ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 3, Special Issue 20, April 2016

Color Image Segmentation using Quad Tree Based Image Decomposition Techniques

Dr. S.Sathappan, Associate Professor, L.Baby Victoria, Research Scholar
Department of Computer Science, Erode Arts & Science College, Erode, Tamilnadu, India.

Abstract

Quad tree decomposition is an operation that subdivided an image into blocks that contain "similar" pixels. Usually the blocks are square, although sometimes they may be rectangular. The pixels in a block are not greater than some threshold. Quad tree decomposition is used in variety of image analysis and compression applications. This research addresses a Quad tree decomposition based image segmentation algorithm for segmenting color images.

1.Introduction

1.1 Image Segmentation

Image Segmentation is nothing but partitioning the image into homogeneous regions. There also exists a variety of images : natural scenes, paintings etc., Despite the large variations of these images, humans have no problem to interpret them. Image Segmentation is the first step in image analysis and pattern recognition. It is a critical and essential component of image analysis system, is one of the most difficult tasks in image processing, and determines the quality of the final result of analysis. Image segmentation is the process of dividing an image into different regions such that each region is homogeneous.

1.2 Digital Image Representation

The term image refers to a two dimensional light intensity function f(x,y), where x and y denote the spatial coordinates and the value of 'f' at any point (x,y) is proportional to the brightness of the image at that point. The digital image is an image f(x,y) that has been discretized both in spatial coordinates and brightness. A digital image can be considered as a matrix whose row and column indices identify a point in the image, and the corresponding matrix element value identifies the gray level of that point. The elements of such a digital array are called as image element, picture elements, pixels or pels.

1.3 Histogram

The distribution of gray levels occurring in an image is called gray level distribution. It is a graph showing the frequency of occurrence of each gray level in the image versus the gray level itself. The plot of this function provides a global description of the appearance of the image.

The histogram of a digital image with gray levels in the range[0,L-1] is a discrete function.

$$P(r_k)=n_k/N$$

Where,
r_k is the Kth gray level

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n_k is the number of pixels in the image with that gray level.
N is the total number of pixels in the image.
K= 0,1,2,…L-1
L = 256
$P(r_k)$ gives an estimate of the probability of occurrence of gray level r_k.

2.Literature Review

Stephane G.Mallat[2] reviewed the recent multi channel models developed in pshychophysiology, computer vision, and image processing. The expansion of the functions into several frequency channels provides a representation, which is intermediate between a spatial and a fourier representation. The mathematical properties of such decomposition are described and the wavelet transform is introduced. The classical multi resolution pyramid transforms developed, show the relation with the decomposition of an image into a wavelet orthonormal basis.

M.A.Roula et.al.,[3] developed the Expectation-Maximization algorithm which is Capable of estimating the parameters of mixture distribution. This paper presents a novel unsupervised algorithm based on Expectation-Maximization algorithm where the analysis is applied on vector data rather than the grey level. This is achieved by defining a likehood function, which measures the estimated features that fit with the present data.

V.Lakshmanan et.al.,[4], described a novel method of performing multi scale, hierarchical segmentation of images using texture properties. The images are first requantized using contiguity-enhanced K-Means clustering. Morphological operations and region growing based on textural properties are used to arrive at the most detailed segmentation.

A discriminant analysis method is used by Koivo and Kim(1989). They have used a tree classification method based on the gray level mean of features and other statistical parameters calculated from low-level processing methods. They were able to classify red oak boards into nine classes with 92% accuracy.

L.M.B. Claudino et.al.,[5] proposed an unsupervised segmentation / classification technique based on wavelet textural analysis and self organizing map clustering.

3 The Proposed Algorithm

1. Open the Image which is to be segmented.
2. Do preprocessing.
3. Decompose the image into different size of blocks using Quad Tree Decomposition technique.
4. Prepare RGB Vector of each and every blocks of original image using the QT decomposed gray image as a reference image.
5. Make Clusters out of the all RGB feature vectors using the newly trained SOM.
6. After that we will have the cluster labels for each pixels in the image.
7. Decide the gray levels of each segments by averaging the pixels corresponding to the class labels in each groups.
8. Display the segmented image.

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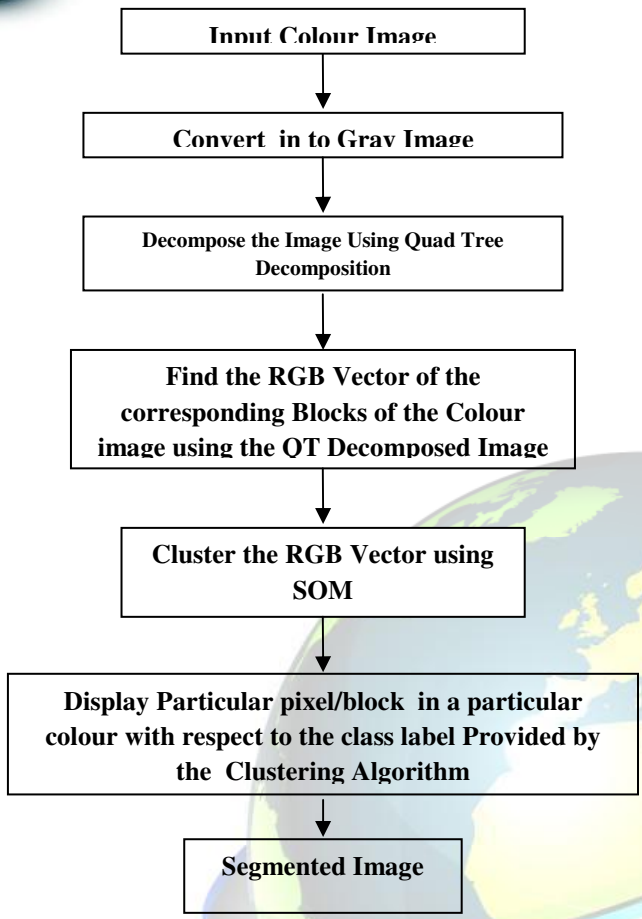


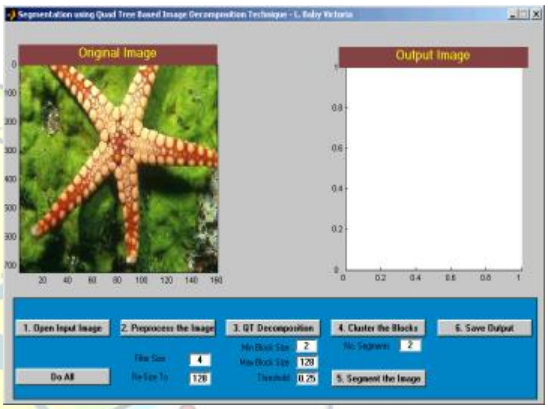
Fig 1 : The Diagram of Proposed System

While doing Sliding Neighbourhood operation, the output values may be computed by assuming that the input image is surrounded by additional rows and columns of zeroes. But in our implementation the border pixel inside the particular radius of operation is discarded. So the output image is little bit smaller than the original.

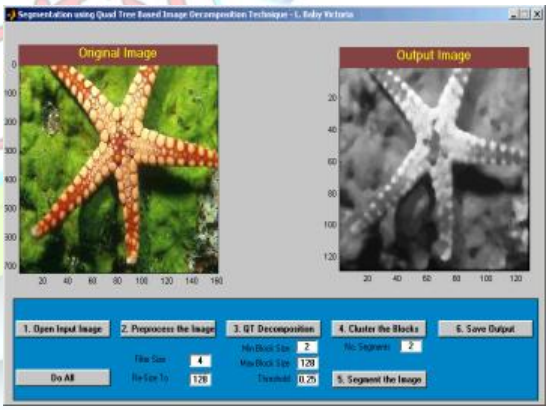
4. The Results and Discussion

In this section, we present the results of the proposed algorithm on real images. These images are taken from the Berkeley Segmentation dataset. To check the results by Angela Chau and Jeff Walters from their paper 'Perceptual Color Image Segmentation' [6] was used. To evaluate the performance of the algorithm in terms of quality and performance, the previous results from the main reference paper [1] was used.

Sample Results with a Standard Image



Fig, 2 : The Main Interface With Input



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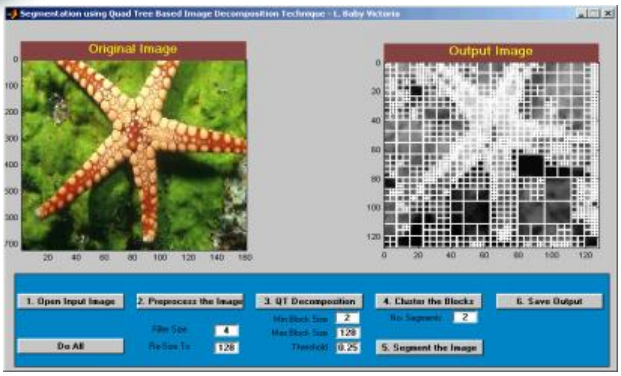

Fig. 4: The Segmented Image : Level k = 2

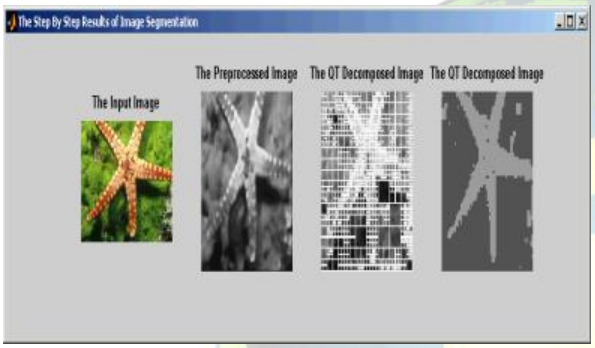

Fig. 5 : The Step by Step Results

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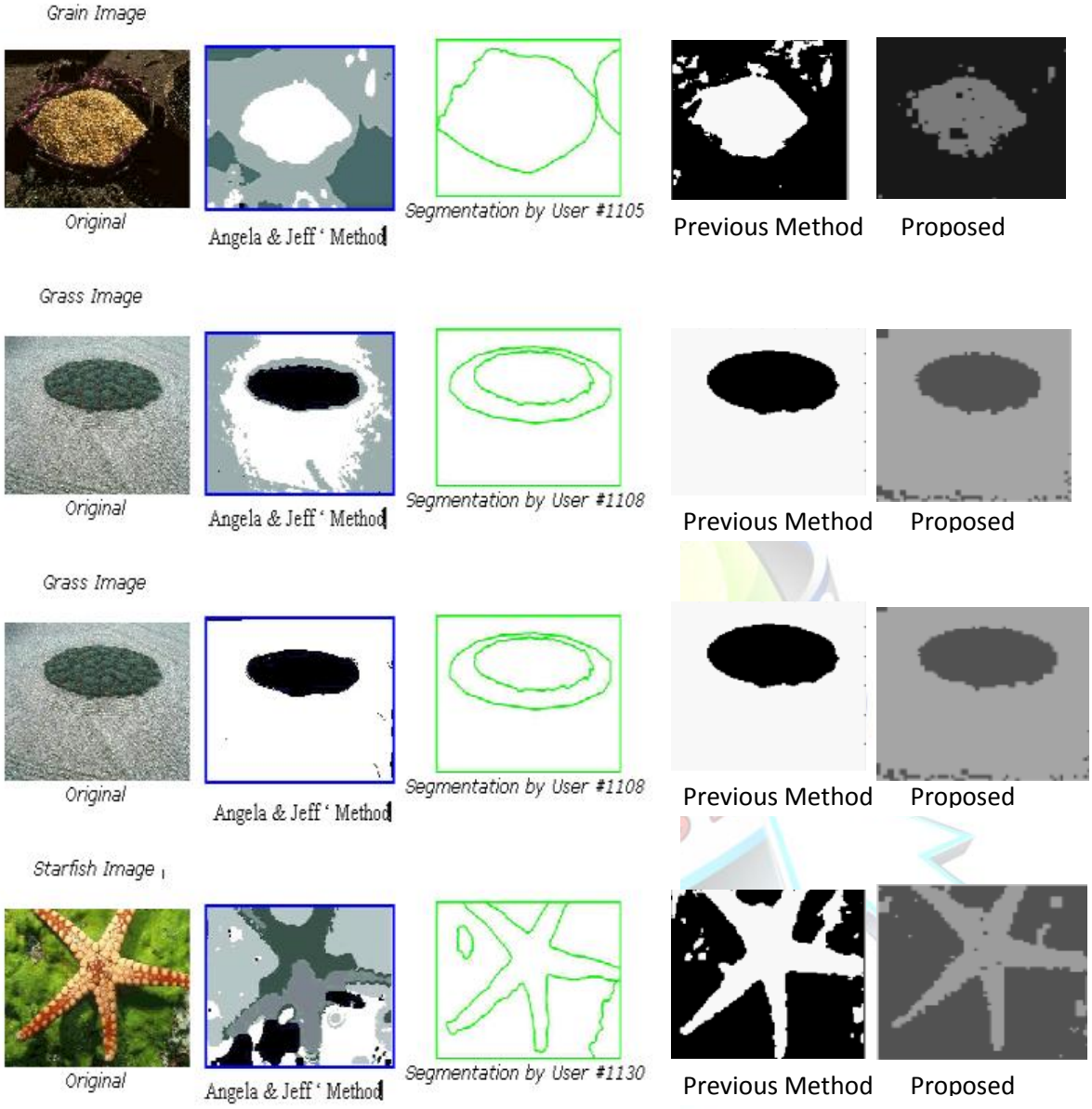

Fig 6 : Comparison results with other methods

5. Performance Analysis

The following table shows the time taken for previous and proposed algorithms for segmenting the images of different sizes.

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Table 1 : Time Taken for Segmentation

Sl. No	Image Size (pixels)	Time Taken For Segmentation	
		Previous LIM Based Method	Proposed Quad Tree Based Method
1	64 x 64	13.86	3.07
2	128 x 128	53.56	3.13
3	192 x 192	55.43	3.23
4	256 x 256	41.89	3.62

As shown in the above table, the time taken for finding segmenting the image in the case of proposed Quad Tree based method is very much less than that of the previous LIM based method.

5. Conclusion and Scope for Further Enhancements

The Proposed Quad Tree based image segmentation algorithm has been implemented successfully and compared with the previous LIM based colour image segmentation algorithm on Matlab 6.5 under windows XP operating system. The arrived results were more significant and comparable. The LIM based operation consume lot of time with respect to the size of the image. But the RGB vector based method, the total time taken for segmentation has been reduced very much. The image segmentation is done using k-means clustering in 3-D RGB space using the RGB vectors, so it works perfectly fine with all the colour images. The clarity in the segmented image is very good compared to other segmentation techniques.

In future the technique may be improved by finding optimum segmentation level automatically. The technique can be extended to do texture based image segmentation.

6. References

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