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A Survey on Methods of Plant Disease Detection

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Abstract: ***Plant disease detection is emerging field in India as agriculture is important sector in Economy and Social life. Earlier unscientific methods were in existence. Gradually with technical and scientific advancement, more reliable methods through lowest turnaround time are developed and proposed for early detection of plant disease. Such techniques are widely used and proved beneficial to farmers as detection of plant disease is possible with minimal time span and corrective actions are carried out at appropriate time. In this paper, we studied and evaluated existing techniques for detection of plant diseases to get clear outlook about the techniques and methodologies followed. The detection of plant disease is significantly based on type of family plants and same is carried out in two phases as segmentation and classification. Here, we have discussed existing segmentation method along with classifiers for detection of diseases in Monocot and Dicot family plant.***

Keywords: Classifier, Dicot Plant Disease, Feature Extraction, Monocot Plant Disease, Pre-Processing, Segmentation.

1. Introduction

Plant disease is one of the important factor which causes significant reduction in the quality and quantity of plant production. Detection and classification of plant diseases are important task to increase plant productivity and economic growth. Detection and classification are one of the interesting topics and much more discussed in engineering and IT fields.

There are various techniques emerged to detect the plant disease such as thresholding, region growing, clustering, watershed, etc. To detect plant disease the image should go through pre-processing, segmentation, feature extraction and classification processes. The pre-processing is an improvement process of image data to suppresses unwanted distortion or enhances some image features important for further processing [1].

The segmentation process is to partition an image into meaningful regions and it is vital process through which image features are extracted. There are various features of an image such as grey level, color, texture, shape, depth, motion, etc. Classification process is used to classify the given input data into number of classes and groups. It classifies the data based upon selected features [2].

Section 2 presents basic types of plant families. Section 3 introduces existing methods for detection of plant disease. Section 4 presents various techniques of segmentation and feature extraction. Section 5 presents classification.

2. Basic Types of Plant Families

A. Monocot Family Plant:
Disease identification depends on the type of plant family. There are basically two types of plant Monocot family plant and Dicot family plant [1]. The Monocot family plant has different characteristics such as one seed leaf, leaf veins are straight and parallel, absence of wood. Examples of Monocot family plants are wheat, ginger, corn, rice, millet, lilies, banana, palm, sugarcane, onions, banana tree, bamboo, and grass, turmeric etc.

Turmeric plant has heterogeneous uses in most of the fields. It plays an important role in Indian lifestyle as it has tremendous use in different medicines along with daily food items. The turmeric plant diseases are discussed in detail in the following section.

a) Leaf Blotch:
It has small oval and rectangular or irregular brown spots appear on leaves and it will become dirty brown as shown in Figure 1. The disease is controlled by use of Mancozeb pesticides [3].

Figure 1: Leaf Blotch

b) Leaf Spot:
It causes greyish or whitish spots with brown boundary of different sizes which appear on the upper surface of leaves and the spots are greyish or whitish dark in the center. Due to leaf spot, leaves will get dry and died as shown in Figure 2. The disease is controlled by use of Zineb or Bordeaux pesticides [3].

Figure 2: Leaf Spot

B. Dicot Family Plant

Dicot family plant has characteristics such as two seed leaf, nested leaf veins and complex structured, woody as well as woodless. Examples of Dicot family plants are cotton, potatoes, tomatoes, beans, honeysuckle, roses, peppers, strawberry, coffee, etc. Cotton is preferred to make textile products and yarn products in India. Various precautions and pesticides are available to control the cotton Diseases [2] [4].The cotton plant diseases are discussed in detail in the following section.

a) Bacterial Blight

It is most dangerous disease in cotton plant which infects all the parts of plant leaf as shown in Figure 3. Because of bacterial disease 10% to 30% are losses in cotton production. This type of disease affects during the growth of cotton plant. And it causes seedling blight, black arm, boll rot and leaf spot. This spots turns into brown spots on plant leaf. Bacterial Blight can be controlled and various pesticides are available such as Pseudomonas fluorescens and Bacillus subtilis [4].

Figure 3: Bacterial Blight

b) Fusarium Wilt

This is fungal disease as shown in Figure 4. It infects the plant at any growing stage. Fusarium disease causes the drooping of the older lower leaves, yellowing of the lower leaves, followed by stunting of the plant and death of the plant.

Figure 4: Fusarium Wilt

c) Target Spot

This disease produces tan to brown color spot that have concentric rings like a bull's-eye as shown in Figure 5 Infected plant may look healthy from the top, so it is important to check lower leaves, where the first spot usually appears. It will start with only a few spots but after that, the disease will progress with more infection, and it does not take so much time spread on plant [4].

Figure 5: Target Spot

d) Leaf Curl

It is caused by fungal or virus and it can easily noticeable as shown in Figure 6. Because of leaf curl disease the growth of plant leaf will stop. It is an incurable disease [4].

Figure 6: Leaf Curl

e) Grey Mildew:

This disease found in middle aged or older plant and it looks like pale spot, irregular angular spots on leaf as shown in Figure 7. Usually this spots are 4-5 mm in diameter on plant leaf [4].

Figure 7: Grey Mildew

3. Existing Methods For Detection of Plant Diseases

Earlier papers are describing to detection of the plant leaves diseases using various approaches are discussed below, In [1], they discussed about automatic detection and classification of diseases. Plant disease spots are different in color but not in intensity. Thus color transform of RGB image is used for better segmentation of disease spots. Median filter is used for image smoothing and Otsu method is used to calculate threshold values to detect the disease spot. It doesn't give accurate result for Dicot family plant.

P. Revathi and M. Hemalatha [4] investigated advance computing technology to assists the farmer in plant development process. This approach used mobile to capture infected cotton leaf images. RGB color feature segmentation is carried out to get disease spots. Edge detection technique is used for extraction of image features of spots to detect diseases. Neural network is used to categorize the diseases. The segmentation process is not suitable for Monocot family plant.

S. Dubey and R. Jalal [5] explored the concept of detection and classification of apple fruit diseases. The proposed approach is composed of three steps such as segmentation, feature extraction and classification. K-means clustering technique is used for the image segmentation. The features are extracted from the segmented image and images are classified based on a Multiclass Support Vector Machine (SVM). The proposed approach is specific to apple fruit diseases and cannot be extended to other fruit diseases.

In [6], the approach focused on Cercospora leaf spot detection in sugar beet using hybrid algorithms of template matching and support vector machine. The approach adopts three stages; first, a plant segmentation index of G-R is introduced to distinguish leaf parts from soil contained background for automatic selection of initial sub-templates. Second is robust template matching method adopted for continuous observation of disease development, foliar translation and dynamic object searching. Then, Support Vector Machine (SVM) is used to disease classification by a color features named two dimensional, xy color histogram. The segmentation process is not suitable for other Dicot family plant.

Yan, Han and Ming [7] proposed to select features of cotton disease leaf image by introducing fuzzy selection approach, fuzzy curves and fuzzy surfaces. The features which are extracted from fuzzy selection approach are used for diagnosing and identifying diseases. This approach removes the dependent features of image so as to reduce the number of features for classification.

Sannakki, Rajpurohit, Nargund and Kulkarni [8] proposed an approach to diagnose the disease using image processing and artificial intelligence techniques on images of grape plant leaf. The input image of grape leaf is complex at background. The thresholding is used to mask green pixels and image is processed to remove noise using anisotropic diffusion. Then, segmentation is done using K-means clustering technique. The diseased portion from segmented images is identified. The results were classified using back propagation neural network.

In [9], they investigated approach for automatic detection of chilies plant diseases. For that, CIELab color transformation model is used to extract color feature from infected image. Compare the color feature for detection of disease. There is no effective work done in feature extraction. But it could yield more result accuracy if appropriate work would have been done.

Next paper [10] discussed about the monitoring of grapes and apples plant diseases. It suggests a solution to farmers for healthy yield and productivity. K-means clustering is used for segmentation and artificial neural network is used for classification of features. Also back propagation concept is used for counting the weight of mango. Morphology, color and texture features are extracted for classification.

4. Techniques of Segmentation and Feature Extraction

The following section describes various segmentation and feature extraction techniques for detection of plant diseases.

A. Thresholding:

Thresholding technique is effective for images based on objects of contrast background. In thresholding technique, each pixel in images are separates into foreground (binary "1") and background (binary "0") object of classes based upon their correspondence in gray level intensity. The gray scale image is converted into binary image using Otsu method. The drawback of thresholding is not always straight forward and assigned pixels to a single class. It need not form coherent regions as the spatial locations of pixels and completely ignored [11].

B. Region Growing:

In this technique, if no edges are identified then a region or class is formed by examining the neighboring pixels. The process of region growing is repeated for each boundary pixel in the region under examination [12]. This technique started with considering a seed pixel value and comparing with local pixels values based on functions such as difference between neighboring pixels values. It grows in the direction where the intensity of pixel is low. The region growing technique is proceeding until no more pixels are added. The drawback of region growing method is that it consumes more power and time for computation [13].

C. Partition Clustering:

The segmentation based K-means technique is a partition clustering technique used to partition n number of observations into k clusters in which each observation belongs to the cluster with the nearest mean of the cluster. In this technique, k is the number of clusters in the segmented image and colors present in an image are used for the clustering. The main advantage of segmentation based K-means clustering technique is that it works on local information and global information of image. K-means clustering algorithm is easy to implement and fast, robust and flexible [12]. Particle Swarm Optimization (PSO) comes under evolutionary clustering algorithm. In segmentation process, PSO works on global information and local information of the image. But it does not work well with local information. Usually, PSO works with skew divergence method to extract features of the images. It is difficult to implement and can't work on the problems of non-coordinated system [14] [15].

D. Watershed:
In this technique, a topo-graphic relief can be seen by grey level image while its altitude in relief is considered from grey level of pixel. A water drop flows along a way to get local minimum on a topological relief. The watershed corresponds to relief that is a limited to the adjacent catchment basins of water drops. In segmentation, elevation information is interpreter from the length of gradient. Markers and region merging are the important to conclude local minima of image gradient. Marker based watershed transformation is analyzed by the special marker positions which has determined automatically by morphological operator or user can explicitly define it. The drawback of watershed method is that it could not give accurate result at classification of diseases [12].

E. Edge Detection:
Edge Detection is a general technique that operates on an image and results in a line drawing of the image. The lines represent changes in values such as intersections of planes, cross sections of planes, textures, colors, and lines as well as differences in shading and textures. The main purpose of edge detection is to identify areas of an image where a large change in intensity occurs. In edge detection, canny edge detector is mostly used to detect wide range of edges of images. Canny detection technique has three steps i.e. first, it clears the noise in image and second it obtains gradients of intensity and direction. Last, it determines strong edges of image and also finds begin and end of edges by threshold value. This detection technique is better because, it reduces noise. Edge detection technique is used to extract the image features (color, shape, texture, etc) [13] [16] [17].

5. Classification

The feature extraction process extracts relevant information from the input image in order to reduce the amount of resources required to describe a set of data [7]. The input data transforms into the set of features is known as feature extraction. For feature extraction, feature detection and feature selection should be done. There are various types of features of images such as color, texture, shape, edge, depth, corners, blobs, ridges, morphology, etc. Color Co-concurrence Method (CMM) is a matrix defined over an image having a distribution of co-occurring values at a given offset [16]. Color Co-occurrence Matrix is a matrix in which features are taken into account to arrive at unique features which represent the image. CCM includes Gray Level Co-occurrence Matrices (GLCM), Gray Level Co-occurrence Histograms (GLCH) and Spatial Gray Dependence Matrix (SGDM).

Gray Level Co-occurrence Matrix is created from gray scale images and used to describe the shape feature [18]. The Gray Level Co-occurrence Matrix is based on the repeated occurrence of gray-level configuration in the texture. The spatial gray dependence matrix is used for texture analysis. A spatial gray dependence matrix is created based on hue, saturation and intensity [19]. Run Length Matrix (RLM) is another type of matrix. Same gray pixel values are the part of run and those gray values forms a two dimensional matrix. Example, RM- Q(x, y) x represents gray values and y represents run length [12].

Segmentation and feature extraction are techniques to extract relevant features from the plant leaf. To arrive at the decision and identification, the results from feature extraction are classified. On the basis of survey, we found various types of classifiers such as Artificial Neural Network (ANN) with 87% accuracy rate [19], Back Propagation Neural Network (BPN) with 87% accuracy rate [12][15], Fuzzy Logic with 88% accuracy rate[15] and Support Vector Machine (SVM) with 91% accuracy rate [2] [19].

Support Vector Machine performs classification by constructing an N-dimensional hyper plane that optimally separates the data into different parts. SVM models are closely related to neural networks. SVM evaluates more relevant information in a convenient way [19].

The proposed flow architecture from literature survey integrated with innovative idea is shown in Figure 8. The flow architecture have several steps i.e. first, the infected plant image goes through the image pre-processing phase for enhancing and removing noise from image. Second, the pre-processed image passed to the segmentation for partitioning into clusters. For segmentation, K-means clustering technique is fast, flexible and easy to implement than others. From segmented image extracts the features of image such as color feature, texture feature, shape feature. Color feature is used to simplify the object extraction and identification. For that various color models are used such as RGB, HSI, CMYK and CIELAB. The texture feature is a feature that classifies the segmented regions and also defines the characteristics of regions. Shape is a feature that interprets various facts of objects. Finally, classifier is used for classification and recognition of plant diseases. SVM is one of the best classifier which gives more accuracy than others.

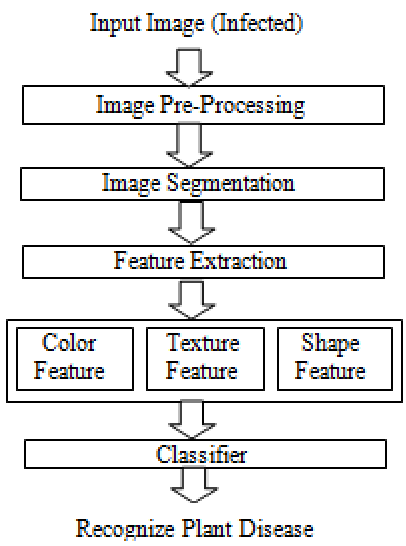

Figure 8: Flow of System Architecture

6. Conclusion

The detection of plant disease is one of the important tasks. A plant disease reduces the production of agriculture. Every year the loss due to various diseases is challenging part in agriculture production. Although work is carried out till time on detection of diseases but proper segmentation of affected part based on type of plant family is still an open problem as a research area. The strategy used in existing system consists of an approach for either Monocot or Dicot family plants but not for both. Though most of the disease detection approaches are in existence but these approaches can be developed further to provide more accuracy in Monocot and Dicot family plant disease detection. From the schemes discussed in the above section, 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. We have included a list of references sufficient to provide a more detailed understanding of the approaches described. We apologize to researchers whose important contributions may have been overlooked.

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