A Novel Method of Color Image Segmentation Using Wavelet and Modified watershed Algorithm

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Abstract - Many peoples are sometimes only interested on the certain parts of the image in the research for a given application. Image segmentation is an important process in many computer vision and image processing applications,it is a valuable tool in many fields including industry, health care, image processing, remote sensing, traffic image, content based image, pattern recognition, video and computer vision etc. The main objective of this project is to segment image by using an advanced bi-orthogonal wavelet transform. This project analyzes the drawbacks of the conventional algorithm for color image segmentation and proposed a method based on bi- orthogonal wavelet transform and thresholding mechanisms over each color channel to overcome segmentation problem so as to improve the image quality under noisy environment.

Keywords - color image segmentation, Modified watershed transform, Bi-Orthogonal wavelet Transform, Region growing, PSNR, MSE, CQM, YUV Transformation.

I INTRODUCTION

Image segmentation is the process of partitioning the digital image into multiple regions. image segmentation represents the first step is image analysis and pattern recognition. Properties like gray level, color, intensity, texture, depth or motion help to recognize similar regions and similarity of such properties, is used to construct groups of regions having a specific meaning.

color image segmentation is mostly used in multimedia applications. In some of the application foreground is important and some of the application needs background as important. Image segmentation improves image quality and reduce the computation load.The goal of color image segmentation is grouping the pixels that have similar feature in an image from the stand point of human visual system. 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.

The rest of the paper is organized as follows. Proposed bi-orthogonal wavelet transform algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

II. PROPOSED ALGORITHM

Bi-orthogonal wavelet transform simultaneously performs the rows and columns operations so it is fast.Here interested part of the image is segmented using Bi-orthogonal wavelet transform as shown in Fig.2.1.

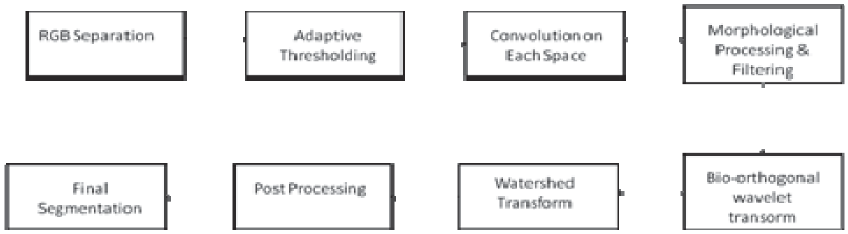

Fig. 2.1: Block diagram of Proposed Method

The flowchart of proposed technique is presented in Fig.2.2.

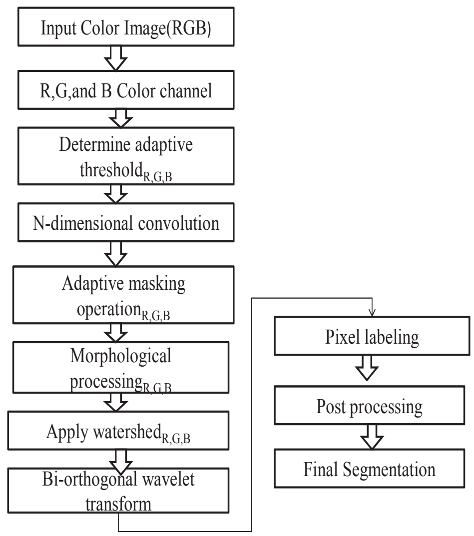

Fig.2.2: The Flowchart of Proposed Bi-orthogonal Wavelet Transform

The Image Segmentation Process is described following steps provided below:

Step1. RGB image as input color image. The original image is extracted into individual color channels that is red(I), green(G) and blue(B) as shown in fig.2.3.

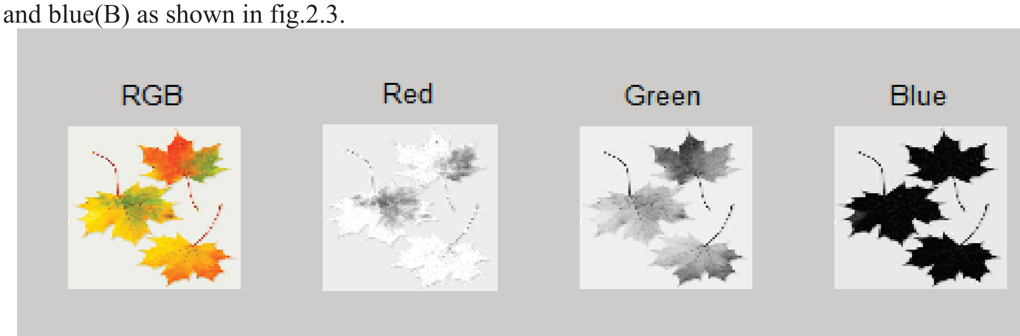

Fig.2.3: Extracted original image into R, G and B channels

Each color channel is normalized 0 to 1.the image normalization process is computed by the Eq.2.1

$$N = \frac{I - min\ (I)}{max(I) - min\ (I)} \quad \text{................ (2.1)}$$

Where the extracted three color channels is represented by I, Image normalization is denoted by N.

Step2. Thresholding

Thresholding is applied to the total image. Thresholding techniques produce segments having pixels with similar intensities. It requires that an object has Homogeneous intensity level and a background with a different intensity level. It can be used to create binary images.

Limitations of Thresholding:

- It is simplest form.
- Only two classes are generated and it cannot be applied to multi channel images.

Adaptive Thresholding

To determine the adaptive threshold, I have used a dynamic threshold selection process(T_1 and T_2)by Eq. 2.2

$$\mathbf{T_1=G_t(N)} \ldots\ldots\ldots\ldots\ldots\ldots(2.2)$$

and Eq. 2.3 based on Gray-threshold function

$$\mathbf{T_2=G_t(N > T_1)} \ldots\ldots\ldots\ldots\ldots\ldots\mathbf{(2.3)}$$

Where, Gray threshold is calculated by G_t

Step3. In this applied image normalization(N) and NDGRID(N-dimensional grid space) into N-dimensional convolution for smoothing image on three color channels as given in fig.2.4. the N-dimensional convolution is represented by c_n. where n is the channel number.

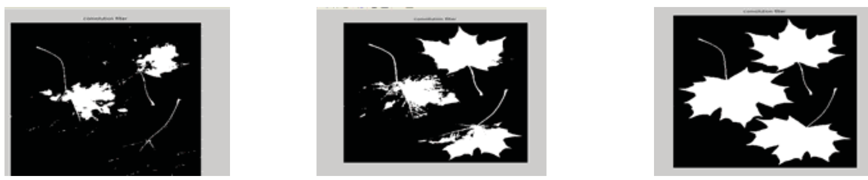

Fig 2.4: N-dimensional convolution filtering

Step4. The masking operations are divided into two stages that is cell and nucleus masking. The adaptive masking operations are used image normalization (N) and adaptive thresholding (T_1 and T_2) on the R, G and B color channels as shown in Fig.2.5.

$$M_1=N>T_1 \ldots\ldots\ldots\ldots\ldots\ldots(2.4)$$

Where, cell-mask and nucleus-mask are denoted by $M_1$and M_2 respectively.

$$M_2=N>T_2\ldots\ldots\ldots\ldots\ldots\ldots(2.5)$$

Fig 2.5: Adaptive Masking Operation on three channels

*Step5***.** For morphological processing, I have applied Impose Minima (imimposemin) function to create morphological process image Fn using nucleus-masking (M2) and adaptive mask image on three color channels as shown in Fig.2.6.

The basic morphological operators are erosion, dilation, opening and closing. In mathematical morphology, a structuring element (s.e) is a shape, used to probe or interact with a given image, with the purpose of drawing conclusions on how this shape fits or misses the shapes in the image.

Fig 2.6: Morphological processing on three color channels

Step6. The watershed algorithm is applied based on the morphological processing image on R,G and B color channels as shown in fig.2.7.it can be represented by $w_{n.}$

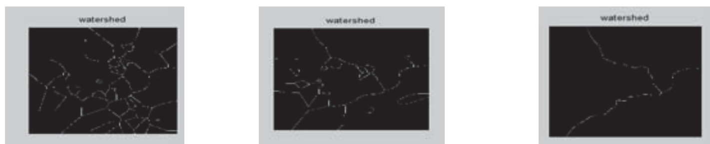

Fig 2.7 : Watershed transform on three color channels

*Step7***.** Bi-orthogonal wavelet transform to two dimensional discrete wavelet transform is used. input side to DWT is used and output side to IDWT is used. it is simultaneously performs rows and columns operations so it is fast.

Step8. The pixel labelled process is started on each color channel after watershed algorithm. To determine a background image, we have used $W_n(\sim M_1) = 0$ functions. The elements of L_n are integer values greater than or equal to 0. It labels foreground objects in the binary image.
The pixels labelled 0 ($L_n = 0$) are the background image. The pixels labelled 1 make up one object, the pixels labelled 2 make up a second object, and so on.
Step9. In post processing operation I have converted R,G and B label image into RGB image using p_n=label2rgb(L_n) for the purpose of visualizing the labelled regions as shown in fig.2.8.where n is the number of channel.

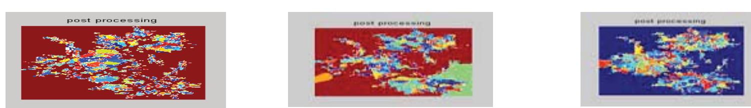

Fig 2.8 : Post processing operation on three channels

Step10. The three color channels are added i.e (red, green and blue) to generate the Enhanced image in the final stage as shown in fig.2.9 and fig.2.10.

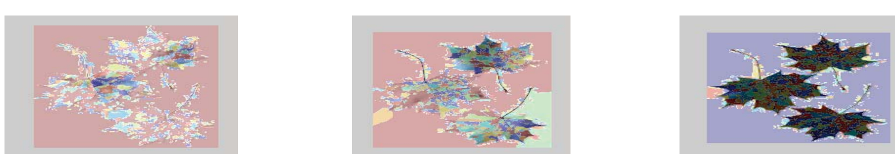

Fig 2.9: Final Segmentation of Three Color Channels

Fig 2.10: Final Output Image

A. Evaluation Parameters

Performance of proposed method is evaluated with existing method using following performance metrics.

- PSNR
- MSE
- YUV Transformation
- CQM

PSNR:

$$PSNR(GI, SI) - \frac{10Logs^2}{MSE(GI, SI)}$$

PSNR means peak signal to noise ratio. The PSNR range between [0, 1], the higher is better PSNR is used to calculate in between two images given in (dB) where ,S is the maximum fluctuation in the input image data type Where, s is 255.where GI is the original image and SI is the segmented image.

MSE:

$$MSE(GI, SI) = \frac{(\sum_{i=0}\sum_{j=0}[GI(i,j) - SI(i,j)^2])}{MN}$$

Mean Square Error (MSE) is calculated pixel-by-pixel by adding up the squared difference of all the pixels and dividing by the total pixel count. M and N are the number of rows and columns in the input images respectively where GI and SI are the original and segmented image. I*j is the image size, GI(i,j) is the original image pixel value, SI(i,j) is the segmented image pixel value.

YUV Transformation:

The authors proposed Image Quality Measure (CQM) based on color transformation from RGB to YUV. An estimated Reversible YUV Color Transformation (RCT) that is created from the JPEG2000 standard and called as RCT is given in equations. Primarily, an original RGB and segmented image are transformed into the YUV (RCT) images by using the RCT.

$$\left(\begin{array}{c|c} Y = \frac{R + 2G + B}{4} & G = Y - \frac{U + V}{4} \\ U = R - G & R = U + G \\ V = B - G & B = V + G \end{array} \right)$$

CQM:

The Color Image Quality Measure (CQM) follows a strategy of changing the way of implementation of the PSNR.

The theory of CQM is based on two main principles.

1.Firstly, a reversible color transformation is realized from RGB to YUV by using an original image and segmented color image.

2. A color transformation is initially used as a pre-processing step before the intra-component coding in any image segmentation application of a color image.

color image quality metrics like PSNR of each YUV color channel (Y, U and V) is calculated separately.

1.Firstly, a reversible color transformation is realized from RGB to YUV by using an original image and segmented color image.

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color image quality metrics like PSNR of each YUV color channel (Y, U and V) is calculated separately.

$$CQM = (PSNR_Y \times R_W) + \left(\frac{PSNR_u + PSNR_v}{2}\right) \times C_W$$

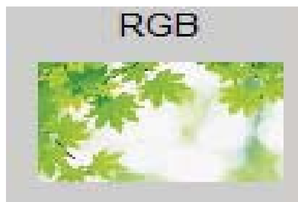
Where, the weighted luminance quality measure ($PSNR_Y$ X R_W) And weighted color quality measure $\left(\frac{PSNR_u + PSNR_v}{2}\right) \times C_w$

Components. C_W and R_W means the weights on the human perception of these cone and rod sensors. C_W and R_W are 0.0551 and 0.9449 respectively.

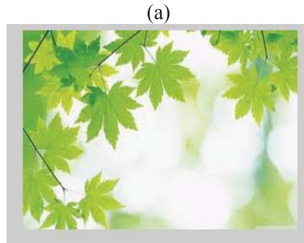
III EXPERIMENTAL RESULTS

Images are taken from the Berkeley image data base and compared the experimental results with two color image segmentation algorithms. An image data base consisting of 50 images is used in this study. the size of the all the images are different and same image with different sizes will be also taken in order to facilitate performance comparison of quantitative displays of the results. these algorithms are implemented in MATLAB code and tested on a notebook. from the figures that our proposed method performs better than the existing method. proposed method can get the better segmentation results.

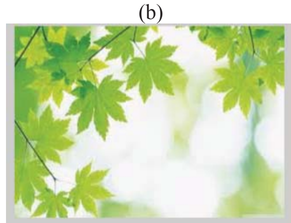
CASE 1:



(a)



(b)



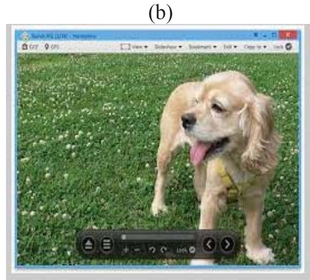
(c)

Figure 4. (a) Original image (b)Existing Method (c) Proposed Method

CASE 2:

(a)

(b)



(c)

Figure 5. (a) Original image (b)Existing Method (c) Proposed Method

Table -1 Experiment Result

S.NO	CASES	METHODS	PSNR	MSE	CQM
1	CASE 1	Existing Method(Modified watershed transform)	9.99	1.76	14.1
		Proposed Method(Bi-orthogonal wavelet transform)	34.13	1.97	34.32
2	CASE 2	Existing Method(Modified watershed transform)	13.11	2.41	11.58
		Proposed Method(Bi-orthogonal wavelet transform)	21.05	5.33	19.05

Table 1 show the performance of two algorithms using PSNR,MSE,CQM. In this compare the performance of modified watershed transform and proposed method to using modified watershed transform and bi-orthogonal wavelet transform with respective to parameters are PSNR,MSE,CQM

CQM is based on the reversiable YUV color transformation. the modified watershed algorithm is more efficient in color image segmentation and reduce the problem of the over segmentation in addition to using bi-orthogonal wavelet transform to increase the performance and improve the image quality, under noisy Environment.

Table -1I Experiment Result

Metrics(Db)	Modified Watershed Transform	BI-ORTHOGONAL WAVELET TRANSFORM
PSNR	11.55	27.59
MSE	2.08	3.65
CQM	12.84	26.68

TABLE II Gives the average performance of two algorithms using PSNR,MSE,CQM. the proposed Bi-orthogonal wavelet transform method is superior to the competing algorithms in efficiency. PSNR value is increases and also CQM is increases.

IV.CONCLUSION

In this paper existing modified watershed transform based on the adaptive thresholding, masking, and morphological operations is simulated. This paper analyzed the drawbacks of the watershed transform as over-segmentation, sensitive to noise and high computational complexity which makes it not suitable for real-time process.

Proposed Bi-orthogonal wavelet transform method produced the better results compared to existing modified watershed transform in terms of PSNR and CQM.

REFERENCES

[1] Y. Wangsheng, H. Zhiqiang, and S. Jianjun, "Color Image Segmentation Based on Marked-Watershed and Region-Merger", Acta Electronica Sinica, Vol. 39(5), pp. 1007–1012, 2011.

[2] M. Edman, "Segmentation Using a Region Growing Algorithm”, Rensselaer Polytechnic Institute, Oct. 18, 2007.

[3] Kumar and P. Kumar, "A New Framework for Color Image Segmentation Using Watershed Algorithm," Computer Engineering and Intelligent Systems, Vol. 2(3), pp. 41-46, 2008.

[4] H C Sateesh Kumar 1, K B Raja2, Venugopal K R2 and L M Patnaik3, “Automatic Image Segmentation using Wavelets” IJCSNS International Journal of Computer Science and Network Security, VOL.9 No.2, February 2009.

[5] A. Aly, S. Deris and N. Zaki, "A Novel Image Segmentation Enhancement Technique based on Active Contour and Topological Alignments," Advanced Computing: *An International Journal (ACIJ)*, Vol. 2(3), May, 2011.

[6] Samer Kais Jameel,Ramesh R.Manza, “Color Image Segmentation using Wavelet,” International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868, Volume 1– No.6, February 2012.

[7] S. Kamdi and R. Krishna, "Image Segmentation and Region Growing Algorithm," International Journal of Computer Technology and Electronics Engineering (IJCTEE), Vol. 2, issue 1, pp. 103-107, 2012.

[8] S. Li, J. Xu, J. Ren, and T. Xu, "A Color Image Segmentation Algorithm by Integrating Watershed with Region Merging," RSKT, LNAI 7414, pp. 167–173, 2012.

[9] M. Christ and M. Parvathi, "Segmentation of Medical Image using K- Means Clustering and Marker Controlled Watershed Algorithm," *Eur opean Journal of Scientific Research*, Vol. 71(2), pp. 190-194, 2012.

[10] X. Han, Y. Fu, and H. Zhang, "A Fast Two-Step Marker-Controlled Watershed Image Segmentation Method," in proc. of IEEE International Conference on Mechatronics and Automation, pp. 1375-1380, Aug.2012.