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An Insight into Plant Disease Detection Using Image Processing- A Review

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Abstract: India mainly depends on Agriculture, as 60-75% of Indian population depends on source of Agriculture directly or indirectly. Agriculture plays a very vital role in terms of social and economic aspects of the country. The crop productivity reduces automatically due to disease that may affect the plants, and also may reduce the quality of the crops. This paper includes a detailed survey on plant disease detection from leaf using image processing. The reason for considering leaf as a source for plant disease detection is, studies have shown that the diagnosis of diseased plant can be achieved better from properties of leaf. The better productivity of the crops is achieved if the plants have resistance against various types of diseases, which may be caused due to Bacteria, Virus or Fungi. But due to external factors and internal factors most of the plants are easily prone to get attacked by various diseases easily, resulting in reduced quality and quantity of crops or fruits. Hence detection and diagnosis of the plant disease at the right time helps in proper productivity of crops. Detection can be achieved using various features like color, intensity, region of attack, size, shape, dimensions etc. This paper presents an overview of various techniques using different methods available for plant disease detection.

Keywords—Plant disease, leaf segment,Image Processing, Morphology, classification

I. INTRODUCTION

Agricultural crops play a very important in Human Diet and Medicines. They are very important sources of energy for Human Beings and Animals. But due to various factors the plants get easily infected by diseases which can cause serious economic and social problems to agriculturists. And if not noticed the problem may still verse if it is consumed by living beings. Hence it is very important to detect and diagnose the plant disease as early as possible. Moreover, before the disease actual affects the target (Crops or Fruits) the signs are shown up in leafs [1] and then in stems. And diagnosis is made easy based on the properties of leaf disease[14] Researches in this field are more concentrated on how to detect the disease on leaf so that it can be diagnosed at early stages before spread to other part of the crops.

To achieve food security and sustainability in agriculture, health of the plant or crop is very important. Manual interpretation of disease detection, classification and diagnosis require tremendous amount of work and experience, moreover the time constrain for processing also matters a lot.

Fungus is the main reason for most of the plant disease. They usually creates pores which when contacts plants creates infection. These pores are usually carried from one plant to another plant by water, wind, splash insects and other equipment. Apart from fungus other agents include bacteria and virus. Some disease may be specific with respect to type of the plant or family it belongs to, but the common category of different types of leaf disease[2] are shown in figure1.1 includes Leaf Spots, Leaf Blights, Rusts, Powdery Mildew, Downy Mildew.

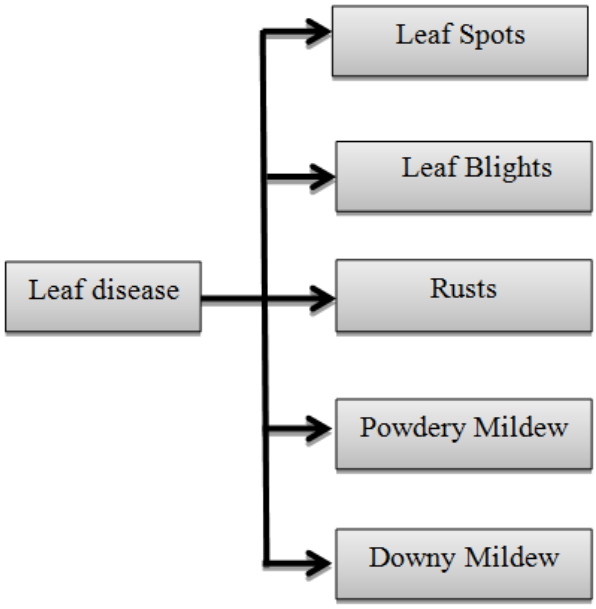

Figure 1.1: Basic Types of Leaf Disease

Leaf Spots: Are the regular and definite spots of varying size, shapes and colors. These spots may look like pimple and usually black in color. The spots when closer to each other

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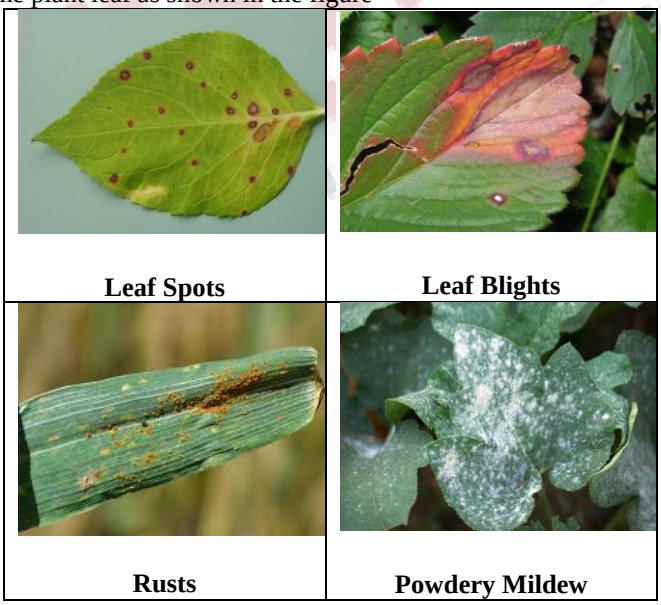
form an irregular structure called blotches. The other names for leaf spot disease includes septoria leaf spot which indicates the name of the Fungus and frog-eye leaf spot

Leaf Blights: Are usually irregular in shape and larger in size when compared to spot leaf disease. Many time the blight are the next stage of spots when they usually grow and join together to form a large irregular shapes of infected area. The other name of Leaf Blights includes Southern corn leaf blight and early blight.

Rusts: They often look similar to spots but these are bright yellow, orange-red, reddish-brown or black in color. The another distinguish feature of rust is, they raise above the leaf surface, and if rubbed with white cloths the color gets deposit on it. Some other types of rust can grow on stem. Rusts most of the times found on grasses and grains.

Powdery Mildew: A disease which is common in cucurbit type of plants caused by fungus Erysiphales, with Podosphaera xanthii. Infected plants have white powdery spots on leaf and in later stage at stems. Later the affected leaves usually turn yellow.

Downy Mildew: They usually appear as yellow to white patches on upper surfaces leaves. And light grey to purplish on under surface of the leaf. These diseases are heavy during raining season and less in sunny. If the disease is not treated with proper pesticide, leaves may eventually turn brown and crisp and die even though the plan has sufficient water.
Sometimes Powdery Mildew and Downy Mildew affects the same plant leaf as shown in the figure



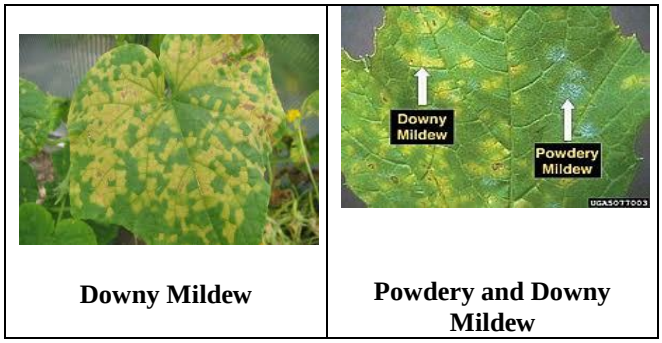


Figure1.2: Images showing different Leaf Disease

II. RELATED WORK

Shanwen Zhang et al [3] studied about how to apply Internet of Things to segment the plant diseased leaf and recognize the type of disease using combination of k-means clustering, pyramid of histograms of orientation gradients algorithms and Super-pixel clustering algorithm. Initially super pixel clustering algorithm is used to divide the color diseased leaf into compact super-pixels, at the second stage the k-means clustering algorithm is applied for segmentation of lesion image from individual super-pixel, finally the pyramid of histograms of orientation gradients features are extracted from red, green and blue color components of each lesion and also from its grey scale image. The experiment was conducted on various diseases plants which indicated the proposed technique was effective.

R.Meena Prakash et al[4] used the image processing framework which includes four parts, Image preprocessing, using k-means clustering to segment the leaf and determine the diseased area, Extracting the feature and finally classifying the type of disease. Statistical gray-level Co-Occurrence Matrix (GLCM) features are used for texture feature extraction. Classification is done with the help of support vector machine (SVM). The steps followed in k-means algorithm includes, initially choose n centroid, then point-to-cluster-centroid distance of all observation in each centroid, later assign each observation with minimum distant to the centroid to that respective cluster. Finally calculate the mean of the observations in respective clusters to produce n new centroids, repeat step two and three till there is no further change in cluster formation and sufficient iteration is performed. The different features extracted include contrast, Homogeneity and correlation. The experiment was conducted to test and classify the disease with respect citrus leaves.

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Anand K Hase et al [5] developed an android application to capture an infected leaf image then classify the type of disease and suggest the remedies for the same. Using image processing techniques the system works on various types of diseases caused due to fungi and viruses. The steps used include initially capturing the image, then resize the input image using geometric transformation, apply grabcut algorithm to extract foreground, covert RGB to HSV, matrix conversion, apply adaptive thresholding, then apply Fast library for approximate nearest neighborhood(FLANN) on input image and dataset images for feature matching, finally detect the type of disease and suggest the remedies. The experiment was conducted for tomato and grape leaf for 100 data sets and obtained an accuracy of above 90% in all cases (bacteria and fungi).

Trimi Neha Tete et al [6] discussed the different methods used in segmentation for diseased area of leaf lesion which includes Thresholding and k-means cluster algorithms. Initially the image of the diseased plant leaf is captured using cameras in the field. Then the image preprocessing is done, later two different segmentation techniques are used to segment and separate the diseased part of the leaf to identify the infected part of the leaf. Finally the category and type of disease is identified. The prior specification about the number of cluster center for k-mean algorithm was specified which produced effective result when compared to normal k-mean algorithm and Thresholding and gave best results for distinct data set.

Varsha P. Gaikwad et al [7] developed an application software solution that automatically segment, detect and identify the wheat plant disease. The four step approach is followed to achieve the above aim, includes image acquisition, second step concentrated on image preprocessing, third step focused on segmenting the affected area in the leaf and finally fourth step is feature extraction which consider color, shape and size. For classification of disease Neural Network is used. In Image acquisition stage subtraction technique is used to suppress background of all images. In preprocessing stage 3x3 median filter is used to remove the unwanted noise from captured image. Later in Segmentation section k—means clustering partition method is used. It prepared cluster in such a way pixels in object is closer to each other and pixels from different objects are far from each other. Feature extraction includes, Texture feature which was extracted using Grey Level Co-occurrence matrix (GLCM), Shape feature including area, perimeter and circularity, Color features acquired using color histogram, color moments and color structure descriptor. Finally classification done using neural network which works on shape, color and texture, and support vector machines for texture and shape feature. Based on the experiments conducted support vector machines gave more accurate results when compared to neural network. The proposed technique effectively classified fungal diseases of wheat plants.

Monzurul Islam, Anh Dinh, Khan Wahid et al [8] presented an integrated approach of combining image processing and machine learning for diagnosing disease from leaf image. This technique successfully classifies the type of disease and also indicates the absence of disease thereof on potato plants. Steps followed in this technique include initially masking out the green region and background of the leaves, thereby retaining the region of interest (ROI) which is the affected part of the leaf. Then by training support vector machine classifier with particular texture and color property the detection and classification of disease is carried out. The applied segmentation approach and vector machine over 300 images provides an accuracy of 95%.

Na Wu et al [9] proposed a novel method to identify individual pixel in the leaf image as healthy or diseased. Color transformation and machine learning algorithm linear discriminant Analysis (LDA) are the approaches used for this method. Four diseases were considered for experiment which includes downy mildew, powdery mildew, angular leaf spot and target spot. At the beginning stage different color features of pixel are extracted followed by multivariate representation, then LDA is used to obtain new feature space. During the testing phase of the experiment, pixel feature of test sample is replaced to the new space and then 1NN(one nearest neighbor) classifier is used for classification. Finally from the original image the symptoms are separated. The experimental results effectively classified the diseased pixel in images which contains shadow and specularly reflected parts when compared to three other techniques, Graph cut, Otsu and K-means.

Shanwen Zhang et al [10] propose three pipelined techniques for cucumber disease recognition. Using k-means cluster formation for segmenting the diseased area from the cucumber leaf, secondly, from lesion information the shape and color shape is extracted, and finally classifying diseased leaf image using sparse representation (SR). The advantage of this approach is cost effective when classification is done in SR space. The author have compared with four other methods used for feature extraction in leaf image dataset on cucumber leaf. The experimental results proved that the proposed approach is effective in classifying seven different types of cucumber disease form leaf database with overall rate of 85.7% better than those of other methods.

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Amrita A. Joshi et al [11] developed an automatic system that identifies and classifies the diseased plants. Four different types of diseases which include, rice blast, rice sheath rot, rice bacterial blight, rice brown spot are identified and classified. Two features like shape and color of the diseased portion is extracted using the developed algorithm. Minimum distance Classifier (MDC) and k-Nearest Neighbor classifier (k-NN) is used to classify the disease by combining the extracted features. The experiment was conducted for 115 rice leafs which are affected by above four letters to evaluate the performance. 70% of the image datasets are used for training purpose of the classifier and remaining 30% of the datasets are used for testing purpose. Classification was experimented using both the types of classifiers. The accuracy obtained using k-NN method is 87.02% and using MDC is 89.23%.

Biswas Sandika et al [12] proposed an automated system for classifying three types of diseases (Powdery Mildew, Downy Mildew and Anthracnose) and also stage of disease in grape plants. Image processing technique and machine learning are used to achieve the above objects. The advantage of the proposed system is that, the input images of the grape leaf are captured with complex backgrounds in uncontrolled environment which may result in sun shine spot or shades. The comparison was done among four types of machine learning algorithms, Random Forest, SVM(support vector machines), PNN(probabilistic neural network) and BPNN(Back Propagation Neural Network) for segmenting the affected area of leaf form background and classifying to the particular type of disease. The different texture features like local texture filters, local binary patterns (LBP), GLCM features, and some statistical features in RGB plane performance are studied for classification. The experimental results proved an accuracy of 86% by using GLCM and Random forest features.

Anand R et al [13] presented an approach to identify the diseased plant leaf from brinjal plant using image processing and artificial neural network. K-mean clustering algorithm is used in is used for segmentation of diseased leaf and Artificial neural network is used for classification. The procedures used for above technique includes initially reading the RGB image, then implementing histogram equalization, image resizing, constructing color transformation structure, apply k-means clustering algorithm, create and apply masking, conversion of affected leaf segment from RGB to hue, saturation, intensity (HSI), Create-spatial-Gray-Level-Dependence Matrices-(SGDM's) for S and H, detecting the feature by using gray-level co-occurrence matrix(GLCM), finally recognizing the disease using artificial Neural Network. Various structural parameters like Area, perimeter, diameter, centroid and mean intensity are used to identify the type of disease in brinjal leaf.

Harshal Waghmare et al [14] used opposite color local binary pattern feature and machine learning to segment and identify the grape leaf disease. The designed system take a leaf image as an input and removes background for segmentation of affected area, then analyzed using high pass filter to detect affected area of the leaf. Later the segmented affected area of leaf is used to retrieve the texture using unique fractal based texture feature. The reason for using fractal based features is they are locally invariant and provides better texture extraction model. Since the texture of different types of disease will be unique, they are classified using multiclass support vector machine. The proposed technique concentrated on major diseases like downy mildew and black rot. The experimental results proved that the proposed technique is able to segment, extract texture feature and identify the type of disease with an accuracy of 96.6%

Aditya Parikh et al [15] proposed an approach to detect the disease in the cotton plant and estimate the current stage of the disease. Because most of the symptoms of disease reflect on leaf, it is considered as base for diagnosing. The main advantage of this method is that the image was captured in uncontrolled environment by untrained person that have complicated background making segmentation of diseased part more complicated and challenging. The technique uses two cascaded-classifiers. Initially classifier segments the leaf from the background using local statistical features. Then the next classifier is trained to detect the type of disease and the stage at which the disease is at present using hue-and-luminance0from HSV0color0space. The widely prevalent disease Grey Mildew caused by fungus is showcased for detection by the proposed algorithm.

Aakanksha Rastogi et al [16] imparted a computationally proficient and simple method to identify leaf disease and also to grade the disease using machine vision technology and image processing. The proposed algorithm is divided into two stages, in the first stage the type of plant is identified using the features of the leaf which follows the steps including pre-processing of leaf image, and extracting the feature using artificial neural network based classification and training, 11 features have been extracted. 29 leaves are used to train the system and 8 leaves are used for testing. In the second stage concentrates on classification of disease in the leaf using k-means clustering algorithm, then extracting the feature and Artificial neural networks based classification, extracting the feature is done0with 40 features0of0the0GLCM matrix (including contrast, energy, homogeneity, correlation) have0been0calculated .Later the grading of disease is done based on the area and amount of disease covered in the leaf.

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Yogesh Dandawate et al [17] proposed an approach to detect and classify the soya bean plant leaf disease and suggest the solution to the farmers through mobile phones. The algorithm includes four steps, image capturing using mobile phones with various camera pixels resolution starting from 2MP, extracting only the leaf part from complex background, statistical analysis and identification. In pre-processing stage the RGB image is converted to Hue Saturation Value (HSV) color space so that it becomes applicable for segmentation and classification. Multi- thresholding is used to extract the region of interest (the leaf part) from image. The cluster based and color based approaches are used for segmenting the affected part of the disease. Support Vector Machines are used for classification of disease. Moreover the proposed technique also addressed the plant species detection based on the shape of the leaf using SIFT (scale-invariant feature transform) algorithm. The experimental was conducted for over 120 images of soya beans leaves which compose of 75 healthy leaves and 45 diseased leaves, and results showed upto 93.79% average accuracy.

Vijai Singh et al [18] gave the survey on different disease classification techniques that can be used for plant disease detection and also proposed a method called genetic algorithm for detecting disease in plant leaf. The proposed system includes the following steps, capturing leaf samples as RGB images, then preprocessing of input image, later segment the affected part using genetic algorithm and finally classify the type of leaf disease. The main part of the algorithm is genetic algorithm which includes generating random population, calculate the fitness, and then select the pair of chromosome. If correct chromosome is selected then replace the old population else select the different chromosome, this step is repeated until the old population is replaced and finally segmented diseased area is obtained. The advantage of proposed algorithm is that the disease can be identified at early stage which makes diagnosis effective. The experiment was conducted for0Banana,0beans,0jackfruit,0lemon,0mango, potato,0tomato,0and0sapota are some of those. The paper concludes with suggestion of using Artificial Neural networks, Bayes classifier and Fuzzy logic for disease identification.

Dhiman Mondal et al [19] et al presented an efficient technique to identify and classify the Yellow Vein Mosaic Virus (YVMV) in Okra plants by using k-mean classifier, Naive Bayesian classifier and image processing. The various features considered for detection and classification includes Number of Histogram peaks, Green Density, Entropy, standard deviation, mean and variance. The basic morphological operators are dilation and erosion Depending on the stage of Yellow Vein Mosaic Virus the input diseased leaf image is classified into namely Highl0Susceptible0(HS), Moderately0Susceptible0(MS), Tolerable0(T) and Resistive0 (R). The experiment was conducted on 79 image set which includes both diseased and healthy leafs of okra plant. The proposed technique showed 87% accuracy in success rate.
Ramakrishnan.M et al [21] presented an upgraded processing technique to identify cercospora disease in groundnut leaf. The technique includes four steps. Initially a0color0renovation constitute0intended0for0the0input0RGB0images0formed.This RGB0is0converted0into0HSV0because0RGB0is0for color generation and0color0descriptor, moreover HSV increases the color component of RGB and also it is a better color descriptor. The next step is plane separation which helps in reducing the overall processing time , in this step the main concentration was on to find out most green pixels so that it is treated as non-diseased part of the leaf. Next step is to extract the color features which give the spatial arrangements of color and texture feature. Statistical approach using co-occurrence matrix is used to extract texture feature. Finally back propagation method is used for training artificial neural network to detect the leaf disease which includes two phases propagation and weight update. The experiment was conducted for 100 images and result showed up 97% efficiency for four different categories of diseases.

Rajleen Kaur et al [22] proposed an automated system to detect the diseased leaf and also percentage of affected area in agricultural crop. Moreover the uniqueness of the proposed technique is it will also identify the type of disease if leaf. Support vector method is used is used with two datasets one for training and others for testing. The steps used for the proposed algorithm includes, Capturing the image, secondly background and black pixels are segmented, later separation of saturation part and hue part of the image is done, finally diseased part of the leaf is segmented and healthy part is separated. SIFT is used for feature matching.

Ole Mathis Opstad Kruse et al [23] classified the individual pixels as healthy or injured in clover plant leaf image. Various feature vectors were extracted from the leaf image including texture and color. Four techniques used to classify the diseased and healthy leaf were compared and evaluated. (1) Fit0to0a0Pattern0Multivariate0Image0Analysis0(FPM)0combined0with0T20statistics0(FPM-T2) which uses principle component analysis and threshold (2) Residual0Sum0of Squares0statistics0(FPMRSS) which uses eigen space of PCA model to calculate residual sum of square (3)0linear0discriminant0analysis0(LDA)0uses xtrain model from previous method to create the mask to classify the diseased laef0(4)0K-means clustering. The experimental results were compared with manual segmentation and disease

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identification process. Linear discriminant analysis resulted in better pixel identification and classification when compared to other three techniques with an accuracy of 95%.

Wan Mohd Fadzil W.M.N et al [24] presented a technique to automatically classify two different types of orchid leaf disease which includes sun scorch and black leaf spot. Border segmentation technique along with morphological processing technique and filtering technique is used to accomplish the classification using MATLAB. In the proposed technique pre-processing stage includes histogram equalization and intensity adjustment and filtering technique includes disc filter, Gaussian filter and median filter. In border segmentation process three morphological process is implemented which are opening (method that is used to remove small0objects0while0retaining0the0shape0and0size0of_bigger _objects), closing (is same as dilation0and0then erosion) and filled holes (are process_where_same0pixels_value_is-added-into a small object that lies inside the segmented leaf). This will give the segmented leaf without noise. Later threshold is used for segmentation of diseased part. White pixels count was considered to classify the disease, for sun scorch the white pixels are more than 200000 and in black leaf spot they are in range from 50000 to 200000. The results from the experiments showed the accuracy of border segmentation system is 86.36%. The experimental results were calculated from 44 samples in which 22 samples are black leaf spot disease affected and 22 samples are sun scorch. The image was first diagnosed by expert for actual detection of disease and then it is tested with the proposed system. The accuracy for black spot disease is 81.82% and that in case of sun scorch it is 90.90%

III. COMMON STEPS IN DISEASE DETECTION

In most of the cases the following steps are followed in plant disease detection as shown in figure 2.1.

- Image Acquisition: The images of infected leaves are captured through high end cameras or smart phones and saved in Jpeg format. These images are taken as a input to MATLAB application using imread command. The quality of the image plays a very important role to increase the efficiency of the classifier model.

- Image Preprocessing: Suppose if the image is not clear or subjected to different types of noises like Gaussian noise, Salt-and-pepper noise, Shot noise Quantization noise, Anisotropic noise or Periodic noise, then it should be removed and enhanced for further processing and analysis task. It may include steps clipping, smoothing and enhancing.
- Image Segmentation: Image segmentation means dividing the image into some meaningful regions. Once the image is denoised and enhanced the area of interest (the disease affected area) should be segmented for further processing.

- Feature Extraction: Indicates the segmented image with area of interest is used to extract the important and distinct features to identify the type of disease. Texture, color, morphology and edges are usually used as important features to detect plant disease. Texture means the color distribution in image, hardness or roughness. In general morphological features gives better result than other feature[20]

- Image classification: The main aim of image classification is to group all the pixels in the image into single class. So that the type of plant disease can be identified to classify to particular group or type.

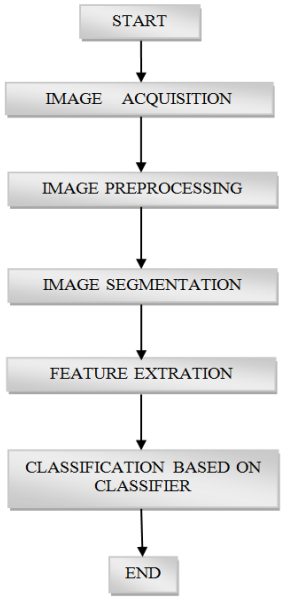

Figure 2.1: Basic flow diagram of plant disease detection and classification.

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CONCLUSION

In this paper a detail survey on various techniques used to identify and classify the type of plant leaf disease discussed. In most of the cases the commonly implemented techniques includes Support Vector method, neural networks, K-means clustering and BPNN (Back Propagation Neural Network) algorithm. Hence, by combing above techniques with still efficient ideas, better identification of plant leaf disease can be achieved.

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