Modelling Based For Segmentation of Quadtree Partitioning Scheme

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Abstract— In this paper a simple quadtree partitioning scheme is proposed, it is based on utilizing the modelling concept effectively. The test results clearly showed an efficient segmentation techniques in terms of preserving the edges and retaining the correlation embedded between image regions.

Keywords— segmentation, edge based, region based, hybrid segmentation, quadtree, modelling.

I. INTRODUCTION

Segmentation basically concerned with extracting useful image information or details based on splitting or partitioning according to homogeneity criteria.

In general, various image segmentation techniques available, the utilization of one over the other determined by the problem nature, but in all cases the spatial domain exploited either of dissimilarity or similarity criteria, using edge based or region based respectively, and a combination between these two ways, normally called hybrid segmentation [1-3]. Reviews of segmentation techniques can be found in [4-10].

The segmentation region based scheme of partitioning of different shaped and sized regions represents best solution to splitting into regions with techniques such as quadtree, horizontal-vertical, triangular and hexagonal, that overcomes the limitations of region growing seeding values and thresholding techniques of multiple image modes problems. Today, the partitioning scheme of variable segmented regions proven its efficiency but still quite affected by the measures of homogeneity criteria and the size and shape of regions [11-12]

Spatial modelling of mathematical base of deterministic part and stochastic part mostly utilized in image coding [13-18], that primarily required model selection, model fitting, and model validation [19-20].

In this paper the modelling concept can be adopted for finding an efficient segmentation technique of region based of quadtree scheme. The rest of the paper organized as follows, section 2 discusses the suggested technique in more details; the result is given in section 3.

II. THE SUGGESTED QUADTREE PARTITIONING SCHEME

This paper is concerned with a typical quadtree partitioning scheme of variable sized square regions of hierarchical representation using the modelling formula, namely the functional component plus random component. Figure (1) shows the segmentation techniques clearly, in which involve the following steps:

1- Start with the gray scale image I corresponds to one segmented square region of size $N \times N$

2- Partition I hierarchically into non-overlapping variable sized square regions ($n \times n$; where $n << N$), according to homogeneity test adopted based on modelling concept, as follows:

a) Use a mathematical function of neighbourhood averaging based to construct the modelled image Ip which looks approximately similar to the original image I.

$$I_p(i, j) = I(i, j-1) + I(i-1, j-1) + I(i-1, j) + I(i-1, j+1)\ldots\ldots\ldots(1)$$

Ip which is the four averaging of neighbouring pixels representation of deterministic part.

b) Find the random error Rs that normally follows a particular probability distribution as a difference between the original image I and the modelled Ip as in equation 2.

$$R_s(i, j) = I(i, j) - I_p(i, j)\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

The error corresponds to the stochastic or probability part.

Here the error (difference) used as a homogeneity measure the of the regions; in other words the difference used as indicator to the partitioning depending on the content; means homogenous or smooth difference region (i.e., un-detailed regions) implicitly refers to higher correlation of the input image region (i.e., each pixel value nearby to others) and no need to partitioning process. Inversely, non-homogenous or un-smooth error region (i.e., detailed regions) implicitly refers to less correlation of the input image region (i.e., edge presents) and partitioning required once or more, such as:

1) Select the partitioning control parameters that determine the regions sizes which limited between maximum and minimum region size, correspond to minimum and maximum tree depth respectively

2) Apply fixed region partitioning scheme using the maximum region sized regardless of its homogeneity contents; simply partition difference image (stochastic part) Rs into fixed sized regions depending on the maximum region sized input selected parameters above.

3) Test each segmented difference fixed region by utilizing the sobel gradient operators (Gx and Gy) of maximum value, for non-homogeneous region the process repeated recursively until homogeneity satisfied or reaching the minimum region sized.
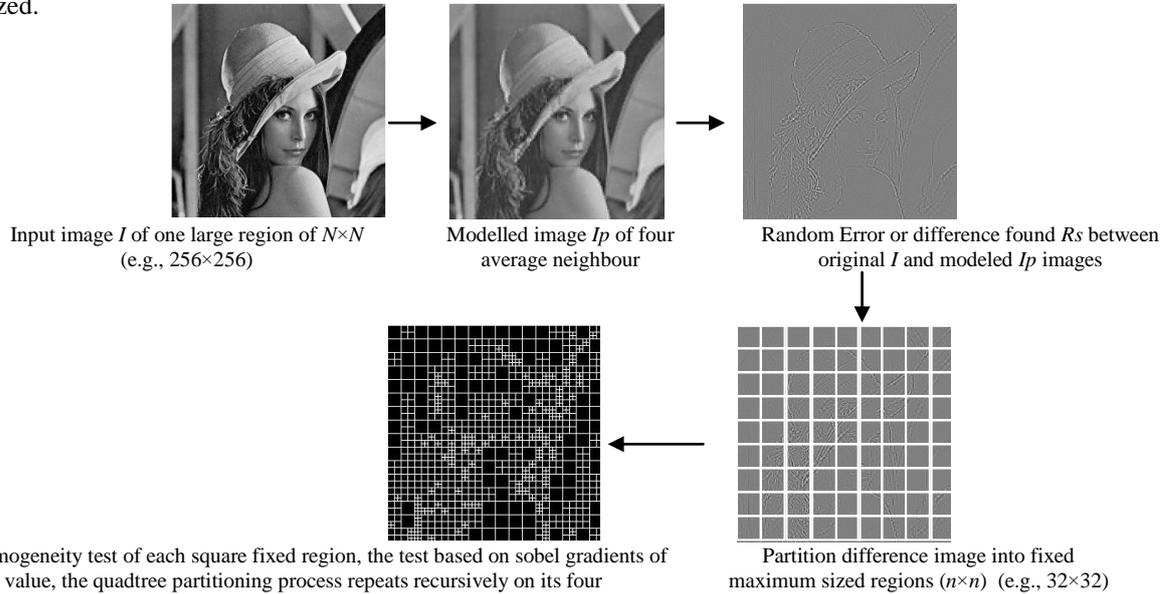

Input image I of one large region of $N \times N$ (e.g., 256×256)	Modelled image Ip of four average neighbour	Random Error or difference found Rs between original I and modeled Ip images

Apply homogeneity test of each square fixed region, the test based on sobel gradients of maximum value, the quadtree partitioning process repeats recursively on its four quadrants until homogeneity satisfied or reaching to the selected minimum region sized.

Partition difference image into fixed maximum sized regions ($n \times n$) (e.g., 32×32)

Fig. 1 The proposed partitioning scheme of quadtree based using the modeling concept.

III.   EXPERIMENTAL RESULTS

The proposed system basically utilized efficiently the error caused by modelling based, since all the rest un-modelled information certainly exists there which used as an indicator to measure the region homogeneity. The test used different maximum & minimum region sizes on the three tested gray square images as shown in Figure (2).

The results illustrated in Table (1) of number of quadtree segmented regions of the tested images, Figure (3) shows examples of the segmented images with various maximum and minimum sized regions.

The segmentation techniques of modelling based exploited the structure of the neighbourhoods in mathematical efficient way. Here the simple averaging of four neighbours used to keep the correlation between adjacent pixels, in other words, the mathematical formula adopted actually to distinguish between image regions contents, where for smooth regions the correlation preserved on the modelled image that leads to free detailed difference image that implicitly means no partitioning required. On the other hand for non-smooth regions the discontinuity unpreserved on the modelled image that leads to presents detailed difference image that implicitly means partitioning required recursively the smoothing preserved as much as possible.

Cleary the number of segmented regions affected by the nature of the image used, the maximum and minimum region sized and lastly the mathematical model adopted.

Fig. 2 Tested images (a) Lena image, (b) Camera-man image and (c) Rose image, all images of size 256×256, gray scale images.

TABLE 1: QUADTREE PARTITIONING ON THE THREE TESTED IMAGES

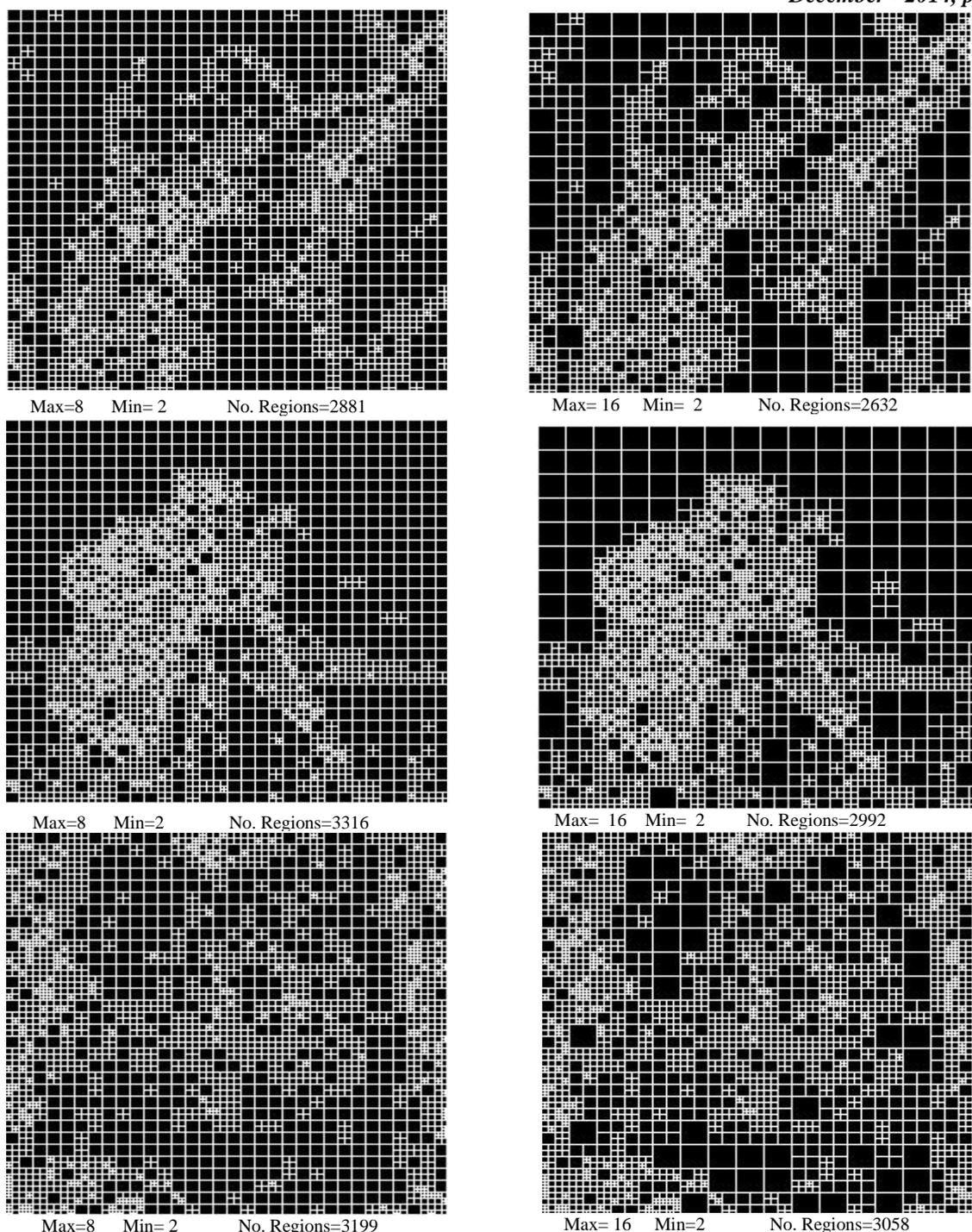| MAXIMUM REGION SIZE	MINIMUM REGION SIZE	TESTED IMAGES		
		NO. REGIONS OF LENA IMAGE	NO. REGIONS OF CAMERAMAN IMAGE	NO. REGIONS OF ROSE IMAGE
8	2	2881	3316	3199
8	4	2263	2218	2488
16	2	2632	2992	3058
16	4	2014	1900	2350
16	8	793	712	904
32	2	2623	2941	3120
32	4	2004	1849	2264
32	8	784	661	844

Fig. 3 Example of tested segmented images

IV. CONCLUSIONS

This paper presented an efficient simple segmentation technique of quadtree based. Experimental results show that the proposed method effectively preserve the edge and retaining the correlation embedded between image regions.

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