International Journal of Engineering & Technology, 7 (3.34) (2018) 874-881

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Plant Disease Detection: a Review of Current Trends

1Mrs. Gaganpreet Kaur, 2Sarvjeet Kaur, 3Amandeep Kaur

1Assistant Professor (CSE), Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India
2Student (CSE), Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India
3Student (CSE), Sri Guru Granth Sahib World University, Fatehgarh Sahib, Punjab, India
**Corresponding author E-mail: [1]gaganpreet_cse@sggswu.org , [2] aulakhsarvv18@gmail.com , [3]amanaulakh1001@gmail.com*

Abstract

Awareness of plant leaf diseases is very salient task in agricultural environment. The prior identification of plant leaf diseases can help to prevent the losses that farmers face due to various plant leaf diseases. The plant leaf diseases in image processing are detected by observing the patterns of leaf images at certain period of time. Observation and identification of leaf diseases is not an easy task to do manually because it requires a lot of time, money, effort etc. So it is better to identify the diseases through an automated system in image processing. There are various image processing techniques available for the detection of plant leaf diseases which consists of some basic steps such as, image acquisition, image pre-processing, image segmentation, feature extraction and image classification. Various types of filtering techniques can be used to de-noise the image so that the diseases can be detected efficiently and clearly because noise creates problems in identification of diseases. This paper presents a survey on various methods used for detection of plant leaf diseases in image processing. Some segmentation techniques like thresholding, edge based, region based, clustering based and partial differential equation based are discussed.

Keywords: *Image acquisition, Image Preprocessing, Image Segmentation, Feature Extraction, Classification, Biotic and Abiotic factors, Fugal Diseases, Bacterial Diseases and Viral Diseases.*

1. Introduction

Food is the basic need of a human in the whole world and this need is fulfilled by the farmers who grow variety of crops. But in today's environment the farmer is suffering various types of problems in growing the crops. The farmer does not suffer from environmental problems only he suffer a great loss in agriculture due to various kind of plant leaf disease that effect the yield of crops[1]. Farmers suffer economic loss due to the increase of leaf diseases[2]. It is not possible for farmers to identify the leaf disease manually, so image processing techniques are best to use for the automated detection of leaf diseases that requires less time, money and effort as compared to manual methods[3]. With the use of automatic identification of leaf diseases at early stage, the production of crops is increased[4]. Various symptoms like spot on leaves and change in leaf color can be used to identify the disease at early stage[5]. The color of leaf changes when it is affected by disease. The color of healthy leaf and diseased leaf will be different[6]. The plant diseases have a great influence in reducing quality and quantity of crops[7]. Using various image processing techniques such as segmentation, classification etc. the leaf diseases can be identified at early stage and the production of crops can be increased[8].

2. Causes of Plant Diseases

There are two types of factors that cause plant diseases: Biotic factors and Abiotic factors[9]. The diseases caused by living components belong to biotic factors such as Fungi, Bacteria, Viral. The diseases caused by nutritional deficiencies, poor soil pH, poor light and extreme weather belongs to abiotic factors[10].

Figure 1: Causes of Plant Diseases

3. Types of Plant Diseases

Plant diseases can be divided into three types: Fungal diseases[9]-[14], Bacterial diseases[9]-[14] and viral diseases[9]-[14].

3.1. VR 360 Set Depending on the Direction

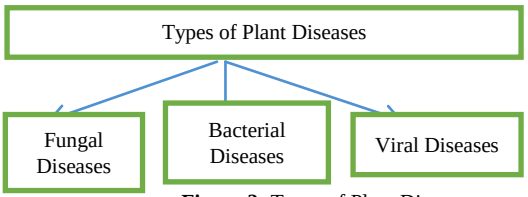

Figure 2: Types of Plant Diseases

3.2. Fungal Diseases

Some of the basic fungal diseases are Wilt, Powdery mildew, Downy mildew, Anthracnose, Alternia, Leaf spot, Grey mildew, Rots, Cankers, Molds etc.[12],[15]. There is fungus on whole plant when the Fungal disease is present[16]. Fungal diseases can be controlled by using various kind of fungicides[9]. Fungi diseases are identified through their morphology[12].

(a)Late blight

(b) Early bight

(c) Downy mildew

Figure 3: Fungal diseases on leaves [2]

3.2. Bacterial Diseases

Most common bacterial diseases are Bacterial blight, Crown gall, Wilts, Soft spots etc.[12],[15]. These diseases are recognized by pale green spots on the leaves. The spots look like dead spots[17].

Figure 4: Bacterial disease- leaf spot [2]

3.3. Bacterial Diseases

Some of the viral diseases are Leaf curl, Leaf crumple, Leaf roll etc.[15]. Viral diseases are caused by virus that is very difficult to identify. The leaves infected by viral diseases may be frizzed and furrowed[18].

Figure 5: Viral Disease- Mosaic virus [2]

4. Steps for Plant Disease Detection

Various steps are followed in image processing to detect the leaf disease are:- Image acquisition, image preprocessing, image segmentation, feature extraction and classification [2],[3],[8],[13],[14] ,[16],[17],[19].

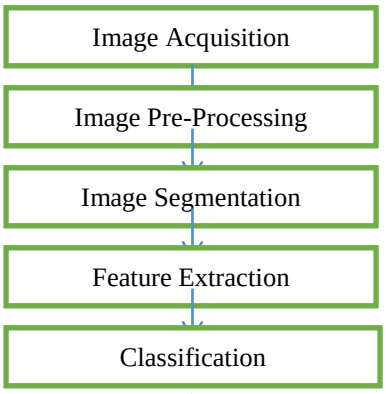

Figure 6: Steps for Plant Disease Detection

4.1. Image Acquisition

In Image acquisition step, images of plant leaves are acquired to perform some operations on image in Image processing system[20]. The images can be acquired through a digital camera or can be downloaded from a authenticated plant image site. The acquired images and their features are stored in an image database[21]. The image database consists of healthy set and diseased set of images[22]. The efficiency of image database depends on eminence of images so the images should be of high quality[23]. The efficiency of database defines the vigor of the system[24]. The images are altered into device independent color space[25].

4.2. Image Pre-Processing

The pre-processing techniques are accomplished to make the image applicable for further processing. The image is resized in pre-processing step of plant disease detection[22]. The pre-processing of images consists of image enhancement, color conversion, removal of noise[23]. In Image enhancement the quality of image is enhanced to increase the visuality. In color space conversion, the RGB image is converted into greyscale using various color models such as CIELAB, YCbCr and HSV. For the purpose of noise removal, various filter are used[24]. The RGB image is converted into CIELAB, YCbCr and HSV because RGB is device dependent color space and image processing system needs images in device independent color space models[26]. After performing the resizing, color space conversion and enhancement, Histogram equalization methods are used to designate intensities[27].

4.3. Image Segmentation

In Image Segmentation the image is segmented into various part based on the similarity between various features. The parts having same features are grouped together[28],[31],[32]. Image can be analyzed easily with segmentation. . Image segmentation can be Local segmentation in which a specific part of image is considered and Global segmentation in which the whole image is considered[29].

Table 1: Summarized survey of various segmentation techniques in plant disease detection

S.No.	Author	Segmentation Technique	Year
1.	Siddharath Singh Chouhan, Ajay Kaul, Uday Pratap Singh and Sanjeev Jain [33]	Region Growing Segmentation technique.	2017
2.	Varun Gupta, Namita Senger and Malay Kishore Dutta [34].	Thresholding based Segmentation technique	2017
3	Bhumilka S.Prajapati, Vipul K.Dabhi and Harshadkumar B.Prajapati [35]	Otsu's Thresholding Segmentation Technique	2016
4.	Pranjali B. Padol and Prof. Anjali A. Yadav [36]	k-Means Clustering Segmentation Technique	2016
5.	Pawan P.Warne and Dr.S.R.Ganokar [37]	k-Means Clustering Segmentation Technique	2015
6.	Prof. R. N. kadu, S. Kangane, S. Vikhe, R. Pandita and V. Inamke [38]	Otsu's Thresholding Segmentation Technique	2015
7.	Deepak J. Dange and Prof. M. A. Sayyad [39]	k-Mediods Clustering Segmentation technique.	2015
8.	P.R. Rothe and R. V. Kshirsagar [40]	Active Contour model Segmentation technique	2014
9.	Eric Hitimana and Oubong Gwun [41]	Fuzzy C-Means Clustering Segmentation technique	2014
10.	Smita Naikwadi and Niket Amoda [42]	k-Means Clustering Segmentation Technique	2013
11.	Faithpraise Fina, Philip Birch, Rupert Young, J. Obu, Bassey Faithpraise and Chris Chatwin [43]	k-Means Clustering Segmentation technique	2013

4.4. Feature Extraction

Feature extraction step retain the various image features that are passed to classifier as its input. Classifier easily classify the image data into clusters by using features. Features can be grouped into two classes:

Local features: - Geometric features such as concave/convex, endpoints, branches etc. belongs to the category of local features.

Global features:- Topological features such as connectivity, number of holes etc. belong to the category of global features[47].

Table 2: Some Feature Extraction Techniques are summarized as follows:

S.No.	Author	Feature Extraction Techniques	Year
1.	Miss. Amruta Ambatkar, Miss. AshwiniBhandekar [55]	Spatial Gray-level Dependence Matrices (SGDM) for Feature Extraction	2017
2.	Pooja V, Rahul Das and Kanchana V [56]	Color Co-occurrence Matrix for Feature Extraction	2017
3.	Monzurul Islam, Anh, Dinh, Khan Wahid and Pamkaj Bhowmik [50]	Grey Level Co-occurrence Matrix for Feature Extraction	2017
4.	Girish Athanikar, and Priti Badar [53]	Grey Level Co-occurrence Matrix for Feature Extraction	2016
5.	Usama Mokhtar, Mona A. S. Ali, Aboul Ella Hassenian, and Hesham Hefny [52]	Gabor Filters for Feature Extraction	2015
6.	Niveditha.R.kakade, Dnyaneswar.D.Ahire [51]	Grey Level Co-occurrence Matrix for Feature Extraction	2015
7.	Garima Tripathi and Jagruti Save [57]	Color Co-occurrence Matrix for Feature Extraction	2015
8.	Aakanksha Rastogi, Ritika Arora, Shanu Sharma [58]	Grey Level Co-occurrence Matrix for Feature Extraction	2015
9.	Smita Naikwadi and Niket Amoda [42]	Color Co-occurrence Matrix for Feature Extraction	2013
10.	Md. Nazrul Islam, M.A. Kashem Mahmuda Akter and Md.Jamilur Rahman, [59]	Color Co-occurrence Matrix for Feature Extraction	2012
11.	Anand.H.Kulkarni and Ashwin Patil R. K	Gabor Filters for Feature Extraction	2012

4.5. Classification

Classification is of two types supervised classification and unsupervised classification. In the supervised classification the set of classified classes are known in advance but on the other side in unsupervised learning set of classes are not known. Classifiers are used for the purpose of classification [60]. Techniques for classification are:- artificial neural network [21],[60], decision tree [60], support vector machine(SVM) [40],[60],[62], Fuzzy measure etc.[46],[48],[60],[61],[62].

Table 3: Summarization of Classifiers:

S.No.	Author	Classifier	Year
1.	Bassam AL-Qarallah, Bashar AI-Shboul, Hazem Hiary, Asmaa Aljawawdeh, Hamad Alsawalqah and Monther Tahat [63]	SVM (Support Vector Machine) Classifier	2017
2.	Priya Pradeep Naswale and P.E.Ajmire [60]	Neural Network, Artificial Neural Network, Support Vector Machine, Fuzzy Measure	2016
3.	Harshal Waghmare, Radha Kokare and Yogesh Dandawate [64]	SVM (Support Vector Machine) Classifier	2016
4.	Amrita.Joshi and B.D Jadahv [65]	k-Nearest Neighbor (kNN) Classifier	2016
5.	Santosh Kumar Sao, and Sandeep B. Patil [62]	SVM (Support Vector Machine), PNN (Probabilistic Neural Network) Classifiers	2015
6.	Rajleen Kaur and Dr. Sandeep Singh Kang [66]	SVM (Support Vector Machine) Classifier	2015
7.	Savita N. Ghaiwat and Parul Arora [67]	k-Nearest Neighbor Classifier (kNN), SVM (Support Vector Machine), Artificial Neural Network (ANN), Self-Organizing Map, Probabilistic Neural Network (PNN) Classifiers	2014
8.	Mr. Sachin B. Jagtap, Mr. Shailesh M. Hambarde [68]	Artificial Neural Network (ANN) Classifier	2014

9.	Pooja Kamavisdar, Sonam Saluja and Sonu Agrawal [61]	Artificial Neural Network (ANN), Support Vector Machine (SVM), Decision Tree, Fuzzy Measure	2013
10.	Auzi Asfarian, Yeni Herdiyeni, Aunu, Kikin and Hamzah Mutaqin [69]	Probabilistic Neural Network (PNN) Classifier	2013
11.	Anand.H.Kulkarni and Ashwin Patil R. K. [21]	Artificial Neural Network (ANN) Classifier	2012
12.	Haiguang Wang, Guanlin Li, Zhanhong Ma, and Xiaolong Li [70]	Probabilistic Neural Network (PNN), Back Propagation (BP), Generalized Regression Networks (GRNN), Radial Basis Function (RBF) Classifiers	2012
13.	Abdul Kadir, Lukito Edi Nugroho, Adhi Susanto, and Paulus Insap Santosa [50]	Probabilistic Neural Network (PNN) Classifier	2011
14.	Guili Xu, Fengling Zhang, Syed Ghafoor Shah, Yongqiang Ye, and Hanping Mao [49]	Fuzzy k-Nearest Neighbor (kNN) Classifier	2011

5. Literature Review

Table 4: Summarized literature Survey:

S.No.	Disease Detected	Plant	Image Processing Techniques	Author
1.	Alternia alternate, Anthracnose, Bacterial Blight, Cercospora Leaf Spot	Pomegranate, Rice, Soybean, Carrot, Rose and Watermelon Leaf	k-Means Segmentation to find the Region of Interest, Color and texture features are extracted and SVM (Support Vector Machine) is used for classification	Pooja Kulinavar, Vidya I. Hadimani [8]
2.	Alternia Leaf Spot, Bacterial Blight and Cercospora Leaf Spot	Cotton Leaf	Thresholding Segmentation, GLCM (Grey Level Co-occurrence Matrix) for feature extraction, SVM classifier for classification	Bhumika S.Prajapati, Vipul K.Dabhi and Harshadkumar B.Prajapati [16]
3.	Powdery Mildew	Cherry leaves	Morphological Operators and Histograms	Varun Gupta, Namita Sengar, Malay Kishore Dutta, Carlos M.Travieso, Jesus B. Alonso [33]
4.	Common Rust, Ceder Apple Rust, Late Blight, Leaf Curl, Leaf Spot and Early Blight	Various kind of leaves	Bacterial foraging optimization based Radial Basis Function Neural Network (BRBFNN) for identification and classification of plant leaf diseases	Siddharath Singh Chouhan, Ajay Kaul, Uday Pratap Singh and Sanjeev Jain [34]
5.	Downy mildew and Powdery mildew	Grape Leaves	k-Means clustering segmentation and SVM Classification	Pranjali B. Padol and Prof. Anjali A. Yadav [36]
6.	Alternia Leaf Spot, Cercospora and Red Leaf Spot	Cotton Leaves	Histogram Equalization , k-Means clustering segmentation and Neural Networks	Pawan P.Warne and Dr.S.R.Ganokar [37]
7.	Late Blight and Early Blight	Potato leaves	GLCM for feature extraction, Otsu Thresholding and SVM Classification	Monzurul Islam, Anh, Dinh, Khan Wahid and Pamkaj Bhowmik[50]
8.	Pest identification	Various types of Crops	Color feature extraction, Morphological Operaters and SVM Classification	Preetha Rajan, Radhakrishnan. B, and Dr.L. Padma Suresh [59]
9.	Black Spot, Anthracnose and Rust	Rose	k-Means Clustering Segmentation, Color Co-occurrence Matrix(CCM) and Laplacian Filters	Miss. Amruta Ambatkar, Miss. AshwiniBhandekar, Miss. Avanti Tawale, Miss. Chetna Vairagade, Miss. Ketaki Kotamkar [55]
10.	Early Blight, Late Blight, Powdery Mildew and Septoria	Leaves	k-Means Clustering Segmentation, Color Co-occurrence Matrix(CCM) and Neural Network Classification	Garima Tripathi and Jagruti Save [57]
11.	Downy Mildew and Black Rot	Grapes Leaves	Pattern Recognition, Fractal Based Features and Multiclass SVM	Harshal Waghmare, Radha Kokare and Yogesh Dandawate [64]
12.	Bacterial, Blight, Blast, Brown Spot and Sheath	Rice	k-NN ,MDC Classification, YCbCr, SVM	Amrita.Joshi and B.D Jadahv [65]
13.	Stripe Rust, Leaf Rust, powdery Mildew and Downy Mildew	Grapes and Wheat	k-Means Clustering segmentation and Back Propagation Neural Network	Haiguang Wang, Guanlin Li, Zhanhong Ma, and Xiaolong Li [70]
14.	Anthracnose, Powdery Mildew, Downy Mildew, Grey Mildew, Leaf Spot, Rot, Wilt, Leaf Blight, Leaf Rust, Smut, Late Blight and early Blight	Mango, Grape, Pomegranate, Beans, soybean, Sunflower, Tomato, Chili and Sugarcane	GLCM, GLRLM, k-NN Classification, Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA), Probabilistic Neural Network (PNN), SVM, Back Propagation Neural Network(BPNN)	Jagadeesh D. Pujari, Rajesh Yakkundimath and Abdulmunaf S. Byadgi [71]
15.	Powdery Mildew	Guava	Region growing segmentation, YCbCr and CIELAB color models , Scale Invariant Feature Transform (SIFT) for feature extraction. k-NN and SVM Calssification	M.Thilagavathi and S.Abirami [72]
16.	Leaf Blight	Soybean	Multithresholding , Color based and cluster based methods for segmentation, SIFT, SVM classification.	Yogesh Dandawate and Radha Kokare [73]
17.	Black Leaf Spot and Sun Scorch	Orchid	Border segmentation, Morphological operators, Pattern recognition and GUI	Wan Mohd Fadzil W.M.N, Shah Rizam M.S.B.R. Jailani, Nooritawati M.T [74]

18.	Canker	Citrus	Histogram Equalization, GLCM and SVM	Shoby Sunny and Dr. M. P. Indra Gandhi [75]
19.	Spots	Sugarcane	Thresholding, SVM (support Vector Machine) , L*a*b* color model and GLCM (Gray Level Co-Occurrence Matrix) .	Evy Kamilah Ratnasari, Mustika Mentari, Raith Kartika Dewi and R.V. Hari Ginardi [76]
20.	Downy mildew and Powdery mildew	Grape leaf	Feed Forward Back Propagation Neural Network, K-means segmentation, Gray Level Co-occurrence Matrix (GLCM)	Sanjeev S Sannakki, Vijay S Rajpurohit, V B Nargund and Pallavi Kulkarni [77]
21.	Early scorch, Cottony Mold, Ashen Mold, Late Scorch and Tiny Whiteness	Cotton leaf	Otsu's Thresholding , K-means segmentation, Color Co-occurrence Method (CCM), Artificial Neural Network (ANN) classification	Mr. N.S. Bharti and Prof. R.M Mulajkar [78]
22.	Alternaria Atternata, Anthracnose and Bacterial Blight	Plant leaves and stem	K-means segmentation, Support Vector Machine (SVM) calssification	Rakesh Chaware, Rohit Karpe, Prithvi Pakhale and Prof. Smita Desai [79]
23.	Brown Spot	Rice	L*a*b* color space, K-means segmentation, Euclidean Distance	Prabira Kumar Sethy, Baishalee Negi and Nilamani [80]
24.	Powdery Mildew and Downy Mildew	Grape leaf	HIS color space, Histograms, Morphological operators, Gabor filtering, Artificial Neural Network (ANN) classification	Sushil R. Kamlapurkar [81]
25.	Early Scorch, Bacterial Leaf Spot	Banana, Beans, Rose leaf	Smoothening filters, Thresholding, Color Co-occurrence Matrix (CCM), Support Vector Machine (SVM) classification	Vijai Singh and A.K. Misra [82]
26.	Blight, Leaf Nacrosis, Gray Mildew, Alternaria and Magnesium Deficiency	Cotton	K-Nearest Neighbor (KNN), Principal Component Analysis (PCA)	Viraj A. Gulhane and Maheshkumar H. Kolekar [83]
27.	Leaf Blotch, Leaf Spot and Rhizome Rot	Turmeric	Principal Component Analysis (PCA), Information gain, Relief-f, Support Vector Machine (SVM), Naïve Bayes classifier	Pream Sudha [84]
28.	Bacterial Leaf Blight, Septoria Brown Spot and Bean Pod Mottle	Soybean	K-means clustering, Thrseholding	Sachin. B. Jadhav and prof.Dr.. Sanjay B Patil [85]
29.	Early Blight, Septoria Leaf Spot, Bacterial Spot and Iron Chlirosis	Tomato	Kurtosis filters, Skewness filters, Inverse difference segmentation, Support Vector Machine (SVM) classification	Sagar Vetal and R.S. Khule [86]
30.	Alternia, Mosiac Rust, Anthracnose, Angular Spot and Powdery Mildew	Apple and Cucumber	Super pixel algorithm, K-means segmentation, Pyramid of Histograms of Orientation Gradients (PHOG) algorithms	Shanwen Zhang, Haoxiang Wang, Wenzhun and Zhuhong You [87]

6. Noise in Images and De-Noising Filters

6.1. Noise

Noise create undesirable information in digital images that may effect the quality of digital image. Noise can occur when the image is transmitted from one computer to another via a transmission medium. It is good to de-noise an image before detecting the features or necessary information in an digital image[88]. There are various types of noises such as, Gaussian Noise, Speckle Noise, Impulsed Valued Noise(Salt and Pepper Noise)[89],[90],[91],[92], Quantization Noise[90],[91], Periodic Noise, Photon Noise(Poisson Noise)[90],[92], Poisson Gaussian Noise, Structured Noise, Gamma Noise, Rayliegh Noise, White Noise, Brownian Noise(Fractal noise), etc.[88].

6.2. Filters for De-Noising Digital Images

The noise in digital images may cause problems in detecting various features of digital images. Usually the features observed in noisy image and an image that have no noise will be most different to each other. So it is always better to remove the noise using various filters to properly extract and observe the features of a digital image[88],[92]. In Image processing there is a variety of filters available to de-noise the digital image such as, Mean Filter, Median Filter[89],[92], Gaussian Filter, Weiner Filter[92], Kuan Filtering, Wavelet Transform for de-noising, Bilateral Filtering, Morphological Filtering, Homomorphic Filtering etc[88].

7. Conclusion

Detection of plant diseases at early stage is necessary because diseases reduce the production of crops. Image processing methods helps in detecting the diseases automatically whereas the manual detection is not an easy task as it require lot of money, time and effort. The review given in this paper provide informational knowledge in the field of agriculture that can be used by researchers to detect the diseases at early stage. Biotic and abiotic factors affect the crop production and leads to plant diseases. The plant diseases are detected by extracting the features of plant images and classifying these features that helps in detecting the condition of plant as healthy or unhealthy. Early disease detection increase the crop production. This paper present various image processing methods applied by various researchers in the field of agriculture for feature extraction, segmentation and classification. Various image processing methods applied on different plants are described. There are various image processing techniques available for the detection of plant leaf diseases which consists of some basic steps such as, image acquisition, image pre-processing, image segmentation, feature extraction and image classification. Various types of filtering techniques can be used to de-noise the image so that the diseases can be detected efficiently and clearly because noise creates problems in identification of diseases.

References

[1] Vivek Ugale and Deepak Gupta, "A comprehensive survey on agricultural image processing," International Journal os Science and Research (IJSR), Vol.5, Issue.1, pp-133-135, 2016.

[2] Ms. Kiran R. Gavhale and Prof. Ujwalla Gawande, "An overview of the research on plant leaves disease detection using image processing techniques," IOSR Journal of Computer Engineering(IOSR-JCE), Vol.16, Issue.1, pp-10-16, 2014.

[3] Sachin D. Khirade and A.B. Patil, "Plant disease detection using image processing," International Conference on Computing Communication Control and Automation, pp. 768-771, 2015.

[4] Rajneet Kaur and Miss Manjeet Kaur, " A brief review on plant disease detection using in image processing," International Journal of Computer Science and Mobile [Computing(IJCSMC), Vol.6 ,Issue 2, pp.101-106, 2017.

[5] Dixit Ekta Gajanan, Gavit Gayatri Shankar and Gode Vidya Keshav, "Detection of leaf using feature extraction for android based system," IJSRST, Vol.4, Issue.2, 2018.

[6] Mrunalini R. Badnakhe and Prashant R. Deshmukh, "Infected leaf analysis and comparison by otsu threshold and k-means clustering," International Journal of Advanced Research in Computer Science and Software Engineering, Vol.2, Issue.3, pp-449-452, 2012.

[7] Piyush Chaudhary, Anand K. Chaudhari, Dr. A. N. Cheeran and Sharda Godra, "Color transform based approach for disease spot detection on plant leaf," International Journal of Computer Science and Telecommunications, Vol.3, Issue.6, pp-65-70, 2012.

[8] Pooja Kulinavar, Vidya I. Hadimani, "Classification of leaf diseases based on multiclass SVM classifier," International Journal of Advance Research, Ideas and Innovations in Technology, Vol.3, Issue.4, pp-321-325, 2017.

[9] Priyanka Thakur, Preeti Aggarwal and mamta Juneja, "Plant disease detection and classification using image processing: A review," International Journal of Recent Research Aspects, Vol.4, Issue.3, pp-22-27, 2017.

[10] [Zulkifli Bin Husin, Abdul hallis Bin Abdul Aziz, Ali Yeon Bin Md Shakaff and Rohani Binti S Mohamed Farook, "Feasibility study on plant chili disease detection using image processing techniques," Third International Conference on Intelligent Systems Modelling and Simulation, IEEE, 2012.

[11] Arti N. Rathod, Bhavesh Tanawal and Vatsal Shah, "Image processing techniques for detection of leaf disease," International Journal of Advanced Research in Computer Science and Software Engineering, Vol.3, Issue.11, pp-397-399, 2013.

[12] Prakash M. Mainkar, Shreekant Ghorpade and Mayur Adawadkar, "Plant leaf disease detection and classification using image processing techniques," International Journal of Innovative and Emerging Research in Engineering, Vol.2, Issue.4, pp-139-144, 2015.

[13] V. Ramya and M. Anthuvan Lydia, "Leaf disease detection and classification using neural networks," International Journal of Advanced Research in Computer and Communication Engineering, Vol.5, Issue.11, pp-207-210, 2016.

[14] Arpita Patel and Mrs. Barkha Joshi, "A survey on the plant leaf disease detection techniques," International Journal of Advanced Research in Computer and Communication Engineering, Vol.6, issue.1, pp-229-231, 2017.

[15] Naik Durgesh Manikrao and Dr. Prof. A.J.Vyavahare, "Disease detection of cotton crop using image processing technique: A survey," International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol.3, Issue.6, pp-204-210, 2015.

[16] Bhumika S.Prajapati, Vipul K.Dabhi and Harshadkumar B.Prajapati, "A survey on detection and classification of cotton leaf diseases," International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), IEEE, 2016.

[17] Vishnu S and A. Ranjith Ram, "Plant disease detection using leaf pattern: A review," International Journal of Innovative Science, Engineering & Technology, Vol.2, Issue.6, pp-774-780, 2015.

[18] Priya P. and Dony A. D souza, "Study of feature extraction techniques for the detection of diseases of agricultural products," International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol.3, Issue.1, pp-4-8, 2015.

[19] Lisha Khadke, Sunil Jadhav, Kalpesh Jadhav, Ashwin Kasbe and Prof. Santwana Gudadhe, "A survey on identification of plant diseases," International Journal of Engineering Technology Science and Research, Vol.4, Issue.8, pp-1104-1107, 2017.

[20] Muhammad Thaqif bin MohamadAzmi and Naimah Mat Isa, "Orchid disease detection using image processing and fuzzy logic," International Conference on Electrical, Electronics and System Engineering, IEEE, 2013.

[21] Anand.H.Kulkarni and Ashwin Patil R. K. , "Applying image processing technique to detect plant diseases," International Journal of Modern Engineering Research (IJMER), Vol.2, Issue.5, pp-3661-3664, 2012.

[22] Chaitali G. Dhaware and Mrs. K.H. Wanjale, "A modern approach for plant leaf disease classification which depends on leaf image processing," International Conference on Computer Communication and Informatics (ICCCI), IEEE,2017.

[23] Prabhjeet kaur and Dr. Sanjay Singla, "A review on the plant leaf disease detection techniques," International Journal of innovations in Engineering and Technology (IJIET), Vol.7, Issue.2, pp-539-543, 2016.

[24] Ms. Kiran R. Gavhale, Prof. Ujwalla Gawande and Mr. Kamal O. hajari, "Unhealthy region of citrus leaf detection using image processing techniques," International Conference for Convergence of Technology, IEEE, 2014.

[25] Pallavi.S.Marathe, "Plant disease detection using digital image processing and GSM," International Journal of Engineering Science and Computing (IJESC), Vol.7, Issue.4, pp-10513-10515, 2017.

[26] Khushal Khairnar and Rahul dagade, "Disease detection and diagnosis on plant using image processing-A review," International Journal of Computer Applications, Vol.108, Issue.13, pp-36-38, 2014.

[27] Trimi Neha Tete and Sushma Kamlu, "Plant disease detection using different algorithms," Proceedings of the Second International Conference on Research in Intelligent and Computing in Engineering, Vol.10, pp-103-106, 2017.

[28] Dilpreet Kaur and Yadwinder Kaur, " Various image segmentation techniques: A Review," International Journal of Computer Science and Mobile Computing(IJCSMC), Vol.3, Issue 5, pp.809-814, 2014.

[29] Patel Jigna. J, "Various segmentation techniques in image processing," International Journal of Engineering Science and Computing, Vol.7, Issue.6, pp-12781-12783, 2017.

[30] Song Yuheng ang Yan Hao, "Image segmentation algorithms overview.

[31] Nida M. Zaitoun and Musbah J. Aqel, "Survey on image segmentation techniques," Procedia Computer Science, Vol.65, pp-797-806, 2015.

[32] Lahouaoui Lalaoui, Tayeb Mohamadi and Abdelhak Djaalab, "New method for image segmentation," Procedia Social and Behavioral Sciences, pp-1971-1980, 2015.

[33] Varun Gupta, Namita Sengar, Malay Kishore Dutta, Carlos M.Travieso, Jesus B. Alonso, "Automated segmentation of powdery mildew disease from cherry leaves using image processing," IEEE, 2017.

[34] Siddharath Singh Chouhan, Ajay Kaul, Uday Pratap Singh and Sanjeev Jain, "Bacterial foraging optimization radial basis function neural network (BRBFNN) for identification and classification of plant leaf diseases: An automatic approach for plant pathology," IEEE, 2017.

[35] Bhumilka S.Prajapati, Vipul K.Dabhi and Harshadkumar B.Prajapati, "A survey on detection and classification of cotton leaf diseases," International Conference on Electrical, Electronics and Otimization Techniques(ICEEOT) IEEE, 2016.

[36] Pranjali B. Padol and Prof. Anjali A. Yadav, "SVM Classifier based grape leaf disease detection," Conference on Advances in Signal Processing (CASP) IEEE, 2016.

[37] Pawan P.Warne and Dr.S.R.Ganokar, "Detection of diseases of cotton leaves using k-mean clustering method," International Journal of Engineering and Technology(IJET), Vol.2, Issue. 4, 2015.

[38] Prof. R. N. kadu, S. Kangane, S. Vikhe, R. Pandita and V. Inamke, "Leaf disease detection using Arm7 and image processing," International Journal of Engineering Research and Applications (IJERA), Vol.5, Issue.2, pp-68-71, 2015.

[39] [39] Deepak J. Dange and Prof. M. A. Sayyad, "Computer vision image enhancement and plant leaves disease detection," International Journal of Modern Trends in Engineering and Research, pp-106-110.

[40] P.R. Rothe and R. V. Kshirsagar, "A study and implementation of

active contour model for feature extraction: with diseased cotton leaf as example," International Journal of Current Engineering and Technology, Vol.4, Issue.2, pp-812-816, 2014.

[41] [Eric Hitimana and Oubong Gwun, "Automatic estimarion of live coffee leaf infection based on image processing techniques," Second International Conference on Signal, Image Processing and Pattern Recognition, Sydney, pp-255-266, 2014.

[42] Smita Naikwadi and Niket Amoda, "Advances in image processing for detection of plant diseases," International journal of Application or Innovation in Engineering & Management (IJAIEM), Vol.2, Issue.11, pp-168-175, 2013.

[43] Faithpraise Fina, Philip Birch, Rupert Young, J. Obu, Bassey Faithpraise and Chris Chatwin, "Automatic plant pest detection and recognition using k-means clustering algorithm and correspondence filters," International Jornal of Advanced Biotechnology and Research, Vol.4, Issue.2, pp-189-199, 2013.

[44] Diao Zhihua, Wang Huan, Song Yinmao and Wang Yunpeng, "Image segmentation method for cotton mite disease based on color features and area thrseholding," Jornal of Theoretical and Applied Information Technology, Vol.48, Issue.1, pp-527-533, 2013.

[45] R. Yusnita, fariza Norbaya, and Norazwinawati, "Intelligent parking space detection system based on image processing," International Jornal of Innovation, Management and Technology, Vol.3, issue.3, pp-232-235, 2012.

[46] S. Phadikar, J. Sil, and A. K. Das, "Classification of rice leaf diseases based on morphological changes," International Journal of Information and Electronics Engineering, Vol.2, Issue.3, pp-460-463, 2012.

[47] Gaurav Kumar and Pradeep Kumar Bhatia, "A detailed review of feature extraction in image processing," Fourth International Conference on Advanced Computing and Communication Technologies IEEE, 2014.

[48] [48] Abdul Kadir, Lukito Edi Nugroho, Adhi Susanto, and Paulus Insap Santosa, "Leaf classification using shape, color, and texture features," International Journal of Computer Trends and Technology, pp-225-230, 2011.

[49] Guili Xu, Fengling Zhang, Syed Ghafoor Shah, Yongqiang Ye, and Hanping Mao, "Use of leaf color images to identify nitrogen and potassium deficient tomatoes," ELSEVIER, Vol.32, pp-1584-1590, 2011.

[50] Monzurul Islam, Anh, Dinh, Khan Wahid and Pamkaj Bhowmik, "Detection of potato diseases using image segmentation and multiclass support vector machine," 30th Canadian Conference on Electrical and Computer Engineering(CCECE) IEEE, 2017.

[51] Nivedita.R.kakade, Dnyaneswar.D.Ahire, "Real time grape leaf diseases detection," International Journal of Advance Research and Innovative Ideas in Education, Vol.1, pp-598-610, 2015

[52] Usama Mokhtar, Mona A. S. Ali, Aboul Ella Hassenian, and Hesham Hefny, "Tomato leaves diseases detection approach based on support vector machines," International Computer Engineering Conference, pp-246-250, 2015.

[53] Girish Athanikar, and Priti Badar, "Potato leaf diseases detection and classification system," International Journal of Computer Science and Mobile Computing, Vol.5, pp-76-88, 2016.

[54] Preetha Rajan, Radhakrishnan. B, and Dr.L. Padma Suresh, "Detection and classification of pests from crop images using support vector machine," International Conference on Emerging Technological Trends (ICETT), 2016.

[55] Miss. Amruta Ambatkar, Miss. AshwiniBhandekar, Miss. Avanti Tawale, Miss. Chetna Vairagade, Miss. Ketaki Kotamkar, "Leaf disease detection using image processing," International Conference on Recent Trends in Engineering Science and Technology (ICRTEST), Vol.5, Issue.1, pp-333-336, 2017.

[56] Pooja V, Rahul Das and Kanchana V, "Identification of plant leaf diseases using image processing techniques," IEEE International Conference on Technological Innovations in ICT for Aggriculture and Rural Development (TIAR), pp-130-133, 2017.

[57] Garima Tripathi and Jagruti Save, "An image processing and neural network based approach for detection and classification of plant leaf diseases," International Journal of Computer Engineering & Technology (IJCET), Vol.6, Issue.4, pp-14-20, 2015.

[58] Aakanksha Rastogi, Ritika Arora, Shanu Sharma, "Leaf disease detection and grading using computer vision technology & fuzzy logic," 2nd International Conference on Signal Processing and Integrated Networks, IEEE, 2015.

[59] Md. Nazrul Islam, M.A. Kashem Mahmuda Akter and Md.Jamilur Rahman, "An approach to evaluate classifiers for automatic disease detection and classification of plant leaf," International Conference on Electrical, Computer and Telecommunication Engineering, 2012.

[60] Priya Pradeep Naswale and P.E.Ajmire, " Image classification techniques-A Survey," International Journal of Emerging Trends and Technologies in Computer Science(IJETTCS), Vol.5, Issue.2, pp.236-239, 2016.

[61] Pooja Kamavisdar, Sonam Saluja and Sonu Agrawal, "A survey on image classification approaches and techniques," International Journal of Advanced Research in Computer and Communication Engineering, Vol.2, Issue.1, pp.1005-1009, 2013.

[62] Santosh Kumar Sao, and Sandeep B. Patil, "A survey on classification techniques for plant disease detection using image processing," International Journal for Scientific Research & Development, Vol.3, Issue.4, pp-1122-1125, 2015.

[63] Bassam AL-Qarallah, Bashar AI-Shboul, Hazem Hiary, Asmaa Aljawawdeh, Hamad Alsawalqah and Monther Tahat, "An image processing approach for cucumber powdery mildew infection detection," Proceedings of the New Trends in Information Technology(NTIT), 2017.

[64] Harshal Waghmare, Radha Kokare and Yogesh Dandawate, "Detection and classification of diseases of grape plant using opposite colour local binary pattern feature and machine learning for automated decision support system," 3rd International Conference on Signal Processing and Integrated Networks, IEEE, 2016.

[65] Amrita.Joshi and B.D Jadahv, "Monitoring and controlling rice diseases using image processing techniques," International Conference on Computing Analytics and Security Trends(CAST) IEEE, 2016.

[66] Rajleen Kaur and Dr. Sandeep Singh Kang, "An enhancement in classifier support vector machine to improve plant disease detection," 3rd International Conference on MOOCs, Innovation and Technology on Education IEEE, pp-135-140, 2015.

[67] Savita N. Ghaiwat and Parul Arora, "Detection and classification of plant leaf diseases using image processing techniques: A review," International Journal of Recent Advances in Engineering and Technology(IJRAET), Vol.2, Issue.3, 2014.

[68] Mr. Sachin B. Jagtap, Mr. Shailesh M. Hambarde, "Agricultural plant leaf disease detection and diagnosis using image processing based on morphological feature extraction," Vol.4, Issue.5, pp-24-30, 2014.

[69] Auzi Asfarian, Yeni Herdiyeni, Aunu, Kikin and Hamzah Mutaqin, "Paddy diseases identification with texture analysis using fractal descriptors based on fourier spectrum," International Conference on Computer, Control, Informatics and its Applications, IEEE, 2013.

[70] Haiguang Wang, Guanlin Li, Zhanhong Ma, and Xiaolong Li, "Application of neural networks to image recognition of plant diseases," International Conference on Systems and Informatics(ICSAI), IEEE, 2012.

[71] Jagadeesh D. Pujari, Rajesh Yakkundimath and Abdulmunaf S. Byadgi, "Image processing based detection of fungal diseases in plants," Procedia Computer Science, Vol.46, pp-1802-1808, 2015.

[72] M.Thilagavathi and S.Abirami, "Apllication of image processing in diagnosing guava leaf diseases," International Journal of Scientific Research and Management (IJSRM), Vol-7, Issue-7, pp-5927-5933, 2017.

[73] Yogesh Dandawate and Radha Kokare, "An automated approach for classification of plant diseases towards development of futuristic decision support system in indian perspective," International Conference on Advances in Computing, Communications and Informatics(ICACCI) IEEE, 2015.

[74] Wan Mohd Fadzil W.M.N, Shah Rizam M.S.B.R. Jailani, Nooritawati M.T, "Orchid leaf disease detection using border segmentation techniques," IEEE Conference on Systems, Process and Control (ICSPC), pp-168-173, 2014.

[75] Shoby Sunny and Dr. M. P. Indra Gandhi, "An efficient citrus canker detection method based on contrast limited adaptive histogram equalization enhancement," International Journal of Applied Research, Vol.13, pp-809-815, 2018.

[76] Evy Kamilah Ratnasari, Mustika Mentari, Raith Kartika Dewi and R.V. Hari Ginardi, "Sugarcane leaf disease detection and severity

estimation based on segmented spots image," International Conference on Information, Communication Technology and System, IEEE, 2014.
[77] Sanjeev S Sannakki, Vijay S Rajpurohit, V B Nargund and Pallavi Kulkarni, "Diagnosis and classification of grape leaf diseases using neural networks," 4th ICCCNT IEEE, 2013.
[78] Mr. N.S. Bharti and Prof. R.M Mulajkar, "Detection and classification of plant diseases," International Research Journal of Engineering and Technology (IRJET), Vol.2, Issue.2, pp-2267-2272, 2015.
[79] Rakesh Chaware, Rohit Karpe, Prithvi Pakhale and Prof. Smita Desai, "Detection and recognition of leaf disease using image processing," International Journal of Engineering Science and Computing (IJESC), Vol.7, Issue.5, pp-11964-11967, 2017.
[80] Prabira Kumar Sethy, Baishalee Negi and Nilamani, "Detection of healthy and defected diseased leaf of rice crop using K-means clustering technique," International Journal of Computer Applications, Vol.157, Issue.1, 2017.
[81] Sushil R. Kamlapurkar, "Detection of plant leaf diseases using image processing approach," International Journal of Scientific and Research Publications, Vol.6, Issue.2, pp-73-76, 2016.
[82] Vijai Singh and A.K. Misra, "Detection of plant leaf diseases using image segmentation and soft computing techniques," Information processing in Agriculture, Sciencedirect, pp-41-49, 2017.
[83] Viraj A. Gulhane and Maheshkumar H. Kolekar, "Diagnosis of diseases on cotton leaves using principal component analysis classifier," Annual IEEE Inadia Conference (INDICON), 2014.
[84] Pream Sudha, "Feature selection techniques for the classification of leaf diseases in turmeric," International Journal of Computer Trends and technology (IJCTT), Vol.43, Issue.3, pp-138-142.
[85] Sachin. B. Jadhav and prof.Dr.. Sanjay B Patil, "Grading of soybean leaf disease based on segmented image using K-means clustering," International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Vol.4, Issue.6, pp-1816-1822, 2015.
[86] Sagar Vetal and R.S. Khule, "Tomato plant disease detection using image processing," International Journal of Advanced Research in computer and Communication Engineering (IJARCCE), Vol.6, issue.6, pp-293-297, 2017.
[87] Shanwen Zhang, Haoxiang Wang, Wenzhun and Zhuhong You, "Plant diseased leaf segmentation and recognition by fusion of superpixel, K-means and PHOG," ELSEVIER, pp-866-872, 2018.
[88] Sanjib Das, Jonti Saika, Soumita Das and Nural Goni, "A comparative study of different noise filtering techniques in digital images," International Journal of Engineering Research and General Science, Vol.3, Issue.5, pp-180-191, 2015.
[89] Er. Amita Kumari and Er .Pankaj Dev Chadha, "A survey on filtering technique for denoising images in digital image processing," International Journal of Advanced Research in Computer Science and Software Engineering, Vol.4, Issue.8, pp-612-614, 2014.
[90] Mohd Awais Farooque and Jayant S. Rohnakar, "Survey on various noises and techniques for denoising the color image," International Journal of application or Innovation in Engineering and Management(IJAIEM), Vol.2, Issue.11,pp-217-221, 2013.
[91] Toran Lal Sahu and Mrs. Deepti Dubey, "A survey on image noises and denoise techniques," International Journal of Advanced Research in Computer Engineering and Technology(IJARCET), Vol.1, Issue.9, pp-77-80, 2012.
[92] Govindaraj. V and Sengottaiyan. G, "Survey of image denoising using different filters," International Journal of Science Engineering and Technology Research(IJSETR) Vol.2, Issue.2, pp-344-351, 2013.