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Blend Color Image Segmentation of Statistical Region Merging Algorithm

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Abstract: As, there is a need of image segmentation mostly in every fields like Industrial inspection, optical character recognition and all other computer related applications. It is essential step in image processing in computer vision but also a challenging procedure. In this study, introduced blend color image segmentation algorithm to overcome varies difficulties in region based segmentation. The boundaries are located by color gradient recognition method before that RGB is converted to CIE L*a*b color space using this technique histogram is formed. The histogram then generates gradient thresholds. The gradient values are increased until region is detected in different sequence. The regions with similar characteristics are merged by using statistical region merging. This process provides a very efficient procedure for an organized image segmentation.

Key words: Image segmentation, CIE L*a*b color space, region growing, statistical region merging

INTRODUCTION

Segmentation of image is a vital progression in object detection, content-based image recovery and medical image progression and computer vision applications. Segmentation of image is the method of separating a digital image into various sections. The intention of segmentation is to make simpler depiction of an image into more significant and not difficult to analysis. Generally, segmentation procedures are occupied on one of the following approaches; they are satisfying homogeneity property in image feature over a large region and detecting rapid change in image feature within a small neighborhood. In image segmentation several other techniques are available. In this study, considered about the seven classification of segmentation methods: edge-based technique region based methods hybrid approaches, clustering active contours approaches graph-based segmentation techniques and watershed-based segmentation techniques. In dissimilar regions, the pixel properties such as color, intensity and texture should be varied quickly by edge detection method (Gonzalez and Woods, 2008).

The similar values are found in the adjacent pixels within the identical region or pixel in Region based methods (Fan *et al.*, 2001; Calderero and Marques 2010). To obtain higher standard of segmentation, the hybrid methods be inclined to edge discovery and region based method are set together (Deng and Manjunath, 2001; Navon *et al.*, 2005). The Clustering algorithm helps to manage the patterns into groups or clusters by means of setting a path towards the structure of the data set. The Active Contour model is one of the mainly winning models in segmentation of an image. The boundary of the objects are detected by the contour present in the images (Lankton and Tannenbaum, 2008). Graph-based segmentation techniques, an subjective image personified like a graph, the final target from a segmentation perspective is to separation and it is employing metrics that give up a set of detached sub graphs. Watershed segmentation is morphological oriented image segmentation. In watershed segmentation, the gradient degree of an image is contemplated like a topographic surface (Nguyen *et al.*, 2003). This manuscript is ordered in the subsequent manner.

Literature review: A numerous hybrid region based image segmentation procedures are available in the color images. Whereas, some distinctive algorithms are presented. The researchers proposed JSEG algorithm contains of color quantization and spatial segmentation. The technique of region growing is perhaps used to slice the image based on the multiscale functionalities of J images. In JSEG algorithm, several limitations are present. One primary problem is sourced by the changing darks due to the brightness. There is no clear boundary through visual perception (Deng and Manjunath, 2001).

The researchers presented an automatic seeded region growing procedure for segmentation of color

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images. The first seeds are usually chosen and the color image is separated into areas. Then, every area shares to a seed. The small or similar regions are merged by the help of region-merging. This algorithm is utilized the fixed threshold values and provides better results. Sometimes, it may not create the finest results for all the images and noticed some small objects are missed also the time complexity is high (Shih and Cheng, 2005).

In this study, the researchers proposed a method to achieve a active threshold-based segmentation. The planned method is helped in the region increasing process where the dark and bright areas are efficiently segmented. However, the performance of the algorithm affected by the bright areas and other modifications in illumination which posses some problems but the results are normally acceptable (Balasubramanian *et al*., 2008).

In this study, the researchers planned a new Gradient SEGmentation algorithm (GSEG) that instinctively uses gradient information for selecting the clusters for images in the CIE color model. The algorithm gives better results but time complexity is high (Ugarriza *et al*., 2009). In proposed technique, segmentation of an color image uses the double hierarchy Complex Wavelet Transform (DT-CWT) which is combined with a growing-merging approach (Celik and Tjahjadi, 2010). Additionally, hybrid region based approaches have also been proposed (Gevers, 2002; Navon *et al*., 2005).

MATERIALS AND METHODS

Colour image models: Usually, an image that contains color is indicated in RGB component. The RGB representation is widely matched for color demonstration whereas RGB model is not favorable for color analysis with respective to its high connection among R, G and B components.

In respect to segmentation of color image, a suitable preference of color model is also essential for segmentation. The CIEL ab color model is selected from the several color models cause of three major possessions whereas:

- Separation of achromatic figures from chromatic figures
- Even color space
- Similar to human visual perception

At this point, L* represents the luminance module while a* and b* represent color modules. The color model of CIE lab encompasses the entire spectrum including colors outside of human vision.

Gradient operators: The intensity of edges existent in an image and assistance to trace the singular regions of an image which is to be segmented are given by edge discovery method. The proposed algorithm makes use of this method. The different approximates of the 2D gradient are the base for first order subordinates of a digital image The gradient of an image f (x, y) in a position (x, y) is defined as the vector:

$$\Delta f = \begin{bmatrix} Gx \\ Gy \end{bmatrix} = \begin{bmatrix} \frac{\partial x}{\partial f} \\ \frac{\partial y}{\partial f} \end{bmatrix} \quad (1)$$

Degree of this vector is given by:

$$\nabla F = \text{Mag}(\nabla F) = \left[Gx^2 + Gy^2 \right]^{1/2} \quad (2)$$

where, ∇f is the gradient. Depending on the partial subordinates ∂f/∂ x and ∂f/∂ y at every pixel position the gradient of an image is computed (Gonzalez and Woods, 2008).

Region growing: The grouping up of sub regions into greater regions is said to be Region growing which is based on predefined principles for growth. The preliminary approach is to initiate with a group of seed points and from these grows regions by attaching to every seed those immediate pixels that have related belongings, Such as gray level, color and shape. In noisy images, region growing based techniques are better than the edge based techniques. Figure 1 illustrate the region growing process.

The similarly criteria considered for region growing may be one (or) more of the following descriptors:

- Intensity values
- Texture
- Color
- Size
- Shape of the region

In region growing, three main issues should be taken during the process. Assortment of seed points. Selection of parallel principles and allocation of a stopping rule (Gonzalez and Woods, 2008). In proposed method above three problems are solved as follows. Firstly, the selection of seed points is absorbed on the histogram analysis of gradient map. Secondly, the color image segmentation is mainly absorbed on the proposed method, so choosing color and intensity for similarity descriptors. Finally, the gradient value increased by all the pixels is located and stops the process of region growing.

Statistical region merging: Statistical region technique is used to reduce the over segmentation by means of region merging algorithm.

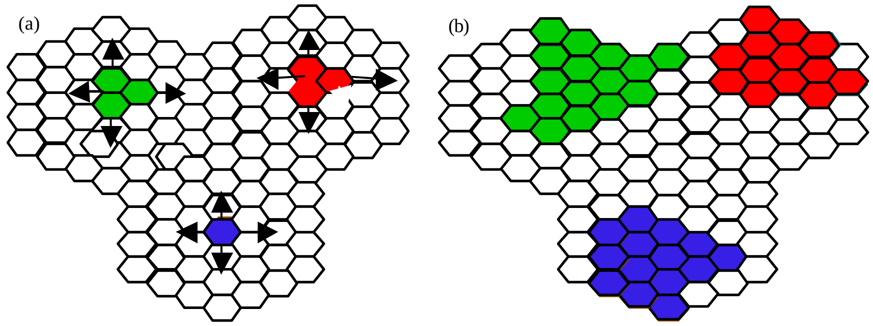

Fig. 1: Region growing process: a) Seed pixels b) Region designed when a few repetitions of growing

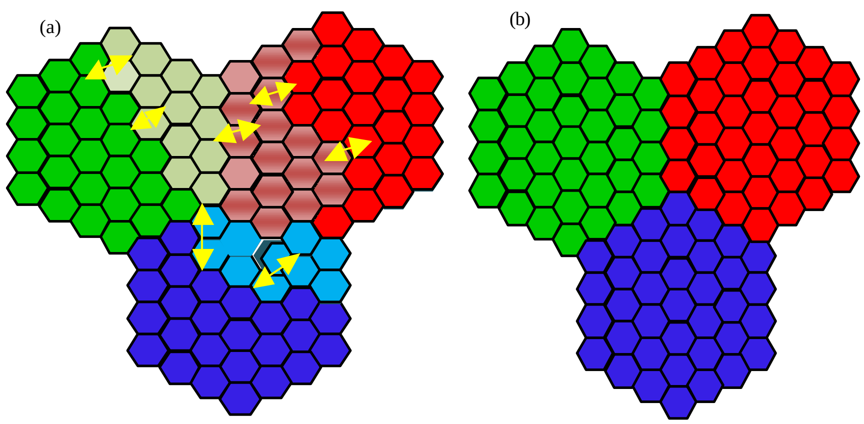

Fig. 2: Region merging: a) Initial regions and b) Reorganised region plot when a few repetitions of merging

Region merging processes remove the incorrect boundaries and false areas by merging neighboring regions that belong to the identical object. Figure 2 shows the region merging process. Statistical Region Merging (SRM) is used in the proposed method.

Statistical Region Merging (SRM) is an upcoming modern color image segmentation technique. It is mainly based on region merging. This technique experiences the problem of interference in which the image is shown as a pragmatic instance of a strange hypothetical image whose statistical correct regions are to be rebuilt. The merits of this technique contain its easiness, robustness, computational competence and outstanding enactment without the use of quantization. Two effective components involved in defining a region merging procedure. The first one is the merging predicate which confirms whether the contiguous regions are combined or not. Second is the order follows to test the regions by merging it into one another.

In Statistical Region Merging (SRM) relate the merging predicate that trials if two regions G1 and G2 of which G1UG2 emerges from the same statistical region of a perfect view (Nock and Nielsen, 2004). The perfect position is not known. However, it is assumed that every pixel is denoted by a group of distributed by means of each observed color. The following properties should be satisfied in the optimal regions. Properties are as follows: internal any statistical region and for any conduit, statistical pixels have the similar anticipation value for each conduit; the anticipation value of contiguous regions is dissimilar for at least one conduit (Nielsen and Nock, 2003). Consider the following sort function derived for RGB images:

$$F(s1,s2) = \max_{j\varepsilon\{R,G,B\}} |s2_j - s1_j| \quad (3)$$

From the model, the subsequent merging predicates are obtained for RGB images (Nock and Nielsen, 2004):

$$P(G1,G2) = \begin{cases} \text{true} \quad \text{if } \forall j \in \{R,G,B\}, |\overline{G2}_j - \overline{G1}_j| \\ \leq \sqrt{b^2(G1) + b^2(G2)} \\ \text{false} \quad \text{othrwise} \end{cases} \quad (4)$$

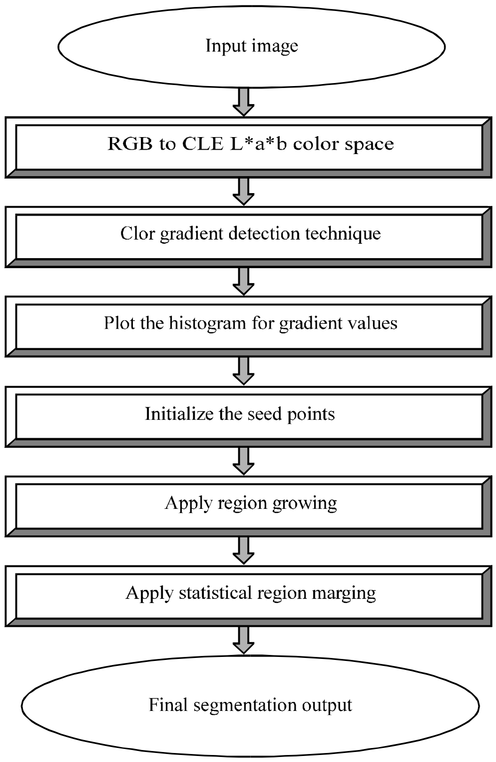

Fig. 3: Overview of the proposed algorithm

Where:

$$b(G) = g\sqrt{\frac{1}{2Q|G|}\operatorname{In}\left|\frac{G_{|G|}}{\delta}\right|} \tag{5}$$

and each color channel belongs to the set {1, 2, ..., g}, g = 256. Where, Q is the number of random variables representing. Each color channel which makes it possible to quantify the statistical complexity of the ideal segmentation imagery. The |G| = pixel number in region G. Ancillary sort functions and merging predicates could be in progress if the speed and value of segmentation.

Proposed work (algebraic SEGmentation ASEG): In this study to propose an Active Region Growing and Statistical Region Merging Algorithm (Algebraic SEGmentation ASEG). Proposed algorithm conquers the difficulty of region growing techniques. Figure 3 shows the overview of the proposed algorithm. Initially, CIE L*a*b color model is attained from RGB color image because RGB color image is not appropriate for color analysis. Then, gradient edge detection is applied CIE L*a*b Color model. The gradient map is used to produce the gradient thresholds. Based on this thresholds value, it compares the gradient and color values of neighboring pixels and appends the similar pixels to start the region growing process.

The seed selection is essential in every region growing process. Here to initialize, the seeds depends upon histogram of the gradient map and fix the seed value. Primary seeds are produced by sensing completely the pixels in the image whose subordinate value decreases under the primary intensity. If no pixel falls beneath this threshold, the gradient value will be raised until all the pixels are sensed and form a region with different seed points. To complete the region growing process where the output is converted into RGB output image. Region growing causes overflow into regions of similar color. Segmentation result is improved when incorporating Statistical Region Merging (SRM) procedure.

By applying the above procedure, over segmentation is reduced and enhances the quality of segmentation. In SRM, the contiguous regions are arranged agreeing to the size of the function using Eq. 3 and determine the merging predicate based on Eq. 4 and 5 which conforms whether the contiguous regions are combined or not, the adjacent regions are in same position even if they fulfill the merge predicate then the regions are merged. Here to take Q = 64 and finally get the final segmentation output.

Performance evaluation: In the proposed scheme, performance evaluation uses Berkeley data set images. Performance measures such as Variation of Information (VOI), Global Consistency Error (GCE) and Probability Random Index (PRI) are calculated to assess the recital of the system.

Probabilistic Rand Index (PRI): The multiple ground-truth images are evaluated against the result of segmentation and compares with the PR Index. The associations between couples of pixels as a function of inconsistency in the ground-truth set (Unnikrishnan and Hebert, 2005).

Global Consistency Error (GCE): Measures the level to which the regions in one segmentation are subsections of the regions in a second segmentation. Partitions that are correlated in this direction are deliberated to be regular, since they can denote the similar regular image partitioned at dissimilar scales (Martin *et al*., 2001).

Variation of Information (VOI): Calculates the conditional entropies between the class tag deliveries of the result S and the GT data.

According to the proposed method, it helps to the quality of the segmentation which results by calculating the segmentation parameters (PRI, GCE and VOI) that is the intrinsic changeability of probable elucidations among human spectators of an image, i.e., many satisfactory ground truth segmentations connected with every normal image.

The proposed method was tested using the Berkeley database. In University of California, this data bank is openly available. This database delivers 1633 manual segmentations for 300 images produced by 30 human subjects. To improve the segmentation and edge linking these types of segmentation techniques are synthesized.

RESULTS AND DISCUSSION

The quality of segmentation of an image is viewed accurately, if PRI is large and the values from zero to one and also VOI, GCE are small and the values from zero to infinity. The PRI, GCE, VOI values are compared to existing and proposed method are shown in Table 1. For the proposed method (ASEG), the value of the PRI is high and GCE is the same compared to GCEBFM method and VOI is smaller. Similarly the PRI is greater than the JSEG method and the other two measurements are not evaluated. The GSEG method does not perform any evaluation in the image segmentation.

In Table 2 the proposed method is compared to existing methods with average time, image size and environment. The proposed method (ASEG) has also the less average time and larger image size than the GCEBFM, JSEG and GSEG methods. This also uses MATLAB environment.

This is to illustrate the segmentation outcomes of the projected technique on regular images attained from Berkeley segmentation databank. Results obtained from proposed method (Algebraic SEGmentation-ASEG) in comparison to the GSEG, are shown in Fig. 4.

Table 1: Performance evaluation of proposed and existing method

Methods	PRI	GCE	VOI
GCEBFM (Lazhar Khelifi)	0.8	0.19	2.10
JSEG (Deng et al)	0.77	-	-
GSEG (L.G. Ugarriza et al)	-	-	-
ASEG (proposed method)	0.81	0.91	1.35

PRI score (the higher value is the better); GCE, VOI (the lower value is the better)

Table 2: Average time, image size and environment for different segmentation algorithms

Methods	Avg.time (sec)	Image size	Environment
GCEBFM (Lazhar Khelifi)	˜180	(320×214)	C++
JSEG (Deng et al)	˜6	(184×184)	C
GSEG (L.G. Ugarriza et al)	˜24	(321×481)	MATLAB
ASEG (proposed method)	˜4	(321×481)	MATLAB

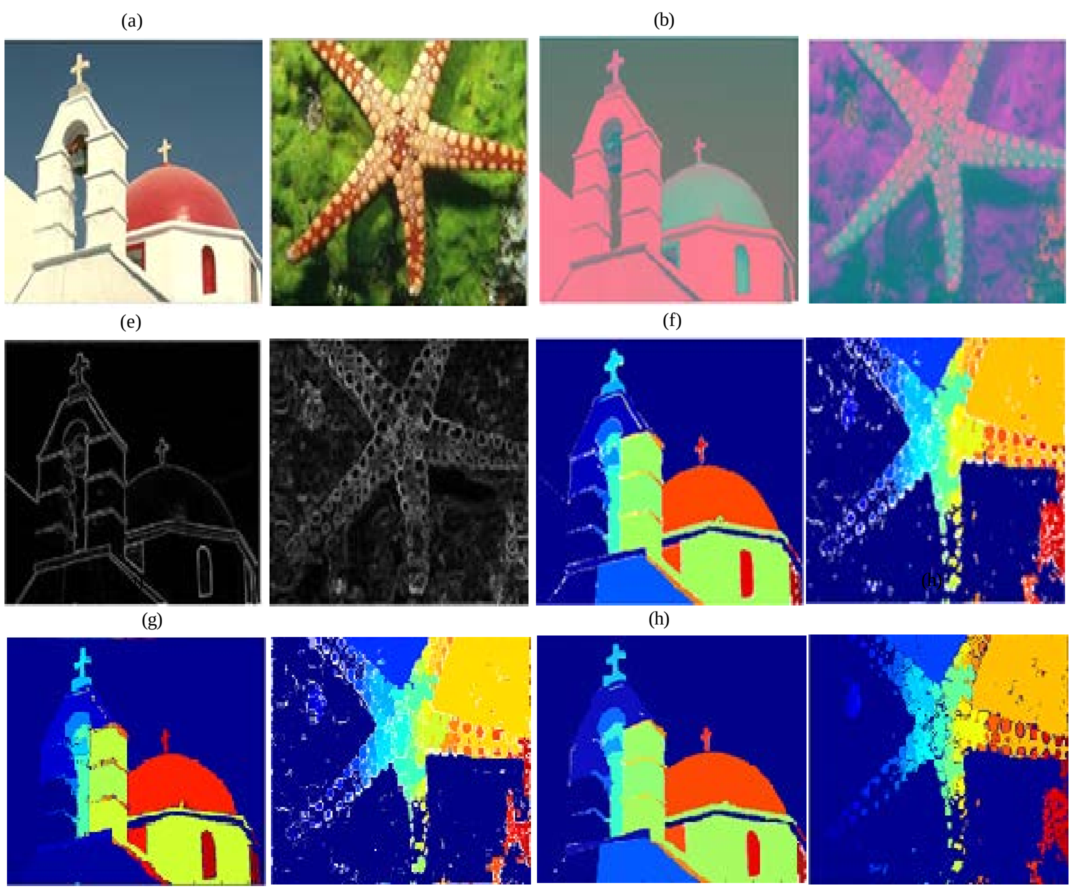

Fig. 4: a) Original image (church and starfish); b) Color space conversion; c) Gradient edge detection; d) Region growing; e) GSEG output; f) ASEG output

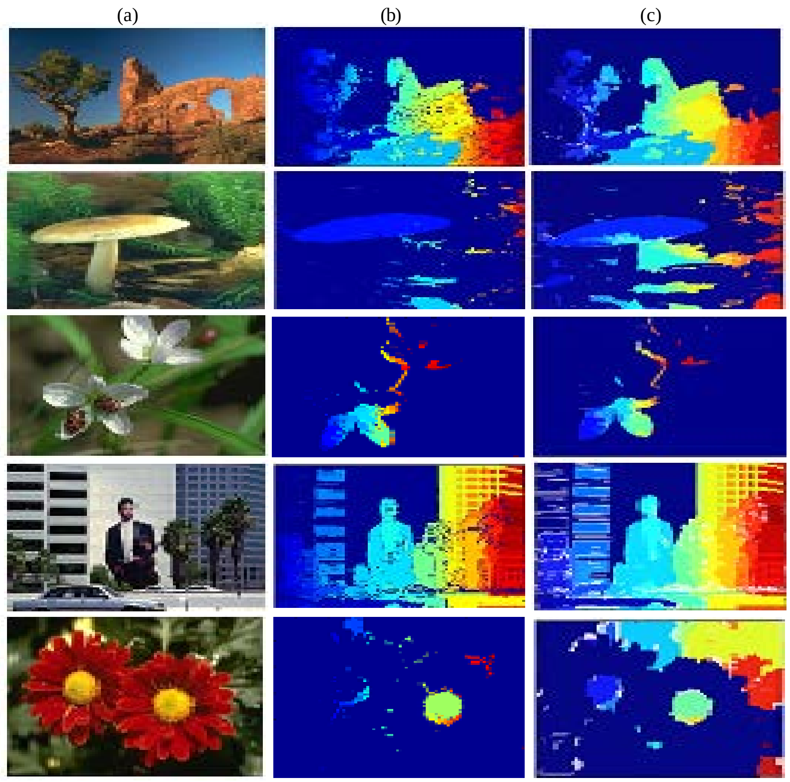

Fig. 5: Segmentation results: a) The original images; b) The segmentation produced by GSEG algorithm; c) Our segmentation proposed results (ASEG)

The segmentation algorithm is applied once the image is converted into CIE L*a*b. The projected technique yields respectable localization and decreases the misclassified regions and other inconsistencies of the gradient. Figure 4 displays the outcomes of church and starfish images. Figure 5 shows segmentation results of some Berkeley data set images. In Fig. 5, the first column displays original images, second column displays output of existing method (GSEG) and third column shows output of proposed method (ASEG). Proposed algorithm provides perfect segmentation outputs and provides stronger partitions between neighboring regions.

CONCLUSION

This manuscript proposed a innovative method which helps to reduce the large amount of computation and high complexity in the progression of an image segmentation in the color images as well as in merging the regions in automatic image segmentation used to progress the accurate segmentation and reduce the over segmentation. The experiential analysis shows and produces better outputs compared with the existing method. It also diminishes the misclassified boundaries. The proposed scheme helps to give improved performance and quality of image segmentation.

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