

Detection and Assessment of Leaf Spot Disease in Black Pepper Leaf

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ABSTRACT: Plants are bound to have diseases. Plant diseases are a major problem, as it can cause significant reduction and loss in both quality and quantity of agricultural products. The black pepper leaves are infected by anthracnose disease and it affects the production. The automatic detection of this disease would lead to effective control in earlier stage of the disease. This work is to automatically classify whether the black pepper leaf is normal or infected by leaf spot diseases viz. anthracnose and phytophthora diseases using image processing. If it is infected, then the area and percentage of infection are computed. The disease detection is tested on 27 black pepper leaves. The detection of normal or infected leaf has accuracy of 100%.

KEYWORDS: disease detection, assessment, image processing, anthracnose, black pepper etc.

I. INTRODUCTION

Agriculture is the mother of all cultures. India being an agricultural country, where more than 54.6% of the population depends on agriculture and allied activities [16]. As per estimates by the Central Statistics Office (CSO), the share of agriculture and allied sectors (including agriculture, livestock, forestry and fishery) was 15.35 per cent of the Gross Value Added (GVA) during 2015-16 at 2011-12 prices [17]. Since there is a growing Indian population, which is increasingly dependent on the agricultural yield, production of crops must be enhanced [15]. In order to grow more the disease must be analyzed in prior.

Black Pepper is known as the “king of spices”, as it has remained the most precious and valuable spice in the world. It is the third most added ingredient in food among the wide range of spices. India is one of the largest producers of black pepper, after China and Vietnam. A wide variety of black pepper is traded at an international level, with India as one of the top five exporters of black pepper, along with Vietnam, Indonesia, Brazil and Malaysia [19].

Black pepper (*Piper nigrum L.*) is a perennial climbing vine grown for its berries extensively used as spice and in medicine. Black pepper has played a pivotal role in India's international trade. India is the third leading producer, consumer and exporter of black pepper in the world [5]. During 2014-15, 65,000 tons of black pepper production were produced in India and it had exported 21,450 tons of pepper valued at INR 1,200 crores [11]. In fact the production rate of Black pepper has decreased tremendously as the diseases affect the crop production. Black pepper is cultivated to a large extent in Kerala, Karnataka and Tamil Nadu and to a limited extent in Maharashtra, North Eastern states and Andaman & Nicobar Islands [5].

The black pepper growing areas in the West Coast of India include (i) coastal areas where black pepper is grown in homesteads (ii) midlands, where black pepper is extensively cultivated on a plantation scale and (iii) hills at an elevation of 800-1500 m above sea level, where the crop is mostly grown on shade trees in coffee, cardamom and tea

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plantations [5].

The crop is being infected with many fungal, bacterial and viral diseases which in turn lead to reduced production. Fungal Pollu disease (Anthracnose) is the disease caused by *Colletotrichum gloeosporioides* [5][14]. The disease is seen throughout the year; especially it appears towards the end of the monsoon. The affected berries show brown sunken patches during early stages and their further development is affected. In later stages, the discoloration gradually increases and the berries show the characteristic cross splitting. Finally, the berries turn black, dry and fall [10]. On leaves, the disease is characterized by grey white to dark brown spots of varying size with several dark dots on it representing the fruiting bodies of the fungus. The lesion or spot has a prominent yellow halo around it. The lesion may coalesce resulting in leaf blight and subsequent defoliation [14]. The anthracnose disease in black pepper leaf will have shot holes which are formed due to shedding of infected leaf area, and phytophthora diseases will have brown portions at the extreme ends. Fig.1 shows six normal black pepper leaves and Fig.2a and 2b shows the stages of sample black pepper leaf infected by anthracnose. Fig.3 shows the anthracnose leaf disease infection in black pepper leaf.

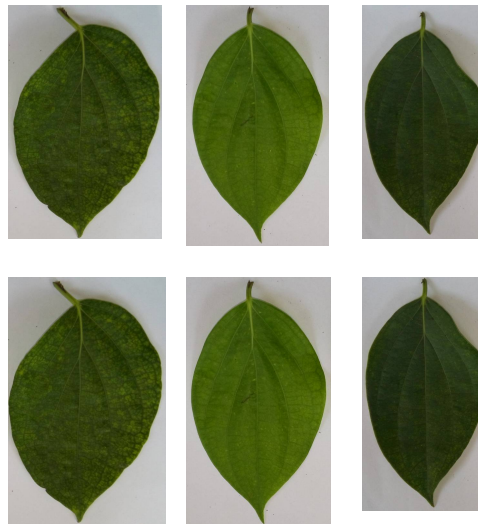


Fig.1. Normal Black pepper leaves



Fig.2a. Brown part surrounded by yellow halo



Fig.2b. Shot holes

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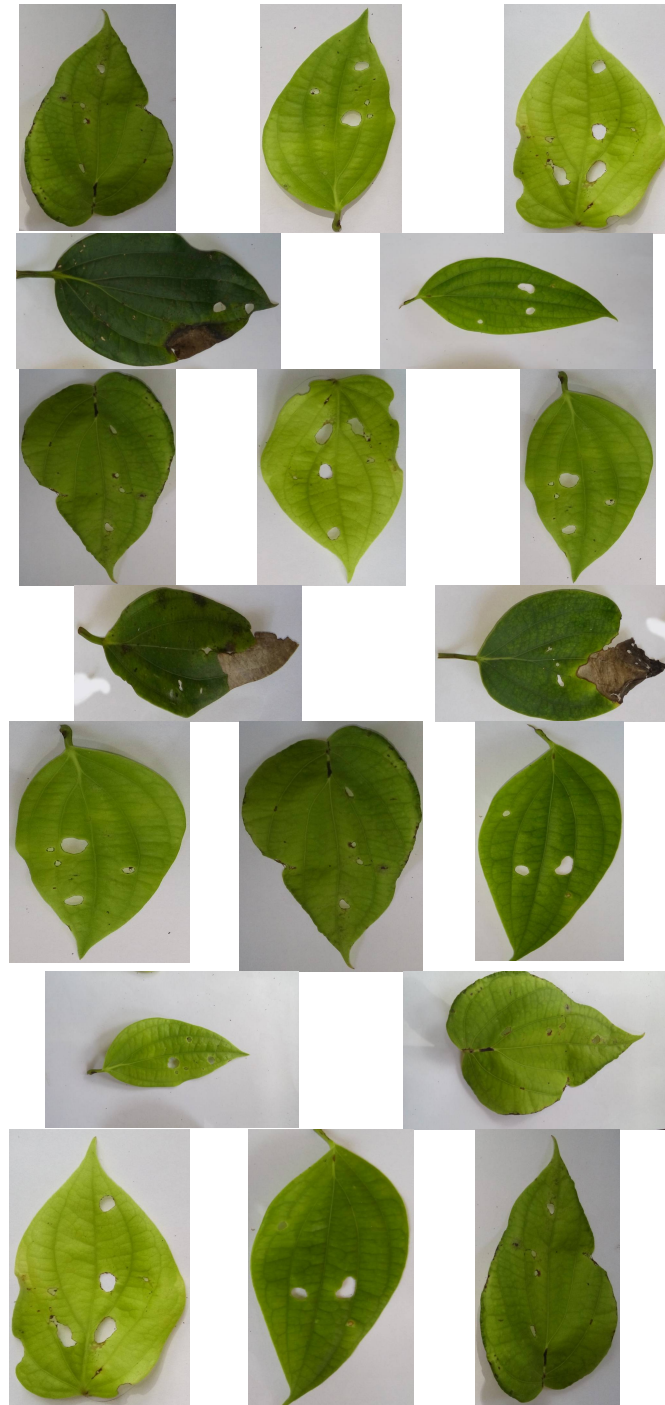




Fig.3. Anthracnose and Phytophthora infections in Black Pepper leaf

Plant diseases can cause significant reduction in crops and lead to poor quality of agricultural products. Research in agriculture is aimed towards increase of productivity and food quality at reduced expenditure and with increased profit. Generally the naked eye method is used to identify the diseases. In this method experts are involved who have the ability to detect the changes in leaf color. This method involves lots of efforts, takes long time and also not practical for the large fields [3] [9]. Many times different experts identify the same disease as different diseases. This method is expensive as it requires continuous monitoring of experts [2] [7].

The development of Computer vision system to detect, recognize and classify plant diseases will avoid human interferences. Development of such an automated system helps farmers to avoid consulting divine experts. Since there is an immense growth in research on the area of Computer Vision and Image Processing, this technique can be employed to find automatically whether the leaf is infected by disease or not. The disease area could also be extracted [1] [4] [6].

II. LITERATURE SURVEY

Jagadeesh D. Pujari, Rajesh Yakkundimath, and Abdulmunaf S. Byadgi (2015) proposed Identification of disease on fruits can be categorized into partially affected, moderately affected, severely affected and normal leaves using Gray Level Co-occurrence Matrix (GLCM) and Gray Level Run Length Matrix (GLRLM) with Nearest Neighbor (NN) classifier. Average classification accuracy of GLCM and GLRLM was 91.37% and 86.715% respectively [1].

In the Identification of disease on cereal crops, the authors suggested to project the patches from image samples using the Random Transformation and Projection Algorithm and classified using Support Vector Machine (SVM) classifier. Average classification accuracy of color features, shape features and texture features was 80.83%, 85% and 85.33% respectively [1].

The method proposed by Bindushree H.B and Dr. Sivasankari G G (2015), considers the pattern that appeared on the leaf for detection of leaf disease. Segmentation is done by K- means clustering to partition the leaf image into three or more clusters. Texture based features like Angular second moment, Correlation, Variance, Inverse difference, Sum Average, Sum Variance, Sum entropy, Entropy etc. are identified. Features are extracted from each cluster using the Gray Level Co-occurrence Matrix (GLCM). The Support Vector Machine (SVM) classifies whether the leaf is normal or diseased one [12].

Tejal Deshpande, Sharmila Sengupta and K. S. Raghuvanshi (2013) proposed Fuzzy Logic for leaf disease identification. The authors first does preprocessing, then segmentation using K- means clustering to partition the leaf image into different clusters. The cluster creates binary image, from which the Total Leaf area A_T and Total Diseased area A_D are calculated. The Percent Infection is calculated and disease grading is done using Fuzzy Logic [13].

Anand H. Kulkarni et al. (2012) presented disease detection using Gabor filter and Artificial Neural Network (ANN). The authors does preprocessing, followed by Image Segmentation using CIELAB color space, to extract the color, texture

and shape factors. Gabor filters computes the energy factor which are then fed into Artificial Neural Network to detect whether the leaf is normal or infected. Average classification accuracy using Gabor Filter and ANN classifier was 91% [8].

Basvaraj S. Anami, J.D. Pujari and Rajesh Yakkundimath (2011) compared the results obtained by Artificial Neural Network Based Classifier for disease identification on Horticulture products which uses texture and color features. The authors do image preprocessing, followed by Color and Texture feature extraction and classification using Multilayered Back Propagation Neural Network. The authors showed that average classification accuracy using Color based recognition, Texture based recognition and Color and Texture based recognition was 80%, 78% and 84% respectively [4].

III. METHODOLOGY

A. IMAGE ACQUISITION

First, the RGB color images are captured using a digital camera. The input images are still images collected from Coconut Research Station, Balarampruam, Trivandrum.

B. IMAGE PREPROCESSING AND SEGMENTATION

The infected leaves may have shot holes or it may contain brown portions surrounded with yellow halos. The disease detections are done by identifying the holes and the brown portions in leaf. The input image is segmented to extract the diseased portion. The diseased portions are shown as white and others are shown as black.

Preprocessing step is done in order to improve the image data which removes background, noise and also suppress undesired distortions. If the image size is very large then it has to be resized to small size for reducing the computational complexity.

First the RGB images of leaves are converted into HSV color space representation. HSV (Hue, Saturation, and Value) color model is a popular color model, which is based on human perception. Hue is expressed as a number from 0 to 360 degrees representing hues of red (which start at 0), yellow (starting at 60), green (starting at 120), cyan (starting at 180), blue (starting at 240) and magenta (starting at 300). Saturation is the amount of gray from zero percent to 100 percent in the color. Value (or brightness) works in conjunction with saturation and describes the brightness or intensity of the color from zero percent to 100 percent. After the transformation, the H component is taken into account and S and V components are left out as they do not give much information [18].

Here, the background area, the leaf area and the diseased portions are computed.

To detect the two leaf spot diseases anthracnose and phytophthora in black pepper leaf the following steps are done.

1. Read the pepper leaf image.
2. Extract R, G and B components in image.
3. Convert RGB to HSV color format to identify the green component in leaf.
4. Extract the Hue, Saturation and Value Component.
5. Find the maximum color component at each pixel in HSV model.
6. Set the pixels in the x and y locations to '1' when saturation component is maximum and otherwise set to '0'. i.e. leaf area is set to '1' and background & diseased area are set to '0'.
7. Compute the leaf area with disease by adding all the 1's.
8. Find the complement of the segmented image. Now diseased area and background is '1' and leaf area is '0'.
9. Remove the isolated white pixels in the background of the image.
10. Extract the white pixels i.e. diseased pixels within the leaf area.
11. Compute the holes area by finding the sum of white pixels.
12. Compute the brown part in the leaf by finding the maximum red component to identify brown parts in

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- leaf. Find the sum of white pixels.
13. Add the holes areas and brown part area to find the total disease area. Compute the leaf area by adding the disease area and leaf with disease.
 14. Compute the leaf area percentage using the equation 1.

$$Leaf_area_percentage = \frac{leaf_area}{image_size} \times 100$$

.....(1)

15. Compute the background area by subtracting the leaf area from original image size.
16. Compute the background percentage using the equation 2.

$$Background_percent = \frac{image_size - leaf_area}{image_size} \times 100$$

.....(2)

17. Display the total number of pixels in Original Image, background and Leaf area.
18. If there is no disease area then displays it is a Normal leaf.
19. Otherwise the pepper leaf is infected by anthracnose disease. Then compute the Percentage of Infection using equation 3 and display the percentage of infection.

$$Percent_infected = \frac{total_disease_area}{leaf_area} \times 100$$

.....(3)

IV. EXPERIMENTAL RESULTS AND DISCUSSION

The experimental work is tested with six normal pepper leaves and twenty one anthracnose infected leaves. Each input image contains one pepper leaf and the images are taken with normal lighting conditions in a white background. The sample normal input images are shown in Fig.1. The anthracnose infected leaves are shown in Fig. 3. The algorithm is implemented using MATLAB. The sample images obtained during the sequence of steps is shown in Fig.4 - 8.



Fig. 4. Sample input image



Fig. 5. Segmentation of Leaf and Anthracnose Holes



Fig. 6. Segmentation of Holes



Fig. 7. Segmentation of Brown parts



Fig. 8. Anthracnose infected portions in Pepper leaf

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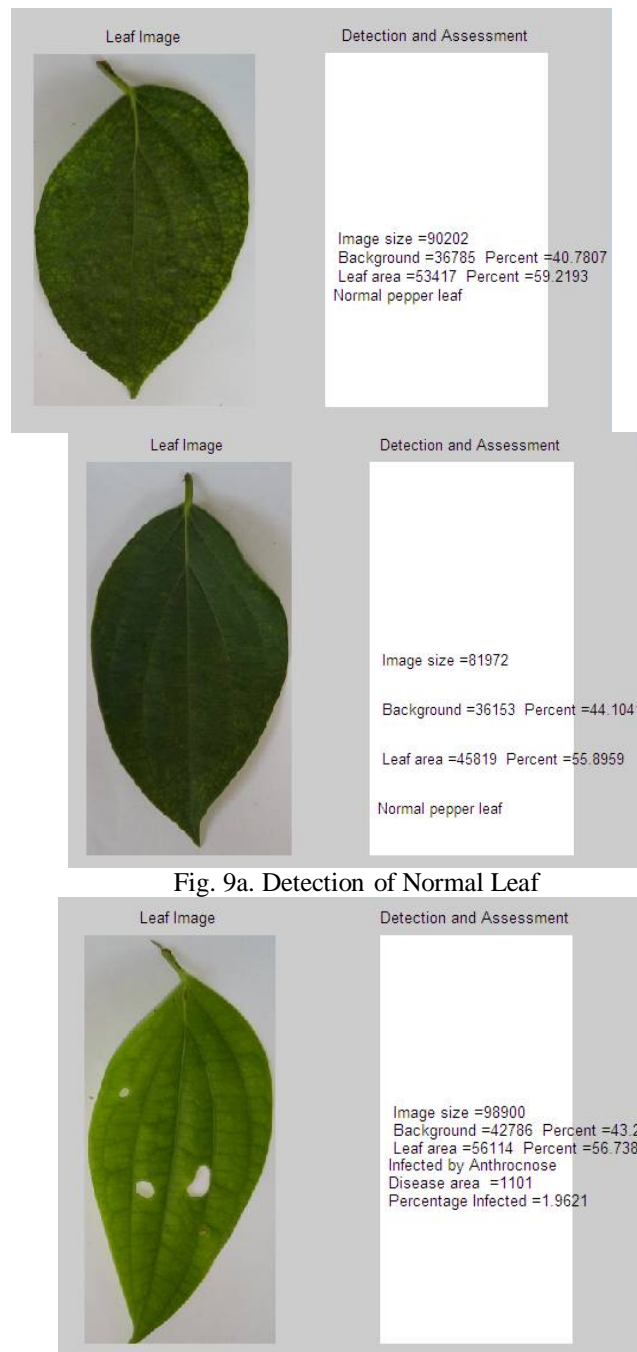


Fig. 9a. Detection of Normal Leaf

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<p>Leaf Image</p> 	<p>Detection and Assessment</p> <pre> Image size =114540 Background =36865 Percent =32.1853 Leaf area =77675 Percent =67.8147 Infected by Anthracnose Disease area =7160 Percentage Infected =9.2179 </pre>
<p>Leaf Image</p> 	<p>Detection and Assessment</p> <pre> Image size =499392 Background =334365 Percent =66.9584 Leaf area =165007 Percent =33.0416 Infected by Anthracnose Disease area =33345 Percentage Infected =20.2082 </pre>
<p>Leaf Image</p> 	<p>Detection and Assessment</p> <pre> Image size =254771 Background =172721 Percent =67.7946 Leaf area =82050 Percent =32.2054 Infected by Anthracnose Disease area =3422 Percentage Infected =4.1706 </pre>

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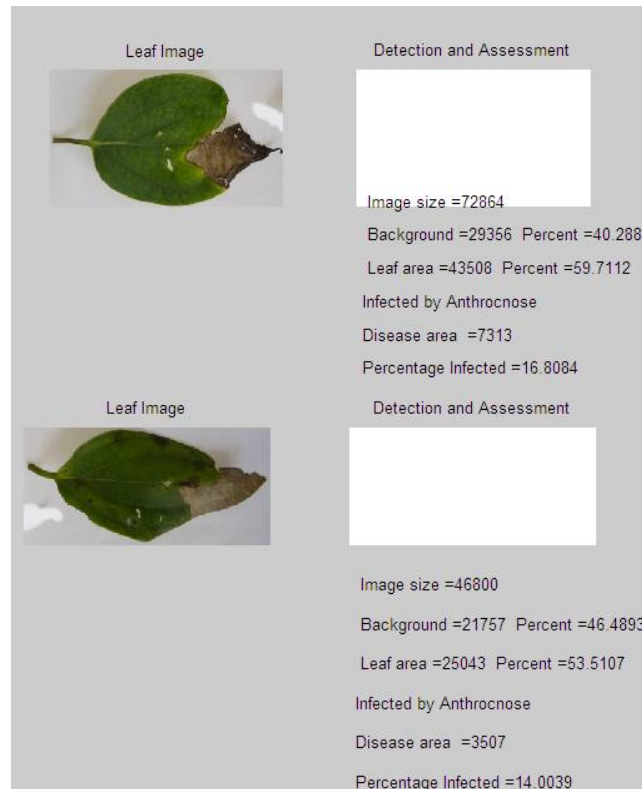


Fig. 9b. Detection and assessment of Anthracnose infected Leaf

The detection of Normal leaf is shown in Fig.9a and detection and assessment of Anthracnose infected leaf is shown in Fig.9b. The performance of the algorithm is analyzed using Confusion matrix. The experimental results are given in Table 1.

Table 1. Performance measurements using confusion matrix

Type of Leaf	Normal	Diseased
Diseased Leaf (21)	----	21
Normal Leaf(6)	6	----

The parameters viz. True Positive Rate (TPR), False Positive Rate (FPR), specificity and accuracy are computed from the confusion matrix. TRP is the rate at which diseased leaves are correctly classified as diseased and False

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Positive Rate is the rate at which the normal leaves are classified as diseased leaves. The accuracy is percentage of both normal and diseased leaves are classified correctly as normal or diseased. From the confusion matrix, the parameters are given below.

$$\begin{aligned} \text{TPR} &= (\text{correctly classified positives}) / (\text{total positives}) \\ &= \text{TP} / (\text{TP} + \text{FN}) \\ &= 21 / (21 + 0) \\ &= 1 \end{aligned}$$

$$\begin{aligned} \text{FPR} &= (\text{incorrectly classified negatives}) / (\text{total negatives}) \\ &= \text{FP} / (\text{FP} + \text{TN}) \\ &= 0 / (0 + 6) \\ &= 0 \end{aligned}$$

$$\begin{aligned} \text{Specificity (Sp)} &= \text{TN} / (\text{TN} + \text{FP}) \\ &= 6 / (6 + 0) \\ &= 1 \end{aligned}$$

$$\begin{aligned} \text{Accuracy (Ac)} &= (\text{TP} + \text{TN}) / (\text{TP} + \text{TN} + \text{FP} + \text{FN}) \\ &= (21 + 6) / (21 + 6 + 0 + 0) \\ &= 1 \end{aligned}$$

Accuracy is 100%.

The proposed algorithm has shown accuracy of 100%. The methods reported in the literature shown accuracy of 91%. When compared to the methods discussed in the literature section, this method outperforms all the results. It does not use any machine learning algorithms like ANN or SVM. This method uses the RGB and HSV color models to identify the diseased portions and it is simple and efficient when compared to the methods that are using SVM.

V. CONCLUSION

The black pepper leaves are infected by anthracnose disease and the yield is affected worse due to this disease. In fact current year's black pepper production in Kerala had reduced due to the various diseases that affect the plant. The Anthracnose fungal disease is air borne, which results in leaf shedding, leading to heavy crop loss. If the disease is detected in earlier stage, effective control measures could be applied. The automatic detection of anthracnose leaf disease in black pepper is done to increase the yield of production. The algorithm described in this work which uses RGB and HSV color models efficiently segments the diseased portion. This work computes the background area, leaf area and diseased area and finally percentage of infection is also computed. The performance of the proposed algorithm is tested by computing the confusion matrix. The accuracy achieved is 100%. It outperforms the results of the recent methods which uses machine learning techniques.

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