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Leaf Image Processing for Venation Extraction For Plant Classification

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Abstract: *The plant classification is challenging research area. Plant classification using leaf features is demanding as leaves are readily available. This paper presents the leaf image processing by using morphological operation and image processing techniques for segmentation of leaf images. This experiment extracts the leaf venation pattern from the leaf image sample and then with morphological operations venation patterns are enhanced for plant classification. This paper is arranged with the steps, Preprocessing the leaf image, Morphological operation, Leaf venation enhancement.*

Keywords: *Canny, Gaussian filter, image segmentation, leaf venation, morphological operation, plant classification.*

I. Introduction

Plants are base part of the ecosystem which maintains the balance in ecosystem. Due to deforesting many plant species are under the roof of extinction. Plants are much important as food stuff for almost all of the livings. Plants are also useful as medicine and for preparation of medicine. Therefore it becomes very demanding research area to perform the plant classification. Doing classification of plant species require the knowledge about common physiological characteristics of all of the shoot components of plants. Plant classification is the process by which we can collect the plants of related group based on common physiological characteristics of various components of plant. Trained botanist and taxonomist perform the set of task for classification of plant species. This task includes methods such as morphological anatomy, cell biology and molecular biological approach as said in M. Amlekar etl. [1]. Cell biology is the branch of study related to the basic building block component of the life called cell. Morphological anatomy is concern with the study of the organism based on the genetically forms and structure. Molecular biology studies molecular mechanism behind the process of functioning of cell, genes and proteins. These methods are required to follow many critical tasks. Performing these tasks is a time consuming process, and it requires more efforts. These processes are less efficient as it is difficult to remember one all the species in the world, and to be expert in examining the various parts of plants to classify them. There are many features which classify the plant species with characteristics leaf component of almost all species can be used for classifying the plant species as they are more readily available. Many researchers have tried to extract the venation pattern. Standard Hough Transform method has proposed by M. Rahmadhani and Y. Herdiyani [2], for automatic initialization of parameter searching, for vein. Thresholding is combined with neural network for vein detection has been proposed by H. Fu and Z. Chi [3]. The principal characteristics of the leaf venation pattern of a species are genetically fixed that provides the basis for using the leaf venation as a taxonomic tool in A. Roth etl. [4]. X. Zheng and X. Wang proposed gray scale morphological operation and gray scale transformation for extracting leaf venation [5]. L. Kue-Bum and H. Kwang-seok [6] have been used projection histogram and morphological opening operation for leaf vein pattern extraction. Plant leaf and leaf venation structure is much important for the complete growth of plant as well as their study become knowledge base for plant biology, ecology of current, past and future ecosystem L. Sack and C. Scoffoni [7].The basic purpose of this experiment is to extract the leaf venation pattern that further can be used for extracting features for plant classification. This experiment finds the leaf venation for main vein and sub vein structure. This paper is arranged with the steps Preprocessing the leaf image, Morphological operation, Leaf venation enhancement, for finding venation of leaf images published in the ICL database.

II. Preprocessing the leaf image

Preprocessing of the leaf images are performed to find the uniformity of the leaf images. All leaf images are converted to gray code format using the formula.

$$0.2989 * R + 0.5870 * G + 0.1140 * B$$

Where R is the red color component G is green color component and B is blue color component of the color leaf image.

This converts the true color leaf image in RGB to the gray scale intensity image by eliminating the hue and saturation information while retaining the luminance. True colors RGB values converted to gray scale values by forming a weighted sum of the R, G, and B components.

III. Morphological operation

Morphological erosion operation transforms the gray code image. Morphological operation is performed to improve the performance of the leaf image segmentation. Wherever the background pixel is overlapped with the foreground pixel in the binary erosion then structuring element is translated pixel to the overlapping pixel for improvement of the segmentation of the leaf image. Morphological erosion operation transforms the gray code image. The value of the output pixel is the minimum value of all the pixels in the input pixel's neighborhood depending upon the structuring element used for removing the pixels on the boundaries of the leaf image. Morphological operation followed by subtraction of the resulting image from the original. Morphological operation uses disk flat structuring element with radius 3 and with default 4 connected components.

i. Opening

Opening performs erosion followed by dilation operation by finding local minima and then maxima of the structuring element for decomposition of the venation component of the preprocessed leaf image.

Where D_B is the domain of the structuring element B and A(x, y) is assumed to be $+\infty$ outside the domain of the image. E(x, y) is eroded image. D(x, y) is dilated image.

1. Erosion

The Erosion block slides the neighborhood or structuring element over an image, finds the local minima, and creates the output matrix from these minimum values. If the structuring element has a center element, the block places the minima there. If the structuring element does not have an exact center, the block has a bias toward the upper-left corner and places the minima there

$$\mathbf{E(x, y) = \min \{A(x + x', y + y') \mid (x', y') \in D_B\}} \qquad \textbf{(equation2)}$$

2. **Dilation**

The Dilation block rotates the neighborhood or structuring element 180 degrees. Then it slides the structuring element over an image, finds the local maxima, and creates the output matrix from these maximum values. If the structuring element has a center element, the block places the maxima there. If the structuring element does not have an exact center, the block has a bias toward the lower-right corner, as a result of the rotation. The block places the maxima there.

$$\mathbf{D(x, y) = \max \{A(x - x', y - y') \mid (x', y') \in D_B\}} \qquad \textbf{(equation3)}$$

ii. Subtracting the resulting image from the original preprocessed image.

IV. Leaf venation enhancement

Here the leaf venation enhancement is done by combined approach of the Sobel and Canny methods. Sobel operator is used to find the threshold of the processed image by morphological operation. Threshold value of the processed image is automatically computed by using Sobel operator by maximum gradient of the derivative of the image. Here the gradient based image processing methods are used for leaf venation pattern enhancement of the leaf image. The gradient based method work on the basis of looking for the maximum and minimum in the first derivative of the image. These methods evaluate the gradient of the image generated along with two orthogonal directions. In these methods, presence of the venation pixels is predicted if the gradient of the image exceeds the threshold value. The gradient can be computed by finding the derivatives along both orthogonal axes x and y. The gradient is estimated in a direction normal to the gradient of the venation pixels M. Amlekar etl [8]. Then the average gradient can be computed. Sobel method finds the threshold of the gray level form of the leaf image as per the maximum gradient of the image. This threshold is tuned and used in Canny method. Canny Method finds the gradient component in two dimensions Gx and Gy. Vein component is predicted by looking for local maxima of the gradient of the image. The gradient is calculated using the derivative of a Gaussian filter K Kaur and S. Malhotra [9]. The size of the filter is automatically selected depend on the sigma, which is the square root of 2. The method uses two thresholds which are selected low and high values, the high value of threshold is used as the tuned threshold from Sobel operator and the low value is 0.4 multiple of the high threshold value. Thus, it detects the venation pattern that includes main vein as well as sub vein web only if they are connected to strong component of venation. The value of the threshold is relative to the highest value of the gradient magnitude of the image.

The venation enhancement is then performed by finding the connected components of the venation pattern extracted by using Canny method for the threshold of the leaf image tuned by using Sobel operator Fig.1 shows the steps of the enhancement of the leaf venation for finding the leaf main vein and sub vein pattern.

Fig.1 a) shows the original true colored image of leaf, it is converted to gray level format as in Fg1b), morphological operations results in the leaf image as shown in Fig.1c). Leaf venation by Canny shown in Fig.1d) then Fig.1e) and Fig.1f) shows the first level and second level enhancement of the leaf venation. Fig.1 g) shows the leaf mid vein and sub vein pattern extracted by following the sequence of operation as shown in the figure.

V. Conclusion

This experiment proposes better methods for finding the leaf venation and its enhancement. This method shows the better visual effect for finding leaf mid vein and sub vein patterns for further operation of leaf image processing for plant classification.

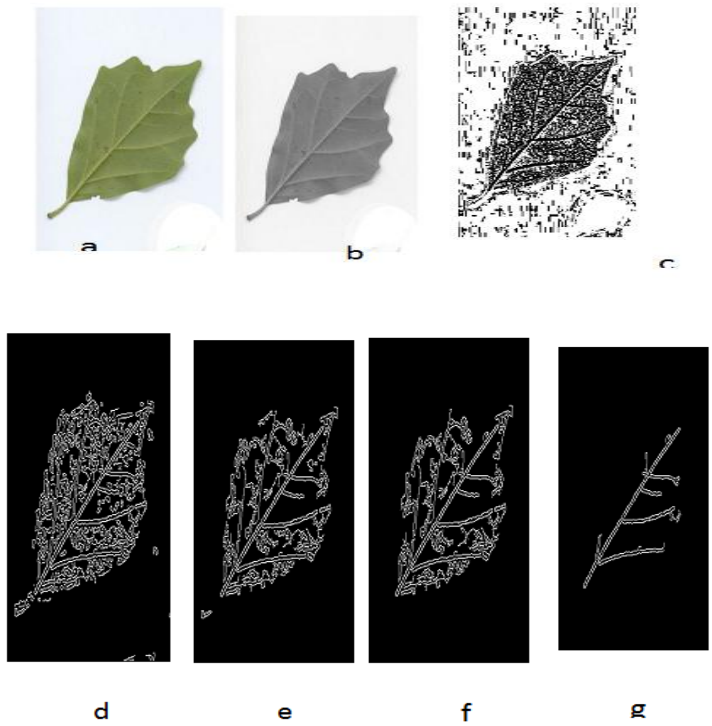

Fig1: Steps of leaf Venation enhancement.

a) Original Leaf Image b) Gray level Leaf Image c) Morphological operation d) Venation Extracted
e) First level of enhancement f) Second level of enhancement g) Leaf mid vein and sub vein

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