Comparative Analysis of Various Filtering Techniques for Cherry Leaf Disease Detection

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Abstract-Image processing tools play an important role in automated disease detection process. Each plant disease detection process follows five main steps: image acquisition, image pre-processing, feature extraction, image segmentation and image classification. Different types of images inherit different types of noise and different noise models are used to present different noise types. This research work is based on de-noising of plant disease images. The various filters like Median Filter, Mean Filter, Weiner Filter, Gaussian Filter and Bilateral filter are applied to de-noise the cherry leaf images. The leaf images are given to k-mean for segmentation and KNN for classification. The simulation is performed in the MATLAB and results of the various filters are compared in terms of PSNR and MSE. The system has less time computational complexity.

Keywords-*Plant Disease Detection;Peak Signal to Noise Ratio (PSNR; Mean Square Error (MSE); K-Nearest Neighbor (KNN); Median Filter; Mean Filter; Weiner Filter; Gaussian Filter; Bilateral Filter etc.*

I. INTRODUCTION

Plant disease detection is basically a process which is used for identification and detection of plant diseases. The plant can be affected by a range of diseases which may be present on leaf, stem and root of plants. The diseases on any of the part of plant directly affect the quality and quantity of crop production. Indian farmers face a range of problems such as less crop production due to the diseases. So it is necessary to detect the diseases earlier as possible to reduce the loss in crop production. Plant disease detection methods using image processing tools are affective to use for identifying and classifying the disease. Automated disease detection systems are accurate and efficient for the purpose of disease detection [1]. Mainly the plant disease are categorized into three categories: bacterial, fungal and viral diseases. The automated systems designed using image processing tools makes use of color properties and other features of leaf image to detect the disease at early stage [2]. The quality and quantity of crops can be increased by detecting the diseases earlier with the help of automated disease detection system [3]. A quantity of diseases does not have any detectable symptoms associated and display very late. In today's modern era, agriculture has become one of the most important part of the population. Energy is the fundament part of the global warming and major source of plants also. Number of diseases is there which badly affected ecological, economical and society losses. To detect plant pathologies there are many ways. A quantity of diseases do not have any detectable symptoms associated and display very late. In those cases, powerful microscopes, is necessary for sophisticated analysis. In other cases, the signs can only be detected in parts of the electromagnetic spectrum that are not visible to humans [4]. A common approach in this case is the utilize of remote sensing techniques that explore multi and hyper spectral image captures. The methods that adopt this approach often employ digital image processing tools to achieve their goals. The naked eye observation method is generally used to decide diseases severity in the production practice but results are subjective and it is not possible to measure the disease extent precisely. Image processing technology in the agricultural research has made significant development [5].

This paper consists of following sections: Section 1 provide introduction to plant disease detection, types of plant diseases that affect the leaves of plants. Section 2 present the literature review carried out in area of plant disease detection. Section 3 discusses the various filters applied in pre-processing step of this work to de-noise cherry leaf image. Section 4 gives the methodology used in this work for detecting the plant diseases. Section 5 describes the experimental results. Section 6 Concludes the work performed.

II. LITERATURE REVIEW

This section discusses various image processing techniques used in several papers for disease detection of plants. The methods employed by various researchers for plant disease detection are discussed below.

Nasreen N. et al. [8], presented a study that focus on the application of texture analysis in microscopic images of plant stem cross sections. The texture features are extracted using GLCM method in this project. The accuracy and precision were obtained as 97%. The SVM classifier Performance may be improved by giving a large training set. In conclusion, this

automatic classification system has efficiency of 97% and is reliable and fast.

Dhaware C.G. et al. [9], proposed a method that focus on automatic leaf unhealthiness classification which establish on leaf image processing. The system approach will give advice to the farmer with minimum efforts. The farmer most effective require to seize the image of the plant leaf the usage of mobile camera and forward it to the DSS, without any additional inputs.

Francis J. et al. [10], presented an algorithm that produces better results and healthy and unhealthy plants can be differentiated with the help of this algorithm. This algorithm helps in identifying the presence of diseases by observing the visual symptoms seen on the leaves of the plant. With the aid of imaging technology the plant disease detection systems automatically detect the symptoms that appear on the leaves and stem of a plant and helps in cultivating healthy plants in a farm. These systems monitor the plant such as leaves and stem and any variation observed from its characteristic features, variation will be automatically identified and also will be informed to the user. This paper provides an evaluative study on the existing disease detection systems in plants.

Islam M. et al. [11], developed an automated system for image segmentation with multiclass SVM. The most significant diseases in potato, late blight and early blight, are identified with a little computational effort. A system can be planned to integrate more number of diseases of various species of plant into the system.

Joshi A.A. et al. [12], proposed a system for monitoring rice bacterial blight, rice blast, rice sheath rot and brown spot diseases in this study. Image processing techniques like segmentation, feature extraction, and two classifiers were used to establish the classification algorithm. In the feature extraction, color and zone wise shape features have been extracted and used as an input to the classifier. For each disease, a separate database has been used for training and testing. Proposed techniques have been tested for four mentioned rice diseases using two classifiers, k-NN and MDC and the accuracy achieved with two classifiers is 87.02 % , 89.23% respectively. There are other rice diseases except four covered in this work. Future work can be to cover other rice diseases. The same techniques can be applied to other crops with little modifications.

Kaur K. et al. [13], discussed that plant and fruit diseases are greatly affecting quality and quantity associated with production. The pesticides and other harmful manure is biggest obstacle in this area. The analysis indicates that automated approach to disease detection within fruits consume mush less time as compared to manual approach. Noise can distort the image. So de-noising mechanism are also elaborated in this case. Diseases in fruits are listed in tabular structure. This work shows that blight is common disease which is infecting most of the fruit crops. In order to tackle such diseases image of distorted leaf is taken and then fed into the system for analysis. Image processing techniques such as pre-processing, extraction, singular valued analysis etc. can be utilized in order to detect disease at early stage.

Tripathi G. et al. [14], introduced a method for detecting the plant leaf diseases which is based on Neural Network Classification. The input image is RGB image. At the segmentation step K-means clustering is used. MATLAB's built in function GLCM is used to extract features like moment, mean, variance, contrast, entropy and correlation. Diseases like Early blight, Late blight, Powdery mildew and Septoria are classified.

Gupta V. et al. [15], proposed a method to detect the powdery mildew disease from cherry leaves. Morphological Operators are used for scanning the whole image. Threshold based segmentation is used to partition the image. Histograms are drawn to detect the diseased and non- diseased portion of leaf.

Barbedo J.G. [16], presented a system for detecting the palm oil leaf disease in which segmentation is performed using k-means algorithm and multiclass Support Vector Machine (SVM) is applied for the purpose of classification. Two types of diseases namely chimaera and anthracnose are considered for analyzing the results. The presented system achieved the accuracy of 97% to classify chimaera disease and 95% to anthracnose. It is shown that the system is reliable for detecting and classifying the diseases at earlier with the use of symptoms present on leaves.

Amruta Ambatkar A. et al. [17], proposed a system to detect three rose diseases namely Black spot, Anthracnose and Rust. In pre-processing step image is cropped and laplacian filter is used for enhancement of leaf image. K-means segmentation is used. 13 color features and 4 shape features are extracted using Color Co-occurrence Matrix (CCM).

III. FILTERS USED FOR DE-NOISING OF CHERRY LEAVES

A. *Mean Filter:-*A sliding window-filter that helps in replacing the center value in the window is known as the mean filter. All the average mean of all the pixel values present within the kernel or window are replaced here.

B. *b. Median Filter:-* A simple and powerful non-linear filter that depends on the order of statistics is known as the media filter. The amount of intensity variation amongst the two pixels is minimized with the help of median filter. The pixel value of the image with respect to the neighboring pixel is not replaced in this filter. However, the median value can be used as a replacement to this value. All the pixel values are sorted initially in ascending order when the median is to be calculated.

C. *Wiener Filter:-* The noise that is identified as corrupted signal is minimized with the help of

Wiener filter. The statistical approach is also used to provide as a base in this filter. Numerous filters have been identified in order to achieve the required response. The noise is minimized with the help of wiener function with different perspective.

D. *Gaussian Filter:-* The Gaussian filtering scheme is based on the peak detection. The peak detection is based on the fact that peaks are to be impulses. The key point is that this filter corrects not only the spectral coefficient of interest, but all the amplitude spectrum coefficients within the filter window.

E. *Bilateral Filter:-* It is basically a non-linear, edge-preserving and Gaussian noise reducing filter used for gray and color images. It tries to smoothen the image and at the same time preserves edges of the image. As we know that color images have three bands i.e. red, green and blue. If these three bands are filtered separately, the smoothness of the image at the edges will be different. Separate smoothing disturbs the balance of colors and unexpected color combinations may appear.

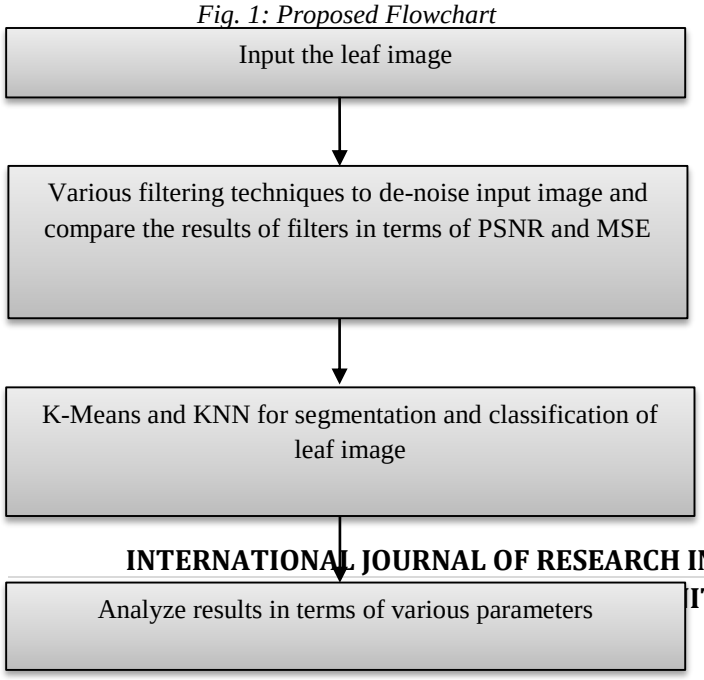
IV. PROPOSED METHODOLOGY FOR THE WORK

The various steps followed by the proposed system to detect the cherry leaf diseases are discussed step by step in this chapter. Following are the phases which are executed for the plant disease detection:

Step 1. Image Acquisition:- Image acquisition is considered as first step of plant disease detection in which leaf images are acquired to perform operations on that to detect the disease. The acquired images are in RGB (Red, Green And Blue) form which are converted into device independent space. The leaf images of cherry plant affected by various diseases are collected from leafsnap.com.

Step 2. Image Pre-Processing:- In this step, the various filtering techniques are applied which will de-noise the image. The various image de-noising techniques used in this work for de-noising the cherry leaf images are described in section 3.

Fig. 1: Proposed Flowchart



Step 3. Segmentation of the input leaves:- K-Means clustering algorithm is applied for segmenting the cherry leaf images. This technique holds the principle of uniformity as its foundation. It states that adjacent pixels inside a region possess similar properties while the properties of pixels associated with different regions are different. This technique aims at obtaining a bigger region with similar properties i.e. a uniform region and minimizing the number of regions. In this method, total numbers of observations are divided into K clusters, where K denotes number of clusters in the segmented area. The main idea is to iteratively determine k centroids, one for each cluster, by optimizing the sum of distances of data-points from their corresponding centroids. This method got the advantage that it works on both local and global information of image.

Step 4. Classification:- The KNN is the classification technique which is applied to classify similar and dissimilar data into more than one classes. K-Nearest neighbor classifiers depend on learning by analogy. The training samples are depicted by n dimensional numeric attributes. Every sample represents a point in an n-dimensional space. Along these lines, the greater part of the training samples is stored in an n-dimensional pattern space.

V. EXPERIMENTAL RESULTS

The proposed algorithm is implemented in MATLAB and performance of the various filters are compared in terms of PSNR, MSE. The comparison between various parameters such as Accuracy, Specificity and Computational time is also shown.

The Fig. 2 shows the comparative results of PSNR generated by various filters like median, mean, weiner, gaussian and bilateral filter.

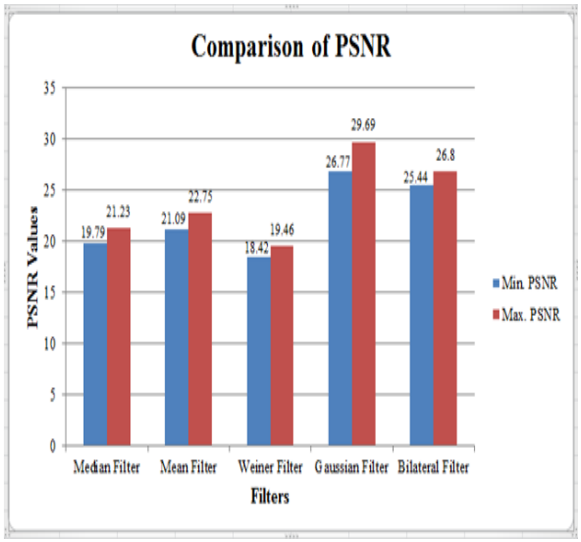


Fig. 2: PSNR Comparison

From Fig. 2, it is analyzed that PSNR value of Gaussian filter is maximum as compared to other filters.

Fig. 3 shows the comparative results of MSE generated by various filters like median, mean, weiner, gaussian and bilateral filter.

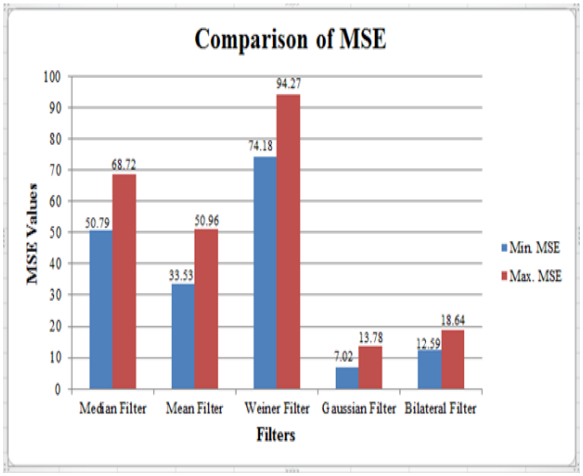


Fig .3: MSE Comparison

From Fig. 3, it is analyzed that MSE value of Gaussian filter is minimum as compared to other filters.

Fig. 4 shows the comparative results of accuracy.

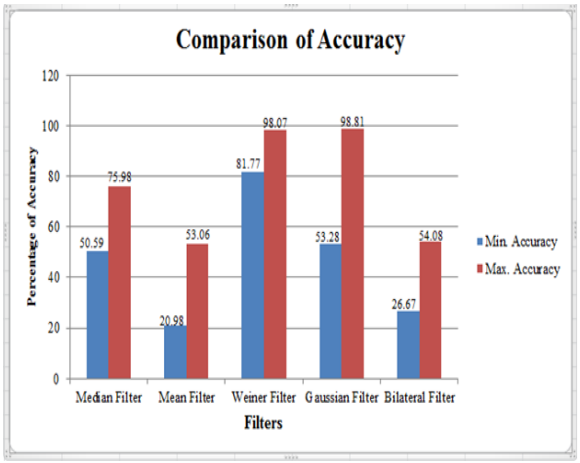


Fig. 4: Accuracy Comparison

From Fig. 4, it is analyzed that the system achieved high accuracy when the leaf image is filtered using weiner and Gaussian filter.

Fig. 5 shows the comparative results of specificity.

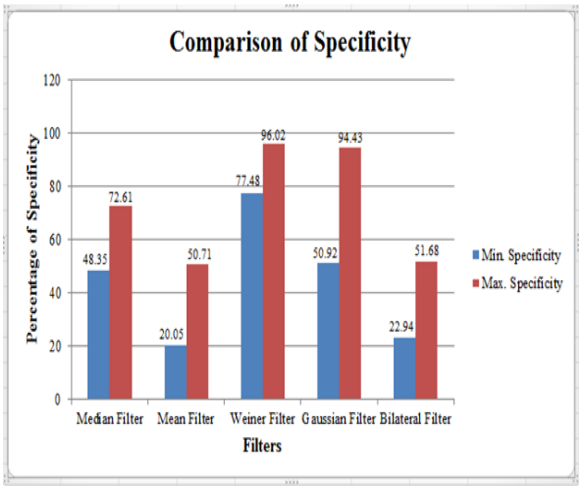


Fig. 5: Specificity Comparison

From Fig. 5, it is analyzed that the system achieved high specificity when the leaf image is filtered using weiner and Gaussian filter.

Fig. 6: shows the comparative results of computational time.

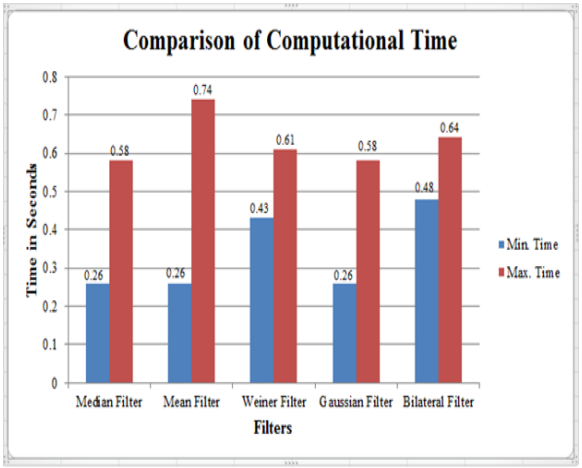
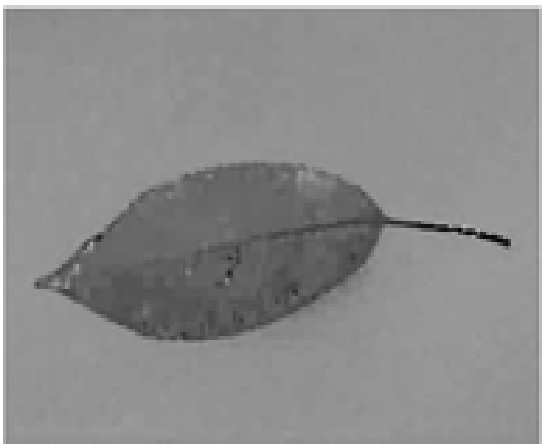


Fig. 6: Execution Time Comparison

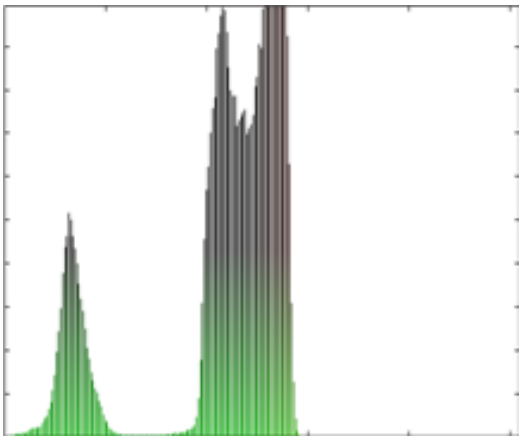
From Fig. 6, it is analyzed that the system has taken less time to detect the disease when leaf image is filtered using Gaussian filter.

(a) Original Cherry Leaf Image



(b) Hue Component of Cherry Leaf Image

(c) Saturation Component of Cherry Leaf Image



(d) Histogram of Cherry Leaf Image

(d) Healthy (white part) Cherry Leaf Image

(d) Diseased (white part) Cherry Leaf Image

Fig. 7: Experimental Results on Cherry Leaf images

The experimental results performed on cherry leaves are shown in Fig. 7 (a)- Fig. 7 (f). The Fig. 7 (a) shows the original cherry leaf image taken for disease detection process. Fig. 7 (b) shows the hue component of leaf image. Fig. 7 (c) shows the saturation component. Fig. 7 (d) shows the histogram of diseased leaf image. Fig. 7 (e) shows the healthy image. The white part in the image is healthy and black part is diseased. Fig. 7 (f) shows the diseased image. The white part in the leaf image is diseased and black part is healthy image.

VI. CONCLUSION

The plant disease detection is the technique which is applied to detect diseases from the plants. The images of plants are highly noisy which affect performs of algorithms from disease detection. The various efficient filters are available for the de-noising of plant images. In this research work, various filtering techniques such as median, mean, weiner, gaussian and bilateral for image de-noising are applied in pre-processing step of plant disease detection. The images are segmented using k-Mean algorithm and KNN (K-Nearest Neighbor) is applied for the purpose of classification. The performance of the filtering techniques is compared in terms of certain parameters such as Peak Signal to Noise Ratio (PSNR) and Mean Squared Error (MSE). The Gaussian filter performed better than other filters in terms of Peak Signal to Noise Ratio (PSNR) and Mean Squared Error (MSE) as the Peak Signal to Noise Ratio (PSNR) generated by gaussian filter is highest among other filters and Mean Squared Error (MSE) is very low as compared to other filters used in this work. The parameters False Positive Rate (FPR), False Negative Rate (FNR), Accuracy, Specificity and Computational Time are also compared. In case of Gaussian filter, False Positive Rate (FPR) is very high and False Negative Rate (FNR) is low when compared to other filters. The computational time taken to detect the disease is less when the cherry leaf image is filtered using Gaussian filter among other filters. This system has less time computational complexity.

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