Review on Detection and Classification of Vegetable Diseases

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Abstract

Diseases in vegetable can cause significant economic, social & ecological loss globally. The disease can affect any part of the crop. For analysis of different types of diseases image processing has been proved to be an effective tool in various fields. Usually, for manual inspection the features of the diseases are extracted. But by machine inspection diseases can be identified automatically and it can be great profit to those users who have not having knowledge about the crop that they are cultivated .There are many classification techniques such as K-mean clustering , fuzzy c-mean clustering, Genetic Algorithm(GA), Back Propagation Neural Network (BPNN), Support Vector Machine(SVM) and Principal Component Analysis (PCA) etc. The aim of this research work is to present an overview of different methods and techniques which was followed in some important research work in the field of image processing for vegetable diseases and gives the general approach to use these techniques.

Keywords: Back Propagation Neural Network Principal Component Analysis Image processing Genetic Algorithm K-mean Clustering Vegetable Diseases.

Introduction

India is an agricultural country where around 70% of the population depends on the agriculture [1]. Losses in the vegetable crop due to diseases are approximately 10 to 30%.Various pathologies like fungal, bacterial, and virus, etc. affects the vegetables and has the potential to cause economic, social and ecologic loss worldwide [2]. Disease identification is a tedious task and mostly diseases are found on leaves, stems and fruit of the vegetable plant. In the past various techniques have been used for detecting and diseases are prevented to minimize any type of losses in vegetable crop. Generally diseases occur in the early stages which may not be seen through naked eye easily. Some disease needs powerful microscopes or electromagnetic spectrum. Images of the vegetable disease are easily processed through digital technology. Therefore, the image processing techniques can be helpful solution for the problem. Applications of image processing in the field of agriculture: (1)To detect the disease infected leaf, stem and fruit, (2)To find affected area by disease, (3)To identify shape of affected area, (4) To find color of affected area and (4)To find the shape and size of vegetables or fruits[3].

Vegetable Diseases Analysis and Its Symptoms

Tomato Diseases

Tomato is the red berry type fruit which can be consumed in different ways, as in ingredient in many dishes.Tomato originates from the nightshade family, Solanaceace. Xu G (2011) identifies the nitrogen and potassium diseases in tomato [4]. Shruti (2014) aims to analyze the fungus in tomato crop using image processing [5].

a) *Anthracnose*: This disease is caused by the fungus which affects leaves, stems and fruit [6]. Symptoms are small circular, bruised spots on the skin that invite other fungus to infect the interior of the fruit. Fig. 1 shows the Anthracnose disease.

b) *Early Blight Disease*: This disease is caused by the fungus Alternaria solani. Molina (2014) proposed an automatic detection method using color based classification of this disease [7]. Symptoms appears on the lower, older leaves as small brown spots with concentric rings. Fig. 2 shows this disease.

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Fig. 1. Anthracnose

Fig. 2. Early Blight

Potato Diseases

Potato (Solanum tuberosum) belongs to Solanaceae family, also known as nightshades [8]. Potatoes are susceptible to different types of diseases. It gets infected on the roots, tubers and leaves.

a) *Pink Rot*: This disease is found in tuber. It is caused by a soil-borne fungus called Phytophthora erythroseptica. Symptoms are tough, leathery, rubber-like texture [8]. Fig. 3 shows this disease.

b) *Late Blight*: This disease is found in leaf of the potato plants. Sandika Biswas (2014) presents a technique for identification of this disease [9]. It is caused by the fungus Phytophthora infestans. Symptoms of this disease are circular grayish brown spots on the leaves. Fig. 4 shows this disease.

Fig. 3. Pink Rot

Fig. 4. Late Blight

Chilli Plant Disease

Destruction of chilly plant occurs due to living (biotic) and nonliving (abiotic) agents. Symptoms are berrant leaf growth, color contortion, stunted growth, fossilize and flawed pods. Zulkifli Bin Husin (2013) proposed a method for detection of chili leaves disease suing RGB model[10].

a) *Frog-eye spots*- This is caused by the fungus Cercospora capsici. Symptoms are small round spots which are light gray in the middle, reddish brown with a gray centre and a reddish-brown margin [11]. Fig. 5 shows this disease.

b) *Anthracnose*- It is caused by the mold Colletotrichum coccodes. Symptoms found on mature and immature fruits. It is characterised by depressions and round, light brown spots. Fig. 6 is showing this disease [11].

Fig. 5. Frog-eye Spots

Fig. 6. Anthracnose

Lemon Diseases

Citrus limon belongs to Rutaceae family and it is a small evergreen tree. It is used as an ingredient in foods and drinks.

a) *Citrus Canker*: This disease is caused by bacteria. Dr.K.Thangadurai (2015) gives an algorithm for detecting this disease using GA [12]. At early stages, the infected leaves have white spongy spots and it will turn into gray or brown color. Young lesions on leaves are usually surrounded by yellow halo [13]. Fig. 7 shows this disease.

b) *Anthracnose:* This disease is caused due to fungus. Dark spots are covered on leaves and fruits [13]. In Fig. 8, this disease is shown.

Fig. 7. Citrus Canker

Fig. 8. Anthracnose

Gram

Gram generally known as ‘chick pea’ or ‘Bengal gram’ and is used as pulse crop in India. Disease can occur on leaf, stem and pods.

a) *Chickpea rust*: It develops in cool and weather condition. Initially it appears on leaves as small, round, brown powdery pustles, Shivanand N (2014) detects this disease by using image processing[14]. Fig. 9

shows this disease.

b) *Sclerotinia stem rot (White mold):* This disease is caused by fungus. Symptoms of this disease are plants quickly wilting and dying without turning into yellow [15]. Fig. 10 shows this disease.

Fig. 9. Chickpea Rust

Fig. 10. Sclerotinia Stem Rot

Onion

Onion is the most commercial vegetable grown all over the worldwide. Onion Crop is attacked by number of diseases at different growth stages.

a) Sour Skin disease: This disease is caused by bacterium Burkholderia cepacia in Vidalia sweet onion. Weilin Wang (2009) presents a method for detection of this disease using near-infrared hyperspectral imaging technology [16]. This disease may cause pulmonary infection in humans. Fig. 11 shows this disease.

Fig. 11. Sour Skin Disease

Cucumber

Cucumis sativus belongs to Cucurbitaceae family and it is an edible fruit [17]. The cucumber plant is having large leaves and curling tendrils which are spread out in the ground.

a) *Downy mildew*- This disease is caused by Oomycete. Youwen Tian (2012) detects this disease by using hyper spectral imaging technique [18]. The characteristics of this disease are yellow or brown spots on the upper side of the leaves and fluffy purplish mildew on underside of leaves. Fig. 12 shows this disease.

Fig. 12. Downy mildew

Soyabean

Soyabean is a species of legume and it is an edible bean which has numerous uses. Generally on soyabean leaves disease occurs.

I. *Soyabean rust:* It generally found in winter season. Symptoms found on the mature leaves [19]. Initially started on the lower leaves as small spots as gray color and on later increase in size into reddish brown color. Lili Ma (2010) diagnoses the efficiency and excess of nitrogen in soyabean leaves using image processing [20]. Fig. 13 shows this disease.

Fig. 13. Soyabean Rust

RELATED WORK

Some important research work for identifying the diseases are described below

Sandika Biswas et al. [9] proposed a method to identify the severity of potato Late Blight disease using image processing techniques and neural network. Total 27 diseased leaf of potato were used for inspection and the images are captured under the complex background. Author uses a decorrelation stretching technique for enhancing the color in the input images. To segment the

images Fuzzy C-Mean clustering approach is used. Neural network is used for classifying the disease. Implemented method shows the result of 93% accuracy.

Shivanand N et al. [14] proposed an automated method to estimate the percentage of rust in chickpea leaves by using image processing. Acquired images are preprocessed using filtering techniques, and then green pixels are masked and removed using specific threshold value. Result shows the total area affected by disease and healthy area.

Molina J. F. et al. [7] proposed a prototype for the detection of early blight disease in tomato using the color-based classification. Region of Interest characterization was done by the experts for total 190 images. Color characterization based on three descriptors such as Color Structure Descriptor (CSD), Scalable Color Descriptor (SCD) and Color Layout Descriptor (CLD).Results shows that CSD is better than SCD and CLD.

Dr. K.Thangadurai, K. Padmavathi [12] aims to detect the Citrus Canker disease in citrus plant like lemon, orange, grapes etc. by using genetic algorithm. To obtain the optimum result author use the genetic algorithm. Initially, image was acquired and preprocessing was done to remove noises. After that segmentation was performed and then extracted feature applied to genetic algorithm.

Wang, L. et al. [21] presented a technique for the recognition of wheat stripe rust and powdery mildew. For recognition of disease author gives a new version of Rotational Kernel Transformation directional (IRKT) feature. Acquired images of infected and non-infected leaves are converted to HSV and YCbCr color spaces. For segmentation Otsu's method used.From segmented areas the kernel based IRKT directional feature used for detection of edges and achieved the statistics directions of noise image. The result showed 97.5% recognition accuracy.

Haiguang Wang et al. [22] present a model to improve the accuracy of image recognition and diagnosis of plant diseases. Two grape diseases plant and two wheat diseases plant were used for research. Image identification is done on the basis of image processing and pattern recognition.K-Means clustering algorithm was used for segmentation of images. After Segmentation, Back Propagation networks (BPN) is used as a classifier. Result shows that through BPN disease was effectively identified. Principal Component Analysis (PCA) is used to dimensions the feature data. For optimum resolution result, prediction accuracy and fitting accuracy for both the grape diseases and wheat diseases were 100%.By PCA, for grape diseases ,prediction accuracy was 97.14% and fitting accuracy was 100% and for wheat diseases prediction and fitting accuracy are 100% respectively.

Xu G et al. [4] present a technique to identify two deficiencies (nitrogen & potassium) in a tomato plant. Color features are extracted based on L× a× b color space in which b^* component considered only. Texture features are also extracted based on Difference operators, Fourier transform, and Wavelet packet decomposition. Genetic algorithm is used for extraction of selected features. Finally the optimized feature combined to fuzzy K-Nearest neighbor classifier for identification.

Youmen Tian, Lin Zhang [18] proposed a method for detecting the Downy Mildew disease in cucumber by using hyperspectral imaging technology. Initially, hyperspectral images of downy mildew affected cucumber leaves are acquired. To obtain the featured images, principal component analysis (PCA) collects the optimum wavelength. Then collected images are combined with the featured image by using fusion technology to get the new images by pixel image fusion. At last, image enhancement, binarization, corrosion and dilatation methods are applied to detect the downy mildew disease. Result shows the accuracy of 90% for detecting the downy mildew disease in cucumber.

Weilin Wang Chi Thai et al. [16] aims to detect the Sour Skin disease in Vidalia sweet onion by using a liquid crystal tunable filter based on hyperspectral imaging (HSI) system. Initially, a number of hyperspectral reflectance and transmittance imaging tests were conducted to examine useful image and spectral feature for detecting the disease. The test results shows that a sour skin infected region was darker than healthy flesh region in the spectral region of 1200-1300nm.

Zulkifli Bin Husin et al. [10] aims to identify the chili plant diseases using RGB color model. Initially, to acquire the images in RGB form LABVIEW software is used. MATLAB tool is used for recognition of diseases in chili leaf. Total 120 dataset was for inspection. Result shows the accuracy of 93.3%.

Shruti, Nidhi Seth [5] proposed a novel machine system that determines the nature of fungus based on spots on the leaves of tomato. Initially, image of leaves are acquired

and then image is segmented on the basis of nature and size of fungus and a criteria was set for accepting and rejecting the crop quality based on fungus level.

S. Arivazhagan et al. [23] proposed an algorithm for detecting and classifying the plant leaf diseases by using texture features. Algorithm consist of four steps, in the first step for RGB input image a color transformation structure was developed, then the green pixel was masked and removed using specific threshold value followed by segmentation process, for creating the useful segments texture statistics was calculated, and finally features which are extracted are applied to classifier. Author uses 500 plant leaves for inspection and by implementing the algorithm result shows an accuracy of 92%.

Lili Ma et al. [20] aim to diagnose the deficiencies and excess of nitrogen in soyaben leaves using image processing techniques. In this research work, 4 gradient of nitrogen soyabean's were planted i.e. 0%, 50%, 100%, 150% of the nitrogen content. Images are preprocessed, enhanced and background was separated using minimum error threshold method. This method made distinction between normal and excessive loss of soyabean leaves.

METHODOLOGY

General approach

For identification and classification in vegetable diseases there are various approaches of image processing and neural network can be applied. A Projected approach for this identification and classification are shown in below Fig. 13

1) *Image Acquisition*- Infected and non-infected images of different vegetables are acquired through digital devices [5][24].
2) *Image Preprocessing*- There are three steps of image preprocessing i.e. image cropping, image converting and image enhancement [5][24]. This process is performed to remove noises from the image.
3) *Image Segmentation*- Segmentation subdivides an image into constituent regions or objects [24]. There are different methods for segmentation such as K-Means Clustering, Fuzzy C-Mean Clustering, Thresholding, Region Growing etc.
4) *Feature Extraction*- Features are extracted from the segmented image to select the Region of Interest (ROI) area [9] [24].There can be number of features extracted from an image such as color, texture and shape features etc.
5) *Identification & Classification*- The aim of this process is to arrange the images into logical data .Various techniques of classification are Neural Network, Support Vector Machine, Genetic Algorithm, Feature analysis etc[9] [24].

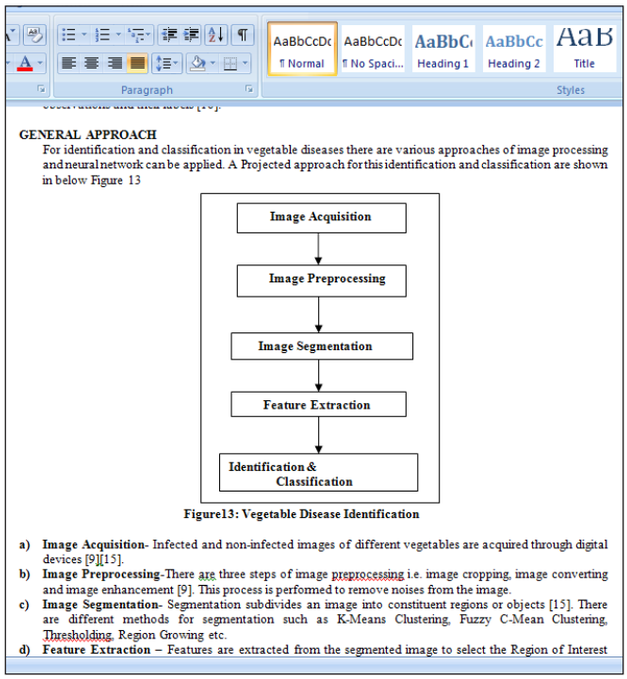

Fig. 6. Vegetable Disease Identification

Different Identification Techniques Used for Detection

For identification of diseases in vegetable there are many techniques available.But which is to be select is a tedious task.

1) *Manual*- In this approach a person identifies the disease in vegetable that is having knowledge and experience on it. This process is a time consuming and it may have a lot of chances of misconception for identifying the disease in vegetables.
2) *Genetic Algorithm (GA)*- Genetic Algorithm is used for optimization.GA is a class of optimization procedures. GA is a method for solving both constrained and unconstrained problems which is based on natural selection. At every step, GA selects the individuals as a parents from the current genera-

tion and then generate the children for the next generation[24].GA does not gives "best solution" but it finds "good solution" always. Advantages of GA are efficient method for solving the complex problem and handle large complex problem also.

3) *Back Propagation Neural Network (BPNN)*- Artificial neural networks were developed from the (human) neural system. BPNN consist of 3 layers having one input, one hidden and one output layer [24]. Advantage of BPNN are it is easy to understand and can be easily implemented. Disadvantages of BPNN are time consuming and complex.

4) *Principal Component Analysis (PCA)* - It is used for variable reductions and it selects the weights on the basis of frequency in the frequency domain. It cannot separate the class linearly [22] [24].

5) *K-Nearest Neighbor*- It is applicable to the small dataset which are not trained. If the size of data set is large then computation speed will be more. It is expensive and sensitive to irrelevant inputs. It is used to calculate minimum distance [24].

6) *Support Vector Machine (SVM)*- SVM is used for classification and regression. SVMs are collection of supervised learning methods. The goal is to find some function that describes the relation between observations and their labels [24].

OBSERVATION & RESULTS

TABLE I. contains the overview of some important research work done for identification and classification on vegetable diseases.

Table I. Comparative Study of Identification & Classification Techniques on different Vegetable Diseases

S.No.	*References*	*Title*	*Applied technique*	*Result*
1.	Sandika Biswas(2014) [9]	Severity Identification of Potato Late Blight Disease from Crop Images Captured under Uncontrolled Environment	Fuzzy C-Mean Clustering & Neural Network	This approach achieves an accuracy of 93% for 27 images.
2.	Dr.K.Thandadurai(2015) [12]	Citrus Canker Disease Detection Using Genetic Algorithm in Citrus Plants", International Journal of Trend in Research and Development	Color & Texture Features applied to Genetic Algorithm	Results shows that Genetic Algorithm gives an optimized result
3	Xu G(2011)[4]	Use of leaf color images to identify nitrogen and potassium deficient tomatoes	Genetic Algorithm	Experime-ntal result shows the accuracy of diagnostic system is above 82.5%
4.	Molina(2014) [7]	Automatic Detection of Early Blight on tomato Crops using a Color Based Classification Strategy	Color based classification(Color Structure Descriptor,Color Layout Descriptor,Scalable color descriptor)	Result shows that Color Structure Descriptor is better than Color Layout Descriptor and Scalable color descriptor.
5.	Youwen Tian ,Lin Zhang(2012) [18]	Study on the Methods of Detecting Cucumber Downy Mildew Using Hyperspectral Imaging Technology	Hyper Spectral Imaging System	This method gives an accuracy of nearly 90% disease detection in cucumber
6.	Weilin Wang, Chi Thai, Changying Li,Ron Gitaitis, E. W. Tollner, Seung-Chul Yoon(2009) [16]	Detection of Sour Skin Diseases in Vidalia Sweet Onions Using Near-infrared Hyperspectral Imaging	Hyper Spectral Imaging System	Result shows that Hyper Spectral Imaging technique is able to detect the disease.
7.	Wang L, Dong F, Guo Q, Nie C, Sun S(2014)[21]	Improved Rotational Kernel Transformation Directional Feature for Recognition of Wheat Stripe Rust and Powdery Mildew	Improved Rotational Kernel Transformation Feature &Otsu's segmentation method	Result showed 97.5% recognition accuracy

(*Contd.*)

Table I. (*Contd.*)

S.No.	*References*	*Title*	*Applied technique*	*Result*
8.	Lili Ma(2010) [20]	Color Analysis of Leaf Images of Deficiencies and Excess Nitrogen Content in Soybean Leaves	Image processing	Result made standard distinction between normal and excessive loss of soyabean leaves
9.	Shivanand N(2014)[14]	Analysis and Estimation of Rust Disease in Bengal gram Based on Thresholding and RGB Extraction using Image Processing.	RGB and texture feature extraction and thresholding technique	Result gives the percentage of rust in chickpea leaves.
10.	Zulkifi Bin Husin(2013) [10]	Plant Chili Disease Detection using the RGB Color Model	RGB color feature applied to MATLAB and LABVIEW software	This research work detects 93.3% disease from 120 chili images plant.

Conclusion and Future Scope

In this research work we review and summarize the image processing techniques that have been used for identifying and classifying the vegetable diseases. The general techniques used for detection of vegetable diseases are Genetic Algorithm, Feature analysis, BPN network, K-mean clustering etc. These methods are used for analyzes the healthy and disease affected vegetables. In the review research work we find that method they are implemented for detection of vegetable disease are successfully achieved. Finally, overall improvement on review research work can be made by using hybrid approach to get the optimized way for detection and classification of vegetable diseases.

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