A Review of Different Techniques to Detect Diseases in Different Plants

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Abstract— In our growing life, new diseases are getting detected day by day, not only in humans but in plants as well. Plant disease detection (using digital image processing) plays an important role to detect the diseases which is a great help to the field of agriculture as having diseases in plants is quite common these days. This paper briefly describes how image processing is used to detect diseases in plants by following a series of steps. The approach used in this paper for segmentation is k-means clustering and for feature extraction GLCM is being used. After feature extraction classification is done by making use of SVM.

Key words: Segmentation, K-means clustering, GLCM, SVM

I. INTRODUCTION

Basically, image consists of finite number of elements called pixels each of which has a specific location and value. Image processing is a technique to extract the required information from an image while performing a series of operations on it. Nowadays, digital image processing is amongst the rapidly growing technologies in the modern world. Also, it forms core research area within engineering and computer science disciplines to assist the areas like nuclear medicine, astronomical observation, signature recognition, number plate detection, agriculture etc. Agriculture field makes huge use of digital image processing as it is useful in harvest control, fruit grading, plant disease detection etc.[1]

A. Plant disease detection

One major application of digital image processing in the field of agriculture is plant disease detection. It helps to incorporate major economic losses in agriculture industry all around the world. To reduce the diseases spread among plants, it is important to monitor plant health and detect pathogen. There are many ways thorough which one can detect pathologies. One traditional method is to visually scout the symptoms. But not all diseases can be detected through this method, only highly experienced farmers can detect the diseases with the naked eye. Also, it is difficult to detect the diseases at early stages. Microscopic analysis should be applied in cases where diseases don't have any visible symptoms. By using PCA and SVD techniques of neural networks an automated system has been developed to detect plant diseases.

B. Image Acquisition

This is the beginning of the plant disease detection Process. In this step database is created by Capturing the high-quality images. The quality of Image matters a lot as the efficiency of the approach depends on the images present in the database. The Leaf images are usually captured using mobile phone camera or digital cameras like Nikon D3200.

C. Image Segmentation

Image segmentation is the defined as the process of dividing an image into various regions each of which are used to extract useful information. Segmentation can be done based on two intensity value properties, one is discontinuity and the other is similarity. Based on these properties segmentation techniques can be classified as:

1) Edge Based (discontinuity).
2) Region Based (similarity).
3) Feature Based
4) Clustering (similarity).
5) Threshold (similarity).

1) Edge based segmentation

Edge Detection is an approach used more frequently for segmenting image based on sudden change in intensity values and results in a line drawing of the image. In this segmentation is done using the edge detection techniques. For segmentation, the first step is to identify the boundary of the image that need to segmented. Discontinuities are detected by identifying the edges. Edge tracing is done by identifying the pixel value and it is compared with the neighboring pixels. For this classification, they use both fixed and adaptive feature of Support Vector machine (SVM). The main purpose of this technique is to identify areas of an image where a large change in intensity values occurs e.g. canny, sobel, prewitt edge detectors most widely used edge detection, canny edge detector to detect wide range of edges of image.[2]

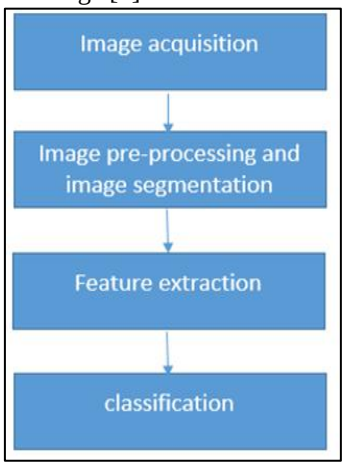

Fig. 1: Block diagram of proposed approach

2) Region Based Segmentation

This technique holds the principle of uniformity as its foundation. It states that adjacent pixels inside a region possess similar properties while the properties of pixels associated with different regions are different. This technique aims at obtaining a bigger region with similar properties i.e. a uniform region and minimizing the number of regions. Region based segmentation can be classified as:

1) Region Growing
2) Region Splitting and Merging

a) Region growing

It is procedure that groups pixels or sub regions into larger regions by examining the neighboring pixels. It is repeated for each boundary pixels. The approach starts by selecting a pixel called as the "seed" point and region grows its size by taking in the neighboring seeds whose properties are like that of the one selected at the beginning.[3]

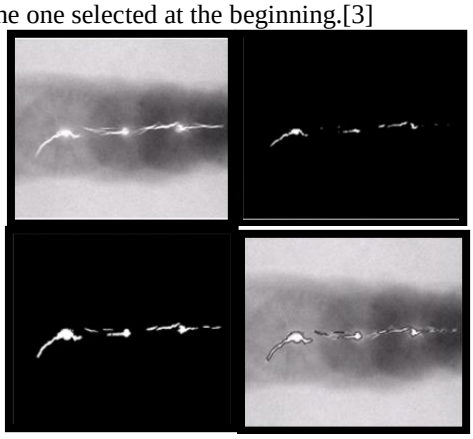

Fig. 2: Region growing segmentation

b) Region Splitting and Merging

In this technique, a region R is subdivided into uniform regions e.g.-smaller and smaller regions into quadrant and sub-quadrants. In this procedure, initial assumption is made that the entire image is a single region, then computes the homogeneity criterion to check some properties, If FALSE, then the region is split into the further smaller regions. This process continues until further splitting is necessary. These small square regions are then **merged** if they are similar irregular regions.

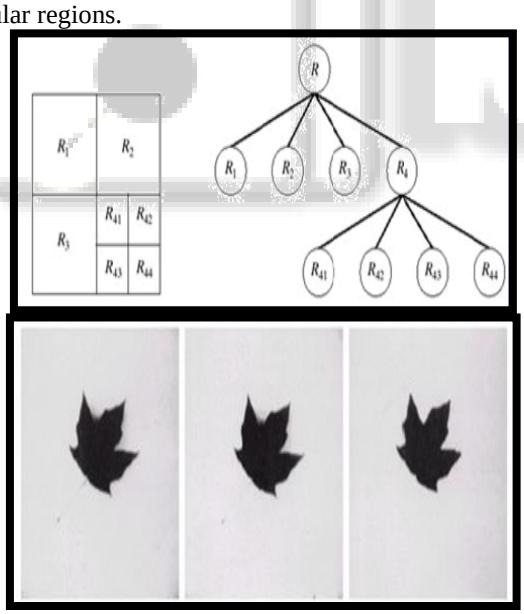

Fig. 3: Region split segmentation

3) Partitioning Clustering (K-Means Clustering)

Segmentation can be done using a different approach called clustering. In this method, total number of observations are divided into K clusters, where K denotes number of clusters in the segmented area. The main idea is to iteratively determine k centroids, one for each cluster, by optimizing the sum of distances of data-points from their corresponding centroids. It is also known as K-means clustering. This method got the advantage that that it works on both local and global information of image. Moreover, is that it works on both local and global information of image.

4) *Threshold segmentation*

Image segmentation is one of the most frequently used methods as it follows an easy approach for segmentation. Firstly, the grey scale is image is converted into binary image and by making use of the histograms of the edges (that are part of the original image) threshold values are determined. The pixels that lie above the threshold value are considered as the objects and the pixels lying below the threshold value are considered as the background. This technique is useful in the cases in which the difference between the object and background has large variations in their intensity values while it also got a limitation that multiple objects cannot be identified by means of this technique.

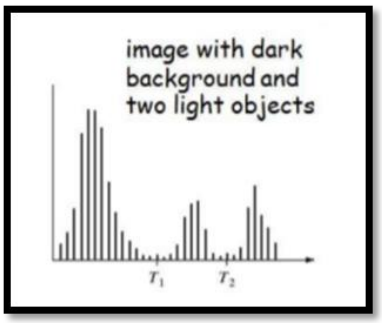

Fig. 4(a): Showing threshold graph of an image with dark background and two light objects

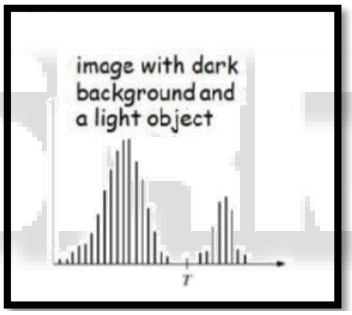

Fig. 4(b): Showing threshold graph of an image with dark background and one light object.

D. Feature extraction

Feature extraction is the means through which one trains the training set data which is to be used in the next step. This is done by extracting useful information out of the processed images. Various techniques used for feature extraction are:[4]

1) Color feature extraction.
2) Texture feature extraction.
3) Shape feature extraction.

1) Color feature

This is the most commonly used technique for feature extraction as color forms the most important property in image classification and retrieval. Another advantage of using this technique is that color is not affected by size, rotation and zooming of the image.

2) Texture feature

Texture is defined as the group of pixels that have some common characteristics. Texture feature can be classified into two categories:

- Statistical
- Syntactic

Our area of focus is statistical texture analysis. In statistical texture feature analysis texture features are obtained by observing the combinations of intensities at some particular positions which are relative to one another. **Grey Level Cooccurrence Matrix** is the technique used in the literature. This is a method of extracting second order statistical texture feature. In this method GLCM is stated as a matrix in which the count of rows and columns is equal to the number of grey level G, in the image.

P (i, j | Δx, Δy) is an element taken out of the matrix and is defined as the relative frequency which separates two pixels who are **(Δx, Δy)** distance apart.

P (i, j | d, ɵ), another element from the same matrix that contain probability of changes between grey level **'i'** and **'j'.**

Using various intensity levels G needs to store a lot of temporary data consisting **G × G** matrix for each combination of **(Δx, Δy)** or **(d, ɵ)**. Due to this reason the size of GLCMs is often kept quite sensitive and hence grey levels are often reduced.

3) Shape features

Shape is considered as an important element of an image. In order to have efficient shape feature following properties must be present in the image.

- Identifiability.
- Translation, rotation and scale invariance.
- Affine invariance.
- Noise resistance.

The shape extraction techniques can be classified into two categories; region based extraction and the contour based extraction.

The contour based method is used to calculate the feature from the boundary except from the interior region whereas the region based extraction determine the feather from the entire region.

E. Classification

After successful completion of feature extraction, features are to be used to classify and identify the leaf using decision tree classifier to classify plants based on texture-related features of leaf such as GLCM. It is the point when classification come in picture. Classification includes the process of comparing feature vectors to the various models and find the closest match. The obtained training data set is to be used to match the feature vectors.

SVM (support vector machine) is a popular tool used for classification and is implemented in this paper as well. SVM takes set of useful data as an input and in one of the two separate classes. The basic idea of SVM is to find the optimal hyperplane which separates the instances space. Finding an optimal hyperplane is similar as solving a quadratic equation. Most classification models are established on the basis of empirical risk minimization principle. This principle tends to reduce the training error and a sureness interval. SVM lays its foundation on the concept of decision planes that are used to define decision boundaries. Various variants of SVM to solve problem of hyperplane are SVM-SMO, LS-SVM, υ-SVM etc.[5]

II. LITERATURE REVIEW

This section describes works done by researchers in different domains such as fruit grading system, weed detection, classification of plants etc.

Santanu Phadikar and Jaya Sil describes a Software system for disease detection based on the infected images of various rice plants. Images of the infected rice plants using digital camera are captured and then processed using techniques like image growing, image segmentation and zooming to detect infected parts of the plants. Then infected part of the leaf has been used for the classification using neural network. The methods employed in this system are both image processing and soft computing technique**.[6]**

H. Al-Hiary, S. Bani-Ahmad et.al. Proposed method to Accurate Detection and Classification of Plant Diseases In the first step is to identify green Colours pixels. Then pixels are masked based on specific threshold values that are obtained using Otsu's method, and then mostly green pixels are masked. The other additional step is that the pixels with zeros red, green and blue values and the pixels of infected clusters from the boundaries were completely removed. SGDM matrix generated for H and S, and then GLCM Function is called to calculate the features. The experimental results demonstrate that this technique is a powerful technique for the detection of plant leaves diseases.[7]

Sabah Bashir, Navdeep Sharma surveyed on Remote Area Plant Disease Detection Using Image Processing. In this paper, a method is proposed for detection of disease in malus domestic using methods like k-mean clustering, texture and color analysis. Algorithm used for texture segmentation is CCM method. As RGB images of leaves are converted into HSI color space representation. Then this is used to generate co-occurrence matrix (CCM). By comparing texture and color images plant diseases can be detected.[8]

Dr. A. N. Cheeran, Piyush Chaudhary proposed, an algorithm which uses image processing for disease spot segmentation in plant leaf .in the first phase automatic detection and classification of plant diseases is done.. For image smoothing median filter is used. Otsu method is used to calculate the threshold. An algorithm which is independent of background noise, plant type and disease spot color was developed and experiments were carried out on different "Monocot" and "Dicot" family plant leaves with both, noise free (white) and noisy background. In this paper a comparison of the effect of CIELAB, HSI and YCbCr color space in the process of disease spot detection is done.[9]

Haiguang Wang, Guanlin Li, in this study, the image recognition of two kinds of grape diseases (grape downy mildew and grape powdery mildew) and two kinds of wheat diseases (wheat stripe rust and wheat leaf rust) was conducted by using image processing technologies and BP networks. Based on the data of the extracted color features, shape features and texture features from disease images and their combined features, BP networks constructed by using different function combinations were used as the classifiers to identify grape diseases and wheat diseases, feature combinations respectively. The image recognition of plant diseases using BP networks was also conducted based on the

dimension-reduced data that were obtained by using PCA to process the data.[10]

Sagar Patil, Anjali Chandavale in these paper different plant disease detection techniques is discussed. Many segmentation techniques and classifiers are given**.** From the schemes discussed, it is concluded that K-means clustering method for segmentation is widely used by most of the researchers. For classification and feature extraction, GLCM along with SVM classifier were found to be better in performance in comparison to others.[11]

Prof. Sunil Deokule, Shital Banker used edge detection and color matching histogram techniques to detect diseases of plants. The system includes two phases, in first phase; all the disease and healthy leaves are given as input to the system.

In the Second phase, testing samples are given as input to the system. In both the phases, first the RGB components are converted into three layers red, green and blue; greyscale image. For edge detection, Canny Edge Detector is used. Then, histogram is plotted for each component of healthy and disease leaf image and stored in the systems. A comparison is performed with stored results and disease infected or not infected plants are identified.[12]

Savita N. Ghaiwat, Parul Arora study different classifiers. To predict the class of a test example k-nearest-neighbor is simplest algorithm but one of the disadvantage of the k-NN method is the time complexity of making predictions. Additionally, neural networks are tolerant to noisy inputs, but it's difficult to understand structure of algorithm. SVM was found competitive with the best available machine learning algorithms in classifying high-dimensional data sets. In SVM computational complexity is reduced to quadratic optimization problem and it's easy to control complexity of decision rule and frequency of error.[13]

Hiteshwari Sabrol, Satish kumar the algorithm begins with digital image acquisition of infected and non-infected plants; perform image pre-processing, differentiate disease infected region from a non-infected region using color space conversion, segmentation, extract features from segmented images for recognition and classification based on Feature Analysis, Neural Network, Support Vector Machine and Fuzzy and Rule-Based Classification. This survey expected to useful for researchers from plant pathology and pattern recognition field.[14]

Prajakta Mitkal, Priyanka Pawar, in this paper concept of disease detection of sugarcane leaf based on feature extraction is proposedThis approach can also be developed using normal techniques like JAVA, but using MATLAB gives the efficient and effective result. This application is helpful for farmer and laboratory where they can easily protect their crops from disease in early stages and can increase in growth of production.[15]

III. TABLE OF COMPARISON

Author	Year	Description	Outcome
Santanu Phadikar and Jaya Sil	2008	Work is done on Diseased rice images which are classified using SOM Neural network.	Successful classification is achieved for different cases.
		Zooming algorithm is used for classification of test images.	
H. Al-Hiary, S. Bani-Ahmad	2011	Green pixels are masked using Otsu's method's. K-mean clustering and neural network are formulated for clustering and classification.	Algorithm was tested on five diseases on the plants- Early scorch, Cottony mold, ashen mold, late scorch, tiny whiteness. Precision between 83% and 94%, is achieved.
Sabah bashir, navdeep sharma	2012	This paper presents an effective method for detection of diseases in Malus Domestic using methods like K-mean clustering, CCM, color and texture analysis.	The experimental results indicate that proposed Approach significantly enhances accuracy in automatic detection of normal and affected produce.
Piyush Chaudhary, Anand K. Chaudhari, Dr. A. N. Cheeran et al.	2012	In this paper a comparison of the effect of CIELAB, HSI and YCbCr color space in the Process of disease spot detection is done. Median filter is used for image smoothing.	In this method, different disease spots are detected accurately and results are not affected by background, type of leaf, type of disease spot and camera
Sagar Patil1, Anjali Chandavale	2013	In this paper discussed existing segmentation method along with classifiers for detection of diseases in Monocot and Dicot family plant.	For classification and feature extraction, GLCM along with SVM classifier were found to be better in performance in comparison to others

Table 1: Comparison

IV. CONCLUSION

In this work, it is being concluded that plant disease detection is the technique to detect infected portion from the leaf. The plant disease detection consists of two steps, in the first step the image segmentation is done and in the second

step technique of feature extraction and classification is applied which will classify diseases and normal portion in the image. In this paper, various techniques of plant disease detection are reviewed and discussed in terms of various parameters

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