A Review and Comparison of Plant Disease Detection Techniques

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Abstract - The Plant disease detection is the technique which is applied to detect diseases from the infected plants. The plant disease detection techniques consist of two phases, in the first phase segmentation of the input image done which detect diseased portion from the input image. The technique of features extraction is applied which will extract the features of the image and also classify extracted features using various classifiers. In this paper, various techniques of segmentation, feature extraction and classification is reviewed and discussed in terms of various parameters.

INTRODUCTION

1.1 Image Processing

Image consists of finite number of elements each of which has a particular location and value. These elements are called picture element and pixels. Digital image processing refers to processing of digital images by means of digital computers. It is a process to convert an image into digital form and perform some operations to get an enhanced image and extract useful information from it. There are different types of image processing fields like nuclear medicine, astronomical observation, signature recognition, number plate detection, agriculture etc. Digital image processing is widely used in agricultural field. It is used in, harvest control, fruit grading, seeding and food picking, plant disease detection etc.

1.2 Plant Disease Detection

Plant diseases cause several devastating economical, social and ecological losses. It is necessary to detect plant disease accurately on its minor stage to protect the quality and quantity of crops. There are several ways to detect plant pathologies. Some diseases do not have any visible symptoms associated and farmers can't recognize it easily. In those cases, normally some kind of sophisticated analysis, usually by means of powerful microscopes is necessary. In other cases, the signs can only be detected by imaging machine which cover almost the entire electromagnetic

spectrum ranging from gamma to radio waves that are not visible to humans. . Farmers use naked eye observation method to detect the diseases with their experience but it is very hard to detect disease at very early stage by this method. To identify different plant disease an automated system has been implemented using different classifiers such as back propagation, PCA and SVD techniques of neural network [1].

1.3 Segmentation Techniques

In Image segmentation, an image is divided into small regions so that useful information can be extracted from the data. There are two ways by which image segmentation can be done. First method is based on discontinuities e.g.-edge detection and Second method is based on similarities e.g.thresholding done using Otsu's method.

1.3.1 Region based segmentation

1. Region Growing
2. Region Splitting and Merging

1. 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 start with a "seed "point and then grow regions by appending to each seed those neighboring pixels that have properties similar to the seed .

2. 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.

1.3.2 Partition Clustering

The segmentation based technique is a partition clustering technique which is used to partition n number of observations into k cluster each object belongs to particular one cluster. Here k is the number of clusters in the segmented image. The main

advantage of segmentation based K-means clustering technique is that it works on both local and global information of image. This algorithm is easy to implement, fast, robust and flexible [2].

1.3.3 Edge Detection

Edge Detection is a the approach used more frequently for segmenting image based on sudden change in intensity values and results in a line drawing of the image. The lines represent changes in values such as intersections and cross sections of planes, textures, colors, as well as differences in shading 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.

1.4 Artificial Neural Networks

Artificial Neural Networks are the models which are inspired by the biological neural network. Artificial neural networks process the information like the human brain but they are slow in processing but they achieve performance near to biological neurons So, ANN's pattern are widely used in the automatic identification and classification of plant diseases. Classification processes the data in groups or classes. Classification is usually called as supervised learning technique [3]. Artificial neural networks consist of processing units which are typically organized in the form of layers. It has input layer from which signal is propagated to output layer through some hidden layers by which weights can be updated. The data flows from an input layer to the output layer in feed-forward network. Some of the classifiers used are.

1.4.1 BPA (Back Propagation Analysis)

BPA is algorithm which is used to train artificial neural network. It is mathematical algorithm in which signal from outer layer propagate to the input layer. It is used to train the hidden layers. In this error is calculated and propagated back to hidden layer by which we can train our network. In this any number of hidden layers can be used but less than or equal to input layer. It provides supervised learning to neural networks.

1.4.2 PCA (Principal component analysis)

Principal component analysis is a dimensionality reduction technique in data analysis [4]. First important property comes from scheme of compressing a set of high dimensional vectors into a set of low dimensional vectors and then reconstructing. Second parameters can be directly calculated from data. Third, compression and decompression can easily performed on model parameters as they require only matrix multiplications.PCA is widely used method for plant disease detection. But it is less accurate than SVM.

1.4.3 Singular Value Decomposition (SVD)

It is factorization of real and complex matrix. It is used in many applications like signal processing. Special feature is that it can be performed on any real matrix [5]. It is effective method to split the components which are linearly independent and has its own energy contribution. Several SVD properties are very advantageous for images such as maximum energy packing, solving of least mean squares problem, calculating pseudo- inverse of a matrix and multivariate analysis. . Let's say, we have a matrix A with m rows and n columns with rank $r \leq n < m$ .then the a can be factorized into three matrices.

$$A = USV^T$$

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 it identify green Colours pixels. Then pixels are masked based on particular 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 domestica 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. colour transform of RGB image is performed for better segmentation of disease spots.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 colour 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 colour 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 colour 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 colour 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-neighbour 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 colour 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 proposed. After doing review on various techniques and algorithms conclusion given is that compared to other algorithms, SVM algorithm gives the better result. This 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].

Author	Year	Description	Outcome
Santanu Phadikar and Jaya Sil	2008	Work is done on Diseased rice images which are classified using SOM Neural network .Zooming algorithm is used for classification of test images.	Successful classification is achieved for different cases.
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 Domestica using methods like K-meanclustering,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.	2012	In this paper a comparison of the effect of CIELAB, HSI and YCbCr colour space in the	In this method different disease spots are detected accurately and results are not affected by background, type of leaf,

Cheeran et al.		Process of disease spot detection is done. Median filter is used for image smoothing.	type of disease spot and camera.
Haiguang Wang, Guanlin Li, Zhanhong Ma, Xiaolong Li	2012	Two grape disease (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.PCA is used to feature extracted of diseased images.	grape diseases was obtained as the fitting accuracy was 100% and the prediction accuracy was 97.14%, and that for wheat diseases was obtained as the fitting accuracy and the prediction accuracy were both 100%.
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
Shital Bankar, Ajita Dube,Pranali Kadam, Prof. Sunil Deokule	2014	The colour features extraction are applied on samples that are healthy leaf of plant and the diseased leaf of the plant. Plant diseased is detected by using histogram matching.	Canny edge detection and histogram matching gives accurate results.
Savita N. Ghaiwat, Parul Arora	2014	This paper present survey on different classification techniques that can be used for plant leaf disease classification, such as k-Nearest Neighbour Classifier, Probabilistic Neural Network, Genetic Algorithm, Support Vector Machine, and Principal Component Analysis, Artificial neural network, Fuzzy logic.	SVM was found competitive with the best available machine learning algorithms in classifying high-dimensional data sets.
Hiteshwari sabrol,Satish kumar	2015	This paper proposed algorithm for digital image acquisition of infected and non-infected plants; perform image pre-processing, differentiate disease infected region from a non-infected region using segmentation, extract features from segmented images for recognition and classification	results shows that highest accuracy for plant disease recognition and classification done under three categories i.e. Feature Analysis using colour-based classification,Neural Networks using PCA and SVM with 100% accuracy
Prajakta Mitkal,Priyanka Pawar, Mira Nagane et al.	2016	In this paperwork is done for sugarcane leaf disease detection in which green pixels are removed then the image is segmented useful segment used for extraction finally texture statistics is completed and according to analysis disease prevention is provided	SVM algorithm gives the better result as compare to other algorithms. This approach can also be developed using normal techniques like JAVA, but using Matlab gives the efficient and effective result

Table 1: Table of Comparison

CONCLUSION

In this work, it is been concluded that plant disease detection is the technique to detect infected portion from the leaf. The plant disease detection consist 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 is reviewed and discussed in terms of various parameters

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