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Comparative Research on Region based Image Segmentation Algorithms

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Abstract: Image segmentation is crucial part of image processing. This paper reviews various region based digital image segmentation algorithms .After basic introduction, we have also discuss comparison of such type of algorithms. A central problem, called segmentation, is to distinguish objects from background. For intensity images four popular approaches are: threshold techniques, edge-based methods, region-based techniques and connectivity-preserving relaxation methods.Threshold techniques, which make decisions based on local pixel information, are effective when the intensity levels of the objects fall squarely outside the range of levels in the background. Because spatial information is ignored, however, blurred region boundaries can create havoc.A region-based method usually proceeds as follows: the image is partitioned into connected regions by grouping neighboring pixels of similar intensity levels. Adjacent regions are then merged under some predefined criterion involving homogeneity or sharpness of region boundaries.

Keywords— : ***image processing, image segmentation ,region based segmentation, Thresholding.***

Introduction

Image segmentation is basically understood as part of image processing in which it divides a digital image into its continuous, disconnect and nonempty subset, which gives suitability to removal of attribute. Almost all segmentation algorithms are based on discontinuity around edges and similarity in same region[1],[3].In image segmentation ,we divide main image into various parts for the sack of our understanding or depending upon the application that we are using .Ideally, before start of actual image processing noise in the image should be eliminated. Image segmentation should be stopped when we get better visual results.Before actual start of image processing, color spaces should be changed into given color space. then for reducing the noise different filtering techniques might be used.Image segmentation algorithms decide segmentation results, so for that we have to choose proper algorithm.In this paper region based image segmentation algorithms are classified and reviewed .then they are discussed in depth.

$f(x,y)$

$f_1, f_2, f_3, \ldots, f_n$

I. CLASSIFICATION OF REGION BASED IMAGE SEGMENTATION ALGORITHMS

A. Thresholding methods

Thresholding techniques made decision on local pixel information.

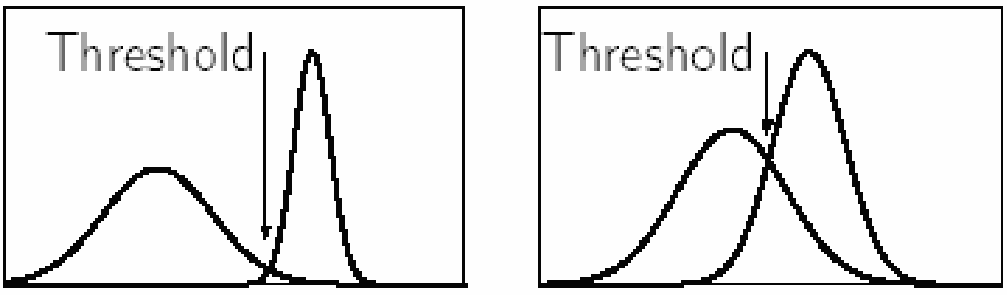

Fig-1.1 Threshold Selection

In this section we will basically discuss about main two types of region based segmentation i.e. Thresholding and region operating[4]. Region based algorithms partitions image into regions which are similar according to fix predefined criteria. Thresholding, region splitting, region merging are prime examples of this technique.

Automatic Thresholding can be divided mainly into two sub categories i.e. local thresholding and global thresholding. Otsu[5],[6] is one of the global thresholding methods and also it is very effective. If object percentage is quite less than background then pixels in background would be incorrectly consider as object .Even for opposite case Otsu method will lead to false segmentation.so for that modified Otsu algorithm is used. The general problems of Otsu algorithms can be removed by using modified Otsu. The modified Otsu algorithm is formulated by modifying probability distribution of Otsu algorithm to segment object and background perfectly.

The principle of thresholding techniques is based on the characteristics of the image. It selects appropriate threshold for separating the objects from background[1]. The thresholding techniques can be divided into global ,local and dynamic techniques[7],[8].

B. Region Operating

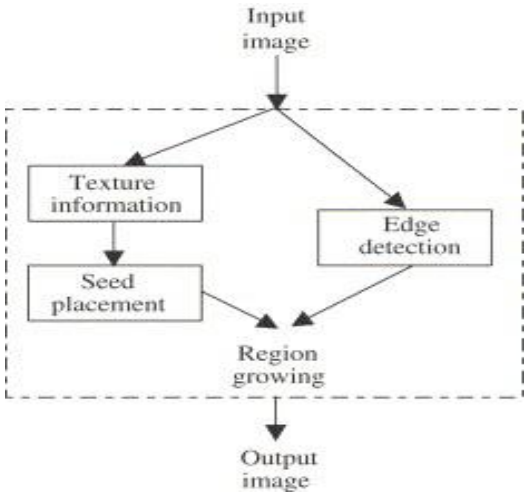

Fig.1.2 Region growing algorithm application for extraction of edge and text

1.1. Region operating concepts

The segmentation which is primarily executed by thresholds[2] . The disadvantage of this type of algorithm that they consume more time.

1.1.1 Region growing:

Region growing is a method that groups pixels into larger regions based on some fixed predefined criteria

1.1.2 Region splitting and merging:

In these method(s) rather than choosing seed points, users can divide an image into a set of random, separate regions and then combine and/or divide the regions in an attempt to justify the conditions of image segmentation.

1.2 Region-Based Segmentation Algorithm and Implementation

1.2.1 Region splitting

In this case we try to satisfy the homogeneity property where pixels that are similar are grouped together. If the grey levels present in the region do not satisfy the property, we divide the region into four quadrants. If the property is satisfied, we leave the region as it is. This is done recursively until the entire region satisfies the property. To explain this in terms of graph theory, we call each region a node. This node (parent node) is split into its four children (leaf nodes) if it does not satisfy the given property. If the node satisfies the property, it is left as it is. We now check each leaf node sees if these leaf nodes satisfy the given property. If yes, they are left unaltered and if no, there are further split.

This particular splitting technique has a suitable illustration in the form of a quad tree. (That is a tree in which a node has four descendents).Let us consider the figure as shown below

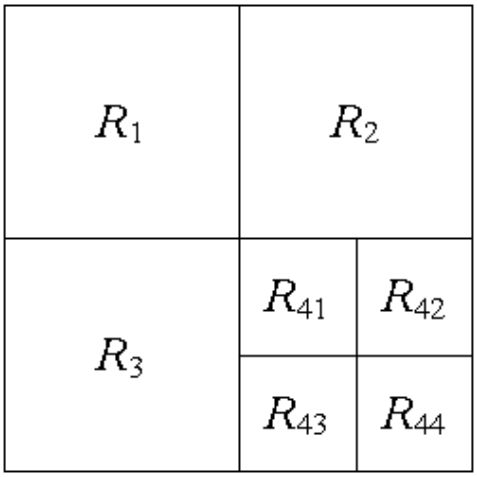

Figure1.3 Region splitting

In this, image R represents the entire image and hence R is the parent node. This parent node is split up into four leaf nodes, R_1, R_2, R_3, and R_4. Of these leaf node, only R_4 does not contain pixels which satisfy some common property and hence it split again i.e., R_{41}, R_{42}, R_{43}, and R_{44}. The quad tree for this division as shown in figure

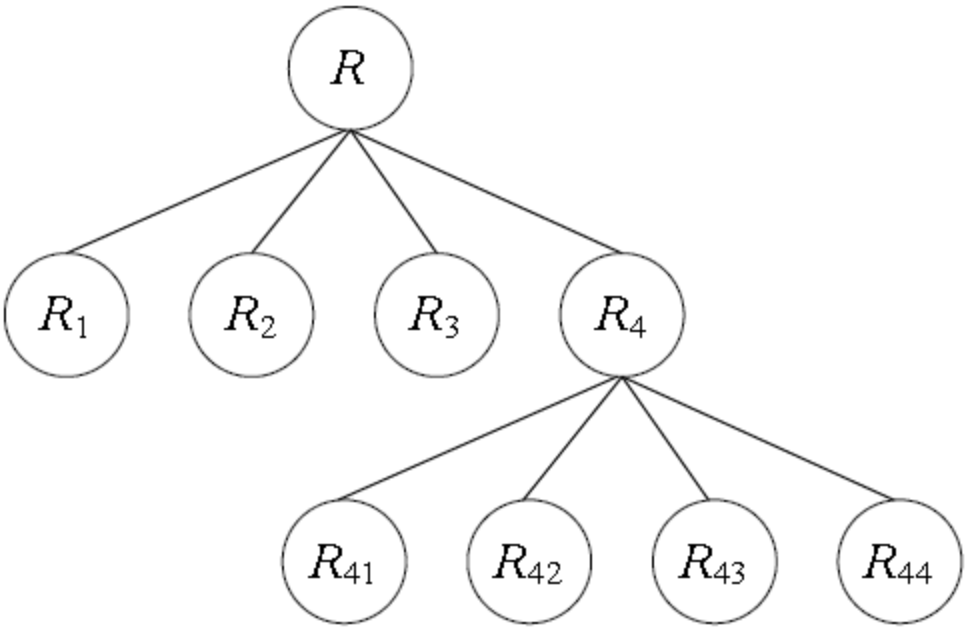

Figure 1.4 Quad tree

This method is applicable to images whose number of rows and number of columns are some integer power of 2 .

1.2.2 Region merging

The region merging method is exactly opposite to the region splitting method. Like the region splitting method, region merging is also applicable only to images whose number of rows and columns are a power of 2.In this method, we start form the pixel level and consider each of them as a homogenous region. At any level of merging we check if the four and adjacent homogenous regions arranged in a 2×2 fashion together satisfy the homogeneity property. If yes, they are merged to form a bigger region, otherwise the regions are left as they are.Let us take the same 8×8 image as an example and perform region merging, we use the predicate
We merge this image 2×2 regions.

5	6	6	6	7	7	6	6
6	7	6	7	5	5	4	7
6	6	4	4	3	2	5	6
6	4	5	4	2	3	4	6
0	3	2	3	3	2	4	7
0	0	0	0	2	2	5	6
1	1	0	1	0	3	4	4
1	0	1	0	2	3	5	4

Figure 1.5 Image after first step of merging

5	6	6	6	7	7	6	6
6	7	6	7	5	5	4	7
6	6	4	4	3	2	5	6
6	4	5	4	2	3	4	6
0	3	2	3	3	2	4	7
0	0	0	0	2	2	5	6
1	1	0	1	0	3	4	4
1	0	1	0	2	3	5	4

Figure 1.6 Image after merging

We check the four adjacent homogenous regions; image obtained after the second step of merging is shown in figure.Split and merge We have just explained region splitting and region merging. Region splitting starts with the whole image as one big region and splits this region into four quadrants. We continue splitting until all the sub-region satisfies the predefined homogeneity property (predicate)[9]. In region merging each pixel is taken as a small region. We merge small regions into larger regions if they satisfy the homogeneity property.So, when do we use region splitting and region merging?If homogenous regions are small, the region merging technique is superior to the region growing technique. If most of the regions in an image are homogeneous, the region splitting technique is preferred to the region merging method.In most applications, a combination of split and merge technique are used. Together they are called the split and merge techniqueIn the split and merge technique we start with a rectangular regions of size $a \times b$ pixels. We check the homogeneity property for each region. If the homogeneity property fails, we split up the region into four quadrants each of size $a/2 \times b/2$. If the region satisfies the homogeneity property, we merge it with the adjacent region forming a $2a \times 2b$ size region

III. Conclusion

In this paper basically ,we have talk about two types of algorithms i.e. Thresholding and region growing. In Thresholding type complexity is high and processing rate is fast in most types while in region growing complexity is low. The best Thresholding type is Otsu. Depending upon the application, we may use combination of this algorithms.

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