{cases}0, & f(x,y)<T_1\\ 1, & T_1\le f(x,y)\le T_2\\ 0, & f(x,y)>T_2\end{cases} \quad \ldots (1)$$

where

T_1 is lower threshold value

T_2 is upper threshold value

In the developed work original grown leaves properties are viewed for all segmented images. The highest and lowest values of all the pixels are noted to get the significant nature of RGB values and it is converted into threshold values.

By considering the highest and lowest values of RGB componentsthese equations are formulated to get thresholding values of colors.

red (x, y) = red pixel value
green (x, y) = green pixel value
blue (x, y) = blue pixel value

Multilevel thresholding based segment is thus carried out based on RGB color transformation and the images of diseased leaves are Segmented successfully.

Gray Level Co Occurrence Matrix for Feature Extraction

Gray level co occurrence matrix is a methodology widely utilized for extraction of feature. It has been a significant method for extraction of feature which computes the pixel pair relationship in the image. The co occurrence matrix C(i,j) number the pixels co occurrence with gray values i and j. The co occurrence matrix dimension is N*N. Henceforth the complexity in computation depends on the count of gray scales utilized for quantization. Numerous elements like energy, correlation, inertia and entropy are extricated from co occurrence matrix to minimize dimensionality of feature set.

Distribution elements closeness is measured by homogeneity in gray level co occurrence matrix to gray level co occurrence matrix diagonal.

The co occurrence features are calculated by utilizing the threshold image for mapping with components of R, G, B input image to that image. The values of corresponding features are stored in feature library after extraction and differentiation of co occurrence features of leaves are done with relevant feature.

Feature Selection by Rough Set Approach

Feature selection is to determine the feature with minimal subset and retain maximum accuracy while denoting the original features of groundnut leaves. In real world issues, feature selection is done for reduction of abundant noise or misleading feature. The need for feature subset is caused by its relevancy and redundancy. A feature is said to be appropriate if the decision has predictive features or else it is irrelevant. Hence feature selection is a significant evaluation to find the necessary features of a diseased leaf.

Rough Set Approach is utilized as a tool to find out data dependencies and to minimize the attribute counts in a dataset. An indefinable subset is mentioned by two definable subsets called lower and upper approximation. The necessity measures are evaluated by lower and upper approximation functions.

Let T (U, A, C, D) be decision taken where as U is a universe of object A is a set of primitive features, C is a set of conditional attribute, D is a decision attribute, and C, $D \subseteq A$. For an arbitrary set $P \subseteq A$, an indiscernibility relation is as follows,

If $P \subseteq c$ and $x \subseteq v$ then lower and upper approximation of X with respect to P defined as

$$\mathrm{PX} = \{x \in U : [x]_{IND(P)} \subseteq X\} \quad \ldots (2)$$

$$[x]_{IND(P)} = \{y \in U : a(y), \forall a \in P\} \quad \ldots (3)$$

Is the equivalence class of x in U/IND(P)

The P positive region of D is a set of all objects from the Universe U which can be classified with certainty to one class of employing attributes from P. Thus the features are selected by the approximation using rough set approach and fed for classification.

Classification of Diseased Leaves

Classification of diseased leaves with disease is a challenging test methodology of classification discrimination of input features into few classes classifies is utilized to classify texture feature. Generally classification is introduced in pattern recognition field but it is applied in a number of fields.[13] Hence classification is utilized in image processing of diseased leaf also. Choosing the appropriate type of classifier for leaf disease application is a highly challenging task. Hence ANN and SVM classifier are utilized for classification of leaf diseases.

By making use of sample principles ANN are designed. ANN is trained to recognize the diseased image of leaves and also it comprehends the input and output relationships. ANN process is subdivided into three stages.

***Initial stage*:** Relevant coefficients in ANN structure like weight and bias is set up carefully with appropriate values.

Training stage: The significant part of data like observed concentration (input) and leakage source location (output) are fed to ANN.

***Validating and testing ANN*:** For validating the precision of trained ANN new data samples are tested. The diseased leaf image undergoes all the above processes and classified. Support Vector Machine analyzes the diseases in the leaves of groundnut which is utilized for classification and analysis of regression. Experimental results show that the SVM has maximum accuracy in searching.

Results and Discussion

The developed work is presented on MATLAB software toolbox with i3 processor having 4GB RAM. For evaluating the performance of developed work nine set of diseased groundnut leaves are taken into consideration. The considered leaf images are infected with cercospora, *alternaria alternate*, anthracnose, bacterial blight. The diseased leaf images are processed as per the developed methodology likely followed by preprocessing with median filter, segmentation with multithreshold based color segmentation followed with feature extraction and feature selection by GLCM and rough set approach. For classifying groundnut leaves with ANN and SVM is utilized.

In the developed work classification accuracy is evaluated by ANN and SVM. Hence comparative analysis is made with the ANN and SVM by using confusion matrix. The ratio of approximately identified samples of images to the test image sample count is defined as percentage of accuracy. Minimization of mean square error value will enable us to find the appropriate values of pixels for evaluating unhealthy parts of diseased leaf in groundnut.

According to input images the levels of iteration can be increased step by step. Occurrence of error can be minimized by sending it back to hidden layer in neural network. The above figures shows the complete process of the developed methodology whereas the input image of groundnut leaf is inspected and preprocessed with filter and preprocessed image is segmented and the significant

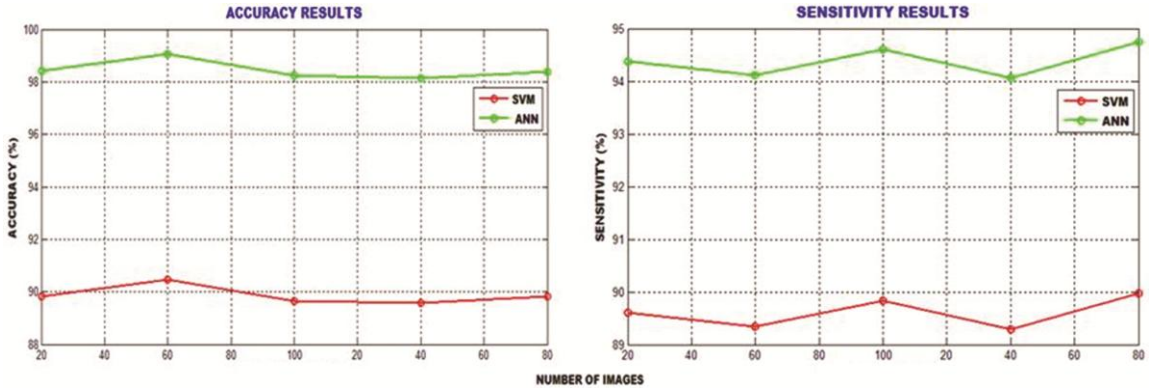

Fig. 3 — Accuracy and Sensitivity between ANN and SVM Classifier

features are selected and evaluated by feature selection and feature extraction of diseased leaf is shown in the image.

Comparison of ANN and SVM classifier

The performance of ANN in terms of accuracy is measured for different quantity of images and found to be superior than the existing SVM technique[14] at all stages with minimum percentage of accuracy of 98% for ANN and 89% in case of SVM technique. The Fig. 3 proves the superiority of ANN over SVM and results compares sensitivity measure of both ANN and SVM techniques. The sensitivity of ANN is measured form different number of images and found to be better than the existing SVM technique at all levels with minimum sensitivity measure of 94% for ANN and 89% for SVM technique.

Conclusions

Plants suffer a number of defects during their life span. They get often affected by diseases from environmental factors and other climatic conditions which affect the plants growth. Hence a method is developed for recognition of groundnut leaf disease which is done through automatic recognition and classification of diseased leaves. In the decrypted work the color transformation, color co- occurrence matrix and feature extraction is made with ANN and SVM to get a high efficiency output. The results when distinguished with similar method, the developed method is superior in computational efficiency and performance in terms of accuracy and sensitivity. In future the developed work can be distinguished with other classification methodologies.

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