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Machine Intelligence for the Detection of Plant Diseases Using Image Processing

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MACHINE INTELLIGENCE FOR THE DETECTION OF PLANT DISEASES USING IMAGE PROCESSING

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Abstract **--- The economic growth of the country depends upon the quality and quantity of the plant production. The diagnosis of the diseases is needed at an earlier stage before it becomes worse. Proper preventive care will increase the production of fruits and vegetables. Thus, automated recognition of diseases in plant plays a vital role in agricultural yields. Several image processing approaches have been developed for disease diagnosis in a short span. In this work, various machine intelligence techniques include SVM, Back Propagation network, Naïve Bayesian are analyzed and observed and concur Gray Level Co-occurrence Matrix (GLCM) based neural network performs better and gives high accuracy. The experimental results validate that the proposed model achieved a test accuracy is found that to around 93% for alternaria alternate, anthracnose, black spot, bacterial blight, cercospora leaf spot diseases in fruit and leaf.**

Keywords **- Image processing, plant disease detection, classification, Gray Level Co-occurrence Matrix (GLCM), Support Vector Machine, Neural Network.**

I. INTRODUCTION

Agriculture is the backbone of Indian country economy. In worldwide, India is an agriculturally developed country as well as second largest producer of fruits and vegetables production. Almost 70% of the Indian population is dependent on the agriculture and almost one third of the national income comes from the agriculture source. Proper crop protection is important to produce higher quality crops with minimal wastage. It also ensures that more food reaches the markets in good condition, which helps to keep the prices down. It increases the productivity that leads to improve the economy condition of country. So it is very clear that agriculture is great importance not only to the people but in the country as a whole. These concerns have induced a large volume of research studies. However, most of the previous review studies are concentrated on plant disease detection.

Plant studies which refer to studying the visually recognizable pattern of a plant. Typically plant disease detection is seeing through naked eye observation, which is very slow method and gives less accuracy. Identification of diseases in leaf, fruit, stems and finding out the diseases or affected area percentage is very effective in the successful cultivation of crops. These reports will give a basic idea about diagnosing of various diseases occurred on various parts of the plant like stem, fruit and leaves.

Most of the farmer's unconscious about nonnative diseases. With the aid of imaging technology automatically detect the disease symptoms that visible on the plant. Digital image processing methods play a vital role in detecting anomalies in plant images. Various image processing techniques and filters are in practice to detect the attributes of plant like stem, leaf and fruit. In order to achieve an efficient and smart farming system that diagnosis the unhealthy part of the plant.

The objective of this paper is to discuss various parameters and techniques of plant disease detection. The paper is organized into the following sections. First section gives a brief introduction of plant disease detection. In section II is organized as literature review in plant diseases studied are given and also analysis the techniques used. Section III presents the methods and materials, section IV gives simulation results whereas section V concludes the paper followed by references.

II. LITERATURE REVIEW

Different methodologies had been discussed by researchers in detecting and identifying plant diseases. Sharath D M, Akhilesh,et.al (2019) [1] presented a system on pomegranate fruit disease detection. For noise removal uses a Gaussian filter and grab cut method for image segmentation. Identify the bacterial blight diseases using canny edge detection technique [19]. Based on the data comparison procedure to finalize whether the fruit is infected or not. It also suggests a farmer to give proper solution how to overcome the infection problem.

Prof. Shripad S.Veling et.al (2019) [2] used MATLAB tool for detect mango disease detection on leaf, fruit and flower. Fast-Robust Fuzzy C-Means clustering algorithm is used for segmentation of leaf images and the Gray-Level Co-occurrence (GLCM) method is used for infected leaf texture analysis [15]. For classification of plant diseases, support vector Machine (SVM) is used.

Namrata R.Bhimte et.al(2018) [4] discussed a disease detection method for cotton plant leaves. In this, cotton leaf image is taken as input. The RGB Image values were converted into L*a*b* color space. Then by using k-means clustering algorithm, cotton leaf disease segmentation is done. Gray-Level Co-Occurrence Matrix is used for feature extraction to see various statistics such as mean, standard deviation, contrast, energy, entropy, homogeneity and correlation. Finally for classification and detection of disease in the leaf used SVM algorithm [22].

K.Gowthami et.al (2017) [5] proposed a technique that can be used for detecting of black spot and anthracnose leaf diseases in plant. In this RGB image was converted into gray-level image to separate the infected parts from the leaf. Different types of segmentation techniques like Otsu thresholding, k-means clustering, Boundary & Spot detection algorithm are used here. Compute the texture features using color co-occurrence methodology [14][16]. By using ANN and

back propagation classification, it can identify the disease of the infected plant.

Sandesh Raut et.al (2017) [6] presented a technique in which pre-processing involved image resizing, noise removal and conversion of RGB images to gray level. In segmentation, centroid value is calculated using k-means method is applied for dividing image into object. Statistical texture features extraction using Gray-Level Co-Occurrence Matrix configuration technique. Lastly authors used multi-SVM for classification and recognition of leaf and fruit diseases.

Khot.S.T et.al (2016) [8] presented technique for detection of alterneria, bacterial blight and anthracnose diseases in pomegranate disease detection. After image acquisition with the help of image resizing, filtering and morphological operations are done by image pre-processing [22]. In color space conversion technique using RGB, L*a*b*, HSV and YC_bC_r color system. Texture features are obtained from gabor filter, boundaries are extracted using morphological operation. Lastly minimum distance classifier is applied for classification result.

Ms. Kiran R et.al (2014) [9] described technique for detect diseases like anthracnose, citrus canker, overwatering and citrus greening in citrus plant. Image pre-processing involved YC_bC_r color system, L*a*b* color space and discrete cosine transform for color space conversion. Feature extraction is done with the help of Gray-Level Co-Occurrence Matrix. Radial basic kernel and polynomial support vector machine are used for classification of fruit diseases.

Arti N. Rathod et.al (2014) [10] proposed a technique for detecting diseases in leaf. In this create the color structure RGB to CIELAB transformation. After applying the k-medoid cluster and remove the masked green pixels. The GLCM function to calculate the texture features statistics in effective manner. Finally to recognize the diseases using neural network configuration [5][20][23].

III. MATERIALS AND METHODS

Plant diseases can be identified at initial or early stage may help the farmers to identify the disease in feasible and accurate manner. Here is the brief review of the various techniques in literature review section. The following steps for plant disease detection using image processing techniques.

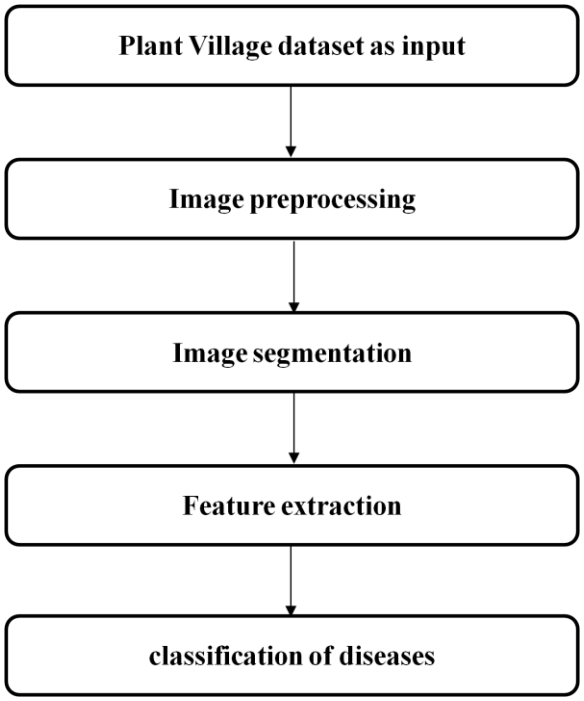

Figure 1: Block diagram of basic steps for plant disease detection

IMAGE ACQUISITION

First step in digital image processing is image acquisition. In this capture the images through digital camera or mobile

phone for further operations. In this work, plant village dataset repository has been used [12].

METHODS USED IN PREPROCESSING

For further processing of image data, pre-processing plays a major role in digital image processing. To remove unwanted objects or noise in an image, different pre-processing techniques are considered. Mostly used methods are,

I. Image Clipping & Resizing

To increase or decrease the total number of pixels that will improve the processing speed in fast manner.

II. Color Conversion

The input image is converted into gray level image for the easy way of disease diagnosis. In these using two methods one is average method and another one is weighted method. To need less memory to store grayscale image than to store an RGB image. To distinguish features of an image easier when deal with a single – layered image than multi-layered (RGB Color) image.

III. Noise Removal

To remove the unwanted pixels in image is essential in image processing. Mostly used noises are median filter, salt and pepper, speckle, Gaussian and poisson noise. The median filter performs better for removing salt-and-pepper noise, poisson noise for gray-level images and gaussian filter for blurred noise.

METHODS USED IN ENHANCEMENT

To brighten the information content in images that will improve the visual quality of plant images.

I. Histogram Equalization

In computer image processing by using the histogram equalization technique to enhance the image contrast level. Spread out the most frequent intensity values in graphical representation. Contrast Limited Adaptive histogram Equalization (CLAHE) is applied to each neighborhood from which a transformation function is derived. Cumulative Distribution Function is used to distribute the intensity values in images to enhance the plant diseases.

II. Green Channel Extraction

The plant images are classified into Red, Green and Blue channels. Among these three color component, the green component extraction is used for preprocessing. Before the extraction, adaptive histogram equalization is a method to enhance the image contrast. Log transform concept that expand the dark pixel value and reduce the light pixel value. As a result images are easy to separate the green component plane.

METHODS USED IN SEGMENTATION

I. K-Means Algorithm

Divide the object into k number of classes according to set of features. In this one cluster group have same features and other cluster have different features. To minimize the sum of squares value based on distance between object and cluster. It provides high accuracy and consumes very less time.

II. Fast Robust Fuzzy C-Means Algorithm

Improve the robustness of FCM algorithm using the FRFCM algorithm. It is based on morphological reconstruction and membership function. To improve the image quality without using any filter is done by FRFCM. It

is better and suitable way to remove the different types of noise [3]

III. Otsu Thresholding Algorithm

With respect to the thresholding concept that creates binary images from gray-level images by setting all pixels above the threshold have set to one and below the threshold have set to zero. In this algorithm, to separate the pixels into two clusters it helps to find the mean of each cluster. Then calculate the difference between the means. With the help of Otsu's method, threshold is calculated. Based on the threshold value green pixels is removed. Finally get the affected leaf part portion separately [18].

METHODS USED IN FEATURE EXTRACTION

Most unnecessary features can reduce the quality of classification so it is important to remove unwanted features by using the feature extraction concept. The various methods are,

I. Canny Edge Detection

In this technique, to identify area of an image such as textures, colors, shading and lines. Mostly used edge detection technique is canny edge detection. There are few steps to obtain the edges. First convert into grayscale value after perform the Gaussian blur that remove the noise and to determine the direction and image gradient value. Using non-maximum suppression to obtain the strong edges of image and double threshold can takes place. Weak edges that are not connected to strong edges will be removed by edge tracking. Finally get the edges approximately by threshold value.

II. Gray-Level co-occurrence Matrix

Most of the image analysis technique using co-occurrence matrix and wavelet transform. A color co-occurrence matrix is a matrix that calculates the image texture. Similarities between two different feature vectors are calculated by Euclidean distance. GLCM based on second order statistics which accounts for spatial interdependency or co-occurrences of two pixels at specific relative positions. In addition co-occurrence matrix calculated for the direction 0º, 45º, 90º, 135º. GLCM is a tabular format of random combination of gray level values. To be sure, converting RGB values to gray level can reduce the image compression time [17].

III. Morphological Processing

After segmentation process, an image infected part to be expanded using morphology processing. Morphological operations analyses the shape inside the image. An input and output image has same size because of structuring element. Dilation operation grows or thickens the image. Closing is defined as Dilation followed by erosion. However, unwanted pixels are eliminated by dilation and erosion operations.

METHODS USED IN CLASSIFICATION

Nowadays computers have the capacity to upgrade the intelligent algorithms. It is also part of Artificial Intelligence. It makes the system powerful to learn from data without being programmed. It mainly focuses on how to spontaneously recognize complex data and construct intellectual decisions. The following machine learning algorithms are used in classification.

I. Support Vector Machine

To identify and classify crop diseases using support vector machine algorithm. Hyper plane is the main principal of SVM. It

contains two dataset: one is training data and another one is tested data. Based on the training dataset hyper plane or line which segregates the two classes. It is associated with supervised learning algorithm. Support vector that find the points nearest to the hyper plane from both the classes. Distance between the support vector and hyper plane is called margin which will help to decide the right hyper plane. In case where number of dimensions is greater than the number of sample this algorithm is effective one, because high dimensional spaces are available.

II. Naïve Bayesian Classifier

To calculate the probability for each class and the highest probability value is considered as prediction value. However, this classifier is particularly useful for very large dataset. This technique is not related to the existence of any other feature and it recognizes the presence of specific feature in a class based on the frequency and likelihood tables. Well-known features for multi class prediction feature. Calculate the probability values using Gaussian probability Density Function (GPDF).

III. Back Propagation Neural Network:

Back propagation algorithm is the one of the best neural network algorithm. The input layer analyzes the affected region and the output layer specifies the particular diseases. Connect link between the input and output images in hidden layer. It is applied to obtain least error in the classification of disease of the affected region [7].

IV. Genetic Algorithm:

A genetic algorithm is the evolutionary optimization algorithm that determines the number of clusters. In the color image, pixel has R, G, B components and image size m*n. Center of the cluster is calculating the each pixel mean value. Distance between the pixels and their clusters using Euclidean distance for fitness function. This algorithm used operations like selection, cross over and mutation. Extracted features are implemented into the selection process and producing a new generation. This approach will perform until the optimization criteria are reached. It will provide a number of potential solutions to a given problem [10][11].

IV. SIMULATION RESULTS

All the experiments are performed in MATLAB. For input data, samples of plant leaves and fruit diseases like alternaria alternate, anthracnose, black spot, bacterial blight, cercospora leaf spot diseases are considered.

First images of various plant leaves and fruits are acquired from plant dataset. The input image is resized into 256 × 256 pixels.

In Figure 2, user gives the input image from dataset and then performs the enhancement technique to stretch the contrast of an image.

Figure 2. Input Image and Enhanced Image of leaf

In Figure 3, performs same procedure in mango fruit.

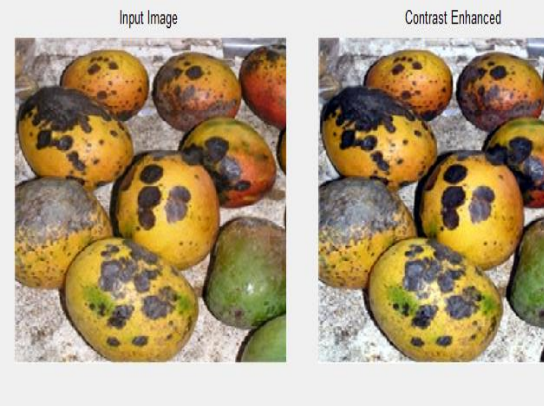

Figure 3. Input Image and Enhanced Fruit image

Figure 4.shows the output of the segmentation using color based k-means clustering algorithm. K-means clustering algorithm applied in plant images and affected features are segmented. To choose the cluster correctly based on that only gets a high accuracy result.

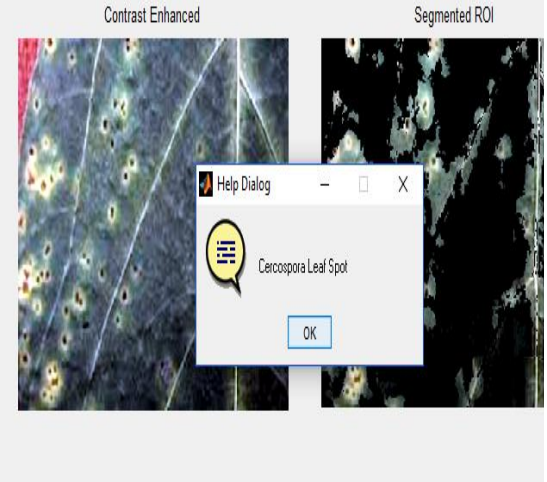

Figure 4. Plant Leaf Segmentation

For Feature Extraction, Gray-Level Co-occurrence Matrix (GLCM) is applied. GLCM reducing the amount of resources needed to represent the large data set. In this thirteen parameters are extracted from the images. In this to calculate the total number of affected areas using the following equation:

$$\text{Affected Ratio} = \frac{\text{No.of affected leaf pixels}}{Total\ \ pixe\ ls} \times 100$$

In Figure 5, classify the infected part of plant using multi-class support vector machine. To work with more than two classes, multi-SVM gives good results than other classifiers. To reduce the single multi-class problem this helps to provide the result in an efficient way.

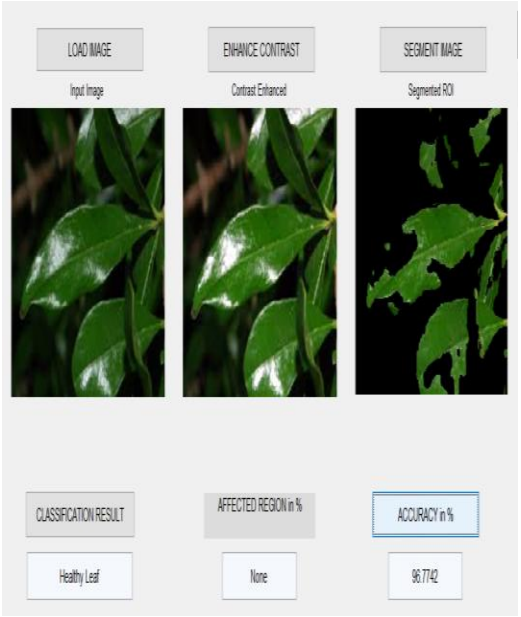

Figure 5. Final Classified Result

Depending upon the feature values classify the input image into six classes like alternaria alternate, anthracnose, black spot, bacterial blight, cercospora leaf spot disease and healthy part images In this final result which displays the appropriate disease details to farmers. It helps to take a proper prevention care before the plant gets fully affected.

The following table 1 describing some reviewed papers along with the details of the methodology, observation and accuracy.

TABLE 1: Plant Disease Detection Techniques

Reference Paper	Observation	Methodology	Accuracy
Dheeb Al Bashish et.al., (2010) [13]	Input Image: ✓ Plant Leaf & Stem Diseases: • Early Scorch • Cottony Mold • Ashen Mold • Late Scorch • Tiny Whiteness	• Segmentation - K-means algorithm • Feature extraction- Color Co-occurrence Method • Classification - Back Propagation Neural Network	93%
Dhiman Mondal et.al., (2015) [14]	Input Image: ✓ Okra Leaf Disease: • yellow vein mosaic virus disease	• Segmentation - K-means clustering algorithm • Feature extraction - Color Co-occurrence Method • Classification - Naïve Bayesian	87%
Zarreen Naowal Reza et.al., (2016) [15]	Input Image: ✓ Jute Stem Area Diseases: • Anthracnose • Black Band • Die back • Stem rot	• Segmentation - hue based segmentation • Feature extraction - Grey-level Color Co-occurrence Method • Classification - Multi-SVM	86%
Pranjali B. Padol et.al., (2016) [16]	Input Image: ✓ Grape leaf Diseases: • Anthracnose • Downy Mildew • Powdery Mildew	• Segmentation - K-means clustering algorithm • Feature extraction - Color Co-occurrence Method • Classification - Linear SVM	88.89%

Ms.Kiran R.Gavhale et.al., (2014) [9]	Input Image: ✓ Grapefruit, lemons, limes and orange leaf Diseases: • Anthracnose • Over Watering • Citrus Canker • Citrus Greening disease	• Image enhancement - SF-CES and color space conversion • Segmentation - K-means clustering algorithm • Feature extraction -Grey-Level Color Co-occurrence Method • Classification - SVMRBF & SVMPOLY	96% & 95%
K.Gowthami et.al., (2017) [5]	Input Image: ✓ Plant Leaf Diseases: • Blackspot • Anthrocnose	• Segmentation - otsu method, k-means clustering algorithm and converting RGB into HIS model • Feature extraction - Color Co-occurrence Method • Classification - ANN with back propagation algorithm	93%
Bed Prakash et.al., (2015) [23]	Input Image: ✓ Mango leaf Diseases: • Bacterial Leaf spot • Red Rust	• Segmentation - k-means clustering algorithm • Classification - Back Propagation Neural Network	94%
Ms. Monika Gupta et.al., (2018) [22]	Input Image: ✓ Leaf Images Diseases: • Alternaria Alternata	• Segmentation- k-means clustering algorithm • Feature extraction - morphology processing and sobel operator • Classification – SVM	96%
Velamakanni Sahithya et al.,	Input Image: ✓ Ladies finger Leaf	• Segmentation - k-means clustering algorithm	SVM:82%

(2019) [21]	Diseases: • Yellow mosaic vein • Leaf spot • Powdery mildew	• Feature extraction - Gray Level Color Co-occurrence Method • Classification - SVM and ANN with poisson noise	ANN:95%
Abirami Devaraj et.al., (2019) [19]	Input Image: ✓ Leaf Image Diseases: • Alternaria Alternata • Bacterial Blight • Anthracnose • Cercospora Leaf spot	• Segmentation - k-means clustering algorithm • Feature extraction - Gray Level Color Co-occurrence Method • Classification - Random Forest Classifier	Not Given
Ch. Usha Kumari et.al., (2019) [20]	Input Image: ✓ Cotton Leaf ✓ Tomato Leaf Diseases: • Bacterial Leaf spot • Target Spot • Septoria Leaf Spot • Leaf Mold	• Segmentation - k-means clustering algorithm • Feature extraction - Gray Level Color Co-occurrence Method • Classification – ANN	92.5%

V. CONCLUSION

In this paper the plant disease detection is done using neural network classifier. For classification purpose, GLCM based color and texture features are extracted. With this method, the use of injurious chemicals on plants can be reduced and hence ensures a healthier environment. This paper reviews and summaries the concept of how to find plant disease using various techniques in image processing by a number of researchers in the past few years. The work can also be seen in depth by the different techniques in plant images. In this, features are extracted from the given training dataset and then mining is applied to identify the exact crop disease. To improve quality of plant, disease detection is essential by complete automation and notification of the affected plant and to give appropriate prevention care and solution for it. Proper suggestion is given by agricultural experts in identifying the correct pesticides and provides idea to farmers how to overcome the problem in effective and efficient manner. To make further research on image processing and analysis method to achieve better detection accuracy with various plant species.

REFERENCES

[1] Sharath D M, Akhilesh, S Arun Kumar, Rohan M G and Prathap C,'Image based Plant Disease Detection in Pomegranate Plant for Bacterial Blight' in communication and signal processing,2019 International Conference on. IEEE, 2019, pp. 0645-0649.

[2] Prof. Shripad S.Veling, Mr.Rohit S.Kalelkar,'Mango Disease Detection by using Image Processing',International Journal for Research in Applied Science & Engineering Technology, Vol.7,issue IV, p-ISSN:2321-9653,2019

[3] K.Gowsalya, P. Sridevi,'Prediction of fruits and flowers using image analysis techniques".International Research Journal of Engineering and Technology, Vol. 6,Issue 2,2019.

[4] Namrata R.Bhimte, V. R. Thool,'Diseases Detection of Cotton Leaf Spot Using Image Processing and SVM Classifier' in intelligent computing and systems(ICICCS),2018 International Conference on. IEEE,2018, pp.340-344.

[5] K.Gowthami, M.Pratyusha, B.Somasekhar and B.Hemanth,'Detection of Diseases in Different Plants Using Digital Image Processing', International Journal of Scientific Research in Engineering, Vol.2, Issue. 2, 2017.

[6] Sandesh Raut, Amit Fulsunge,'Plant Disease Detection in Image processing using MATLAB',International journal of innovative Research in science, Engineering and Technology Vol.6,Issue 6, p-ISSN: 2319-8753,2017

[7] Malti K.Singh, Subrat Chetia,'Detection and classification of plant Leaf Diseases in Image Processing using MATLAB' , International journal of life sciences Research, Vol. 5, Issue 4,pp:120-124,2017

[8] Khot.S.T, Patil Supriya, Mule Gitanjali, Labade Vidya,'Pomegranate Disease Detection Using Image Processing Techniques',International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering Vol.5,Issue 4,p-ISSN:2320-3765,2016.

[9] Ms. Kiran R. Gavhale, Prof. Ujwalla Gawande and Mr.Kamal O.Hajari,'Unhealthy Region of Citrus Leaf Detection Using Image Processing Techniques',IEEE International Conference for Convergence of Technology,pp.978-1-4799-3759-2/14,2014

[10] Arti N. Rathod, Bhavesh A. Tanawala, Vatsal H. Shah,'Leaf Disease Detection Using Image Processing and Neural Network', International Journal of Advance Engineering and Research Development,Vol. 1, Issue 6, 2014

[11] Dr. K. Thangadurai, K.Padmavathi,'Citrus Canker Disease Detection Using Genetic algorithm in Citrus Plants', International Journal of Trend in Research and Development, Vol.2(5),2015

[12] D.P.Hughes and M.Salathe.(2015).'An open access repository of images on plant health to enable the development of mobile disease diagnostics', [online]. Available : https://arxiv.org/abs/1511.08060

[13] Dheeb Al Bashish, Malik Braik, and Sulieman Bani-Ahmad,' A Framework for Detection and Classification of plant Leaf and Stem Diseases', International Conference on Signal and Image Processing,IEEE,2010.

[14] Dhiman Mondal, Dipak Kumar Kole,' Detection and Classification Technique of Yellow Vein Mosaic Virus Disease in Okra Leaf Images using Leaf Vein Extraction and Naive Bayesian Classifier', International Conference on Soft Computing Techniques and Implementations,IEEE,2015

[15] Zarreen Naowal Reza, Faiza Nuzhat, Nuzhat Ashraf Mahsa, Md. Haider Ali,' Detecting Jute Plant Disease Using Image Processing and Machine Learning', International Conference on Electrical Engineering and Information Communication Technology,IEEE, 2016

[16] Pranjali B. Padol, Prof. Anjali A. Yadav,' SVM Classifier Based Grape Leaf Disease Detection', Conference on Advances in Signal Processing,IEEE,2016 [17] Ms.Kiran R.Gavhale , prof.Ujwalla Gawande, Mr.Kamal O.Hajari,'Unhealthy Region of citrus Leaf Detection Using Image Processing Techniques',International Conference for convergence of Technology,IEEE,2014

[18]K.Gowthami,M.Pratyusha,B.Somasekhar,B.Hemanth,Nag,' Detection of diseases in Different Plants Using Digital Image Processing',International Journal of scientific Research in Engineering,2017

[19] Abirami Devaraj, Karunya Rathan, Sarvepalli Jaahnavi and K Indira, 'Identification of mango leaf disease and control prediction using image processing and neural network',International Conference on Communication and Signal processing,IEEE.2019

[20] Ch.Usha Kumari, S.Jeevan Prasad, G.Mounika,'Leaf Disease Detection: Feature Extraction with k-means clustering and classification with ANN', International Conference on computing methodologies and communication, IEEE,2019

[21]VelamakanniSahithya,BrahmadevaraSaivihari, Vellanki Krishna Vamsi, Parvathreddy Sandeep Reddy and Karthigha Balamurugan,' GUI Based Detection of unhealthy leaves using image processing techniques', International Conference on Communication and signal processing,IEEE,2019

[22] Ms.Monika Gupta,Pabbathi Sravani,Reine D Bharali,S.Monica,Nanda Gopal Naik,'Plant Disease Detection using Digital Image Processing',International Journal of Innovation & Advancement in computer science,Vol.7, Issue 5,2018.

[23] Bed Prakash,Amit Yerpude,'Identification of Mango Leaf Disease and Control Prediction using Image Processing and Neural Network', Internationl Journal for Scientific Research & Development,Vol.3,Issue 5,2015.