Detection of Unhealthy Plant Leaves Using Image Processing

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Abstract- *India is an agricultural country and about 70% of our population depends on agriculture. One-third of our national income comes from agriculture. But disease detection in plants plays an important role in the agriculture field and are quite natural. If proper care is not taken in this area, it may lead to serious effects on plants and adversely affects productivity and quality. To detect plant diseases, a fast automatic way is needed. Conventionally, the main approach adopted in practice for detection and identification of plant diseases is naked eye observation through experts. But this method is time-consuming and less efficient. Here, this project is proposed with an idea of detecting plant diseases using image processing techniques. Image processing toolbox of Matlab is used for measuring disease infected area of the leaves. The fundamental steps of image processing and leaf detection are used in this work. The image acquisition is performed by considering a disease affected leaf image. Image contrast is enhanced using Histogram Equalization. Image segmentation is performed with K means clustering. Image feature extraction is performed to extract the features of leaf disease symptoms by using Grey Level Occurrence Matrices. Finally, Support Vector Machine is used for the leaf disease detection & classification. For the experimentation, a dataset of plant leaf affected by bacterial disease 'Bacterial Blight' and fungal diseases 'Cercospora Leaf Spot' are considered.*

Keywords- Image Processing, K-Means Clustering, Plant Leaf Disease Detection, Support Vector Machine, Matlab.

I. INTRODUCTION

"Agriculture is the backbone of the Indian Economy"- said by Mahatma Gandhi. Even today, the situation is still the same, with almost the entire economy being sustained by agriculture. Crop cultivation plays an essential role in the agricultural field. But the loss of food is mainly due to infected crops, which reduces the production rate. So that information about the identification of the symptoms of disease occurrence could be quickly and accurately provided to the farmers, experts and researchers.

Nowadays, enormous attention is largely gained in recent years towards a concept of smart farming where the field conditions are controlled and monitored using the self-operating systems. Various techniques image processing and pattern recognition have been developed for detection of diseases occurring on plant leaves, stems, etc. by the researchers. The main approach adopted in practice for detection and identification of plant diseases is by using Image Processing. The use of image processing technology for plant disease eliminates the subjectivity of traditional classification methods and human-induced errors. The method is also convenient, which simply needs computers, digital cameras with the combination of necessary software programs to realize for the disease batch grading. The main focus of the proposed work is to help the farmers, distress from loss due to imperfect information of a choice of diseases.

II. LITERATURE REVIEW

Savita N. Ghaiwat and Parul Arora present the different classification techniques that can be used for plant leaf disease classification. For a given test example, the k-nearest-neighbour method seems to be the simplest of all algorithms for class prediction. If the training data is not linearly separable, then it is difficult to determine optimal parameters in SVM. The disadvantage of the KNN algorithm is that it is a slow learner and also it is not robust to noisy data.[1]

Ms Kiran R. Gavhale et.al examined a number of image processing techniques used in performing early detection of plant diseases through leaf features inspection. For Pre-processing, DCT domain is used for Image enhancement and color space conversion is done. After that segmentation takes place using the k-means clustering method. GLCM is used for feature extraction to see various statistics such as energy, contrast. For classification of canker and anthracnose disease of the citrus leaf, SVM with radial basis kernel and the polynomial kernel is used. This technique will ensure that chemicals only applied when plant leaves are detected with the disease.[2]

Anand H. Kulkarni et.al proposed a methodology for early and accurately plant diseases detection, using artificial neural network (ANN) and diverse image processing techniques. As the proposed approach is based on ANN classifier for classification and Gabor filter for feature extraction, it shows an average accuracy with a recognition rate of up to 91%. An ANN-based classifier uses the combination of textures, color and features to recognize those diseases.[3]

Khot.S.T et.al described the image processing techniques of Pomegranate fruit diseases detection. Pre-processing involved image resizing, filtering and morphological operations. RGB, La*b, HSV are used to create clusters in segmentation. In the proposed approach, Gabor filter is used in texture and morphology for obtaining boundary of image and color, morphology and texture features are extracted. Shape vectors are extracted from the healthy image and minimum distance classifier (MDC) is applied for training and classification of healthy or diseased images.[4]

Dheeb Al-Bashish et.al developed a fast and accurate method in which the leaf diseases are detected and classified using k-means based segmentation. Sugar beet leaves are used in this approach. Segmentation is this process is carried out to extract the diseased region and the plant diseases are graded by calculating the quotient of disease spot and leaf areas. An appropriate threshold value for segmentation can be obtained using weighted Parzen-window. This reduces the computational burden and storage requirements without degrading the final segmentation results. Then in this paper, this method is based on masking and removing of green pixels, applying a specific threshold to extract the infected region and computing the texture statistics to evaluate the diseases.[5]

Patil SB et.al present the measure of disease severity in the sugar cane with the help of digital image processing. In this method a simple threshold method is used for calculating the leaf area, the triangle threshold method is used for segmentation the lesion area. Fuzzy logic is used for calculating the percentage of infection information.[6]

III. PROPOSED METHODOLOGY

In this proposed work, the proposed image processing technique is presented for plant leaf disease detection and classification. The methodological analysis of the present work is shown in Figure 1 in which we followed the image acquisition, preprocessing, segmentation, feature extraction using GLCM method and then images were tested by SVM classifier.

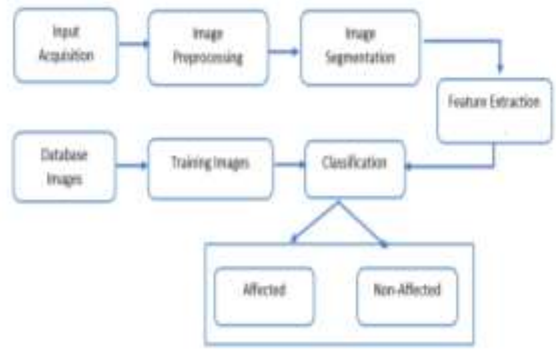

Figure 1: Block Diagram of Proposed Methodology

In this section, the disease affected leaf image is taken as the input and possible disease type is determined as output with the percentage of disease affected portion. The concept is explained detailed as below:

Step 1: Image Acquisition

The first step in the proposed approach is to consider the disease affected leaf image as an input image from the dataset of disease affected leaves. Image is in RGB color value which is further transformed in grey scale image using color scale transformation.

Step 2: Image Pre-Processing

By completing the insertion of the image, the image is pre-processed. The main purpose of Pre-processing is to improve the noise value, suppressing the undesired distortions and enhance the contrast of the image for processing and analysis. The RGB images are then converted to HSV format. The median filter is done for image smoothing and removal of noises. Image enhancement is further carried out for increasing the contrast. In Histogram equalization, the intensity of the image is distributed with the help of using cumulative distribution function. Finally, the remapping function is used to get the equalized intensity of the image.

Step 3: Image Segmentation

Image segmentation is the method used for conversion of the digital image into several segments and rendering of an image into something for easier analysis. In segmentation, Enhanced image is segmented using the k-means clustering method. K-means clustering method is used for partitioning of an image into clusters in which one part of the cluster may contain the image with a major area of the diseased part. It is applied to classify the image based on the presence of a number of feature classes. In k-means clustering, classification is done which is by minimizing the Euclidean

Distance values. In this work, image is segmented in three sub-feature images with three different types of Region of Interest (ROI).

Step 4: Feature Extraction

In feature extraction, diseases affected ROI is selected from the segmented images. Then, Convert the RGB color (ROI) image into grey scale image. Statistical texture features are obtained to maintain the Grey Level Occurrence Matrices (GLCMs) for texture analysis. In this matrix, different statistical features values of Skewness, Standard Deviation, Homogeneity, Contrast, Smoothness, Correlation, Kurtosis, Energy, Entropy, Mean, Variance, RMS, and IDM. These values are calculated from the disease-affected portion. Finally, image features are extracted based on those values.

Step 5: Disease Detection and Classification

After extracting color and texture features, Support Vector Machine(SVM) is performed for disease detection. SVM is a supervised learning model with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis using the equation below:

SVM = SVMtrain (disease_feat, disease_type)

Where,
SVMtrain is the SVM training function.
disease_feat which maintains the values of disease affected leaves.
disease_type maintains the corresponding disease labels of Bacterial Blight and Fungus Anthracnose.

Based on the symptoms, expert dataset values and extracted features, disease type is evaluated. The validation process is an important steps in developing an accurate process model using SVM. The dataset for validation process is used to verify the accuracy of the SVM model. Finally, disease type with accuracy is analyzed and the percentage of disease affected region is evaluated by the ratio of disease data and leaf data.

A. Dataset Considered

The proposed concept is used to detect plant leaf diseases. For this, we have considered the dataset having different types of diseases in leaf (Bacterial Blight, Cercospora Leaf Spot). In this concept, we have considered the dataset images of mainly fungal and bacterial affected leaf images. Bacterial Blight is bacteria affected leaf disease. Cercospora Leaf Spot are fungus affected leaf diseases. In this dataset, some healthy leaf images are also considered for the evaluation of better results.

IV. EXPERIMENTAL RESULT AND ANALYSIS

A. Results in Matlab

Learning is a process by which the system learns the input parameter as a query image and classifies the input image according to the disease affected based on the textural features. It can be from the generated GLCMs, e.g. contrast, correlation, energy, entropy and homogeneity. By calculating the GLCM texture feature values of Skewness, Standard Deviation, Homogeneity, Contrast, Smoothness, Correlation, Kurtosis, Energy, Entropy, Mean, Variance, RMS, and IDM which is used to extract the disease symptoms.

All the experiments are performed using MATLAB. Following samples of data diseases in plant leaves are taken as input along with the healthy leaves.

(a) Bacterial Blight
(b) Cercospora Leaf Spot

The segmented image has been performed into different plant diseases using a feature extraction method. Figure 2 shows the image after the segmentation process.

Figure 2 Input and Segmented Image of Leaf 1 (Healthy Leaf)

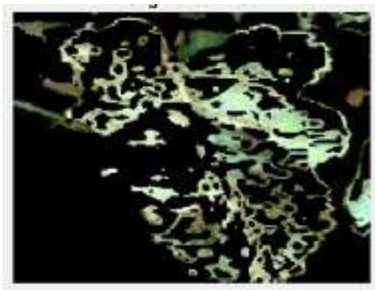

Figure 3 Input and Segmented Image of Leaf 2 (Cercospora Leaf Spot)

Figure 4 Input and Segmented Image of Leaf 3 (Bacterial Blight)

The above figure 3 and 4 shows the disease affected leaves under the segmentation process. The leaves of Cercospora leaf spot and Bacterial Blight has been considered for testing. By this testing, leaves which are good, and disease affected are detected separately.

FEATURES	
Mean	45.2763
S.D	61.3455
Entropy	4.05364
RMS	10.3502
Variance	3217.61
Smoothness	1
Kurtosis	2.38514
Skewness	0.959701
IDM	255
Contrast	0.287822
Correlation	0.957281
Energy	0.383272
Homogeneity	0.95727

Figure 5 Healthy Leaf along with Features Using Matlab GUI

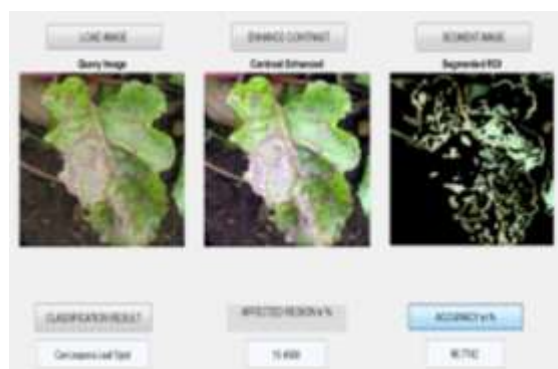

Figure 6 Cercospora Leaf Spot Detection of Sample Leaf 2 along with Features Using Matlab GUI

From Figure 5 and 6, it can be observed that the proposed method is able to locate the disease spots and achieve good segmentation results regardless of the complexity of poor illumination.

Table 1 Various Features Extracted for Different Sample Leaf Images

Features	Leaf 1 (Healthy leaf)	Leaf 2(Cercospora Leaf Spot)	Leaf 3 (Bacterial Blight)
Mean	45	38	21.74
SD	61	70	54.58
Entropy	4.05	2.84	2.93
RMS	10.35	7.88	7.42
Smoothness	1	1	1
Skewness	0.95	1.5	2.98
IDM	255	255	255
Contrast	0.28	1.411	2.75
Correlation	0.95	0.64	0.42
Homogeneity	0.95	0.91	0.91
Energy	0.36	0.50	0.65

Table 2 shows the disease type and their corresponding parameters of the affected region for images of sample leaf in Figure 2, 3 and 4.

Table 2 Disease Type and Other Parameters for Images in Figure 2– Figure 3

Parameters	Leaf 1	Leaf 2	Leaf 3
Disease	Cercospora Leaf Spot	Bacterial Blight	Healthy leaf
Affected region	15.4568	15.0124	None
Accuracy	97.77	96.77	96.78

V. HARDWARE RESULTS

For a real-time application, leaf detection is obtained by interfacing Arduino with Matlab in the computer. The implemented

concepts are tested on some sample leaf and identify the condition of leaf whether it is affected or not. The entire hardware model of the project is shown in Figure 7.

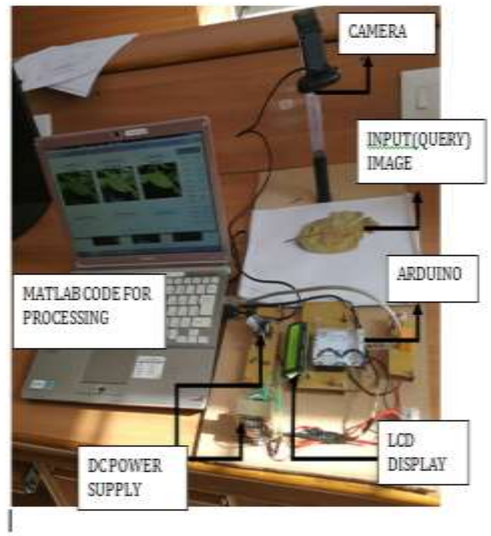

Figure 7 Hardware Setup

The type of disease shown in the LCD display according to the type of leaf placed under it as shown in Figure 8.

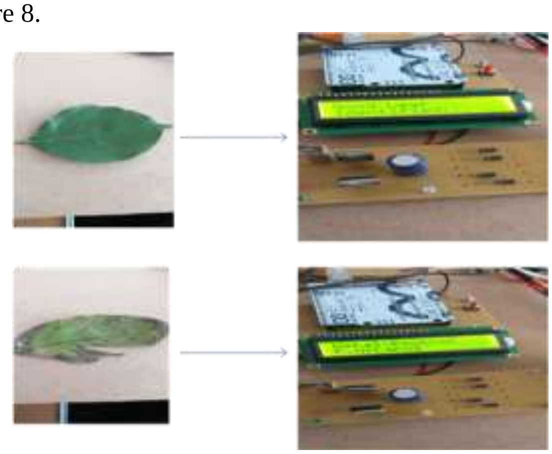

Figure 8 Experimental Results

VI. RESULTS AND COMPARATIVE ANALYSIS

From table 1, it is observed that

- IDM and smoothness values are constant and Homogeneity values are always less than one irrespective of leaf images undertaken for the test.
- Mean, Entropy and RMS of the healthy leaf are higher than that of disease affected leaf.
- Skewness factor, Energy and Contrast values are minimum and about less than one for healthy leaf and compared to disease affected leaf.

From table 2, it is observed that different leaves are affected by a different percentage. The accuracy of results varies from 96.78 % to 97.77% for the proposed concept.

From the evaluated results, it was observed that if the skewness and contrast values are in the range greater than one it is categorized as disease affected leaves if not, it is grouped under healthy leaves.

Two diseases are considered namely Bacterial Blight and Cercospora Leaf Spot.

Comparatively, if the skewness value is higher than two than the leaf is affected by Bacterial Blight. But if the skewness value is higher than one than the leaf is affected by Cercospora Leaf Spot. For a healthy leaf, skewness and contrast values are always less than one.

VII. CONCLUSION

With the objective recognize disease infected status on the leaf the project ride through. Image processing approach is used here to detect and classify leaves according to specific diseases considered here. In particular, the detection diseases considered here are Bacterial Blight, Cercospora Leaf Spot. These diseases are mainly of fungal and bacterial diseases. In the proposed concept, SVM is implemented to improve disease detection results. The analysis gives different disease classification techniques for plant disease detection. Based on the values of Mean, Entropy, RMS, Contrast, Energy, Skewness, the leaves are categorised here. ssSkewness factor, Energy and Contrast values are always minimum for healthier leaf if it's not the algorithm categorise this under the unhealthy leaf. Experimental results show that the proposed system can successfully detect and classify the plant disease with accuracy varies from 96.78% to 97.77%. With less computational efforts the optimum results were obtained. This algorithm finds its application in the detection of plant disease at the earlier stage.

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