Advanced Plant Leaf Classification Through Image Enhancement and Canny Edge Detection

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Abstract: **Accuracy in identification of any plant is achieved by understanding and extracting the plant features. Image processing techniques has gained interest in identifying the plants in realist and accurate manner. Among them, Edge detection techniques has very important role in creation of database for plant identification. Edge filtering and optimization technique to create continuous edges makes Canny edge detection widely popular to retrieve image characteristics. The proposed contour based image segmentation process filter morphological features from plant leaves. Detailed vein and texture extraction of plant leave using Canny edge detector are explained.**

Keywords: **Plants, Image processing, Canny edge detection, Morphological features.**

I. INTRODUCTION

Benefits of plants were known to the world since centuries. Richness and variety of plants in tropical countries including India are on great advantage, but are challenging, including accurate identification of plants in optimistic and realistic manner. Plant components such as flowers, fruits, stem, seeds, root and leaves are used in plantidentification and classification [1]. Conventional way of identification of plants are complex and time consuming. Apart from Botanist method of identification of plants through morphological features, recognition of leaf features through photo images of plant parts are low cost and convenient, and considered to be first choice among the researchers. Leaves, as it exists on the plants for several months, plant identification through leaf features like, leaf apex, arrangement, margin, shape, color, base, venation and texture play an important role [2], howeveris challenging. Consistency of the selected features and the ability to classify exactly the leaves is the major determining component of plant identification.

Due to the recent invention in digital technologies, there is an increase automatic process of species identification. Digital camera, mobile technologies, access to database, advanced image processing technologies and improvement in pattern recognition led automated species identification into reality[3,4].

In digital image technology, image processing algorithms compare the feature set extracted from the input image with available data set. Image segmentation [5,6] is the first step in understanding image and extracting useful information. In plant identification, leaf object extraction is carried by the segmentation process. The result of the recognition application varies according to the segmentation accuracy; hence the selection of segmentation algorithm reflects the accuracy of the plant identification [2].

Edge detection is considered to be one of the key technology in digital image processing. This process trace region with strong intensity contrasts. It reduces inessential information in the image, keeping the structure of the image same. The important features of the image corners, lines, curves are extracted by recognizing object boundaries, which make this to be well known as boundary based image segmentation [6,7].

There are numerous edge detection methods, but canny edge detector is considered to be most reliable. It enhances signal local ratio, noisy environment resistance and noise removal by smoothing, better localization and responsebut consume more time making difficulty in reaching real time response [8,9]. In order to overcome these difficulties, the present work aims to identify plants through its leaves, using improved image enhancement technology through contrast stretching followed by canny edge detection.

II. LITERATURE REVIEW

In [3] made a systematic literature review of various computer vision techniques for plant identification. It reported that the applied methods identified plants through its various plant organ/features like shape, texture, color, margin and vein structure.

As the conventional methods of plant identification are known to be time consuming, plant image processing considered to be promising for species identification [5, 10, 11]. Application developed by [12] recognizes tropical plants and allows users to contribute to the data base and also works offline.

Probabilistic neural network based leaf recognition is explained in [13]. In this method, RGB image is converted into binary format in image preprocessing phase and boundary enhancement is performed by 3x3 spatial mask. In feature

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extraction phase basic geometric features are obtained to define digital morphological features and are extracted and processed with Principal Component Analysis to form the input vector.

In [14]Multilevel wavelet decomposition and multilayer perceptron (MLP) based edge detection for grayscale image is explained, which utilized multi-level perception and backpropagation. In [15] histogram based overall estimation of vein is conducted and usingSobel operation leaf vein pixels are extracted. In [9] authors introduced improved canny edge detection algorithm by replacing Gaussian smoothing kernel, gradient magnitude of canny operator and gradient kernel for Asphalt concrete applications which managed to detect real edges by avoiding false noisy edges.

Leaf image based plant recognition combining threshold method with artificial neural network classifier is explained in [1]. Two stages of segmentation are carriedout, including histogram based vein region detection and segmentation by artificial neural network based classifier.

Plant disease could also be identified with canny edge detection combing color histogram 16]. [17] developed various leaf features were extracted with this technique and classified multiplicity of plants.

From, the above, it can be seen that though researchers have attempted plant classification using canny edge detection, the accuracy of the result varied due to varied reasons. Present work attempted to refine the accuracy of canny edge detection technology by enhancing the contrast stretching.

III. PROPOSED FEATURE SET

Many studies have proposed different methods for the segmentation of the leaf in an image. Out of many edge detection techniques, the proposed work aims to extractthe leaf veins patterns with improved Canny edge detection algorithm. Problem with Canny edge detection is that it misses important edges with high threshold and create false edges by low threshold. Smoothing process using Gaussian mask[9] reducing the noise but Sobel edge detection algorithm[15] running in the next step is again introducing noise. Lastly, angle of the magnitude the pixel and its neighboring pixels decide the new pixel value.

To overcome the noise creation in canny edge detection, input image is passed though gray scale converter and contrast stretching process. Major steps of vein extraction process of single imageare explained in the flow chart given in Fig. 1.

In the proposed method, for plant leaf vein pattern extraction, ten leaves samples are selected to create the data set. All the images are in good representative and captured in white background.

The complete process is designed and tested in android platform using Android Studio 2.2.2. Java programming language is used in programming side and Android xml is used to create front end of the application.

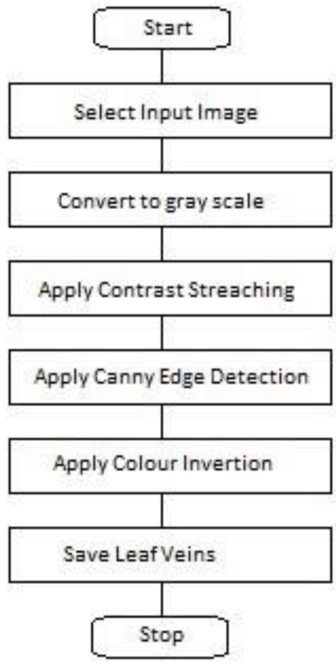


Fig. 1. Leaf vein extraction methodology

Step 1: Gray Scale Conversion

Selected images are stored in Android application resource directory in PNG format. In programming side each image is chosen as bitmap format. Using setSaturation(float value) method of ColorMatrix class, bitmap image converted in to gray scale format.The captured images are different shades of green so gray scale format conversion is necessary. The input image and gray scale converted image of this step are shown in Fig.2.

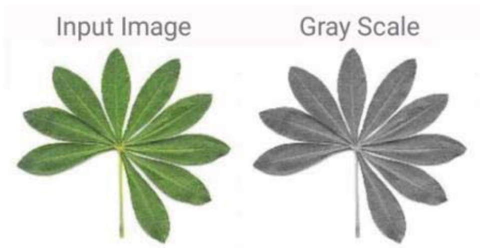


Fig.2: Result of gray scale conversion

Step 2: Contrast Stretching

The contrast stretching process highlighting the essential components of image for the edge detection.Red, green and blue components of m x n sized gray scale image is extracted. Contrast value calculated from the equation $((100+\text{value})/100)^2$. Here, the value is fixed as 30. Comparison on different contrast values are shown in Fig. 3.

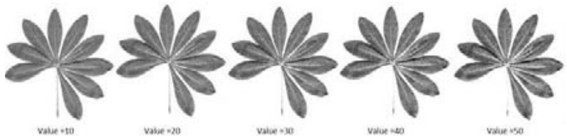


Fig. 3. Comparing different contrast values.

On m x n sized gray scale image for every pixel red, green and blue values are equal. So here, red component is choosingand calculated the new value by the equation

If $(0<Red_{old}<50)$ then $Red_{new}=0$
Else if $(50<Red_{old}<230)$ then
$Red_{new}= Red_{old}+(Red_{old}*contrast_{value}/255)$
Else if $(230<Red_{old}<255)$ then $Red_{new}=255$

Gray scaled image pixels are stretched by extracting red, green and blue components. The result of contrast stretching step is shown in Fig.4.

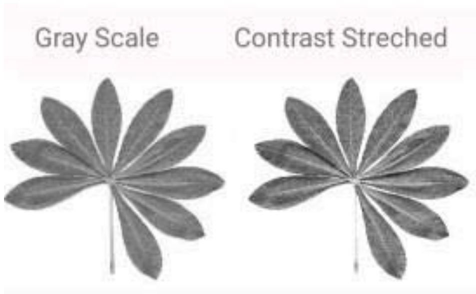


Fig. 4. Result of contrast stretching

Step 3: Canny Edge Detection

In the Canny edge detection, Gaussian blurring algorithmis used to over the image in the first stage. Gaussian function[9] used in canny edge detection is in equation 1:

$$G(x,y,\sigma)=\frac{1}{2\pi\sigma^2}e^{(\frac{-x^2+y^2}{2\sigma^2})} \quad (1)$$

After Gaussian blurring, gradient values of image are extracted for low thresholdvalues and high threshold valuesseparation. In the next step, in thelow threshold values and high threshold values edges with gradient magnitude greater than high threshold value are selected as strong edges and gradient magnitude between low and high threshold are selected as weak edges. If weak edges are connected to strong edges, then they are considered.Magnitude[9] and direction [9] of images is calculated using following equations 2.

$$\text{Magnitude} = \sqrt{(\partial G/\partial x)^2+(\partial G/\partial y)^2}$$

$$\text{Direction: } \Theta = \arctan\left(\frac{\partial G/\partial y}{\partial G/\partial x}\right) \quad (2)$$

The complete canny edge detection process[9] is shown in Fig. 5.

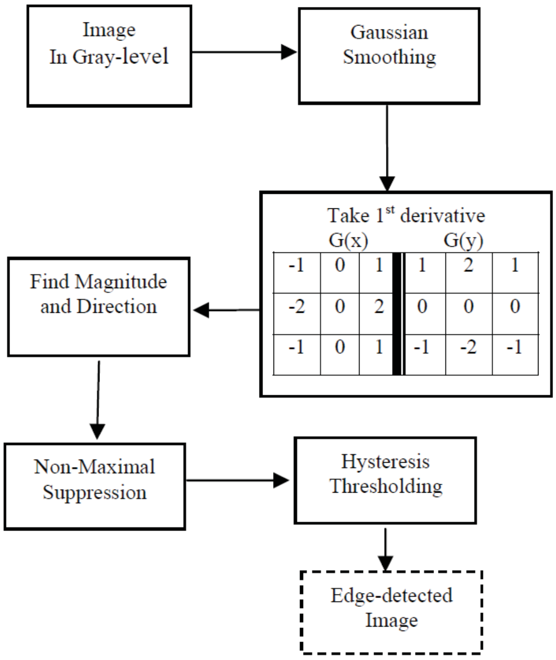


Fig. 5. Canny edge detection [9].

The result of canny edge detection step is shown in Fig.6.

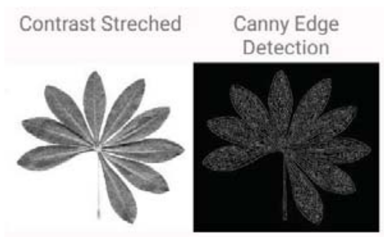


Fig. 6. Result of Canny Edge Detection.

Step 4: Color Inverting.

Result of canny edge detection output is in black background. So color inversion procedure is applied to get more comfortable image for future analysis. The color inverted image after canny edge detection step is shown in Fig.7.

Fig. 7. Result after color inversion.

IV. DISCUSSION

In this paper, main attempt is made to eliminate the noise or extra edges created by canny edge detector. A new contrast stretching equation introduced in this work converted the gray value 0 to 50 value as zero and 230 to 255 as 255. In the normal scenario, if images are directly passed into the canny edge detection, it produces extra edges in the resultant images. But in the proposed work, with the help of contrast stretching method, a clear vein set is produced. By fixing contrast stretching value 30 the number of pixels' selection after canny edge detection is increased. Comparison of contrast value from 10 to 150 vs number of pixels detected is shown in Table 1. In this table the y axis representing number of pixels produced and x axis representing contrast value from 10 to 150.

Vein extraction of different leaves are shown in the Table 2. The resultant samplesshowthe noise reduction achieved by the proposed methodology over ordinary detection methodology.

TABLE 1: Graphical representation of contrast value from 10 to 150 vs number of pixels detected.

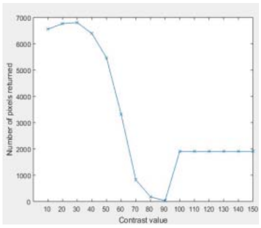
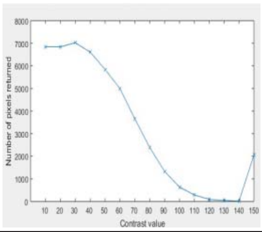
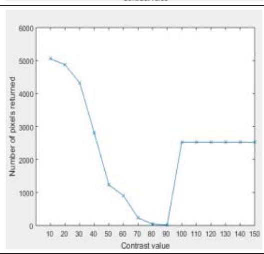
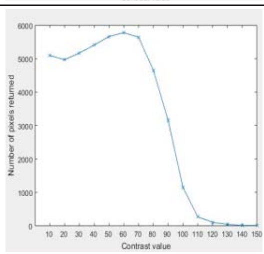
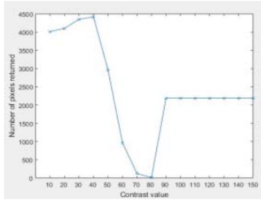
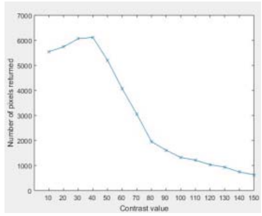
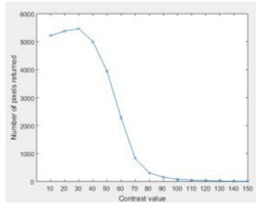
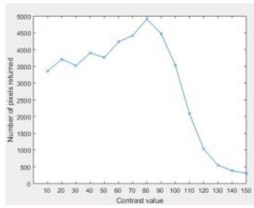
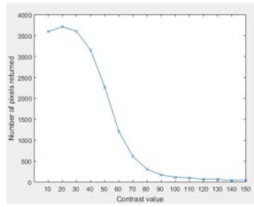
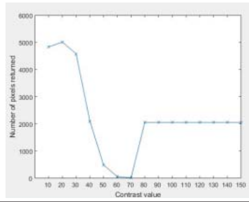
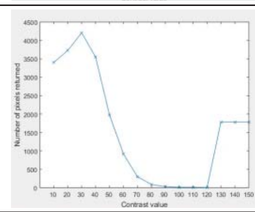
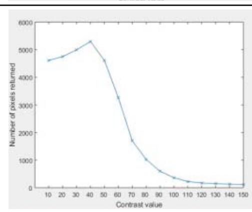
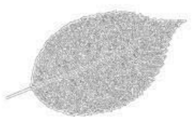
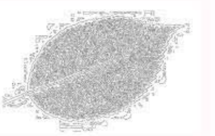
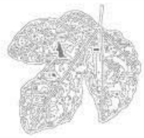
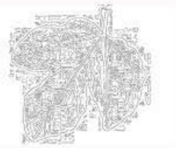
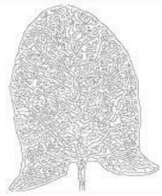
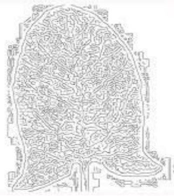
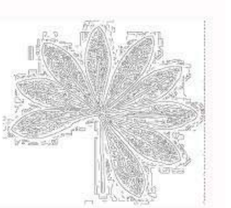
SI No	Leaf	Graph representation
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

TABLE 2: Comparison of Normal Edge Detection and Proposed Method

Input Image	Result of proposed method	Direct usage of Canny edge detection
		
		
		
		
		

V. CONCLUSION AND FUTURE WORK

Leaf vein based plant identification is important for botanists and researchers. The proposed work introduced extraction of vein structure of plant leaf using canny edge detection algorithm. Normal usage of canny edge detection misses important edges and create false edges. Contrast stretching before applying canny edge detection reduce the false edge creation and creating smooth vein structure of plant leaf. This new algorithm is easy in implementation and also improve the efficiency in plant identification. The proposed method not limited to plant leaf vein detection, as they can be extended to other images of interests, especially for image pattern recognition and objects identification.

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