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Boundary & Geometric Region Features Image Segmentation for Quadtree Partitioning Scheme

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Abstract— in this paper, an efficient image segmentation scheme is proposed of boundary based & geometric region features as an alternative way of utilizing statistical base only. The test results vary according to partitioning control parameters values and image details or characteristics, with preserving the segmented image edges.

Keywords— Image segmentation, boundary & region segmentation and quadtree partitioning scheme.

I. INTRODUCTION

Segmentation or more preciously image segmentation plays an integral role in computer vision, basically based on separating or splitting into regions. Today, the segmentation process lie at the heart of various techniques, such as traffic control system, medical imaging, face detection, image & video compression. The segmentation techniques generally fall into two categories: boundary based and region based depending on the way image intensity values exploited, where first type based on discontinuity or dissimilarity in gray level simply by utilizing the convolution along masks helping to identify the edges presents in an image, while second type based on continuity or similarity in gray level allowing the extraction of similar regions or desired objects by using one of three available methods, thresholding, split and merge, and region growing. The selection between segmentation types limited by the problem nature, reviews of various segmentation techniques can be found in [1-10].

In general, region techniques of grouping or segment based is a very important problem in visual perception [11]. Typically, thresholding the most popular techniques, works efficiently in case of dominating two color modes where only two gray level available, the separation of foreground from background is easy and quickly. Alternatively way in case multiple dominating color modes where variety of image details or characteristics presents, the other two techniques utilized efficiently, region growing is a bottom up method based on selecting the initial seed values, in which the pixels add to regions if it's satisfy the homogeneity criteria, the techniques characterized by the inherently problem of choosing the initial seed value and the way of expanding the region, and is computationally expensive. The variable region size of split and merge techniques which is a top down method represents the ideal solution, based on divide and conquer. Currently various forms of portioning schemes are utilized such as quadtree, horizontal-vertical, triangular, and hexagonal. The quadtree represents the popular, simple and adopted in a large number of researches [12-17], basically the technique starts with the whole image and repeatedly test each region, if do not satisfy the homogeneity measure then each region is partitioned into four quadrants, the process continues iteratively until homogeneity is satisfied.

In this paper, a split and merge techniques of quadtree based is introduced to efficiently partition the image region by exploiting the boundary based techniques and the geometrical region features. Section 2 is devoted to describe the suggested partitioning scheme in details; the results, is given in section3.

II. GEOMETRIC FEATURE BASED QUADTREE PARTITIONING SCHEME

The quadtree partitioning scheme of variable square block sizes of hierarchical representation, characterized by simplicity and overcoming edge degradation problem by preserving edge details as much as possible.

The main drawback of quadtree partitioning method is the difficulty of selecting the homogeneity criteria, the widely most common measures of statistical base are adopted (i.e., mean, variance and standard deviation), making it quite affected by homogeneity distribution. To overcome this complexity, the proposed scheme try to incorporate the geometric features along with segmentation of boundary based. The quadtree partitioning scheme involves the following steps:

1. Start with the input image I of square size N×N that represented as a one region or one segment as a whole (see Figure 1a).
2. Perform the homogeneity criteria of quadtree partitioning scheme based on utilizing the edge detection and geometrical features (i.e., size, position and orientation), the steps are applied:

   a) Determine the partitioning control parameters, as follows:
      1. Maximum Region Size corresponds to minimum tree depth.
      2. Minimum Region Size corresponds to maximum tree depth.

3. Number of Edge Pixels in each region corresponds to number of pixels whose gray level represented by one's (i.e., non-zero's values) after applying an edge detector.
4. Geometric Feature Threshold Value of Orientation based corresponds to moment of inertia in both coordinates of tested region.

b) Partition the image I into non-overlapping regions of size equals to maximum region size (see Figure 1b).

c) Apply the homogeneity test to the fixed sized regions resultant from the above step that implies of:
1. Find the edge detection to the tested region using sobel operator due to simplicity, popularity and efficiency. This leads to create a binary region of zeros and ones for nonedge and edge regions respectively (see Figure 1c).
2. Compute the geometrical region features based on size, position and orientation, as follows:

$$Size = \sum_{x=0}^{MaximumRegionSize-1} \sum_{y=0}^{MaximumRegionSize-1} R(x,y) \qquad (1)$$

$$x_c = \frac{\sum_{x=0}^{MaximumRegionSize-1} \sum_{y=0}^{MaximumRegionSize-1} y \cdot R(x,y)}{Size} \qquad Size \neq 0 \qquad (2)$$

$$y_c = \frac{\sum_{x=0}^{MaximumRegionSize-1} \sum_{y=0}^{MaximumRegionSize-1} X \cdot R(x,y)}{Size} \qquad Size \neq 0 \qquad (3)$$

$$m_{Ix} = \sqrt{\frac{\sum_{x=0}^{MaximumRegionSize-1} \sum_{y=0}^{MaximumRegionSize-1} (y-\bar{x})^2 \cdot R(x,y)}{Size}} \qquad Size \neq 0 \qquad (4)$$

$$m_{Iy} = \sqrt{\frac{\sum_{x=0}^{MaximumRegionSize-1} \sum_{y=0}^{MaximumRegionSize-1} (x-\bar{y})^2 \cdot R(x,y)}{Size}} \qquad Size \neq 0 \qquad (5)$$

Where Size of the region that corresponds to the summation of region of binary values (i.e., number of ones or edge pixels in tested region), for non-zero size values or for edge region, the center of mass (i.e., position) represented by x_c and y_c, and moment of inertia (i.e., orientation) represented by m_{Ix} and m_{Iy}.

3. Test the region homogeneity using the orientation threshold values, namely if (mIx > threshold in x direction) & (mIy > threshold in y direction) then the partition is required, in other words for non-homogenous region the partitioning repeated on its four quadrants, until the homogeneity condition satisfied or reaching the minimum region size (see Figure 1d-f).

III. EXPERIMENTAL RESULTS

For testing the suggested quadtree partitioning scheme of geometric based; different partitioning control parameters adopted on three selected standard images (see Figure 2), all the images are square gray (i.e.,8bits/pixel) of size 256×256. The experimental results are listed in Table 1 for the three tested images. The number of segmented regions, which is the number of non-overlapping variable square sized regions, adopted as an indicator to various segmentation results that vary according to the images characteristics or details.

The number of regions affected by two factors; first the size in terms of maximum and minimum region size that determine the size of the regions where small values leads to large number of small detail regions, and vice versa. The second factor is the quality of the segmented regions that implicitly depends on two parameters, the first parameter is the number of edge pixel threshold value that simply classify the regions into edge and non-edge region whereas small selected value means large number of edge regions needs to be segmented repeatedly (i.e., each time partitioned into four quadrants) with edge preserving, while large selected value means less number of regions required partitioning; that effectively decrease number of regions with edge degradation. The second parameter is the moment of inertia threshold value or also referred orientation threshold value where two values required for x & y coordinates respectively, whereas small values increase the number of regions where segmentation required and vice versa.

The proposed technique is characterized by simplicity, fast implementation and high efficiency due to preserving edge details with accurate segmentation. The segmented scheme tested images with different partitioning control parameters are shown in Figure 3.

ACKNOWLEDGMENT

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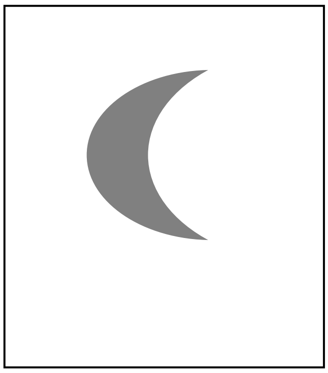
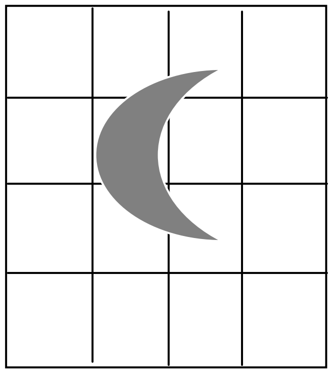
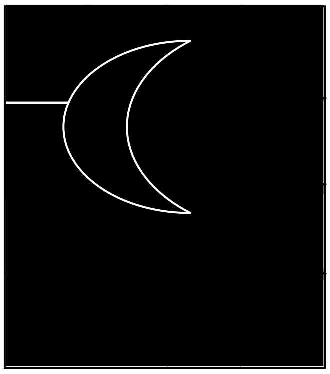


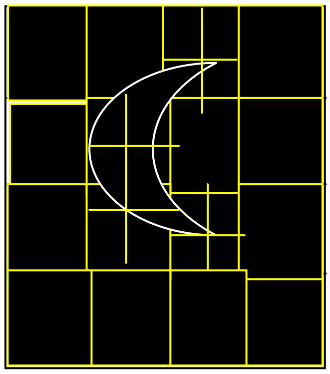
(a) Input image considered as one region as a whole



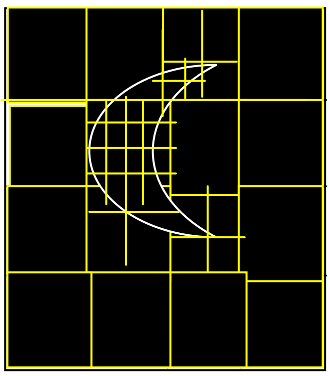
(b) Partition image into fixed sized region regardless of its homogeneity depending on Maximum Region Size



(c) Apply edge detector using Sobel operator for each region, makes easy separation into edge and nonedge region



(d) For each nonedge region, homogeneity test applied where the geometrical feature computed and if do not satisfy the measure the quadtree partitioning scheme performed

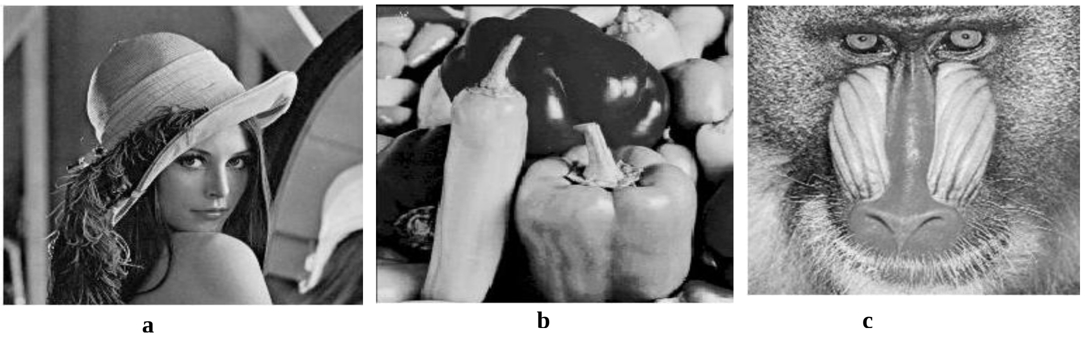


(e) Quadtree partitioning scheme repeated on its four quadrants, until the homogeneity condition satisfied or reaching the minimum region size

Fig 1. Quadtree partitioning scheme process

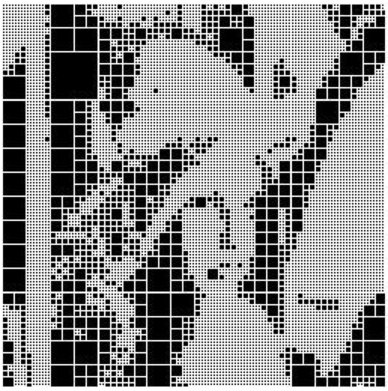
Partitioning Control Parameters				Lena Image	Pepper Image	Baboon Image
Max. Size	Min. Size	No. Edge Pixels	Orientation Threshold Value	No. Regions	No. Regions	No. Regions
8	2	2	0.2	14551	13315	16333
8	4	2	0.4	3940	3679	4006
16	2	4	0.2	13240	11410	16141
16	4	4	0.5	3670	3214	4190
16	8	8	0.2	931	907	1022
32	2	2	0.1	14548	13267	16688
32	4	2	0.7	3880	3574	4240
32	8	16	0.3	847	883	1018
32	16	16	0.1	247	218	256
16	2	2	0.5	7966	12952	16297
16	2	4	0.2	13240	11222	16141
16	2	8	0.4	10105	10246	15229
32	2	2	0.4	14497	13146	16320
32	2	4	0.4	13159	11362	16129
32	2	8	0.4	10006	10243	15140
32	2	16	0.4	7906	9970	13645
32	2	32	0.4	3385	8035	7270
32	2	8	0.2	10198	10297	15259
32	2	8	0.3	10109	10018	15016
32	2	8	0.4	9805	9943	14929
32	2	8	0.5	9304	9871	14674
32	2	8	0.6	9245	9853	14540
32	2	8	0.7	9004	9721	14491
32	2	8	0.8	8683	9430	14092
32	2	8	0.9	8359	9175	13813
32	2	8	1	7936	8863	12913
32	2	8	1.1	7195	8320	10840
32	2	8	1.2	2740	2683	4018

Table 1: **Number of quadtree segmented regions of tested images using different partitioning control parameters.**

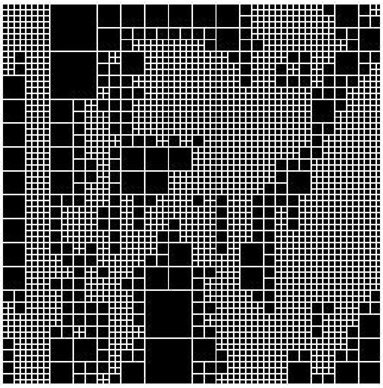


a **b** **c**

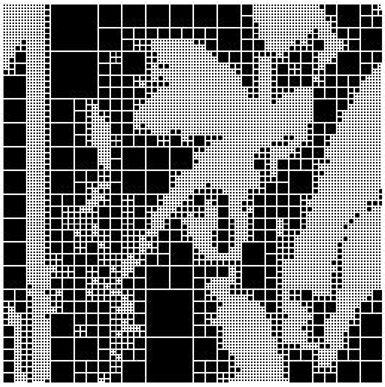
Fig 2. Tested images (a) Lena image, (b) Paper image , and (c) Babbon image



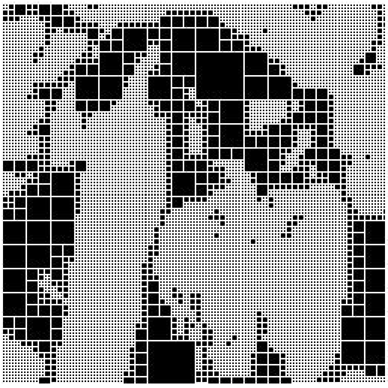
Max. Size=32, Min. Size=2
No. Edge Pixel=8
Orientation Threshold= 0.5
No. Segmentation=9304



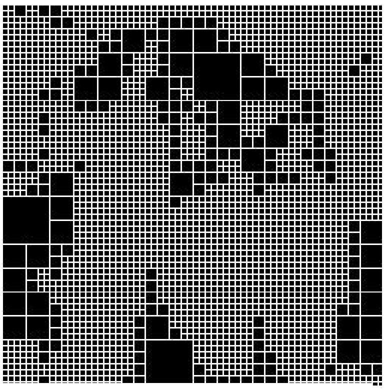
Max. Size=32, Min. Size=4
No. Edge Pixel=16
Orientation Threshold= 0.5
No. Segmentation=2482



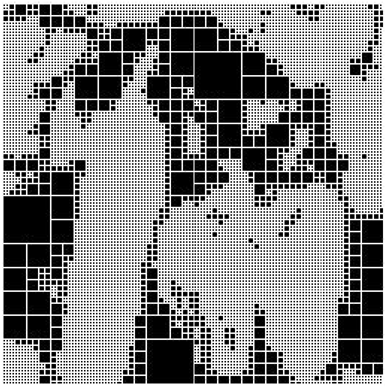
Max. Size=32, Min. Size=2
No. Edge Pixel=16
Orientation Threshold= 0.7
No. Segmentation=6955



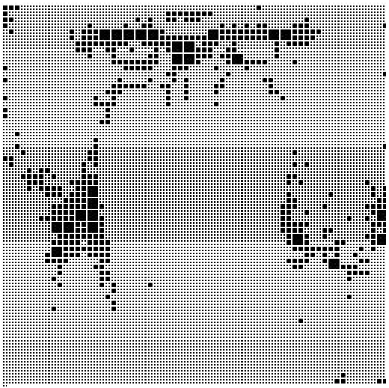
Max. Size=32, Min. Size=2
No. Edge Pixel=8
Orientation Threshold= 0.5
No. Segmentation=9871



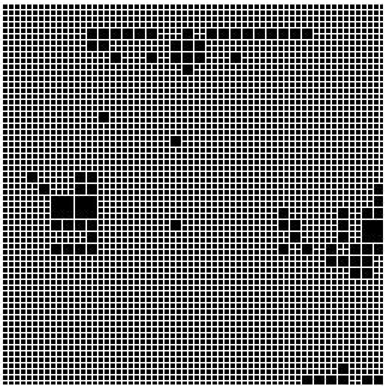
Max. Size=32, Min. Size=4
No. Edge Pixel=16
Orientation Threshold= 0.5
No. Segmentation=2923



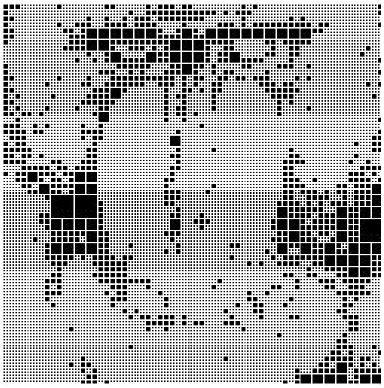
Max. Size=32, Min. Size=2
No. Edge Pixel=16
Orientation Threshold= 0.7
No. Segmentation=9463



Max. Size=32, Min. Size=2
No. Edge Pixel=8
Orientation Threshold= 0.5
No. Segmentation=14674



Max. Size=32, Min. Size=4
No. Edge Pixel=16
Orientation Threshold= 0.5
No. Segmentation=3823



Max. Size=32, Min. Size=2
No. Edge Pixel=16
Orientation Threshold= 0.7
No. Segmentation=12415

Fig 3: Examples of segmented tested images with different partitioning control parameter values.

REFERENCES

[1] Fu, K. S. and Mui, J. K. 1981. A Survey on Image Segmentation. Pattern Recognition, 13,3-16.
[2] Robert, M. H. and Linda, G. S. 1985. Image Segmentation Techniques. Computer Vision, Graphics, and Image Processing, 29,100-132.
[3] Zhanga, Y.J. 1996. A Survey on Evaluation Methods for Image Segmentation. Pattern Recognition, 29(8), 1335–1346.
[4] Umbaugh, S. E. 1998. Computer Vision and Image Processing: Practical Approach Using CVIP tools. Prentice Hall

[5] Seemann, T. 2002. Digital Image Processing using Local Segmentation. Ph.D. thesis, Monash University, Australia.
[6] Gonzalez, R. C. and Woods, R. E. 2003. Digital Image Processing 2nd edn. Prentice Hall.
[7] Rajeshwar, D. and Priyanka, S. 2010. Image Segmentation Techniques. International Journal on Electronics & Communication Technology (IJECT), 3(1),66-70.
[8] Narkhede, H.P. 2013. Review of Image Segmentation Techniques. International Journal of Science and Modern Engineering (IJISME), 1(8), 54-61.
[9] Selvanayaki, K. S. and Somasundaram ,R. M. 2013.: A Survey on Image Segmentation Techniques for Edge Detection. IJCA Proceedings on International Conference on Innovation in Communication, Information and Computing 2013 ICICIC 2013(2):31-34.
[10] Gurjeet, K. S., Sri, G. G. and Sahib, R. K. 2013. Review on Recent Image Segmentation Techniques. International Journal on Computer Science and Engineering (IJCSE), 5(2),109-112.
[11] Thomas, L. and Jitendra, M. 1998. Contour Continuity in Region based Image Segmentation. Computer Vision, I, 544-559.
[12] Vaisey, D. and Gersho, A. 1987. Variable Block-Size Image Coding. Proceedings of the IEEE international conference on Acoustics, Speech, and Signal Processing, 1051 – 1054.
[13] Seferidis, V. and Ghanbari, M. 1994. Generalised Block-Matching Motion Estimation using Quad-tree Structured Spatial Decomposition. Proc. IEE-I./ IEE Proceedings - Communications, 141(6), 446-452.
[14] Lee, J. 1995. Optimal Quadtree for Variable Block Size Motion Estimation," in Proc. ICIP/ The International Conference on Image Processing (ICIP), sponsored by the IEEE Signal Processing Society, 3, 480-483.
[15] Ying, W., Yiwen, J. and Qunsheng, P. 1998. Merged quadtree fractal image compression. Optical Engineering 37(8), 2284-2289
[16] Golchin, F. and Paliwal, K.K. 2003. Quadtree-based classification in subband image coding. Digital Signal Processing, 13, 656–668.
[17] Keissarian1, F. 2009. A New Quadtree-based Image Compression Technique using Pattern Matching Algorithm. International Conference on Computational & Experimental Engineering and Sciences (ICCES), 12(4), 137-143.

