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Region Growing and Object Extraction Techniques

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Abstract: ***For some applications, such as image recognition or compression, whole image cannot be processed directly for the reason that it is inefficient and unpractical. Therefore, several image segmentation algorithms were proposed to segment an image before recognition or compression. Image segmentation is to classify or cluster an image into several parts (regions) according to the feature of image, for example, the pixel value or the frequency response. Up to now, lots of image segmentation algorithms exist and be extensively applied in science and daily life. According to their segmentation method, we can approximately categorize image segmentation algorithms into region-based segmentation, data clustering, and edge-base segmentation. Each approach has its own pros and cons. This paper presents a brief review of some of the promising region growing and object-extraction techniques enlisting their advantages and limitations.***

Keywords: image segmentation, snakes, region growing, extraction, intelligent scissors

1. Introduction

Segmentation involves partitioning an image into a set of homogeneous and meaningful regions, such that the pixels in each partitioned region possess an identical set of properties. Image segmentation is one of the most challenging tasks in image processing and is a very important pre-processing step in the problems in the area of image analysis, computer vision, and pattern recognition. In many applications, the quality of final object classification and scene interpretation depends largely on the quality of the segmented output. In segmentation, an image is partitioned into different non-overlapping homogeneous regions, where the homogeneity of a region may be composed based on different criteria such as gray level, color or texture.

Techniques like histogram based, edge based region based clustering and combinations of these techniques have been developed in the area of image segmentation. Even though many algorithms were available, a single algorithm appropriate for all images is not yet available. Segmentation is an essential process in image processing because of its wide application such as image analysis, medical image analysis and pattern recognition. For any image, colour and texture are the most significant and basic features. Normally, colour textured image segmentation consisted of two steps: (i) extracting the feature and (ii) clustering the feature vector. Haralick features may be extracted from the integrated colour and intensity co-occurrence matrix by a hybrid approach [2] and using an extended interval Type – 2 Fuzzy C mean clustering algorithm. The future vectors are clustered into several categories in regard to different areas of the textured images.

For the segmentation of intensity images, there are four main approaches [3], [9], namely, threshold techniques, boundary-based methods, region-based methods, and hybrid techniques which combine boundary and region criteria. Threshold techniques [5] are based on the postulate that all pixels whose value (gray level, color value, or other) lie within a certain range belong to one class. Such methods neglect all of the spatial information of the image and do not cope well with noise or blurring at boundaries.

Boundary-based methods [6] use the postulate that the pixel values change rapidly at the boundary between two regions. The basic method here is to apply a gradient operator such as the Sobel or Roberts filter. High values of this filter provide candidates for region boundaries, which must then be modified to produce closed curves representing the boundaries between regions. Converting the edge pixel candidates to boundaries of the regions of interest is a difficult task.

The complement of the boundary-based approach is to work with the regions. Region-based methods rely on the postulate that neighboring pixels within the one region have similar value. This leads to the class of algorithms known as region growing of which the "split and merge" technique is probably the best known. The general procedure is to compare one pixel to its neighbor(s). If a criterion of homogeneity is satisfied, the pixel is said to belong to the same class as one or more of its neighbors. The choice of the homogeneity criterion is critical for even moderate success [4], [5], and in all instances the results are upset by noise.

The fourth type is the hybrid techniques which combine boundary and region criteria. This class includes morphological watershed segmentation [11] and variable-order surface fitting [3]. The watershed method is generally applied to the gradient of the image. This gradient image can be viewed as topography with boundaries between regions as ridges. Segmentation is equivalent to flooding the topography from the seed points [12] with region boundaries being erected to keep water from different seed points from meeting. Unlike the boundary-based methods above, the watershed is guaranteed to produce closed boundaries even if the transitions between regions are of variable strength or sharpness. The technique encounters difficulties with images in which regions are both noisy and have blurred or indistinct boundaries. The variable-order surface fitting method starts with a coarse segmentation of the image into several surface-curvature-sign primitives which are then refined by an iterative region growing method based on variable-order surface fitting. Because the technique was developed for machine vision applications where the image content may vary considerably, the segmentation is entirely data driven with no scope to involve higher level knowledge. The method is also computationally very expensive.

We present here a new method known as "seeded region growing" (SRG) which is based on the conventional region growing postulate of similarity of pixels within regions, but whose mechanism is closer to that of the watershed. Instead of tuning homogeneity parameters as in conventional region growing, SRG is controlled by choosing a (usually small) number of pixels, known as seeds. This form of control and the corresponding result is readily conceptualized, which allows relatively unskilled users to be able to achieve good segmentations on their first attempt. The result is a robust and easy-to use routine where higher level knowledge of the image composition can be readily incorporated into the technique through the choice of seeds.

The intelligent scissors algorithm [1] treats the image as a graph where each pixel is associated with a node and a connectivity structure is imposed. In this process, there is a need to place points on the boundary of the image. Dijkstra's algorithm is then used to compute the shortest path between the user-defined points and this path is treated as the object boundary. The algorithm is simple to implement, very fast and may be used to obtain an arbitrary boundary with enough points. If the boundary is noisy or of low contrast then a large number of points need to be specified and they are not applicable for 3D boundaries.

Object extraction is to be done using intelligent scissors (also known as livewire). This will also be based upon dijkstra's algorithm. User may interact with program and see intermediate results. When user will select any seed, shortest path from source (current user placed seed) to all other nodes of image graph along the object boundaries will be calculated using dijkstra's algorithm. So, user will be able to see intermediate results and he/she can ignore or accept intermediate path. User finalized sub-path will become part of final extraction process. When, closed contour will be available, and then object can be extracted and placed on any other new/blank image.

2. Region – Based Segmentation Methods

Region-based methods mainly rely on the assumption that the neighbouring pixels within one region have similar value. The common procedure is to compare one pixel with its neighbours. If a similarity criterion is satisfied, the pixel can be set belong to the cluster as one or more of its neighbours. The selection of the similarity criterion is significant and the results are influenced by noise in all instances. In this chapter, we discuss four algorithms: the Seeded region growing, the un-seeded region growing, the Region splitting and merging, and the Fast scanning algorithm.

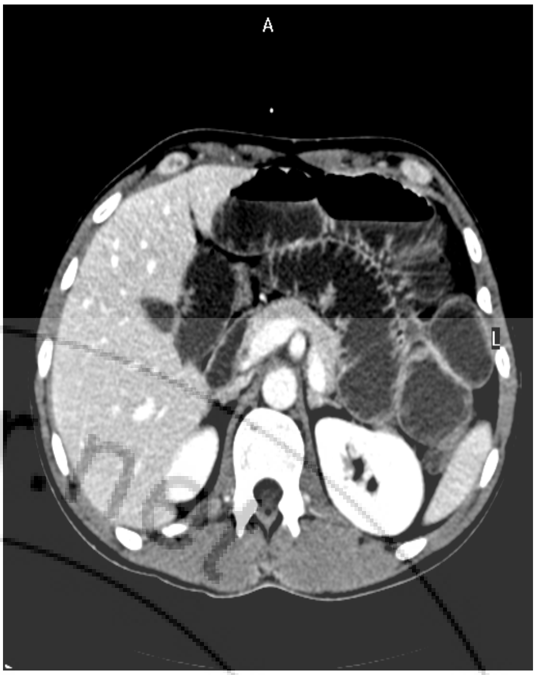

Figure 1

A. The Concept of Seeded Region Growing

The seeded region growing (SRG) algorithm is one of the simplest region-based segmentation methods. It performs segmentation of an image and examines the neighbouring pixels of a set of points known as seed points, and determines whether the pixels could be classified to the cluster of seed point or not [2]. The algorithm procedure is as follows.

Step1. We start with a number of seed points which have been clustered into n clusters, called C1, C2… Cn. And the position of initial seed points is set as p1, p2… p3.

Step2. To compute the difference of pixel value of the initial seed point pi and its neighboring points, if the difference is smaller than the threshold (criterion) we define, the neighboring point could be classified into Ci, where i = 1, 2, …,n.

Step3. Recompute the boundary of Ci and set those boundary points as new seed points pi (s). In addition, the mean pixel values of Ci have to be recomputed, respectively.

Step4. Repeat Step2 and 3 until all pixels in image have been allocated to a suitable cluster. The threshold is made by user and it usually based on intensity, gray level, or color values. The regions are chosen to be as uniform as possible. There is no doubt that each of the segmentation regions of SRG has high color similarity and no fragmentary problem.

However, it still has two drawbacks, initial seed-points and time-consuming problems. The initial seed-points problem means the different sets of initial seed points cause different segmentation results. This problem reduces the stability of segmentation results from the same image. Furthermore, how many seed points should be initially decided is an important issue because various images have individually suitable segmentation number. The other problem is time-consuming because SRG requires lots of computation time, and it is the most serious problem of SRG.

Region Growing is a simple region-based image segmentation method. It is also classified as a pixel-based image segmentation method since it involves the selection of initial seed points. This approach to segmentation examines neighbouring pixels of initial “seed points” `and determines whether the pixel neighbours should be added to the region. The process is iterated on, in the same manner as general data clustering algorithms. A general discussion of the region growing algorithm is described below.

B. The Concept of Unseed Region Growing

The unseeded region growing (URG) algorithm is a derivative of seeded region growing proposed by Lin et al. [14]. Their distinction is that no explicit seed selection is necessary. In the segmentation procedure, the seeds could be generated automatically. So this method can perform fully automatic segmentation with the added benefit of robustness from being a region-based segmentation.

3. Region Splitting and Merging

The main goal of region splitting and merging is to distinguish the homogeneity of the image [10]. Its concept is based on quadtrees, which means each node of trees has four descendants and the root of the tree corresponds to the entire image. Besides, each node represents the subdivision of a node into four descendant nodes.

The process of quantization is implemented in the color space without considering the spatial distribution of the colors. The corresponding color class labels replace the original pixel values and then create a class-map of the image. The CIE LUV color space is used for the color space in JSEG. In second portion, spatial segmentation executes on the class-map instead of regarding the corresponding pixel color similarity. The benefit of this separation is that respectively analyzing the similarity of the colors and their distribution is more tractable than to complete them at the same time.

4. Colour Image Segmentation

Color images can provide more information than gray level images. Color image segmentation [13] is useful in many applications. From the segmentation results, it is possible to identify regions of interest and objects in the scene, which is very beneficial to the subsequent image analysis or annotation. Recent work includes a variety of techniques: for example, stochastic model based approaches, morphological watershed based region growing, energy diffusion, and graph partitioning. Quantitative evaluation methods have also been suggested. Since the problem is of very complex nature, algorithms that can work on large types of date are few. Segmentation becomes different due to the texture of the image. In case of Images containing homogeneous colour regions, Clustering methods in colour space will be sufficient. However natural scenes are rich in colour and texture. It is difficult to identify image regions containing color-texture patterns.

Figure 2

5. Some Important Issues

Then we can conclude several important issues about region growing:

1. The suitable selection of seed points is important. The selection of seed points is depending on the users. For example, in a gray-level lightning image, we may want to segment the lightning from the background. Then probably, we can examine the histogram and choose the seed points from the highest range of it.

2. More information of the image is better

Obviously, the connectivity or pixel adjacent information is helpful for us to determine the threshold and seed points.

3. The value, “minimum area threshold”
No region in region growing method result will be smaller than this threshold in the segmented image.

4. The value, “Similarity threshold value“

If the difference of pixel-value or the difference value of average gray level of a set of pixels less than “Similarity threshold value”, the regions will be considered as a same region.

The criteria of similarities or so called homogeneity we choose are also important. It usually depends on the original image and the segmentation result we want.

Here are some criteria we often use : Gray level (average intensity or variance), color, and texture or shape.

We briefly conclude the advantages of region growing.

6. Advantages of Region Growing

1. Region growing methods can correctly separate the regions that have the same properties we define.
2. Region growing methods can provide the original images which have clear edges with good segmentation results.
3. The concept is simple. We only need a small number of seed points to represent the property we want, and then grow the region.
4. We can determine the seed points and the criteria we want to make.
5. We can choose the multiple criteria at the same time.
6. It performs well with respect to noise.

We can conquer the noise problem easily by using some mask to filter the holes or outlier. Therefore, the problem of noise actually does not exist. In conclusion, it is obvious that the most serious problem of region growing is the power and time consuming.

7. Conclusion and Scope for Future Work

The present paper is an attempt to explore different means to integrate prior knowledge with image segmentation methods. Several techniques are suggested to accomplish segmentation. The comprehensive experimental results show considerable scope for improving the accuracy of the techniques, particularly for images with textured backgrounds.

This review further highlighted the need of human intervention to improve the accuracy of image segmentation by use of seed placement and region growing as it outperforms automatic seed placement algorithms.

There is further need to simplify the time complexity of the various segmentation algorithms. So in this approach we are performing on one seed has been taken and in future work multiple seed can be placed. Also, implementing this algorithm on a parallel or distributed platform may also be undertaken. In future to reduce processing speed, Hybridization of two or more approaches to take advantages of their best properties may be attempted.

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