Hybrid Segmentation Approach and Preprocessing of Color Image based on Haar Wavelet Transform

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ABSTRACT
Color image preprocessing and segmentation has been widely acceptedas an important component of the image mining.In this paper, we have proposed the denoising concept.The method used for pre-processing the color image includes wavelet based segmentation which has the advantage of more efficiency, better quality and accuracy of image. The preprocessing method wavelet transforming has the advantage of multi-resolution inboth time domainsas well as in frequency domain, so it can be used to describe the partial characteristics for both domains. Wavelet denoising is a more successful kind of application of wavelettransforming. Using the multi-resolution of wavelet, the non-steady characteristics of signals can be analyzed efficientlyand give more refined results. The experiment has shown enhanced results produced by our proposed technique than the previous approaches in practice.

Keywords
Color image, Otsu algorithm, wavelet transform, Karhunen-Loeve algorithm,Image Preprocessing, Image-Segmentation.

1. INTRODUCTION
The color images are much more intricate and persists much more information, basically, color spaces always contain three components, for illustration, the most commonly used RGB channels. Each channel of the color space has a high correlation to the others [1]. The studies on color image segmentation are much fewer. So, a robust segmentation with healthier quality for color images is required to meet computer vision's needs.So doing some proper preprocessing of image with the noise is an important question, and has important significance to improve the quality of image [4].

In image understanding, the threshold value of image processing technology has been a blistering issue. Many researchers have been focusing on gray-scale image segmentation on the other hand, more than ten approaches of shaping the threshold have already been proposed, most representative ones are P-tile method, bimodal method, Otsu method, minimum error method, maximum entropy method and the iterative method [11]. These studies are focused on the selection of the best single threshold from gray-level images. In this way, to reduce the redundant information processing is quite important. In the past, a number of classical methods e.g. thresholding [15], region growing [5], edge-detection [9][10][13], histogram-based [3][6][8], and graph partitioning were used for image segmentation.

We will describe some other earlier applications of image segmentation in color image, for instance, Han proposed a palm-print-based identification system in [2], the pre-processing steps including image-thresholding, border tracing and wavelet-based segmentation, the preprocessing method is proved to be effective and can be simulated in other scenarios as well.

A novel fast approach was proposed to achieve image segmentation in color image [1] where the author proposed Color Image Segmentation by Karhunen-Loeve Transform based Otsu Multi-thresholding and K-means Clustering. This method extends the traditional Otsu method from gray level to color images. Moreover, it can achieve better performance and lower computational complexity than similar works. But it is robust to the user inputs and could not save the quality of image.

Another approach has developed a simple but effective method of image segmentation that employs Parzen window technique [14]. The underlying idea of the proposed method is to maximize the difference of spatial probability distribution of the object and background classes. By using the Parzen window technique, the novel criterion function is designed. Finally, the purpose of this paper is not a commentary on the best global thresholding. Rather, if one decides to use one thresholding method for image segmentation, then it shows that the proposed method here can choose the threshold which is as close to optimal as possible. Except for the above advantages, the experimental results actually indicate that the high time complexity is the main drawback of the proposed method.

Color image preprocessing with the help of Haar Wavelet is the basic of this paper which will help in providing steadfast data for image segmentation using Karhunen-Loeve and Otsu algorithm. As we go down, section II describes the proposed system with the methodology used that are Haar Wavelet for preprocessing ,K-L Transform and Otsu algorithm for colored image segmentation, section III results and analysis, section IV conclusion and future work and finally section V gives the references.

2. PROPOSED APPROACH
In this paper, a novel method of preprocessing using Haar wavelet Transform followed by Karhunen-Loeve transform (K- L transform) based Multi- level Otsu together has been proposed to extend the traditional gray level Otsu method to achieve the color image segmentation Then thresholding is applied on preprocessed image. After applying multiple thresholding, we use it to segment the image. The complete procedure is given in fig 1. In the imminent sections this process is explained in detail.

Input is given as color image. Each component of the color image, Red, Green and Blue is separated. Then wavelet transformation is applied for preprocessing on each component and the result is we get a denoised image. We combine the co-efficient of each component to make a color image. This wavelet transformed image is denoised and the size is smaller than the original image.

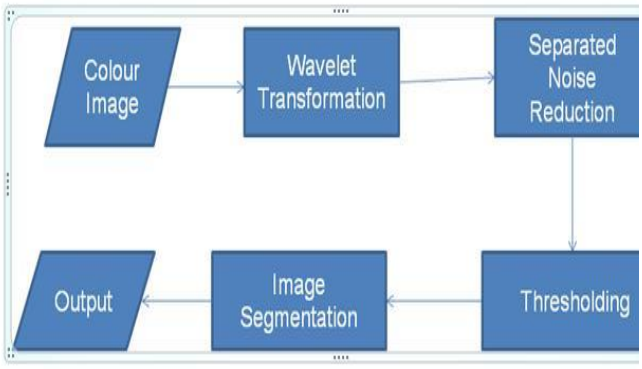

Fig 1: Flow diagram of color image segmentation processes using Haar wavelets

2.1 Wavelets

Wavelet transform is a revolutionary progress of Fourier transform. The wavelet transform has the advantage of multi-resolution either in time domain or in frequency domain, so it can be used to describe the partial characteristics in the both domain. Wavelet denoising in digital image is a more successful kind of application of wavelet transforming. The technique is used for preprocessing of nature image, to remove the noise without smoothing out main features of the data, making it effective for segmentation. Given a set of coefficients, an approximation of the original data can construct by applying the inverseof the wavelet transform used.

Transform color image matrix to wavelet domain:

$$f_w = Wf$$

Process coefficients of wavelet by threshold function

$$\hat{f}_w = T(f_w)$$

Make Inverse transforms:

$$\hat{f} = W^{-1} f_w$$

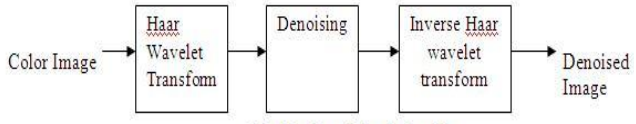

Fig 2. Flowchart of Wavelet denoising

2. 2 Thresholding and Image Segmentation

Considering a color image in RGB color space as an input, all the other colors can be seen as different combinations of three basic colors: red (R), green (G) and blue (B)[7]. In view of the fact that these three components have great correlation with each other, a robust and effective K-L transform should be chosen to reduce the redundant relationships in the color space. The process is to chart the multi-dimensional data with correlation into a new coordinate in the region of the data distribution in order to compress the data information while the orientation of the new coordinate should keep the maximum amount of the information. Prearranged a color image of size (a,b), we can consider it as a three dimensional matrix P(a, b, 3) in which each dimension contains the information of each component. In order to keep the color information, we just change the three dimensional matrix P into two dimensional matrix P' (a*b, 3) which keeps each component that in one column.

- We get three column vectors represent the three components(R,G,B)
- Then, calculate Covariance Matrix by the following formula:

  ∑=[cov(R,R) cov(R,G) cov(R,B) cov(G,R) cov(G,G) cov(G,B) cov(B,R) cov(B,G) cov(B,B)]

- Find corresponding Eigen Vectors and Eigen Values for the three components (Red, Green, Blue)

- Now, formulate a matrix Ø consisting of three elements i.e. Eigen vectors of all the components:

  Ø=[$Ø_R$ $Ø_G$ $Ø_B$] satisfying $Ø^T$ Ø=I, where $Ø^T$ is transpose of matrix ØI is Identity Matrix of order of Ø

- Then, choose that Eigen Vector whose Eigen value is maximum among all Eigen values
- Now, multiply this Eigen Vector with the de-noised 2-D matrix.

- And, at last convert the resultant matrix into 3-D matrix.

After this we get a image on which Otsu method is applied for segmentation. In the luminance of one dimensional gray level histogram of an image, Otsu method takes the variance between classes as the criterion to choose the optimal segmentation threshold.

2. RESULTS AND ANALYSIS

In this section, we compare the results of original image before preprocessing and denoised image after preprocessing. We have also compared the R, G, B component graph before applying Haar wavelet and after applying Haar wavelet. The image is shown after K-L Transform and Otsu segmentation image.

Fig 3(a) Nature Image before processing Fig3(b) Nature Image after preprocessing

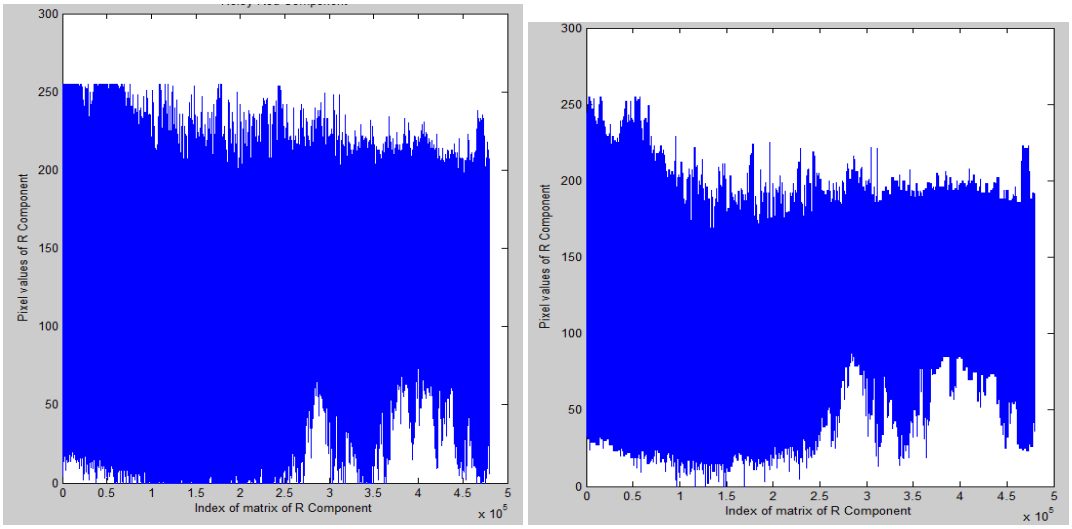

Fig. 4(a) NoisyR Component **Fig4(b) Denoised R Component**

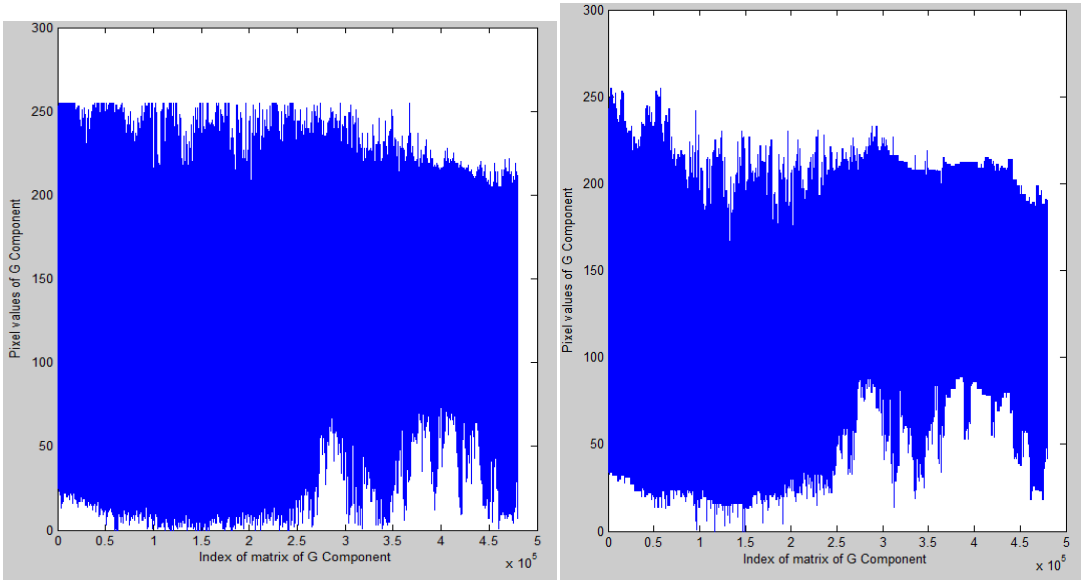

Fig 5(a) Noisy G Component **Fig5(b) Denoised G Component**

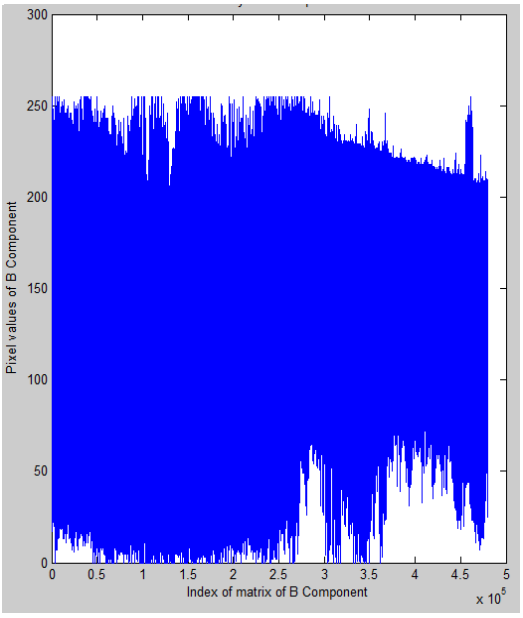

Fig 6(a) Noisy B Component

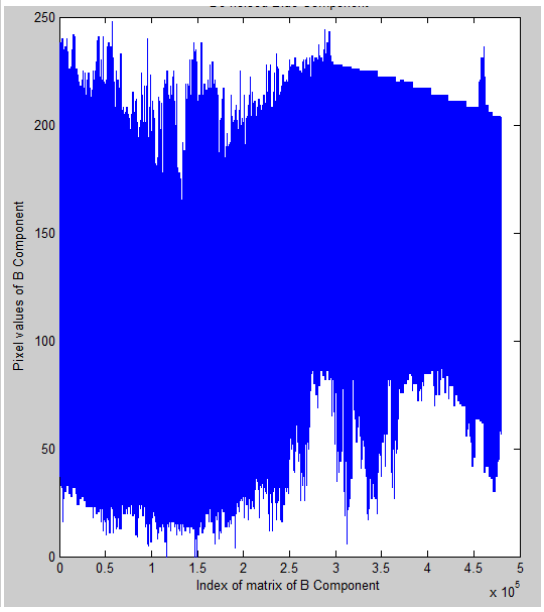

Fig6(b) Denoised B Component

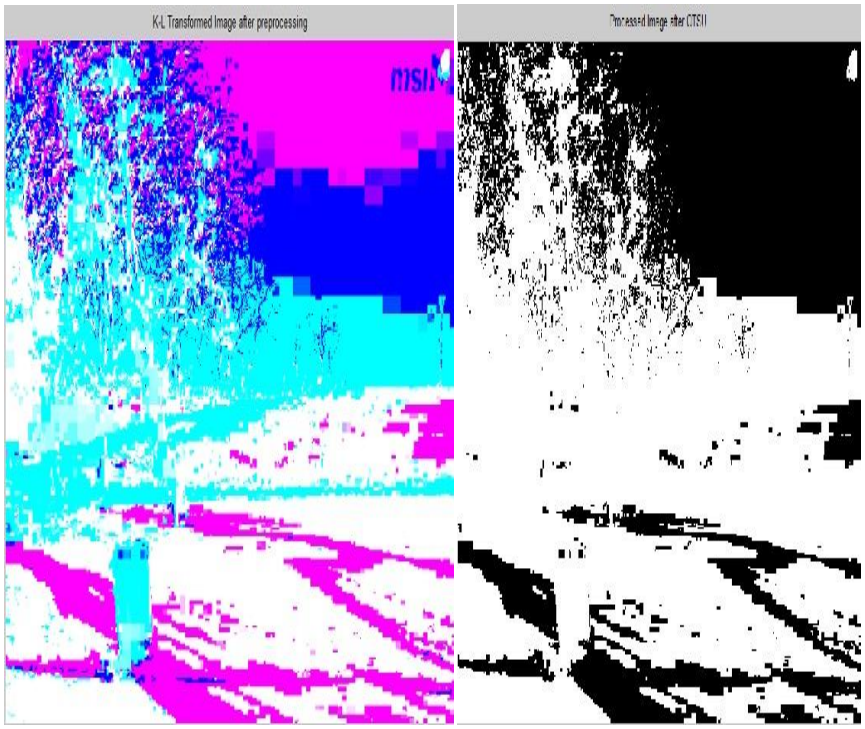

Fig7 (a) Segmented Image after Haar Wavelet and K-L transform

Fig.7 (b) Segmented Image after OTSU

From the results on the above image, we can easily conclude that our method is providing an improved denoised image after preprocessing technique, wavelet transform than the previous attempts without preprocessing [1]. In the above figure 3(a) and 3(b) results of original colored image and denoised image after performing wavelet transform ,R,G and B noisy component and denoised component are shown in fig.4, fig.5 and fig.6 respectively. In fig.7 the results after segmentation are shown which are denoised. Thus the experiments have shown enhanced results by our proposed technique than the previous approaches in practice and save the eminence of the image also.

3. CONCLUSION AND FUTURE WORK

Results show that the use of wavelet transform as a preprocessing technique in the segmentation of color images using K-L Transform and Otsu algorithm has outclassed the previous work which was segmentation without preprocessing.The results of the experiments described in the paper confirms that the K-L and OTSU algorithm after pre-processing performs better than the other standard algorithm while preserving a compatible level of approximation accuracy. Thus the experiments have shown improved results by our proposed technique than the previous approaches in practice and save the prominence of the image also.
In future, we plan to use Self Organizing Map for training the datasets after applying wavelet transform on color image and then will apply segmentation on the results. These results may be classified using classification algorithm and then can be extended to image mining.

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