Computer Based Framework for Identification of Leaf Diseases and Risk Assessment

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Abstract— Leaf diseases can potentially decrease quality as well as quantity of yields in agricultural sector. Diseases on leaf usually slow down the productivity of the plants, so how we will able to detect the leaf diseases before it affects the productivity. Current systems of leaf disease identification have no direct automated methodologies rather identified by naked eyes test. However, this technique is not so efficient in terms of identification time as well as accuracy in distinguishing various types of diseases. Maple leaves exhibits variety of diseases. So to find the leaf disease computer base systems are required. In this way several techniques are used which help in finding the leaf diseases. Leaf disease identification as well as estimation of the spread of disease in individual leaf is a known problem. Several methods are discovered so far such as digital image processing, classification, clustering, and each technique have several algorithms that produce good results respectively in variety of domains. To make the result more effective digital Image processing based automated computer based framework can alter the situation significantly by playing an accurate expert in doing so and hence, saving time as well as cost. Thus, prime objective of the proposed work is to develop a DIP and machine learning based automated disease identification in maple leaves. Moreover, the proposed system calculates affected area too.

Keywords: Leaf Disease Detection; Image Processing; Maple; Machine Learning

I. INTRODUCTION

Agriculture has played a key role in the development of human civilization. If there are leaf diseases found in plants, the productivity of agricultural plants will get affected. Therefore, there are other factors such as soil, seed, water, fertilizers etc. are also affect the overall productivity of the plants. But apart from these factors one more thing which we have to consider that is the very common problem found in the plants such as the leaf diseases. For years, Plant diseases are the main source of plant damage which causes major production as well as economic losses in agricultural areas. Leaf diseases are inevitable, detecting them plays major role. The naked eye observation of farmers followed by chemical test is the main way of detection and classification of agricultural plant diseases. There are usually different types of diseases as bacterial, fungal and caused by insect diseases are found. Few fungal diseases found in maples such as Alternaria alternate, bacterial blight, anthracnose, Cercospora, which affects the productivity of maples tree. These diseases can be detected by identifying the symptoms such as spots and damage arising on leafs. In the past decade only manual method was used for detecting the leaf diseases, which is not so effective. As the technology grow up and in order to manage these diseases effectively, there is a need of an automated system for identifying the condition of the plant. Hence we need to grow more plants. This work requires easy recognition of the diseases in plant leaves.

II. RELATED WORK

Research Current systems of leaf disease identification have no direct automated methodologies rather identified by naked eyes test. However, this technique is not so efficient in terms of identification time as well as accuracy in distinguishing various types of diseases. Maple leaves exhibits variety of diseases. So to find the leaf disease computer base systems are required. In this way several techniques are used which help in finding the leaf diseases. Leaf disease identification as well as estimation of the spread of disease in individual leaf is a known problem. In agriculture sector, this issue is a major concern of people associated with this sector as it is very significant in management of crop quality. Several research efforts have been made in this regard to deliver a reliable and accurate system based with an objective to solve stated issue. Some efforts are discussed in detailed in this section.

Rastogi et al. [1] described a DIP (Digital Image Processing) based framework for feature extraction and classification. Authors discussed color co-occurrence methodology and utilized it for extracting features. They considered color as well as texture to find unique features. However, their technique lacks in discrimination of color histogram. Moreover, the color histogram is very meager representation in most of the realistic images.

Patil and Kumar (2011) [2] explored plant traits and diseases aiming at visually observable patterns. Fruit crops need critical monitoring of diseases as they can significantly affect production significantly. They concluded that image processing can be an effective tool in agricultural applications. It can be employed for detecting diseases in different entities such as leaf, stem, fruit, etc.

Various crops are susceptible to different trait/diseases. Also, insect caused damages are another trait/disease. Use of insecticides, however are toxic to birds and can break animal food chains. Naikwadi and Amoda (2013) [3] developed a software system that may be used for automatic detection leaf diseases. Authors incorporated two steps in segmentation of diseased area. First, they find green colored pixels and then masked them with original one based on specific threshold. Second step completely removes boundary pixels covering the infected area.

Sankur et al. (2014) [4] analyzed image segmentation technique and employed Otsu method of segmentation. Their technique used HSI color system. The H component was effectively used to segment disease area. This resulted in reduction of disturbance caused by illumination changes in the image. Sobel operator is used to evaluate disease spot edges. On the other hand, Joanna et al. (2011) [5] used HSV color space along with the fuzzy c-means clustering to distinguish several pixel classes which are merged into two final classes. One of these two final classes specifies diseased areas.

Methodology proposed by Dheeb Al Bashish et al. (2013) [6] comprises following steps. First step applies K-means to cluster image. Second step employs a Neural network classification technique which takes as input the clustered images from the first step. In their dataset they focused five most common diseases early scorch, Ashenmold, late scorch Cottony mold and tiny whiteness. Neural network showed a precision of 93%.

Khoje et al. (2013) [7] delivered as system for fruit grading. This system utilized Discrete Cosine Transform for this purpose. It ensures the quality of guava and lemon. DCT extracted texture based features of normal and affected surface images. After feature extraction, SVM and PNN classifiers were trained. SVM performed better than PNN.

Anami and Savakar (2009) [8] also applied neural network but it was used to track the effect of foreign bodies on images of pile of food-grains. Green gram, jowar, groundnut, rice, and wheat were focused in their work. Color and texture based features were used and NN was used as classifiers.

Vibhute and Bhode (2012) [9] surveyed multiple image processing techniques in reference to agricultural applications. Remote sensing, fuzzy logic, hyper-spectral imaging, genetic algorithm, wavelet, etc., were some prominent techniques that were explored in their study. A detailed discussion about image processing techniques and their significance in auto-sorting of fruits, crop disease identification and weed detection has been made.

Sungkur et al. (2011) [10] implemented an automated system which is capable of disease spots recognition in sugarcane leaf. Several descriptors, such as aspect ratio, circularity, eccentricity and moments are taken into consideration for this purpose.

III. Proposed Methodology

The aim our proposed approach is to develop a software based system with a aim of automatic leaf diseases detection, and grading based on area infected on various leaves on the plants. For experimental purpose in this approach four types of diseases in maples and hydrangea are considered. These diseases are mentioned in subsequent paragraphs.

Anthracnose: anthracnose is a kind of fungal diseases which is found in warm humid area plants. This disease generally affects the developing leaves and shoots. Usually anthracnose is mentioned in many different plants diseases which has similar symptom that something looks in small area in the form of dead tissue and it grows gradually. Leaves infected by anthracnose are shown in figure 1.

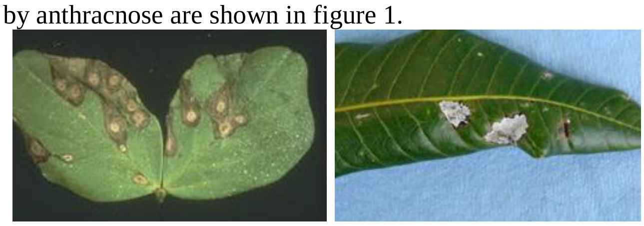

Fig. 1: Anthracnose infected Leaf

Cercospora: It is the most serious disease which is caused by the fungus. This disease reduces the heaviness and increase the infertility. Due to this disease plants lose their tonnage and sucrose and increased impurities. Circular spots having a diameter of approximately 1/8 inch are found in Cercospora infected diseases. In addition, these infected leaves have ash gray centers along with dark brown and/or reddish-purple-brown borders. In the time of rainy, warm, humid weather, theses spots may kill entire leaves. Leaves infected by Cercospora are shown in figure 2.

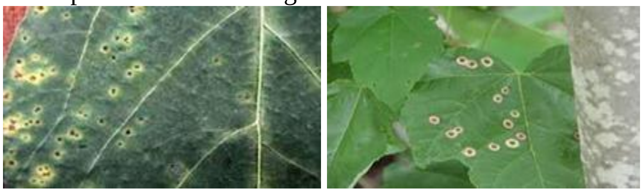

Fig. 2: Cercospora infected Leaf

Bacterial Blight: Bacterial blight is one of the diseases which caused by fungal. The symptom of this disease is a small, pale green spots or streaks which soon appear water-soaked. These diseases are usually found in winter weather on the upper Portion of the leaves. Leaves infected by Bacterial blight are shown in figure 3.

Fi. 3: Bacterial blight infected leaf

Alternaria: Alternaria is another example of fungal causing diseases. This disease usually affects leaves in spring season. It may happen due to late fall higher temperate areas. Moreover, this disease may reach up to thousands of spores per cubic meter of air. Usually, these infections are isolated from soil, food, plants and indoor air. A leaf infected by anthracnose is shown in figure 4.

Fig. 4: Alternaria infected Leaf

These diseases are fungal diseases which are usually found in maple leaves. In the proposed system these diseases are taken for identification of leaf diseases. The proposed methodology is shown in figure 5 and flow diagram for the system activity is represented in figure 6.

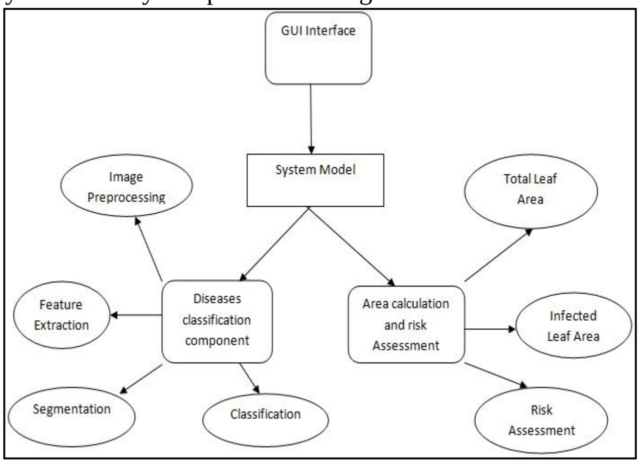

Fig. 5: Proposed system model

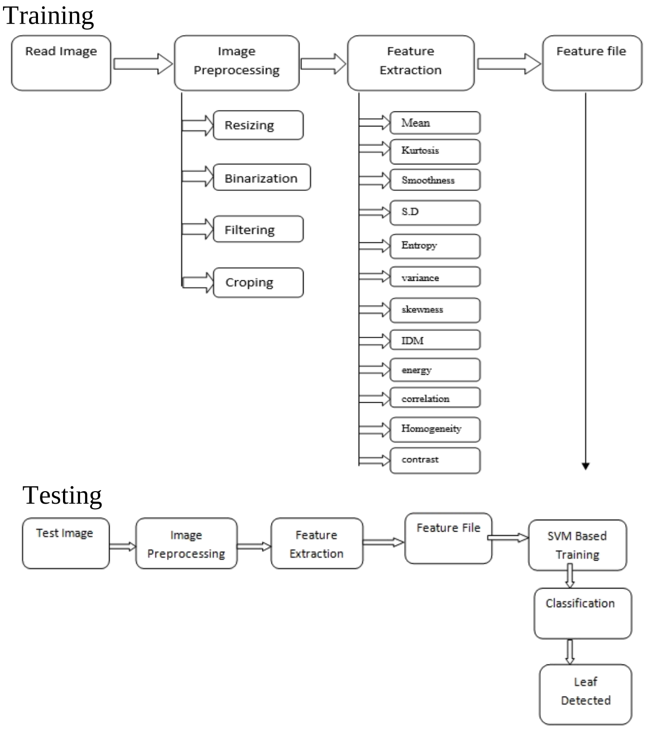

Fig. 6: Flow diagram of proposed system

The proposed system includes two major Components.

A. *First Component*

First component deals with identification and classification of leaf diseases and second component deals with the calculation of Diseases affected area and risk assessment. The first component itself has following phases. Phase 1 is Training Phase, in which the following process is performed such as Image Acquisition Process, Pre-Processing of Image, Extraction of Feature and Support Vector Machine based training and Phase 2 is Testing Phase, it performs Test Image Acquisition Process, Pre-processing of Test Image, Extraction of Feature, and Segmentation (K- means) and Classification. First component will work as follows:

1) *Collection of Leaf Image Data Set:*

This is the first step of our proposed system in which we have collected the leaf images. Since, we are working for five classes of Leaf data that is four diseases (Alternaria, Bacterial blight, athracnose, Cercospora) and fifth is fresh leaf images. All four diseases are fungus based diseases which is normally found in maple Leaf. 25 image samples for each class are collected for making the training data. We are using 13 features for each image and having 125 images for different five classes that makes the train matrix of 125X13. On the basis of this train data, a learning model is trained which is used to test for respective disease in new incoming leaf images.

2) *Image Acquisition:*

Image Acquisition is a technique in which we acquire an image by using camera. Now a time for acquiring the image the only common method is used is photography by digital camera. But other methods can also be used. In the proposed system, the images are fetched from the predefined image library. Image displayed in figure 6 is the simple image of Hydrangea Leaf.

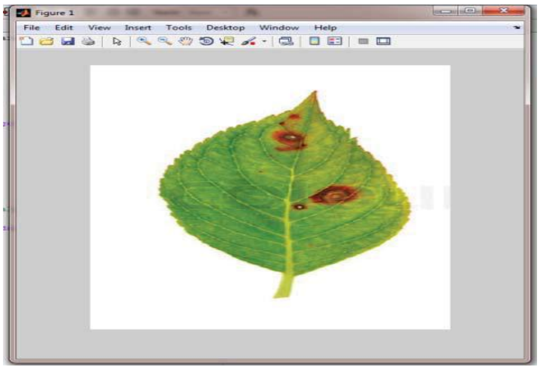

Fig. 7: Image of Hydrangea

3) *Image Pre-processing:*

Image pre-processing is a method in which some operations on image are performed so that we can enhance the image and converted image can be used for the implemented algorithm. For this, the image will be cropped and resized for testing. Apart from this few algorithms are also available for the enhancement of image. For pre-processing an image, following steps are used which consists resize of Image, Filtering of Image, Segmentation of Image and crop the image.

4) *Segmentation Phase:*

For segmentation phase K-means algorithm is used. In K-mean algorithm the similar pixels of an image are grouped to make a cluster. This approach is simple, fast and straightforward. In the proposed system K- Mean Algorithm is used to distinguish the total diseases infected area.

5) *Feature Extraction:*

After segmentation, next process is Feature extractions. The features are extracted on the basis of segmented information and predefined data set. The feature extracted using signal processing, statistical, or structural. Several methods are used for feature extraction such as Color Co-occurrence Method, Grey Level Co-occurrence Matrices, Spatial Gray-level Dependence Matrices (SGDM) method, Gabor Filters, Wavelets Transform and Principal component analysis. In our proposed system 13 features are extracted such as: Mean, S.D., Entropy, RMS, variance, Smoothness, Kurtosis, skewness, IDM, contrast correlation, energy, Homogeneity.

6) *Building Classifier:*

A support vector machine (SVM) is one of the techniques which is used for classification. In the proposed system SVM technique is uses for classification because of its efficient implementations and its performances is excellent for high dimensional problems and for small data sets as well. Once we have created the SVM Classifier model on the training data matrices then we perform the operation of identification of leaf disease. When the new leaf image arrives for testing then

– Evaluate all the 13 features of it.
– Send it to trained classification model.
– Trained model will match it and classify it one of the five classes.

B. *Second Component*

In second component of the proposed system, calculation of Percentage Infection area and Disease Grading is done.

1) Total Leaf Area and Diseased Area Calculation:

First crop and resize the original image and convert it into binary image. Percentage of Infected area (P) is calculated by using the given Equation (1), where, P is Percentage of Infected area, DA is diseased area and TLA is the total leaf area.

$$P = (DA / TLA) * 100 \quad (1)$$

2) Risk Assessment:

After calculating the percentage of diseases area, the infected leaf area is graded in different categories which are as follows given in table 1.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

The main aim of this system is develop a user friendly GUI for finding diseases on leaf, which helps the formers and others to find the disease using this software based system. The GUI is represented in figure 8. The results at various stages of the application are discussed in following sub-sections.

Class	Risk	Percentage Infection
A	Very Low Risk	Between 1% - 10%
B	Low Risk	Between 10% - 20%
C	Medium Risk	Between 20% - 30%
D	High Risk	Between 30% - 40%
E	Very High Risk	Between 40% - 100

Table 1: Grading Scale for diseased leaves

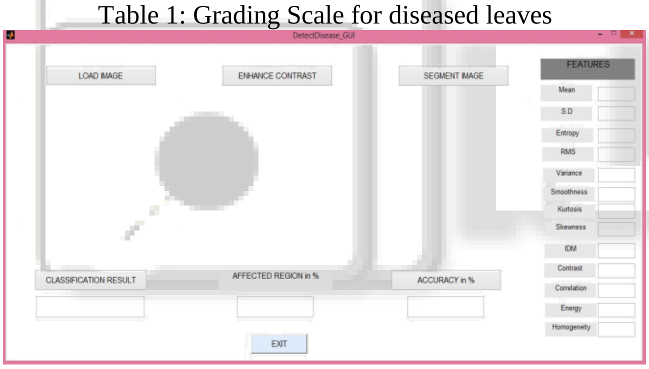

Fig. 8: GUI of proposed system

Firstly, we have to select the load image button to select the infected leaf image whose GUI entry is shown in figure 9 which is loaded with an Alternaria infected leaf image.

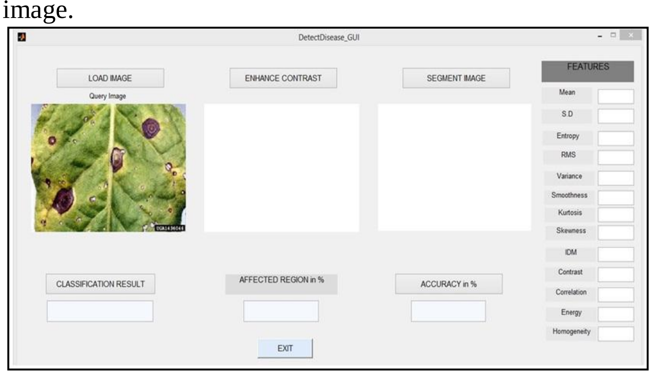

Fig. 9: Loading of an Image

A. Clustering based Segmented Leaf Image

Once the input image has been loaded from the testing set into the GUI, we generate the clusters using K-Means segmentation technique as shown in figure 10.

Fig. 10: Segmented Leaf Image

As shown in figure 10, consider the Gray Scale Cluster which is obtained to help with calculation of the pixel count corresponding to disease affected area. It is utilized further in already mentioned segmentation technique. Another type of cluster is Segmented Leaf Cluster which represents that segmented area of the leaf which is not affected with disease. This segment yields for calculating healthy area pixel count. Third cluster is Diseased Portion Cluster which accounts for determination of total diseased area. Finally, the Background Cluster corresponds to background portion of the input image.

B. Extracted Feature Values

After selecting a particular segment, i.e. 1 2 or 3, which is our Region Of Interest (ROI), button on GUI is used to calculate required feature values to be used in training phase. The snapshot of a sample Alternaria disease affected image is shown in figure 11.

C. Leaf Recognition, Disease Detection and Grading

After Generating Clusters in GUI as user will be able to recognize the leaf in GUI by clicking on the recognize push button in Leaf Recognition Part of GUI. This shows the name of the plant to which the input leaf belongs. In the disease recognition part, user is able to determine the disease name based on various features calculated in the GLCM matrix. Also, user will be able to know the amount of percentage infection in the leaf and the disease grade according to the Risk (i.e. Very High Risk, High Risk, Medium Risk, Low Risk or Very Low Risk) as per table 1.

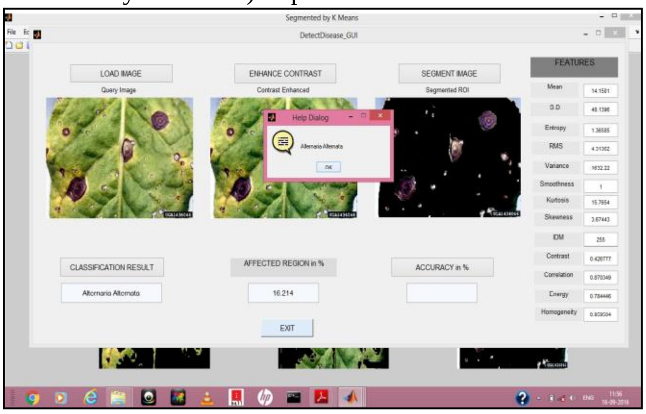

Fig. 11: Feature Extraction and Disease Prediction

V. CONCLUSION AND FUTURE SCOPE

Proposed technique and system is efficient in automatic identification of plant disease. Proposed technique applies

Digital Image Processing (DIP) along with multiple machine learning techniques to achieve the objective. DIP based techniques that are used in the presented work includes color feature extraction (applied on healthy and diseased leaf samples) and edge detection. A classification model is obtained by training on these feature values for healthy as well as diseased leaves. Based on this model, the testing leaf image is immediately classified based on its feature values.

Future work intends to scale the system for large datasets and many more diseases. Also, some advance color features can be incorporated for better result. The same system may be generalized for other agricultural disease pattern identification. We can also apply this technique on the crop which is extremely useful for farmers.

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