Plant Leaf Segmentation Invariant of Background

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Abstract— *In this paper we describe an approach for plant leaf segmentation which is background invariant. Leaf segmentation is a primal pre-processing step to perform various operations on the leaf, which is mostly difficult to achieve with accuracy on varied backgrounds. This method has been tested on a dataset of 200 leaves form 8 different plant species and with each having a different background. The approach is easy to implement and has high accuracy.*

Keywords— *Leaf Segmentation, Leaf Detection, Image Segmentation, Finding Disconnected Components.*

I. Introduction

The goal of segmentation is to change the representation of an image into something that is more meaningful and easier to analyse. Digital images are processed to locate and extract sub images of individual leaves. To perform any operation on plant leaves through examination of images of plant leaves requires as an input an image of single leaf.

Segmentation is an important pre-processing task in many image processing applications and essential to separate plant leafs from the background in the image. Locating and segmenting plants from the background in an automated way is a common challenge. Although many methods are proposed, it is still difficult to accurately segment an arbitrary image by one particular method in the analysis of plant images. This paper describes a simple approach of segmenting leaves invariant to the background with an accuracy of 97% as tested on a dataset of 200 images.

The rest of the paper is framed as follows. In the next section, section 2 overview is explained with the methodology. In the following section, section 3 to section 5 we explain the three major steps involved in this approach. Then in last, section 6 paper is summarised and concluded.

Fig. 1 Input leaf image (RGB 8bit) with random background.

II. Overview

Approach described successfully segments leaf in an image which has the leaf in considerable size as compared to the image. A dataset of 200 leaves form 8 different plant species each having different backgrounds has been used to test this procedure. The approach mainly has three main steps:

- Green enhancement
- Establishing disconnected components
- Finding the largest disconnected component

III. GREEN ENHANCEMENT

Green enhancement is applied to preserve the green component of RGB image and reduce the intensity of components where blue and red exceed the green component. Red and green components are main constituents of any leaf [2], so they are enhanced.

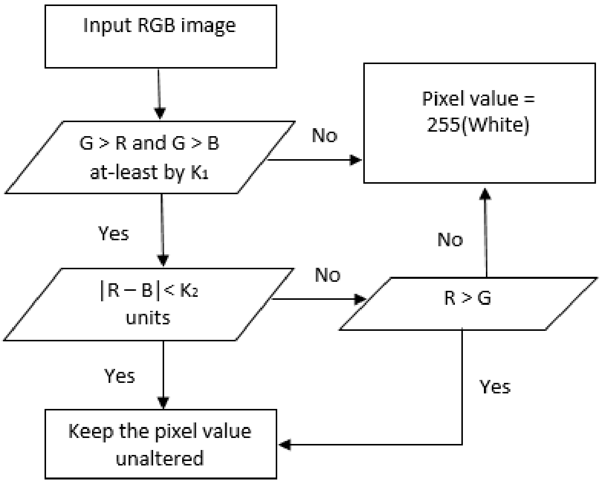

Fig. 2 Process for green enhancement, here R, G, B respectively represent red, green and blue component pixel value for an 8bit image.

Fig. 3 Green enhanced image.

Fig. 3 shows the result of green enhancement. The Fig. 2 explains this process. K1 and K2 have been experimentally determined as 2 and 5 to get best results for 8 bit RGB images.

IV. Establishing Disconnected Components

The image in Fig. 3 has the leaf along with other components. The aim is to establish a boundary between leaf and other components in the image, to establish disconnected components.

Clear boundaries must be established between different components to extract the leaf. The following steps were followed to establish the boundaries:

- Apply median filter
- Find edge matrix
- Perform closing on edge matrix
- Map edges onto the original image

A. Median Filter

Median filter is used as a pre-processing step for further edge detection to be applied. Median filter is used for smoothing the image so that it becomes easier for edge detection and only more obvious edges are detected while small abrasions are blurred. The Fig. 4 shows result on application of median filter.

Fig. 4 Result of median filter.

B. Edge Matrix

Prewitt edge detection algorithm is applied on Fig. 4 .The edge detection is used to find out edges all different components in the image, to be used for separating different components. Fig. 5 shows the result.

C. Closing

Morphological closing is applied on the edge matrix to merge broken edges. Morphological closing is a dilation followed by an erosion, using the same structuring element for both cases. Fig. 6 is the resultant image.

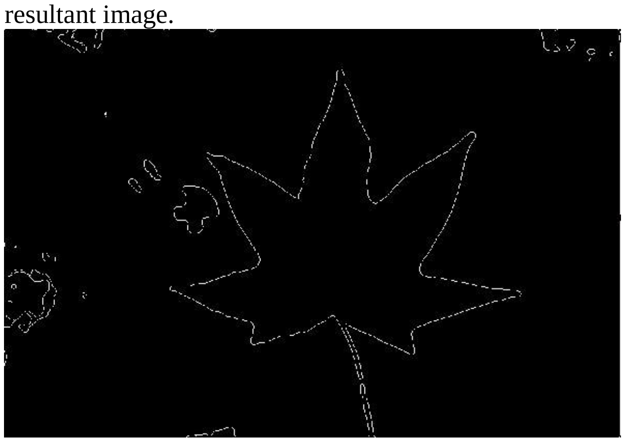

Fig. 5 Edge matrix.

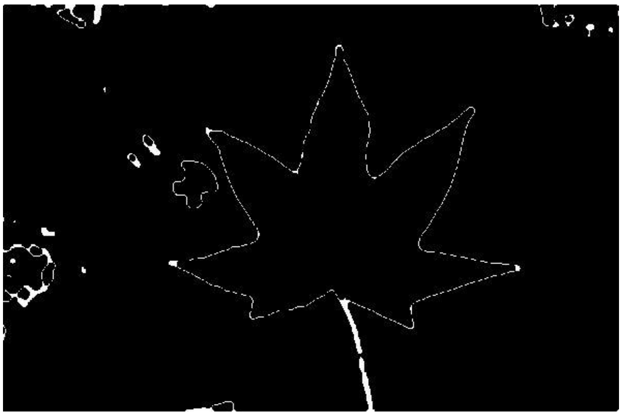

Fig. 6 Edge matrix after closing operation.

D. Mapping Edges on the Image

The edge matrix is mapped onto the green enhanced image Fig. 3 .Thus creating a differentiating boundary between different components and thereby establishing disconnected components. Fig. 7 displays the result of mapping.

Fig. 7 Original image with edges mapped onto it.

V. LARGEST DISCONNECTED COMPONENT

The image would have the leaf as the largest disconnected component. Therefore the aim is to remove the largest disconnected component and use it as a map to extract the leaf. The algorithm involves the following steps:

1. Convert image to binary and negate the image (so as to get background pixels as black).
2. Find connected components in the image:
    - i. Search for the next unlabelled pixel say 'c'.
    - ii. Label all pixels in the connected neighbourhood as 'c', using Flood Fill.
    - iii. Repeat i. and ii. , until all pixels are labelled.
3. Extract the label of the component with largest area.
4. Map these to the image to extract only the part containing the leaf as in Fig. 9.

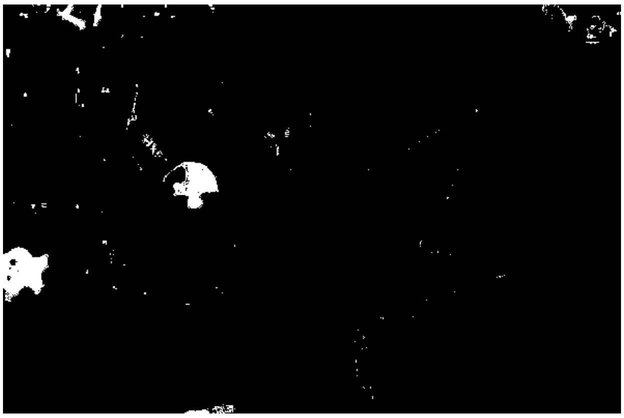

Fig. 8 Resultant of removing the largest disconnected component

Fig. 9 Mapping the largest disconnected component.

VI. CONCLUSIONS

This paper presents a new approach for plant leaf segmentation which is easier to implement as it works with almost any background. The experimental results show that our proposed algorithm segments leaf on varied backgrounds with an accuracy of 97%. Fig. 10 shows the results of this method on some test images from the dataset. Future work is under consideration to improve this approach.

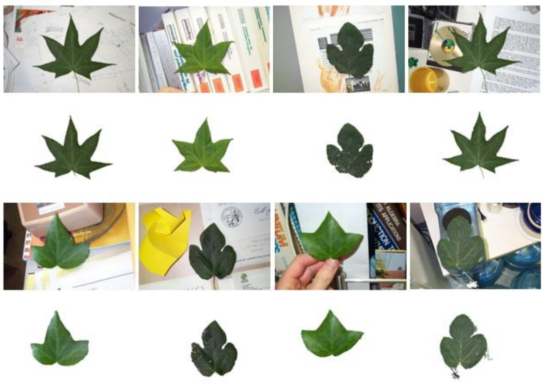

Fig. 10 Results of segmentation on different images.

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