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Analysis of Various Image Segmentation Techniques for Flower Images

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***Abstract*— The identification of flower species is essential for non-botanical person or biodiversity. Today, the issue of flower species identification and classification is being faced by academicians and researchers. A process of extraction, analysis, and understanding of useful information from images is accomplished by an automated process using computer vision. It basically aims to model, replicate and exceed human vision using computer hardware and software. In image processing, the image segmentation is the most appropriate step i.e., removal of the background of images and improve the quality of flower image foreground. This article includes the systematic literature review of various segmentation techniques and comparison of those techniques on flower species identification.**

***Keywords*— Image processing, Image segmentation techniques, flower, performance analysis.**

I. INTRODUCTION

Image processing has a huge application in agriculture area that is having the larger scope well-defined under various applications [5]. There are many applications for flower plant identification which identifies based on its characteristics and classify them into species and family [2]. Identification of proper flower plants is quite challenging because there are a huge number of flower species worldwide [4]. The various flower plants have similar morphological characters such as shape, color and texture so it was very complex process to identify and classify flower spices manually. We need overcome such kind of problems when automatic identify the flower spices is to be introduced [6].

In this paper, we implementing such system using image processing with flower images basis of segmentation methods. The different techniques return the closest match to the query. The proposed technique is implemented and the efficiency of the system is found by testing it on different flower species [3]. Image segmentation becomes simple but powerful tool for separating preferred flower object from background [1]. This work has been implemented using MATLAB 2018a [6].

This paper is prepared as follows. In Section II, we review the total scheme of image segmentation stages. Thereafter in Sections III, different techniques of image segmentation are covered correspondingly, and also the most current methods are explained according to the flower plant. In Section IV, comparisons of various segmentation techniques. In Section V, dataset for image segmentation methods. In Section VI, result and performance analysis. In Section VII, quality measure of image segmentation techniques. And at last Section VIII is conclusion of the paper.

II. IMAGE SEGMENTATION METHODS

Image segmentation techniques are used to divider an image into meaningful parts have similar properties and features. The aim of image segmentation i.e. demonstrating an image into easily analysable and meaningful way. It is the second essential step in image analysis. The goal of image segmentation is to divide an image into segments having similar features or attributes [29]. The initial step in almost all image processing flower detection approaches is to segment the different pixels which appear in flower images into two parts: flower foreground and background. There are various image segmentation techniques available which are used for flower image segmentation. The common segmentation methods are: region based segmentation, threshold based segmentation, and edge based segmentation [19]. These all methods have their own importance [34].

Image segmentation methods are divided into two parts Block-Based and Layer-Based Segmentation Methods; which is show in Fig. 1. When the several structures found in the image then we use Block-Based Segmentation Methods and Layer-Based Methods are used for image recognition that combinations the output of image displays in order to define shape masks. Block-Based Segmentation methods are divided in to various parts like; Region based methods, Edge based methods, Threshold based method. In agriculture applications, particularly in flower plant images, the most common thresholding methods applied by researchers to suppress detect the flower boundaries in image segmentation [13, 16].

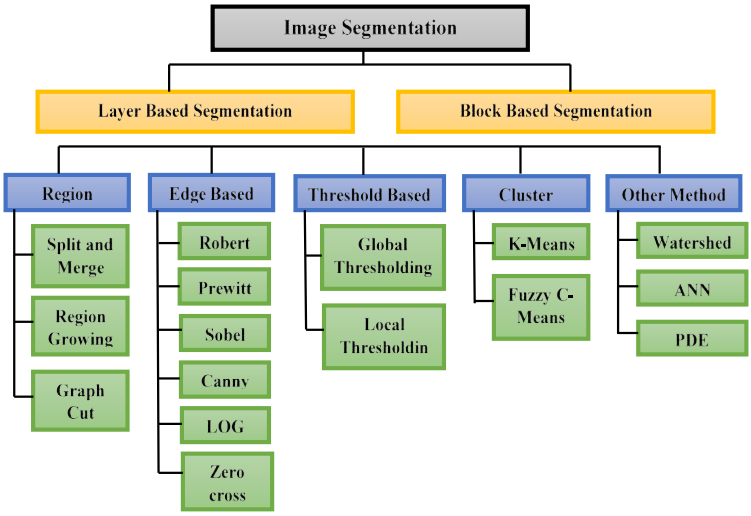

Fig. 1 Types of Segmentation Techniques

A. REGION BASED METHOD

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1) Split and Merge: Split and merge method is a combination of 2 parts, first the whole image taken as a single region and after that it repeatedly split until no more splits are accessible, after the splitting two image's if they are adjacent and similar then regions are merged, and at last merging is repeated up to no more merging is accessible [7, 8, 22, 23, 33 and 35].

2) Normalized Cuts: It also called as a Graph cut method. The aim of this method is reducing the number of regions by optimal splitting. It is depending on graph theory [11, 15, 21 and 41].

3) Region Growing: Region growing is one of the useful method in region based method. It involves the section of initial seed points and classified as a pixel based image segmentation. Initialize with a pixel, repeat until all pixels belong to some region and next adding the pixels based on similarity to the region [12, 13, 17, 36, and 45].

B. EDGE DETECTION METHODS

Edge detection techniques convert image in to grey tones in the image. It is image processing technique for finding the boundaries of objects within image. Edges are local changes in the edge between two sections and image strength. Common edge detection techniques are as follows: [7, 10, 13, 20, 22, 27, and 44]

1) Sobel Edge Detection: Split and merge method is a combination of 2 parts, first the whole image taken as a single region and after that it repeatedly split until no more splits are accessible, after the splitting two image's if they are adjacent and similar then regions are merged, and at last merging is repeated up to no more merging is accessible [7, 8, 22, 23, 33 and 35].

2) Prewitt Edge Detection: The result of the Prewitt method is each point in the image, either the norm of this vector or the corresponding gradient vector. It is same as of Sobel method but have altered kernels. It is better than Sobel edge detection method.

3) Roberts Edge Detection: Robert edge detection is gradient based operator. The input image is convolved with the default kernels of operator, directions are computed and gradient size. The advantage of Robert edge detection technique is its simplicity but having small kernel it is highly sensitive to noise not.

4) LOG Edge Detection: It is the combination of Gaussian filtering with Laplacian to break down the image. The second derivative of smoothed step edge is a function that crosses zero at the location of edge. The disadvantage is that it cannot find angle of edge because of laplician filter.

5) Zero cross Edge Detection: A Laplace filter is a filter which fits in this family, though it sets about the task in a different way. It pursues marks this out as a potential edge point and digital signal of an image passes over a fixed '0' value. Since the indicator has crossed over the point of '0', that's why it is called a zero-crossing.

6) *Canny Edge Detection:* It is a multiple step process to identify a wide range of margins in images with noise suppressed at the same time. The canny edge detector method smooth the image to remove noise using by Gaussian filter and unwanted details of textures. Major application of canny edge detector is for plant images [47].

7) Level-2 Heading: A level-2 heading must be in Italic, left-justified and numbered using an uppercase alphabetic letter followed by a period. For example, see heading "C. Section Headings" above.

C. THRESHOLDING METHOD

The Threshold value (T) depend on images type homogeneity region. The image will be converted into grey scale to binary for reducing the intricacy of the data by an adequate threshold worth. The thresholding operation is classed into 3 varieties supported grey, element values and neighbourhood property [7, 8, 14, 27, 36, and 48].

1) Global Thresholding: Global thresholding operation depends on grey levels. It is difficult when the image is poor distinction, noise and lighting condition. The optimum thresholding technique is applied once there's considerable overlapping of the bar chart. Otsu method uses it's an unsupervised method and optimum thresholding technique [18, 25, and 35].

2) *Local Thresholding:* Local thresholding referred to as the local property of the image and operation is performed supported each the grey level [29]. If the background illumination is non uniform, then a global thresholding methodology fails. A method was adopted using standard derivation (SD) and mean of the neighbouring pixels that avoid failure. The calculation of mean based upon threshold value [35].

D. CLUSTERING METHOD

1) K-mean Clustering: Splits a picture into K groups by adding points, p, to the cluster wherever the distinction between the purpose and therefore the mean is smallest. Some sharp boundaries between clusters assumes Hard clustering [16]. It's an unsupervised clustering algorithm supported their inherent distance from one another that classifies the input data points into multiple categories [30]. It is an iterative algorithm that minimizes the sum of geometrician distance between its cluster centroid and each object [9, 23, 43, and 46].

2) Fuzzy Clustering: The Fuzzy C-Means (FCM) clustering algorithm rule was shape-based image segmentation algorithm [16]. Fuzzy clustering also referred to as soft clustering is a form of clustering in which each data point can belong to more than one cluster. The idea of degree of affiliation in fuzzy clustering is related to the posterior probability in a mixture modelling setting [9, 23, 32, 43 and 46].

E. OTHER SEGMENTATION METHOD

1) *Watershed Based Methods:* The concept of topological interpretation we can use the watershed based methods. The water spills are available where the basins having hole in its minima during represent the intensity. The adjacent basins are merged together when water reaches the border of basin. The borders of region of segmentation and to retain separation between basins dams are required. Using dilation these dams are constructed. The pixels having a lot of gradient are denoted as boundaries which are continuous [15].

2) Partial Differential Equation (PDE): The fast methods of segmentation are partial differential equation based methods. Partial differential equation based methods are appropriate for time critical applications. There are basic two types of PDE methods: convex non-quadratic variation restoration and non-linear isotropic diffusion filter. Blurred edges and boundaries that may be shifted by using close operators are outcome of partial differential equation based methods. The second order PDE method is used to better detect the edges. The boundaries fourth order PDE technique is used to reduce the noise from image and [13]. The convex non-quadratic variation restoration used to remove noise and non-linear isotropic diffusion filter used to enhance the edges.

3) *Artificial Neural Network (ANN):* The learning strategies of human brain for the purpose of decision making we can use the Artificial Neural Network based segmentation methods. The segmentation of medical images this technique is generally used. It is used to separate the background from specified image. Each neural network nodes are connection has a particular weights and a big number of connected nodes. Artificial Neural Network method is independent of Partial differential equation based methods. This technique has basic 2 steps: extracting features and segmentation by neural network [8].

III. COMPARISON OF IMAGE SEGMENTATION TECHNIQUES

TABLE I
THE IMAGE SEGMENTATION METHODS AND THEIR ADVANTAGES AND DISADVANTAGES

Method	Advantages	Disadvantages
Region Based Method	• Work well when the region homogeneity criteria are easily defining and more immune to noise. • It first removes noise and then detects the edges.	• This technique takes time and memory. • It has a characteristic dependency on the variety of seed region.
Edge Detection Method	• Easily detection of the edges. • It is a method works well for images having fine difference between regions and in which human notices thing.	• It is less immune to noise and if the edges are not defined perfectly it is not work. • Not appropriate for too many edges or wrong detected. • It is not an insignificant job to crop a closed curve or boundary.
Thresholding Method	• A simple approach in which there is no any requirement of prior knowledge of image. • It includes fewer calculation complexity. • To find the potential edge pixels using gradient magnitude.	• It doesn't work properly if too many edges are present. • Highly dependent on peaks. • This technique doesn't reflect the facts, so it is not able to assure that partitioned regions are contiguous. • Computationally expensive.
Clustering Method	• Easily detection and implementation. • Eliminates noisy spots. • More homogeneous regions are obtained.	• Determining membership function is not easy. • When fixed number of cluster then it is Difficult to predict k. • Computationally expensive.
Watershed	• Based on mathematical morphology. • Helps to improve the capture range. • Results are more stable. • Detected boundaries are continuous.	• Over segmentation. • Complex calculation of gradients.
Active contour	• Use active contour models. • Preserves global line shapes efficiently.	• To drive the contour, it should find strong image gradients. • Weak image boundaries and image noise it would be lacking accuracy.
Artificial Neural Network	• Use training data to solve complex problem and easily detect errors. • No need to write complex programs.	• Training process consumes more time and therefore it required over training. • Initialization may affect the result. • Overtraining should be avoided.
Partial Differential Equations (PDE) Segmentation	• Faster method. • Best for time critical application.	• More computational complexity.

IV. DATABASE OF SEGMENTATION IMAGE

In this work we have done different segmentation methods and comparison of the output images after applying different algorithms. The fourth contribution is the datasets. Although images are widely available on the internet, there is no site where there is a large collection of multiple images of several categories that can be used straight-forwardly for classification or segmentation. We have created three datasets: a smaller 17 species database, a large 102 species database and another are collected own dataset with 30 species. The evaluation was performed using a flower dataset provided by Oxford University which contains 102 spices of flower having 8189 images. Some practical results and different segmentation methods are shown in next section.

V. PERFORMANCE ANALYSIS AND RESULT

The image segmentation methods discussed in section II and in section VI methods are implemented and established in MATLAB 2018a. Original flower image as shown in fig 2.

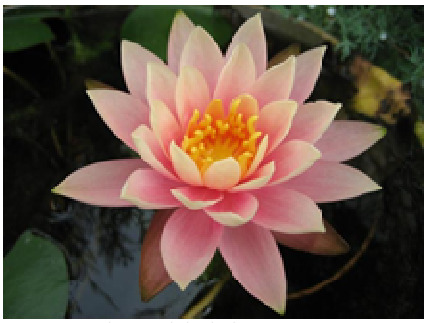

Fig. 2 Original Flower Image

A. Image segmentation using various Region based methods

The following fig. 3 and fig. 4 shows the performance of various region base techniques such as graph cut method and region growing method. The region based techniques were implemented using MATLAB 2018a, and tested with flower image.

Fig. 3 Graph cut Method

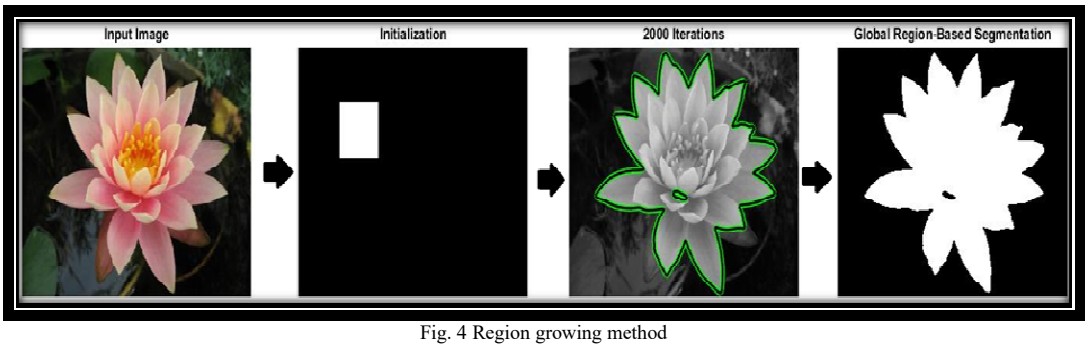

Fig. 4 Region growing method

B. Image segmentation using various edge detection methods

The following fig. 5 shows the performance of various edge detection techniques such as Roberts Edge Detection, Prewitt Edge Detection, Sobel Edge Detection, Canny edge detection, Zero cross Edge Detection and Log edge detection. The edge detection techniques were implemented using MATLAB 2018a, and tested with an image of flower image [16 and 17].

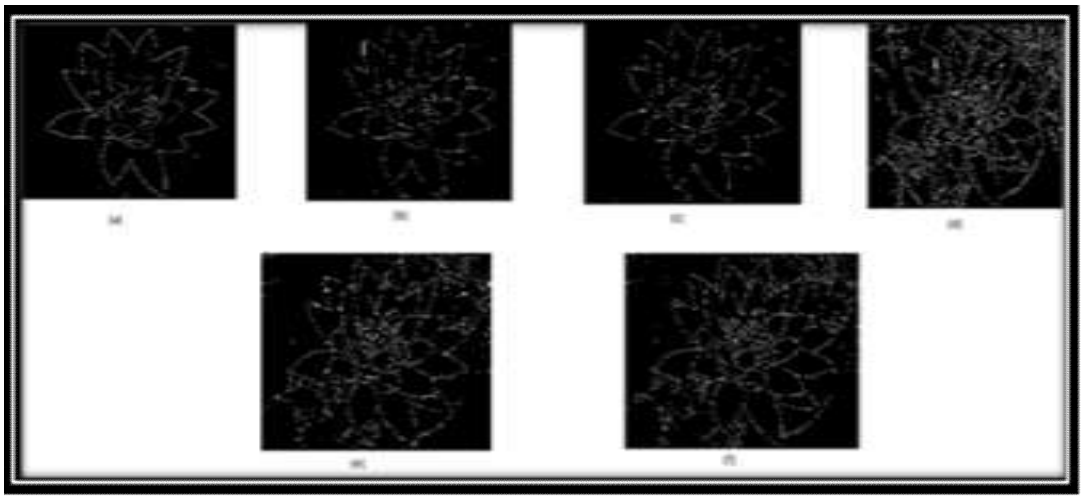

Fig. 5 (a) Roberts Edge Detection (b) Prewitt Edge Detection (c) Sobel Edge Detection (d) Canny edge detection (e) Zero cross Edge Detection (f) Log edge detection

C. Image segmentation using Thresholding method

The following fig. 6 shows the performance of Otsu thresholding techniques. Which is implemented using MATLAB 2018a. Otsu threshold gives better outcome of T= 0.3 (where T is the threshold value).

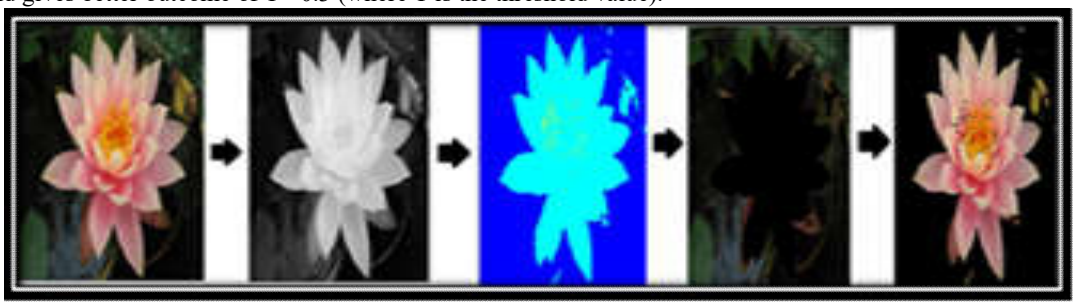

Fig. 6 Otsu thresholding method

D. Image segmentation using Clustering method

The following fig. 7 shows the performance of K-mean clustering techniques. Which is implemented using MATLAB 2018a.

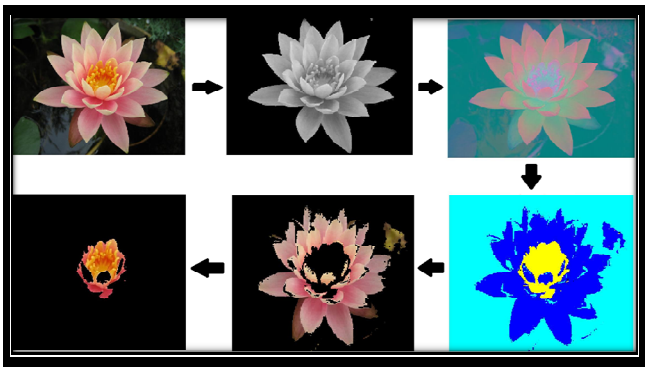

Fig. 7 K-Mean clustering method

VI. QUALITY MEASUREMENT

The implementation work is carried out using image processing toolkit - MATLAB R2018a. Performance analysis helps to most efficient method used for segmenting a flower image by thoroughly analyzing the used parameters values. Performance analysis of four different segmentation methods, which process input flower image with different techniques, is performed using True Positive, False Positive, True Negative, and False Negative. These methods are the frequently used methods for performance evaluation of different segmentation techniques applied on flower image [12, 15]. The other quality measure parameters such as computational TIME, RMSE and PSNR. Table 2 shows detail of flower's image test set experiment of the PSNR, RMSE and TIME.

TABLE II
PSNR, RMSE AND TIME ANALYSIS

Sr. No.	Method	Time (Sec.)	PSNR	RMSE
1	Region based (global region based)	106.2207	3.127511	177.895354
2	Edge detection (Canny)	10.2749	4.173424	157.713547
3	Thresholding (Otsu)	4.0301	5.735604	131.752836
4	Clustering (k-mean)	12.2330	5.103740	141.694564

As the TIME and PSNR and RMSE of the proposed method is less, high, low respectively. This makes this segmentation method accurate and efficient for flower images. From figure 8 the results obtained by applying the image segmentation methods on the any of the flower images [44, 45, 49, and 50].

VII. CONCLUSIONS

This paper discusses the implementation details of different segmentation techniques required for flower image processing. It has categorized the block-based segmentation procedure into different methods like region based, edge-based, thresholding, clustering, etc. In these methods, the techniques are used to improve the flower images and the different segmentation to eliminate the foreground and background images have been described. In this paper, we recommended a best flower image segmentation representation based on OTSU thresholding technique. The experimental outcomes proved that we can achieve good outcomes within short execution-time. Applying OTSU on the three components separately gives a respectable result as compared to other segmentation methods. Moreover, performance evaluation is also discussed using TP and FP methods. This paper is beneficial for researchers who are working in the area of image processing.

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