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Research paper

Image segmentation technique- a comparative study

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Abstract

Image segmentation techniques aims at identification and extraction of foreground objects in an image resulting into individual segments. Segmentation of images basically are so varied from one type of image to other images as each had its own context and varied geometrical properties and thus leading to a challenge in design of a generic algorithmic procedure. In this paper, an effort is formed to compare and study the efficiency of color image segmentation victimization color areas, watersheds, fuzzy c-means and edge detection techniques towards the segmentation of fruit images. The fruit images employed for segmentation are downloaded from various sources of online and also few of the images are synthetically gathered by capturing the fruits images over a plain background. The analysis had resulted in conclusion that performance of fuzzy c -means and watersheds had led to optimal outcomes than other techniques.

Keywords: *Segmentation; Color Image; Canny Edge; Detection K-Means; Clustering Watershed; Fuzzy C-Means.*

1. Introduction

Segmentation of fruit images is one of the most interesting research problem where the challenge lies in extraction of most typical components of fruit images that results in recognition of particular fruit type. Most of the fruits in nature exists in similar textures and shapes, however there exists some unique portions which helps in distinguishing one fruit type from the other. The detection and extraction of such variable regions in the fruits is one of the significant step in fruit image segmentation process. Segmentation of fruit images has many benefits in industries in automatic segregation of a fruit types during production process of soft drinks, also image processing systems are effective in identification of infected fruits leading to spoilage. Numerous experimentations are reported in the area of image segmentation. Some of the related works in this area are summarized as follows.

Bora et.al [1] had proposed a technique for image segmentation using color spaces and a approximate analysis of segmentation of color image techniques using LAB and HSV is performed. The performance is evaluated with respect to the parameters mse and psnr leading to the performance of HSV color space as efficient compared to L * A * B *.Canny, J.et al [2] it had proposed canny algorithm for edge detection which can adeptly locate the utmost edges by depreciating the error rate and maximizing localization. Abdulet al [3] had implemented a technique for segmentation based on gradients of image related to the discontinuity of the first order derivative of image. The discontinuity used is a step edge wherever the intensity of the image changes shortly after a value in one facet of the interuption to a dissimilar value in the other facet. Shanmugavadivu, P. et al. [4] had propped the modified version of canny edge detection method named as MEDC (Modified-EightDirectional Canny) which detects edges in eight directions enabling MEDC to find almost all edges of a given image and claimed to provide better results than canny method on the basis of ENL, ESL values. Bora et al[5] had proposed a color image segmentation method which transforms input color image from RGB to HSV color space followed by extraction of V- channel of HSV normalizes it and transform image between 0 and 1. This normalized V-channel is then sent as an input to the Fuzzy C-Mean (FCM) algorithmic program subject to Otsu thresholding and Sobel filtering for implication of Meyer's watershed algorithmic program. This produces the ultimate segmented image of the color image given. The method is proved to be effective in terms of MSE and PSNR values of the existing watershed algorithm. Shi et al [6] It is a novel technique for figuring out the clustering problem in the vision. The focus is to extract the overall impression of an image. The standardized cutoff criterion measures both the total difference between the different groups and the total similarity within the groups. This approach is developed to segment the static images, movement sequences and results found to be very encouraging. Bruce et al [7] Shows a system capable of tracking various areas up to 32 colors at 30 Hz in common intention hardware. The system includes a system for forming a new execution of a threshold classifier and a region for connected components, a classification and classification system for collecting characteristics of various regions, a perceptual grouping relative Including top-down heuristics. Felzenszwalb et al [8] Addresses the problem of segmenting images in regions.He defined a predicate that measures the evidence of the boundary between two regions using a graphical representation of the image. The algorithm was applied to the segmentation of images using two different types of neighborhoods in the construction graph, and then the results were illustrated with both real and synthetic images. Vese et al [9] This formulation of sets of multiphase levels is new and of interest in itself: it will automatically avoid the problem of the vacuum and the superposition, it needs functions of adjustment of levels for n phases in the constant case by parts, functions of two levels formally enough to represent any of the partitions, according to the four-color theorem. Perona et al [10] in this document, the diffusion coefficient is chosen to vary spatially so that intraregional smoothing is encouraged instead of interregional smoothing. As the boundaries of the region in this focus remain sharp, it helped to obtain a high-quality edge detector that successfully exploits global information.

The algorithmic program involves the elementary local operations that are reproduced on the image, making parallel implementations of hardware feasible.
It is evident from the works reported that the segmentation techniques are categorized into color based, edge based techniques. The color based techniques includes segmentation based on color spaces, region based and watersheds. It is also noticed that most of the works had employed the thresholding techniques in combination with edge detection methods extensively. Therefore, in the proposed research, the performance of color segmentation, watersheds, edge detection and fuzzy C-means is evaluated towards the segmentation of fruit images.

2. Methods compared

2.1. Edge detection

Edges are the sharp discontinuities in the images mainly focusing on separation of one region from the other regions. Edges are also termed as gradients detected using first order derivative or second order derivative operators [11]. Canny edge detection is one the first order derivative edge detection operator which works by multiple stage and adaptable generically for all sorts of edge detection problems [12]. The the problem of detecting such a traditional edge that the lower threshold produces fake edges, but a high threshold releases actual edges. First, requires that the image be poured a face mask that shortened the noise Inside the image, the image goes through a swab algorithm. Finally, pixel values are selected according to the angle the size of that pixel and its neighboring pixels [8]. Unlike: Roberts cross and much like the sobel, the evil function is not much noise. The sharp contour detector performance is good, The only disadvantage is that it takes more time to calculate more difficult.The edge detection initiates with pre-processing of the images to binary form, followed by the filtration using Gaussian 5x 5 filter [13] for the removal of noise from images. Further the filtered image will undergo the estimation of gradient directions and magnitude as per the definition of first order derivative which is as formulated below.
Let Gx and Gy represents the gradient directions with corresponding to x and y axes then gradient direction continuous with respect to x- axes orientation is given by (1).

$$G x = f (x +1) - f (x) \quad (1)$$

Where f represents an image and f (x +1) f (x) Indicates the next pixel and current pixel Positions. Similarly, the gradient direction continuous with respect to y- axes orientation is given by (2).

$$G y = f (y +1) - f (y) \quad (2)$$

And the gradient magnitude M is given by (3).

$$M = \sqrt{G_x{}^2 + G_y{}^2} \quad (3)$$

Based on the gradient outcomes all the non-maximum pixel amplitudes are suppressed by retaining the local maxima pixels in the image. Once all the gradient descendants are determined through non maxima suppression, the threshold in technique is applied on all the pixels with local maxima amplitudes which is also termed as thresolding with hysteresis in canny edge detection.

2.2. K-means clustering algorithm

Clustering may be a means of dividing a bunch of data into groups of specific ranges. It will be produced moderately High quality packages that see low level of computing and required accounts. This technique focuses on reduce the total square spaces between everyone pixel points and center of mass. This is usually one of the most popular methods of k-means clustering. In k-means clustering, it divides a set of data into k sets of data [11-12] and divides the given set of data into k disjoint clusters. The K-means algorithmic rule consists of [2] separate phases. The primary stage calculates the k center, the second stage computes the nearest cluster from every point to the center of the corresponding datum. There are many ways to outline the nearest center of mass distance, the common methods is Euclidean distance. When the groping is finished, the new center of mass for the every cluster is recalculated and a brand new Euclidean distance between each center and each datum is calculated based on the center of mass, and also the cluster with the littlest Euclidean distance Point allocation. Each group in a division is delineated by its member objects and its center of mass. The center of mass for each group is the point where the total distances for the group are less. Therefore, K-means is a repetitive algorithmic rule that depreciates the totality of distances from all objects in the cluster to the center of the cluster.

2.3. Fuzzy C-means

Fuzzy C-Means (FCM) is one of the technique of clustering that allows to divide piece of data into two or additional clusters. In recognition of pattern this technique is employed. Fuzzy C-Means relies on depreciation of objective function as given by

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\| x_i - c_j \right\|^2 \quad 1 \le m < \infty$$

Where m is real no bigger than 1, u_{ij}^m is the degree of membership of xi in cluster j, xi is the i th of d-dimensional measured data, cj is expressing the resemblance between the d-dimension center of the cluster, and ||*|| is any norm the middle and any calculated data.

2.4. Watershed segmentation

Watershed segmentation works good if you are able to distinguish or "mark" the foreground object and the background location, segmentation employing a watershed transform works well. Marker-controlled watershed segmentation succeeds the subsequent basic process:

1) Calculate the function of segmentation. This can be an image whose dark area is that the one you are attempting to divide.
2) Calculate foreground markers. These are the points that connect the pixels within each object.
3) Calculate background markers. These are the pixels that do not belong to any object.
4) Change the segmentation of function to have only edge values at the foreground and background markers
5) Measure the watershed transformation of the changed the function of segmentation.

2.5. Color image segmentation

Using color image segmentation technology to extract high-color information from the image. Morphological methods are used to remove the noise on the image and make some points on the image smooth. The color space conversion method is used to convert other color spaces to RGB. K-means algorithm and other clustering algorithms are used to locate the appropriate number of clusters and segment images in different color spaces. Clusters with the largest mean variance are divided into new clusters.

3. Experimental study

The implemented methods are experimented on fruits images which are downloaded from various sources of online and also few of the images are synthetically gathered by capturing the fruits images over a plain background. The evaluation of experimental results are carried out through subjective studies. The results of the methods are shown in the figure 1 to figure 5.

3.1. Color image segmentation

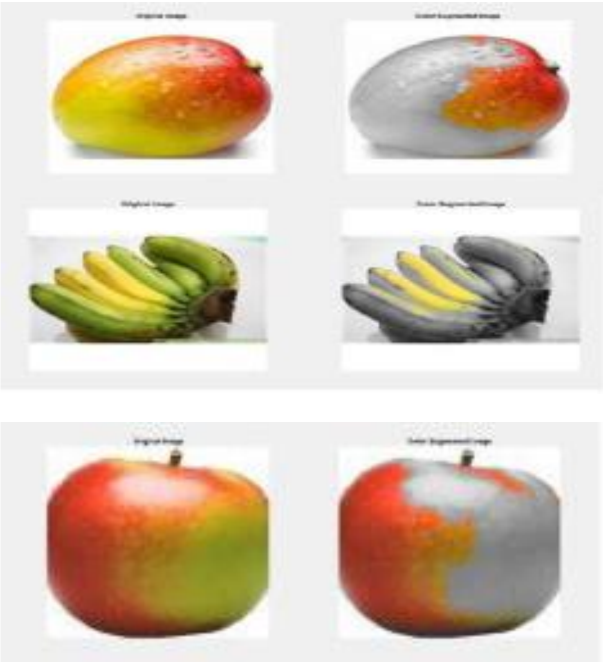


Fig. 1: Segmentation Using Color Spaces.

3.2. Watershed segmentation

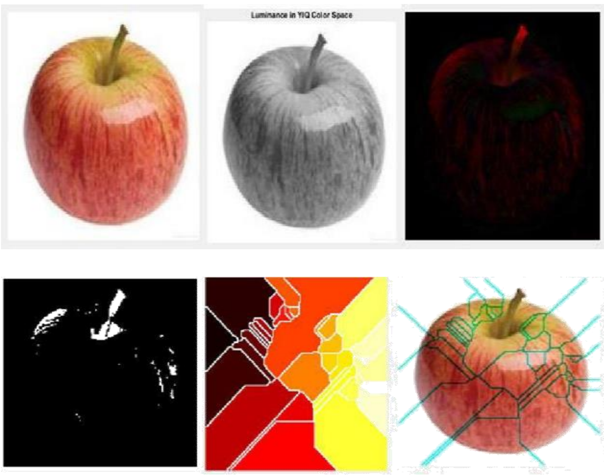


Fig. 2: A) Segmentation Using Watershed.

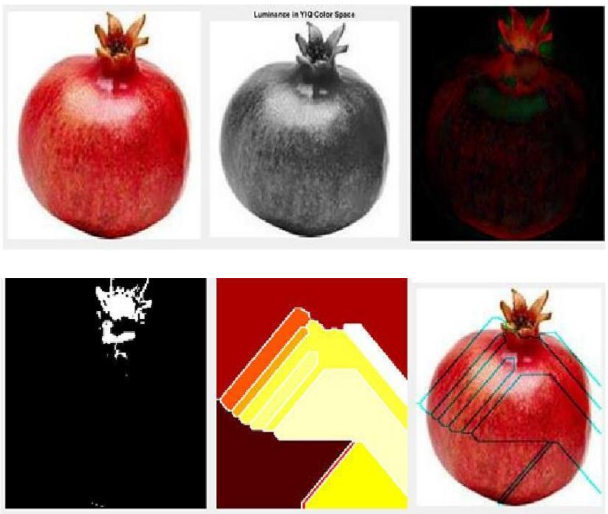


Fig. 2: B) Segmentation Using Watersheds.

3.3. Edge detection

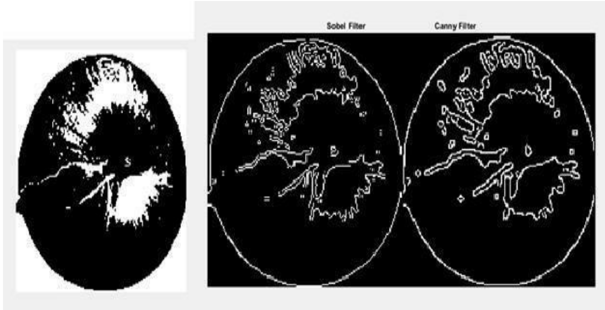


Fig. 3: A) Segmentation Using Sobel (Left) and Canny (Right) Figure 1 Segmentation Using Color Spaces Edge Detection.

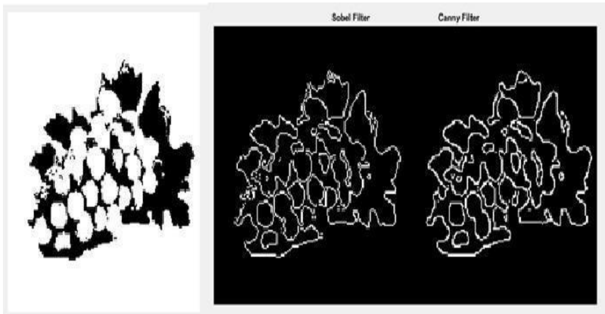
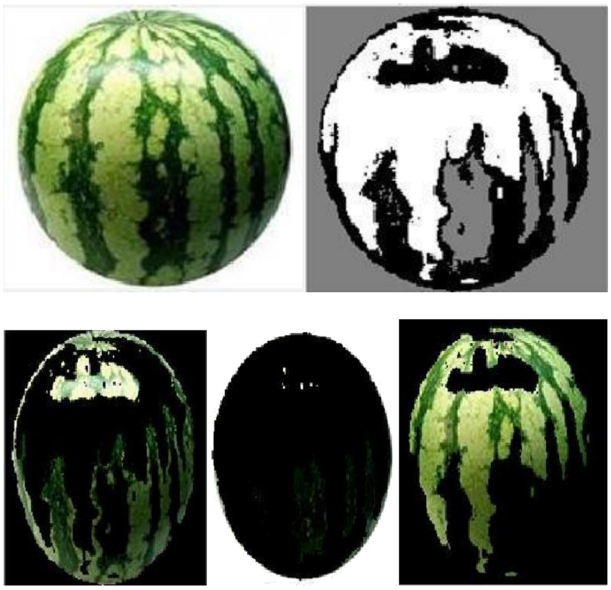


Fig. 3: B) Segmentation Using Sobel (Left) and Canny (Right) Edge Detection.

3.4. K-means



Cluster 1 Cluster 2 Cluster3

Fig. 4: B) Image Segmentation Using K-Means Clustering.

3.5. Fuzzy C-means

Fig. 5: A) Image Segmentation Using Fuzzy C-Means Clustering.

Fig. 5: B) Image Segmentation Using Fuzzy C-Means Clustering.

4. Performance metrics

	Techniques experimented				
Categories	Canny Edge	K-Means	Watershed	CIS	Fuzzy C-Mean
Apple	A	G	A	G	G
Grapes	A	A	A	A	A
Mango	P	A	A	A	A
Watermelon	A	G	G	P	A
Banana	G	A	A	A	A
Orange	P	A	A	A	A
Strawberry	A	G	A	G	A
Pomegranate	A	A	G	A	A
Pine apple	G	P	A	A	A

The performance metrics gives the performance of different methodologies that we have experimented. In the table A represents accurate, G represents good, P represents poor and CIS represents color image segmentation.

5. Conclusion

Segmentation of image is the first step from image processing to image analysis. Segmentation of image is the image is divided into multiple parts, so that the image of the object and the background have a significant difference .In this paper, we studied several segmentation methods. For various applications, there are suitable segmentation methods that can be applied. Partitioning an image using segmentation techniques leads to extract different regions with similar attributes. It also detects high level information of an image for image analysis and further researches. The segmentation of images depends on many factors, that is, the color of the pixel, the intensity of the texture, content of the image and domain of the problem Methods with similar attributes can be combined to improve the results of segmentation and achieve greater precision. It is not possible to consider a single method for all types of images or all methods work well for a particular type of image. In addition, there are possibilities to analyze different methods in groups to deduce useful results. The analysis had resulted in conclusion that performance of Fuzzy C-means and watersheds had led to optimal outcomes than other techniques.

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