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LEAF AREA DETECTION IN DISEASED LEAVES OF DALBERGIA SISSOO (SHISHAM) USING SEGMENTATION AND CHANNEL DETECTION TECHNIQUE

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Dalbergia sissoo Roxb. (commonly known as Shisham in Pakistan) is a slow to medium growing tree having high economic importance due to its fine timber quality. It is in danger in Pakistan due to various diseases like leaf blight, wilt, leaf rust, and die-back. The traditional approach for the detection of infected leaf area requires human experts to inspect the leaves by naked eye. This approach is time-consuming and sometimes proves to be expensive. Pathogen infection alters the physiology of trees and results in deteriorating the wood quality which could directly affect its market value. With digital image processing techniques, plant diseases can be detected during the early stages. Early detection of chronic Shisham diseases and appropriate measures for treatment can help to save this plant species from extinction. This study proposes a novel technique based on segmentation and channel detection for precise detection of infected leaf, also computing the value of a healthy and diseased area. Early detection of Shisham chronic diseases helps to take appropriate measures to save this species, as it is already under threat of complete evanescence. Our proposed algorithm, "Segmentation and Channel Detection (SACD)" has achieved more than 95% accuracy in the detection of infected leaf area, which is a significant achievement for further processing
Keywords: Leaf area detection; Segmentation and Channel detection (SACD); Digital Image Processing; Precision Agriculture; *Dalbergia sissoo.*

INTRODUCTION

Agriculture is the backbone of economic development and it includes trees, crops, vegetables, fruits, and woods. *Dalbergia sissoo* is commonly known as 'Shisham' in Pakistan. This tree species is a primary source of quality timber. For the past few years, several diseases, including die-back and wilt, are the main causes of severe damage to Shisham in Pakistan. Similar diseases and their associated damages to this tree species are also found and reported in Nepal. These diseases are severely damaging this tree, as leaves and branches drop in the early stages. Leaves turn yellow and become dry resulting in the gradual death of the tree in a period of 1 to 6 months (Ahmad *et al*., 2015). In UP, India, it was Bakhshi (1954) who observed this deadly disease of Shisham in plants and natural forests.Traditional methods of disease detection in Shisham involve a physical examination of leaves and branches with the naked eye. These old methods require human experts, are also less accurate, and expensive. The world is now moving towards Precision Agriculture (PA), a technological revolution in the agriculture field. Computer Vision (CV) and Digital Image Processing (DIP) technologies are very helpful in the early detection of plant diseases with more accuracy as compared to traditional naked-eye observation by human experts. Plant diseases are categorized as infectious or non-infectious. Disease symptoms can be systemic or local, primary or secondary and microscopic or macroscopic. Shisham being a precious tree has unfortunately passed through several highly destructive and damaging challenges from several decades that are not only destroying its plantation badly but also pushing it towards fear of complete extinction. The main causes of this disaster include lack of proper planning and management in plantation and distribution, smuggling, and cutting forests without legal rights, and diseases like leaf rust, leaf blight and die-back (Mukhtar *et al*., 2015). It is reported that disease severity increases under drought and high moisture conditions in soil (Bajwa and Javaid, 2007). Human experts are unable to detect healthy/infected leaf areas accurately with naked-eye observation and this practice is expensive.

Khirade and Patil (2015) presented several techniques, based on image segmentation and feature extraction to identify plant leaf diseases by using clustering and filtering. A survey of various classification techniques was presented by Ghaiwat and Arora (2014) to classify diseases in a plant leaf. Jhuria *et al*. (2013) used Artificial Neural Network (ANN) for disease detection in fruits by using texture, morphology and color features. Kulkarni and Patil (2012) presented a methodology based on ANN and diverse image processing to detect plant diseases by using color and texture features. Thangadurai and Padmavathi (2014) proposed a method to detect diseases in plant leaves using histogram equalization and gray scale conversion techniques. Arivazhagan *et al*. (2013) developed a system to automatically detect and classify several diseases in plant leaves and achieve 94% result accuracy. The system works in a four-step process consisting of color transformation followed by masking and segmentation of the input images. Bashir and Sharma (2012) proposed a method to remotely detect diseases in *Malus domestica* by using co-occurrence matrix and K-means clustering techniques and achieve better accuracy in detecting normal and affected regions in the input images. Patil and Kumar (2017) proposed a system for plant disease detection using texture, shape and color features. As a sample, three diseases of soybean leaf are taken and their shape, texture, and color are analyzed. The system works with a combination of already implemented Local Gray Gabor Pattern (LGBP) providing much better results of 96% as compared to the previous 52% results. Bama *et al*. (2011) proposed a method to retrieve plant images by using leaf texture features shape and color for the retrieval process. Dhaygude and Kumbhar (2013) presented a methodology to detect plant leaf diseases by using vision-based algorithms for detection purpose and masking pixels having a green color with Color co-occurrence (CCM) matrix. In the current era, a simple and précised way is required for the identification and quantification of a diseased portion in plants. In this regard, the present study is conducted to provide a DIP based solution for earlier identification of diseased areas accurately with percentages.

MATERIALS AND METHODS

In this study, a novel technique based on Segmentation and Channel Detection in Red, Green, Blue (RGB) color space is devised to identify a healthy/diseased leaf area. Based on this technique an algorithm named Segmentation and Channel Detection (SACD) is proposed. In the first step, the data set consisting of a set of images are acquired using a digital camera. Pre-processing is applied, followed by image enhancement and filtering, which results in the extraction of desired information about the percentage of healthy/infected leaf area. Finally, the results are displayed. Figure 1 shows the flow chart of the proposed SCAD algorithm. The proposed technique consists of the following basic steps:

i. Image capturing
ii. Pre-processing (Resizing)
iii. RGB to gray-scale conversion
iv. Image segmentation
v. Total leaf area calculation
vi. Filtering
vii. Infected leaf area calculation
viii. Regeneration of Segmented image
ix. Results (values of healthy/infected area) display

Steps of the SACD Algorithm

1. Read image (*i*)
2. Resize *i*
3. Convert *i* to gray-scale
4. Convert gray-scale to binary image (by using pre-computed threshold value)
5. Fill "holes" (morphological operation)
6. Calculate total leaf area
7. Detect 'RED channel' in *i*
8. Subtract RED channel from gray-scale
9. Convert intensity image to binary (by using pre-computed threshold value)
10. Calculate infected leaf area
11. Regeneration of segmented color image
12. Display percentages of infected/ healthy area

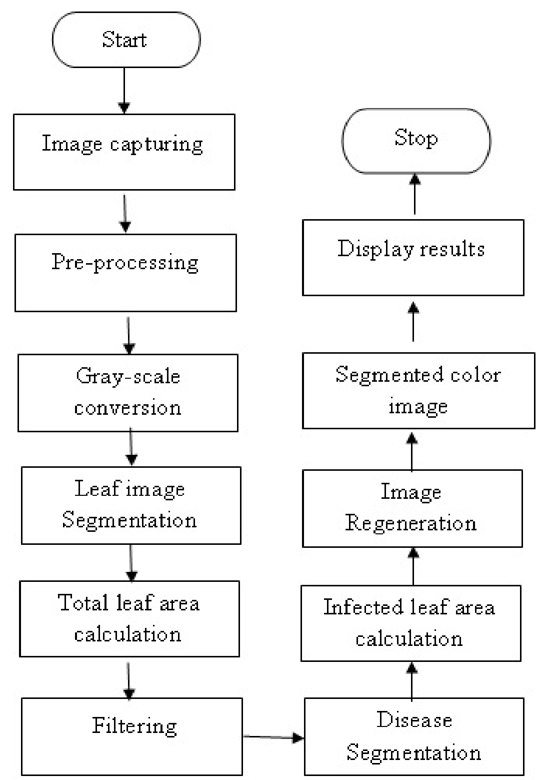


Figure 1. Flow chart of the SACD algorithm

Image Capturing Device Specifications

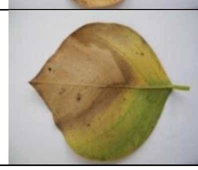
Camera model: Nikon Coolpix P7000
Effective pixels: 10 megapixels
Type: Compact
White balance: Auto

Tool used

"MATLAB R2015a"

Data Set: Sample data consists of 1000 images of Shisham leaves that are collected according to the criteria given in Table 1.

Table 1. Criteria for sample data.

Category No.	Leaf condition	Sample Size	Sample Image
I.	Small Portion infected (1-25%)	250	
II.	Near to half portion infected (26-50%)	250	
III.	More than half portion infected (51-100%)	250	
IV.	Non infected (0-<1%)	250	

RESULTS AND DISCUSSION

In the present study, our proposed algorithm SACD is very simple and easy to use technique, which performs well, and gives about 97.2% accuracy in the process of healthy/infected leaf area detection in Shisham leaves. A total 1000 Shisham leaves images are taken as sample data. The sample data is then divided into four categories with a sample size of 250 images for each category. On 972 images belonging to one of the four pre-defined categories, our algorithm correctly identifies the healthy/infected leaf area.

Table 2. Analysis and accuracy of all categories.

Category	Sample size	Pass	Fail	Accuracy
Category I (Small portion infected)	250	240	10	96.0
Category II (Near to half infected)	250	242	8	96.8

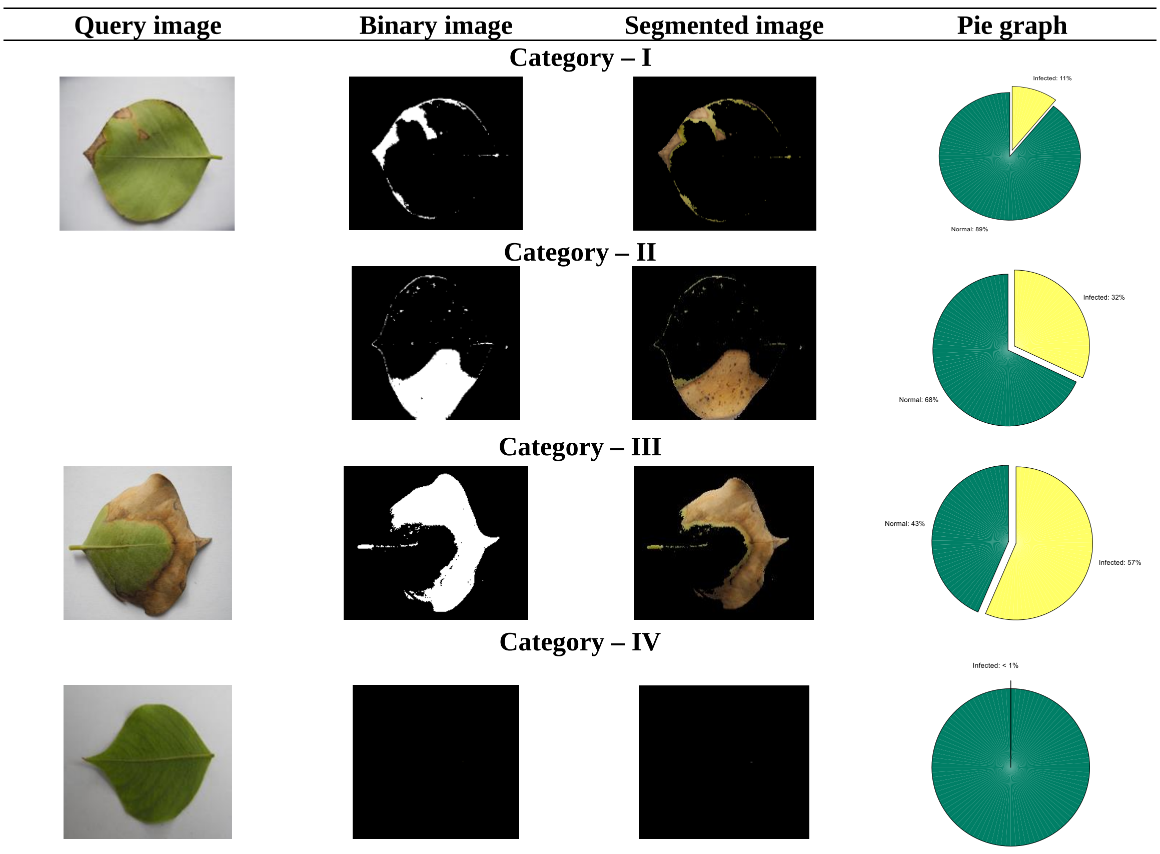


Figure 2. Testing results of all categories

Table 3. Results comparison [Thakur *et al*. (2017)]

Authors name	Sample size	Extracted features	Classifier used	Parameters used	Results
Arivazhagan *et al*.	500 images	Contrast, Energy, Cluster shade	SVM, Minimum distance criterion	Accuracy of detection	With SVM 94% with minimum distance criterion 86.77%
Pujari *et al*.	990 images	LBP features	KNN, ANN	Computation time, accuracy	Using ANN 84.11% with KNN 91.54%
Mokhtar *et al*.	200 images	402 texture features	SVM	Accuracy	With cauchy kernel function 100% with Laplacian kernel function98% with invmult kernel function 78%
SACD	1000 images	Healthy/Infected Leaf area	Segmentation & Channel etection	Accuracy	97.2

Category III (More than half infected)	250	240	10	96.0
Category IV (Green/No infected area)	250	250	0	100.0
Total	1000	972	28	97.2

On 28 images, it fails to correctly identify a healthy/infected leaf area because of the milky white color of infected area. Table 3 compares the result accuracy of some of the previously proposed algorithms for plant disease classification and detection with our proposed SACD algorithm (Thakur *et al*., 2017).

Performance Evaluation of the Proposed SACD Algorithm

True Positive TP = 972
True Negative TN = 0
False Positive FP = 0
False Negative FN= 28
Precision = 972/(972+0) = 1
Accuracy = TP+TN/(TP+TN+FP+FN)
= 972+0/(972+0+0+28) = 0.972

***Conclusions*:** In this research study, a new algorithm SACD has been proposed to precisely and accurately identify a healthy/infected leaf area in Shisham. The proposed algorithm is simple in working and accurately identifies infected leaf area along with calculating and displaying the percentages of both healthy/ infected area in Shisham leaves by implementing gray-scale conversion, image binarization, channel detection along with image filtering and segmentation techniques using a specific manual threshold value. MATLAB has been used for implementation. The accuracy rate achieved was 97.2%, which is better than the techniques presented in Review of Literature. The system is helpful for Plant Pathology and Forestry to detect physical disease symptoms accurately in order to enhance precision agriculture and plantation.

Future Work: Firstly, Development of a desktop/mobile app to provide more support and user-friendly interface, i.e. graphical user interfaces (GUI). Secondly, Disease classification techniques can be combined with this algorithm to develop a disease identification system along with disease classification features. Such disease identification and classification system could be beneficial for local farmers and Forestry/Plant Pathology departments by providing support for enhancing agricultural industry and plantation.

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