Edge Detection and Image Analysis using Quadtree Decomposition

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Abstract

Edge detection is important task in image processing. It covers wide range of applications from segmentation to pattern matching. It reduces the complexity of image allowing more costly algorithms like object recognition, object matching, object registration or surface recognition from stero-images to be used. The Edge detection is the most common approach for detecting meaningful discontinuities in the grey level. Edges may be viewpoint dependent - these are edges that may change as the viewpoint changes, and typically reflect the geometry of the scene, objects occluding one another and so on, these generally reflect properties of the viewed objects such as markings and surface shape. In two dimensions, and higher, the concept of a projection has to be considered. In this paper we have illustrated the experimental results for edge detection by region splitting and merging using Quad tree decomposition. The result is useful for Image Data Compression, Image Analysis and Recognition.
Keyword: Image Analysis, Segmentation, Edge detection, Region splitting and merging, Quadtree, Predicates

1. Introduction

The basic image processing methods steams from two principal application areas; such as improvement of pictorial information for human interpretation and processing of an image data for storage, transmission and representation for autonomous machine perception. Although the large scale image processing system are used for massive applications such as, processing of satellite images, remote sensing applications, seismic data processing, hence such type of images perceives very dense information, so lots of efforts are to be taken for manipulation of these images. Image interpretation is an integral part of an image processing application; therefore, image segmentation is used for the analysis of an image. In-general image segmentation algorithms are based on two basic concepts of similarity and discontinuity with respective to intensity values in the image. Edges and critical points are basic information for the segmentation. Edge and region are two complementary features of segmented surface. Therefore, the integrated methods combining both methods are frequently employed for solving range image segmentation problems [1]. The edge-based methods are used for detecting discontinuities of surface in range images. The principal approach based on the criteria of similarity is to build the region that satisfies the predefined fidelity criteria defined using the predicates and the principal approach behind discontinuity is to partition the image based on the abrupt changes in the intensity values of the image. The region based segmentation methods are used for detecting continuous surfaces that have similar geometrical properties [1]. As well

as [2] Homogeneity plays an important role in image segmentation since the result of image segmentation would be several homogeneous regions. Most of the region growing algorithms typically start with seed pixels, then iteratively add to regions unassigned neighbouring pixels, with satisfy one or several homogeneity criteria. Three criteria of homogeneity

1) Local homogeneity criteria (LHC): -- which enable to analyze the colour different between two adjacent pixels
2) Average homogeneity criteria (AHC1) which enable to analyze the colour diff Beth a pixel & the set of pixels, belonging to definite regions which are adjacent to this pixels

Average homogeneity criteria (AHC2): -- Which enable to analyze colour diff ban a pixel & mean value representative of a definite region [3].

The edge detection is an important issue for complete understanding of image; hence building the regions is the simplest form of image analysis and image segmentation, where regions are considered as segment of image. Quad Tree is an image segmentation method basically used for region growing and merging and based on similarity criteria were it prepares the segment by applying the predicate on image. Edge detection is important task in image processing. It covers wide range of applications from segmentation to pattern matching. It reduces the complexity of image allowing more costly algorithms like object recognition, object matching, object registration or surface recognition from stero-images to be used. [4]. The Edge detection is the most common approach for detecting meaningful discontinuities in the gray level. Edges may be viewpoint dependent - these are edges that may change as the viewpoint changes, and typically reflect the geometry of the scene, objects occluding one another and so on, or may be viewpoint independent - these generally reflect properties of the viewed objects such as markings and surface shape. In two dimensions, and higher, the concept of a projection has to be considered.

2. Methodology

A typical edge might be (for instance) the border between a block of red color and a block of yellow; in contrast a line can be a small number of pixels of a different color on an otherwise unchanging background. There will be one edge on each side of the ine. Edges play quite an important role in all applications of image processing.

Region Based Segmentation methods has objective to partition an image into regions. The basic formulations for regions are

(a) $\bigcup_{i=1}^{n} Ri = R$

(b) Ri is a connected Region, i = 1,2, …… n

(c) $Ri \cap Rj = \phi$ for all i and j , $i \neq j$

(d) P(Ri) = TRUE for i =1,2,….. n

(e) $P(Ri \cup Rj)$ = FALSE for $i \neq j$

Equation (1) [5] [6]

Here, P(Ri) is the logical predicate defined over the points in the set Ri and Ø is the null set, the condition (a) indicates that the segmentation must be complete that is every pixel must be in region, (b) indicates that point in the region must be connected in some predefined sense, (c) indicates that the regions must be disjoints, (d) indicates that, this deals with the properties that must be satisfied by the pixel in a segmented region that is P(Ri)=TRUE if all pixel in Rj have the same gray level and (e) indicates that the region Ri and Rj are different in the sense of predicate P.[7]

Region growing and merging: As its name indicates, region growing is procedure that groups pixel or sub regions into larger regions based on predefined criteria. The basic approach is to start with the set of "seed" points and from these grow regions by appending to each seed those neighbouring pixels that have properties similar to the seed.[8] The selection of similarity criteria depends not only on the problem under considerations but also on the type of image that available. The use of connectivity was the fundamental in solving the above problem. [7]

Region splitting and merging using quadtree: This is an alternative method to subdivide an image initially into set of arbitrary, disjointed regions and then merge and/or split the regions in an attempt to method basically used for region splitting and merging; based on the criteria of similarity were it prepares the segment by applying the predicate satisfy the conditions for region formation as per eq (1). By splitting and merging algorithm that iteratively works towards satisfying these constrains of similarity [9] [10].

Let X represents the entire image region and selects the predicate P. One approach for segmenting X is to subdivide it successively into smaller and smaller quadrant regions so that for any region Xi, P (Xi) = TRUE. Hence start with the entire region. IF P(X) = FALSE, divide the image into quadrants. If p is FALSE for any quadrant, subdivide that quadrant into sub quadrants, and so on. This particular splitting techniques has a convenient representation in the form of a so called quad tree [4][11]

3. Results and Discussion

Quadtree decomposition is used for edge detection with respect to the region growing and merging. While applying a quadtree the input image must be in gray scale and the size of image must be in power of 2, this will certainly helps in decomposition of an image into 2n regions. The regions were merged as per eq (1).

As the images acquired from the problem domain are need not to be in grayscale or need not be the square so modification must be required in the quadtree so as it has to be applied on the input image and must prepare the regions for the same. Quadtree is modified by incorporating preprocessing on input image by converting source image into grayscale and size of source image is resized (if necessary) in the power of 2. Therefore the improved algorithm of quadtree is as follows

Algorithm

Quadtree (Threshold T, NoRegions N)

1. For all N Regions, Split each Ni into four disjoints quadrants Ni (Xj), for which T (Ni (Xj)) =FALSE
2. Merge any adjacent Regions Ni (Xj) and Ni (Xk) for T (Ni (Xj) U Ni (Xk)) = TRUE
3. Stop when no further merging or splitting of region N is possible.

With the help of this algorithm we can easily specify the total number of regions to be prepared with corresponding threshold. As the threshold is increased progressively the edges generated using quadtree are minimum due to the merging of regions.

4. Conclusion

The edge detection is an important issue for complete understanding of image; hence building the regions is the simplest from of image analysis and image segmentation. Quadtree is an image segmentation

(Threshold) on image. As the predicate is increased progressively, the blocks containing the edges by Quadtree are less with respect to the blocks contains the edges at low threshold. This is due to the merging of regions by *Quadtree*. In this paper proposed technique is applied on different data sets of images by varying threshold values, and we have counted the number of regions prepared with respect to input and output image is as shown in table and graph.

References

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Results

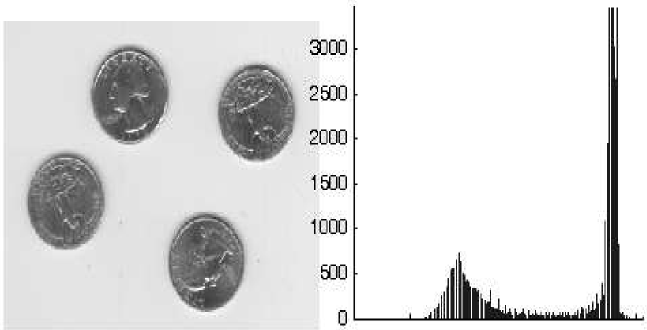


Figure (3.a) eight.tif with its histogram

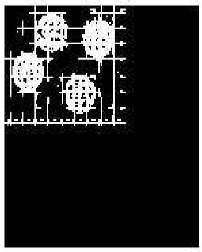
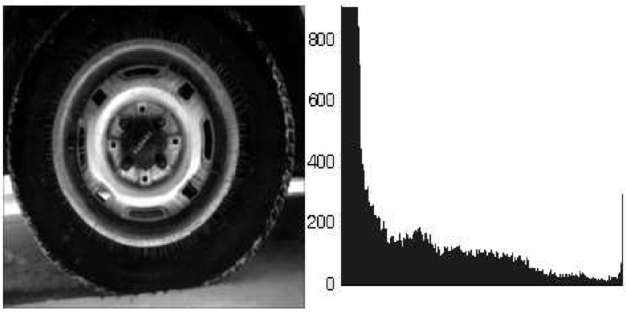


Figure (3.b) Quadtree at 24 Regions with 0.05 Threshold



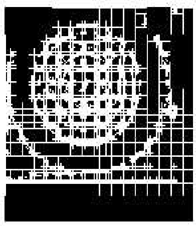
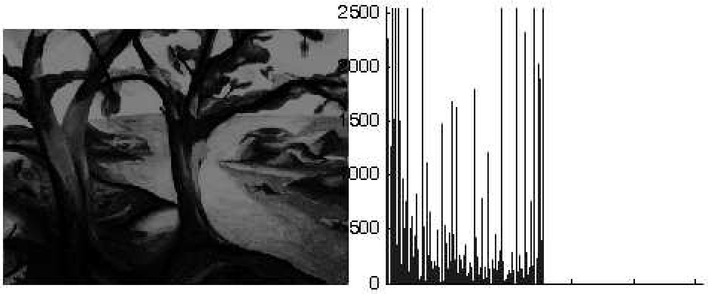


Figure (3.c) tire.tif with its histogram

Figure (3.d) Quadtree at 2^4 Regions with 0.20 Threshold



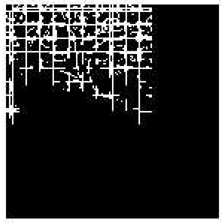
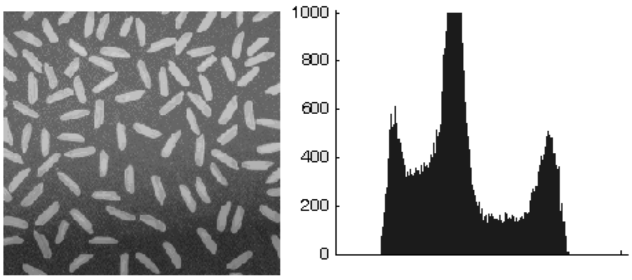


Figure (3.e) Tree.tif with its histogram

Figure (3.e) Quadtree at 2^4Regions with 0.25 Threshold



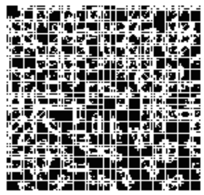
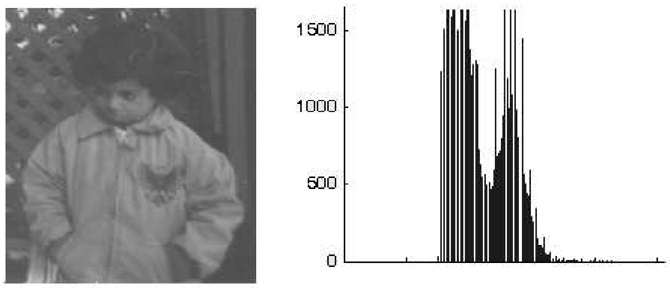


Figure (3.f) rice.png with its histogram

Figure (3.f) Quadtree at 2^4Regions with 0.05 Threshold



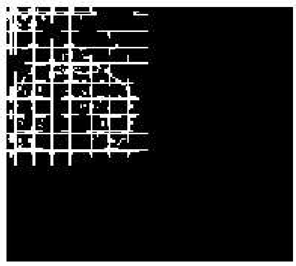


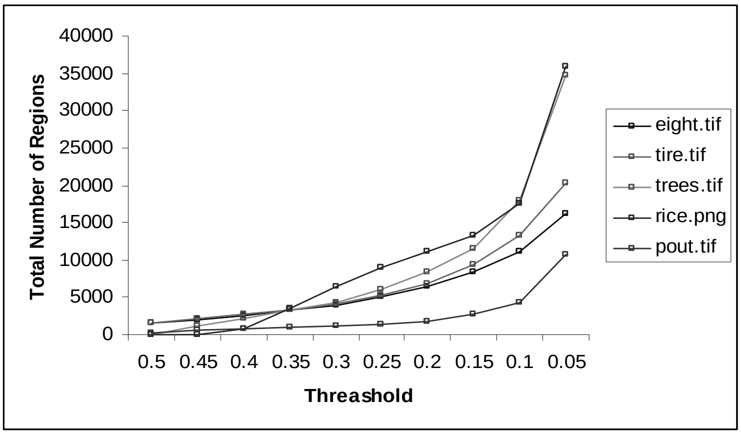
Figure (3.g) pout.tif with its histogram

Figure (3.g) Quadtree at 2^4Regions with 0.20 Threshold

Table 1: Threshold vs. Number of Blocks containing Edges

Threshold	Total Number of Regions				
	eight.tif	tire.tif	trees.tif	rice.png	pout.tif
0.5	1509	1542	0	0	260
0.45	2041	2119	1158	67	535
0.4	2552	2697	2230	856	707

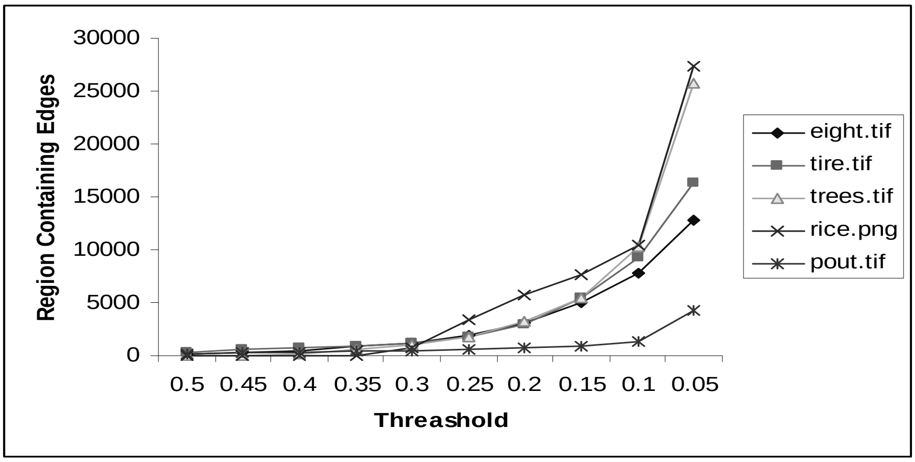
0.35	3266	3364	3405	3506	993
0.3	3971	4046	4330	6389	1093
0.25	4994	5251	5977	9068	1345
0.2	6371	6808	8442	11213	1795
0.15	8323	9360	11582	13178	2646
0.1	11063	13193	17897	17501	4288
0.05	16117	20237	34729	35975	10668



Graph 1: Graph represents Threshold vs. Total Number of Regions

Table 2: Threshold vs. Number of Blocks containing Edges

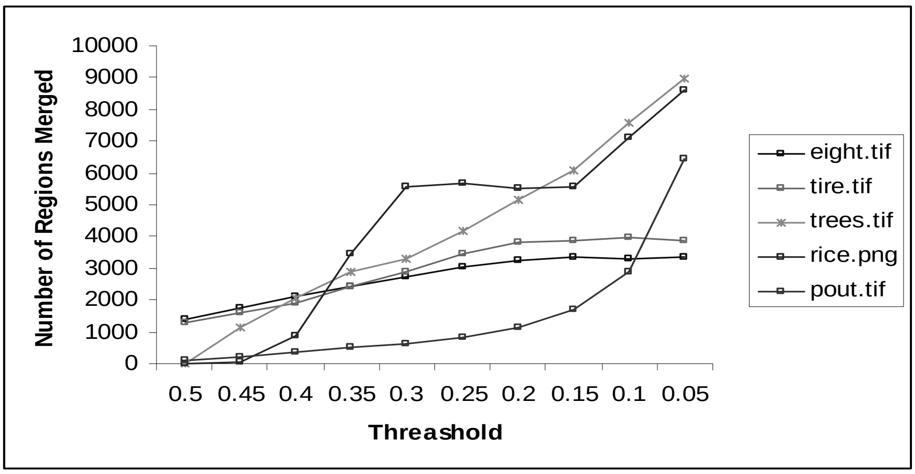
Threshold	Total Number of Region containing edges				
	eight.tif	tire.tif	trees.tif	rice.png	pout.tif
0.5	100	232	0	0	144
0.45	268	536	16	0	304
0.4	428	772	184	0	356
0.35	828	932	532	32	480
0.3	1232	1164	1012	800	484
0.25	1964	1788	1804	3388	544
0.2	3120	2980	3308	5688	680
0.15	4980	5492	5500	7612	920
0.1	7776	9248	10332	10412	1392
0.05	12784	16364	25784	27376	4228



Graph 2: Graph represents Threshold vs. Total Number of Regions containg the Edges

Table 3: Threshold vs. Number of Blocks Merged

Threshold	Total Number of Region Merged				
	eight.tif	tire.tif	trees.tif	rice.png	pout.tif
0.5	1409	1310	0	0	116
0.45	1773	1583	1142	67	231
0.4	2104	1925	2046	856	351
0.35	2438	2432	2873	3474	513
0.3	2739	2882	3318	5589	609
0.25	3030	3463	4173	5680	801
0.2	3251	3828	5134	5525	1115
0.15	3343	3868	6082	5566	1726
0.1	3287	3945	7565	7089	2896
0.05	3333	3873	8945	8599	6440



Graph 3: Graph represents Threshold vs. Total Number of Regions Merged.