

A New Approach for Colour Texture Segmentation Based on SRM

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Abstract: *Image processing techniques have become increasingly important in a wide variety of applications due to the advent of computer technology. With the increased application of colour images, the colour image segmentation is more and more concerned by researches. There are many image segmentation techniques for segmenting an image but no one can tell which one is the better. Different techniques are used depending upon the domains. Image segmentation has been subject of considerable research activity and segmentation plays an important role in image understanding, image analysis and image processing. This paper presents an approach for segmenting a coloured image in a perceptual meaning. This approach includes two steps first where an input image is colour quantized by using K means clustering algorithm. Next we apply Statistical Region Merging (SRM) algorithm for segmentation. Finally we are comparing segmented results for quantized image and also unquantized image by using metrics like probabilistic random index (PR), global consistency error (GCE), and variation of information (VI).*

Keywords: Statistical Region Merging (SRM), Probabilistic Random Index (PR), Global Consistency Error (GCE), Variation of Information (VI).

1. Introduction

Images are one of the most important medium of conveying information. The main thing is to understand images and extracting the information from them such that the information can be used for other tasks. The main goal of segmentation is to simplify and change the representation of an image into something that makes us to analyze. Hence image segmentation plays a very important role towards conveying information that is represented by an image and also assists in understanding the image.

In most of the image analysis operations, individual objects need to be separated from the image, so that the description of those objects can be transformed into a suitable form for computer processing. Image segmentation is a fundamental task which is responsible for separating operation. The main function of image segmentation is to partition an image into its constituent and disjoint sub-regions based on the uniformity in their properties like intensity, colour, and texture within a sub-region. There are some segmentation algorithms relying on both discontinuity and uniformity.

One of the fundamental issues in image processing fields and in computer vision is image segmentation. Because it is the basis of higher level applications like in medical imaging. Since segmentation is an important and basic task in image analysis so it is involved in many image analysis applications, particularly in those related to pattern classification, e.g. medical imaging, remote sensing, security surveillance, military target detection. Also image segmentation has a scope in automatic detection of man-made objects such as roads and buildings from digital aerial images which is useful for scene understanding, image retrieval, and surveillance and updating of geographic information system database. Since now a day's most of the

image processing applications are based on colour images. Hence there is a need to segment colour images.

The main objective of this paper is to segment a colour image into homogeneous regions with perceptual meaning and also in a way to extract the information from them so that the information can be used for other tasks. We know that human visual system is good at segmenting a natural scene image into perceptually homogeneous regions. But it is difficult to automatically segment such images into regions with perceptual meaning. Hence, intensive research has been carried out in this area from last two decades. There are many segmentation techniques but those techniques fails to segment an image with perceptual meaning.

2. Proposed System

The proposed color image segmentation is performed in two steps. First a colour quantization to an input colour image is applied. The purpose of colour quantization is to represent the image in relatively less number of distinct colors. The Colour quantized image visually looks like as similar as that of the original image. The colour quantization is done due to the constraints like less memory and it enables good compression of an image. For colour quantization any clustering algorithm can be applied. In this paper K-means clustering algorithm is used for colour image quantization. The flow chart of K-means clustering algorithm is as shown in Figure 2. This algorithm first defines the number of clusters and also number of iterations. Next the initial centroids are defined and the squared Euclidian distance between each sample and each centroid is calculated. Each sample is assigned to its nearest cluster centroid.

Next Statistical Region Merging (SRM) algorithm is applied for image segmentation purpose. This is an algorithm used

for image segmentation where it uses merging criteria which is called as merging predicate. This algorithm first computes the normalized image gradient then builds up pairs in each cluster. Then it computes the distance between those two pairs. Two regions are defined and the total deviation of those two regions is calculated. The distance between pairs is compared with the total deviation depending upon which those two regions are merged. The process flow is as depicted in Figure 1.

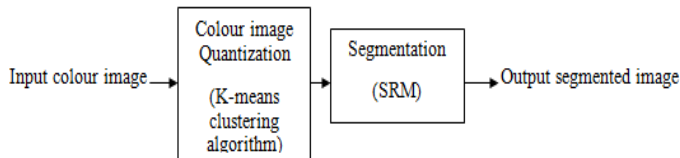


Figure 2: Process Flow

3. Colour Image Quantization

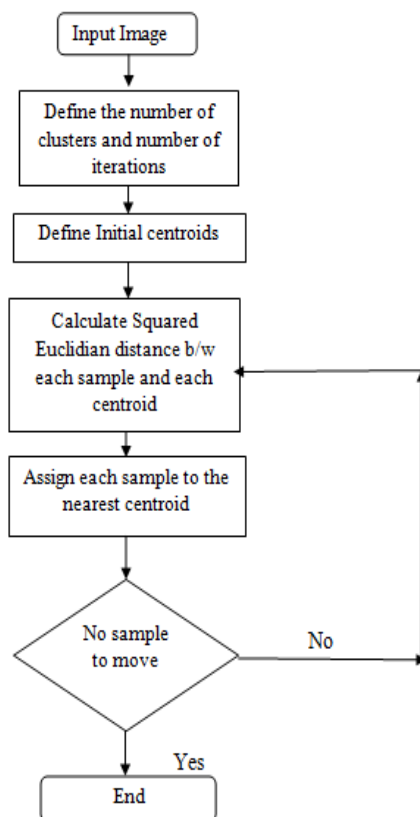


Figure 2: Flow chart for k-means clustering algorithm

The purpose of color quantization is to represent the image in relatively less number of distinct colors. The Color quantized image visually looks like as similar as that of the original image. The color quantization is done due to the constraints like less memory and it enables good compression of an image. The basic strategy employed by these recent adaptive minimum maximum- discrepancy quantizers is a two-step approach. The first step is to group original image colors in a hierarchical fashion into clusters that are as tight or as small as possible. The second step is to compute a cluster representative or quantized color for each cluster.

For color quantization any clustering algorithm can be applied. In this paper K-means clustering algorithm is used

for color image quantization. The flow chart of K-means clustering algorithm is as shown in Figure 2.

4. Statistical Region Merging (SRM)

Statistical region merging algorithm is one of the image segmentation algorithms. This algorithm has some desirable features. It relies on a simple interaction between a merging predicate easily implementable, and an order in merging approximable in linear time. Furthermore, it can be adapted to most numerical feature description spaces (RGB, HSI, $L^*u^*v^*$, etc.). SRM is a recent color image segmentation technique based on region growing and merging. The method models segmentation as an inference problem, in which the image is treated as an observed instance of an unknown theoretical image, whose statistical (true) regions are to be reconstructed. The advantages of this method include its simplicity, computational efficiency, and excellent performance. Let I be an observed image that contains $|I|$ pixels, each of which is comprised of R, G, B color channel values belonging to the set $\{0, 1, \dots, g-1\}$ (where $g=256$ for 24-bit RGB images with 8 bits per color channel). Like other region growing algorithms, SRM is based on two major components; a merging predicate and the order followed in testing this predicate. The predicate is defined as (1):

$$P(R, R') = \begin{cases} \text{true} & \text{if } \forall a \in \{R, G, B\}, \\ & |\bar{R}_a - \bar{R}'_a| \leq \sqrt{b^2(R) + b^2(R')} \\ \text{false} & \text{otherwise.} \end{cases} \quad (1)$$

where R and R' represent the two regions being tested, \bar{R}_a denotes the observed average for color channel a in region R and $R|p|$ is the set of regions with p pixels. Let S_1 be a set that contains all pairs of adjacent pixels in the image based on 4-connectivity, p and p' be pixels in image I , and $R(p)$ stand for the current region to which a pixel p belongs. The SRM algorithm first sorts these pairs in increasing order according to a function $f(p, p')$. After the sorting is completed, the order is traversed only once, performing the merging test $P(R(p), R(p'))$ for any pair of pixels (p, p') for which $R(p) \neq R(p')$, and merging $R(p)$ and $R(p')$ if it returns true.

With high probability, the algorithm suffers only one source of error for image segmentation: over merging, that is, the fact that some observed region may contain more than one true region. The algorithm does not suffer neither under merging, nor the most frequent hybrid cases where observed regions may partially span several true regions. Yet, there is more: With high probability, this over merging error is, as we show, formally small as the algorithm manages accuracy in segmentation close to the optimum, up to low order terms.

The execution time of our basic implementation of SRM, which is not optimized, segments our largest images (512 X 512) in about one second on an Intel Pentium 1 IV 2.40 GHz processor.

5. Experimental Results and Analysis

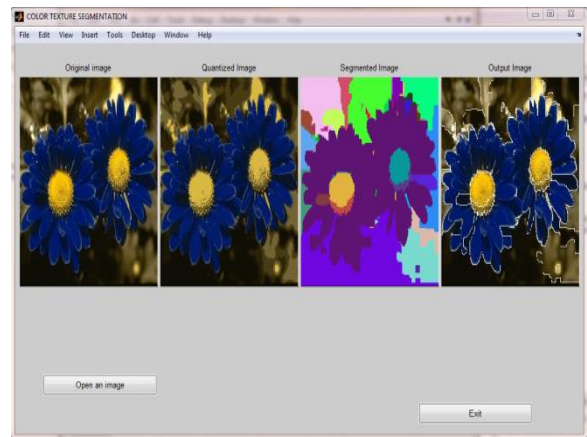
Experiments were conducted in coloured images to evaluate the performance of the proposed method. This method is used to segment an image into distinct colour-textured

regions. The metrics used for quantitative evaluation of the proposed method were the following.

- The *Probabilistic Random Index* (PR) allows the comparison of a test segmentation using multiple ground truth images. It measures the fraction of pixel pairs, whose labels are consistent in the test segmentation and the ground truth one.
- The *Global Consistency Error* (GCE) measures the tolerance up to which one image segmentation can be considered as a refinement of other. A zero value of GCE means that the segmentations are identical, whereas a nonzero value means that the inconsistency exists between the two segmented images.
- The *Variation of Information* (VI) measures the amount of information lost or gained from one segmented image to another segmented image.

5.1 Figures and Tables

The experimental results (i.e., Segmented Output) for different sized images is shown in Figure 3. Comparison between quantized image and unquantized image is also shown. The GUI shows the outputs like quantized image, colour labeled image, and final segmented output image.



(c)

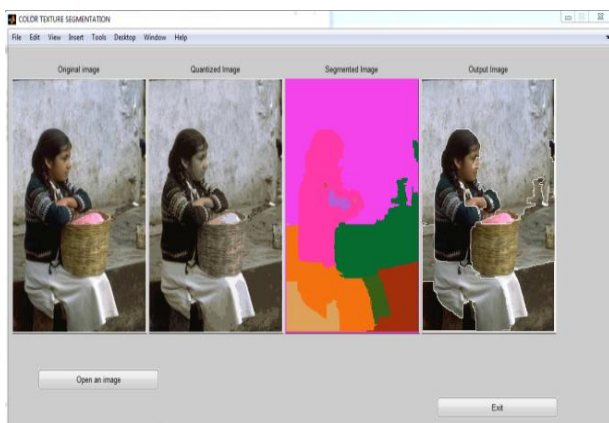
Figure 3: Output segmented images of different sizes

(a) 266x400 (b) 640x745 (c) 399x321

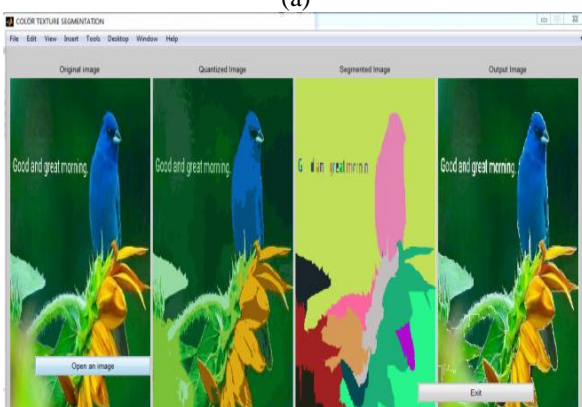
Table 1 shows these metrics for different sized colour images. The VI metric for different images is not much hence it will be convenient to use quantization before segmentation so that memory requirement will be less.

Table 1: Comparison between Quantized image and unquantized image

Image Size	Prabalistic Random Index	Global Consistency Error	Variation of Information
266x400	1.1140	0.1697	0.9086
399x321	1.1134	1.1296	0.6651
600x400	1.1210	0.1089	0.8656
640x745	1.0043	0.3928	2.0081



(a)



(b)

6. Conclusion

This is a new approach for the colour image segmentation. The proposed algorithm segments a natural scene image in a perceptual way. This algorithm is applied on different sized colour images. This algorithm takes an execution time of 1s per image. The proposed method requires significantly lower computational complexity and therefore, is feasible to real-time image processing. The experimental results are also shown for different sized colour images and also comparison between segmentation for quantized image and unquantized image. Result indicates that there is not much difference between the segmented output for quantized image and unquantized image.

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