International Journal of Engineering & Technology, 7 (3) (2018) 1157-1160

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET
doi: 10.14419/ijet.v7i3.11774
Research paper

Sine cosine optimization based multilevel segmentation of digital images

S. Rakoth Kandan [1] *, P. Srinivas Rao [2], B. Durgalakshmi [3]

[1] Professor, Dept. of CSE, Jayamukhi Institute of Technological Sciences, Warangal, India
[2] Associate Professor, Dept. of CSE, Jayamukhi Institute of Technological Sciences, Warangal, India
[3] Research Associate, School of Computing Sciences & Engineering, VIT University – Chennai, India
*Corresponding author E-mail: rakothsen@gmail.com

Abstract

This main objective of this paper is to present a sine-cosine optimization algorithm for multilevel segmentation of real-time and medical images. It chooses the threshold values for all R, G, B channels of real life and medical images through effectively exploring the solution space in obtaining the global best solution. The results are compared with existing methods and finally, the proposed method is able to offer better segmentation results than that of an existing method.

Keywords: *Image Processing; Multilevel Segmentation; Optimization.*

1. Introduction

Image segmentation is a process of subdividing the image into portions with homogeneous characteristics in respect of texture, gray value, position, etc. Now a day's image segmentation technique has been applied for various types' medical applications for the purpose of disease identification. Even though various methods available early for the segmentation no method applying for all kind of medical images such as brain, liver, retinal, etc. Numerous segmentation methods are available among that thresholding based segmentation is a very simple and effective method for performing the image segmentation.

In further thresholding based methods can be further divided into two types i.e. bi-level and multilevel. In bi-level using one threshold value create two classes that are below or above the threshold value, in multilevel creates nc classes with nc-1.

While comparing the existing thresholding approaches Kapur's entropy gives better performances than any other approaches.

During the recent years, there have been many studies on the automatic diagnosis of retinal diseases using several features and techniques. It is well-known fact that the segmentation of color image demonstrates to be more useful than the segmentation of grayscale image because color image expresses much more image features than grayscale image. In fact, a great number of combination of R, G, and B chromatic components [1] characterizes each pixel.

The segmentation of fundus images would have been more effective if segmentation is performed considering the rich chromatic information in all the three color channels of fundus images. However, it requires the computational cost considerably higher than that needed for grayscale image, but it is no longer a major problem with the increasing speed of computation. In fact, there has been a remarkable growth of techniques for the segmentation of color images in this decade [2].

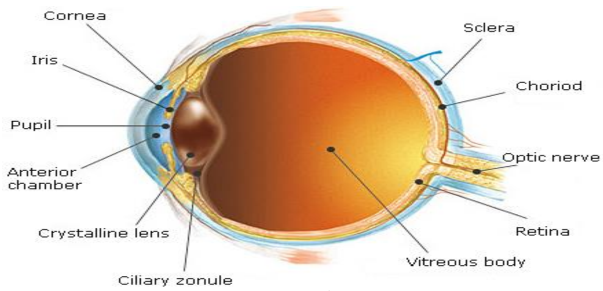


Fig. 1: Structure of Human Eye.

In the literature, a number of methods for segmenting the optical disk, blood vessels, exudates, cataracts, etc have been suggested [3-8]. Most of these methods consider the gray level representation or a single color plane in segmenting the fundus images, rather than taking into account the multiple color channels of fundus images. For instance, the contrast-enhanced L channel of L*U*V* color spaces has been used to apply morphological operations as well as H-Maxima transform for detecting exudates in [3]. The gray level image has been thresholded to segment optic disc and exudates in retinal images in [6]. A geometrical model of vessel structure involving grayscale image has been suggested for detection of the optic disc in retinal images in [7]. In the grey level version of the color original image has been used to segment the optical disk on two of the three different approaches presented: multi-thresholding and active contour without edges [8].

The largest organ of the human body is the skin. It covers the entire body and thickness varies from 0.5mm to 4mm or more on the palms of hands and the soles of feet. The first defense line of our human body is skin. Its primary roles are to protect the body and to maintain the integrity of internal systems. Its other functions are insulation, temperature regulation, sensation, and the production of vitamin D [9].

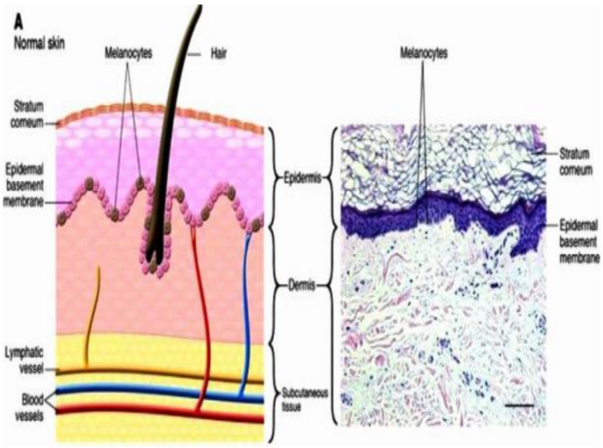


Fig. 2: Human Skin Structure Layers – Epidermis, Dermis, Hypodermis.

Recently, sine cosine optimization algorithm (SCAO), a population-based algorithm that inspired by the exploration and exploitation phases for solving optimization problems, has been applied for performing multilevel segmentation of grayscaled images and found better results compare with existing methods. The main motive of this paper is to build a multilevel thresholding based method for segmenting the real life and medical images in RGB color space by modifying the FFO based grayscale segmentation method [10].

2. Proposed method

This section describes an SCA based multilevel segmentation method for various medical images. The PM is an extension of the segmentation method suggested by the authors in [11] with a view of processing the R, G, B chromatic components different medical images.

In preprocessing median filter is used for the noise removal. Each chromatic channel of RGB images is further divided into number classes through a number of classes – 1 and number of threshold values is represent by $\{T_1, T_2, \ldots, T_{nc-1}\}$. These thresholds act as a separator between the consecutive classes of $\{C_1, C_2, \ldots, C_{nc}\}$ in the range of threshold values of $\{[0,\ldots,T_1], [T_1+1,\ldots,T_2], \ldots, [T_{nc-1}+1,\ldots,L]\}$ for each chromatic channel, Where L is the max. Pixel intensity value of the digital image. In the PM, each component is defined to denote the threshold levels of all the three-color spaces as decision variables as

T_1^R, T2R, TRnc-1,

sca = $T_1^G, T_2^G, \ldots, T^G_{nc-1}$,

T_1^B, T_2^B, TB_{nc-1}

The SASCA searches for optimal threshold values by maximizing a fitness function FF. based on Kapur's entropy as

$$FF = \sum_{colour \in R,G,B} \left\{ \sum_{i=1}^{nc} H_k^{colour} \right\}$$

Where H_k^{colour} represents k th entropy of the selected color channel of RGB image and is evaluated by

$$\left.\begin{array}{ll}
H_1^{colour} = \sum_{j=0}^{T_1^{colour}} \frac{p_j^{colour}}{x_1} \ln\left(\frac{p_j^{colour}}{x_1}\right) & ; \quad x_1 = \sum_{j=0}^{T_1^{colour}} p_j^{colour} \\
H_2^{colour} = \sum_{j=1+T_1^{colour}}^{T_2^{colour}} \frac{p_j^{colour}}{x_2} \ln\left(\frac{p_j^{colour}}{x_2}\right) & ; \quad x_2 = \sum_{j=1+TL_1^{colour}}^{T_2^{colour}} p_j^{colour} \\
\vdots & \quad \vdots \\
\vdots & \quad \vdots \\
H_{nc}^{colour} = \sum_{j=1+T_{nc-1}^{colour}}^{L} \frac{p_j^{colour}}{x_{nc}} \ln\left(\frac{p_j^{colour}}{x_{nc}}\right) & ; \quad x_{nc} = \sum_{j=1+T_{nc-1}^{colour}}^{L} p_j^{colour} \\
colour \in \{R, G, B\} &
\end{array}\right\}$$

p_j^{colour} Represents probability distribution at j Th intensity level of the selected color channel of RGB fundus image and is calculated by

$$p_j^{colour} = \frac{h_j^{colour}}{np^{colour}} \; ; j \in \{0,1,\cdots,L\} ; colour \in \{R, G, B\}$$

h_j^{colour} Indicates a number of pixels that correspond to j Th intensity level of the selected color channel of R, G, and B.

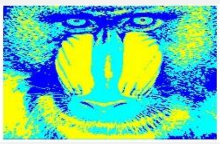
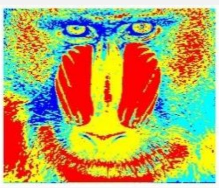
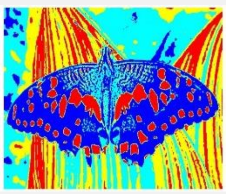
np^{colour} Represents the total number of pixels in the selected color channel of R, G, and B.

Xj denotes the probability of set c_j

3. Results and discussions

The proposed method has been tested on two sets of images. The size of the image is adjusted to have 512 × 512 pixels with the height is proportionally altered with a view to having the true shape of the images. The software packages are developed in the Matlab platform and executed in a 2.67 GHz Intel core- i5 personal computer. The results of the proposed method are compared with that of the grayscale based existing method explained in [11] with a view to studying the performances.

Table 1: Results for Real Life Images

Level	Baboon	Girl	Hunter	Butterfly
				
2				
3				

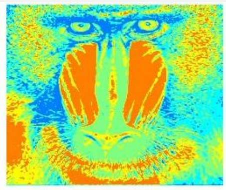
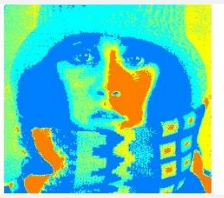
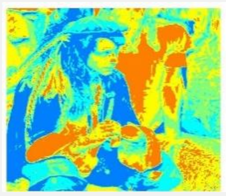
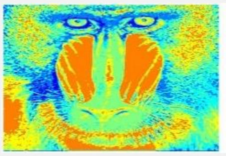
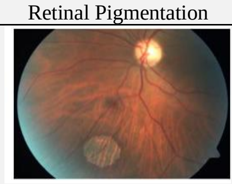
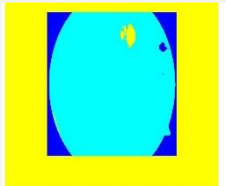
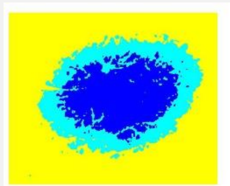
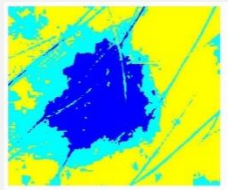
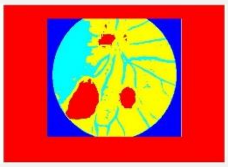
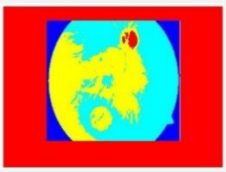
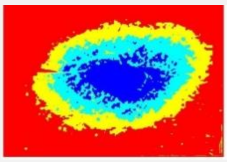
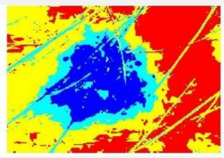
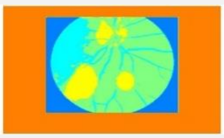
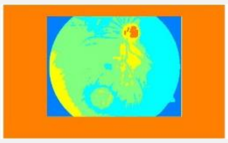
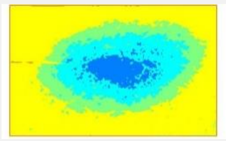
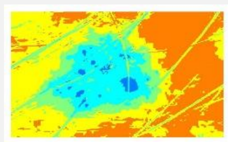
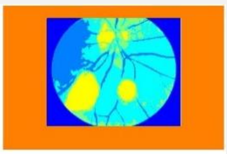
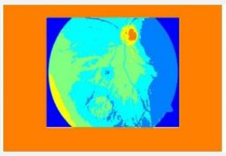
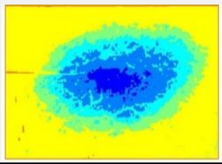
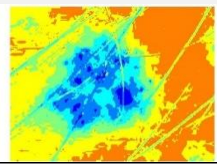
4				
5				

Table 2: Test Results for Medical Images

Level	Retinoblastoma	Retinal Pigmentation	Hemangioma	Hemangioma
				
2				
3				
4				
5				

The results for threshold levels of 2, 3, 4, and 5 are obtained and presented in Table 2 and 3 for image 1 and 2 respectively. This table also includes the original RGB and grayscale converted tongue images. The threshold values for the PM are given in the second column of the tables, while for the EM, they are given in the fifth column of the tables. It can be observed that the segmented color image, given in the third column of the table, conveys more accurate information than that of the segmented gray image given in the last column of the

table. The segmented color images are also converted into grayscale images and presented in the fourth column of the tables. The visual comparison of grayscale images of the PM with those of the EM also ensures that the PM is able to make better segmentation. The visual analysis of these results clearly indicates that the segmented results are better with more number of threshold levels.

4. Conclusion

SCA is a population-based optimization algorithm that simulates to finding the optimal values for the parameters from the all possible values to maximize or minimize the output. A self-adaptive SCA based methodology for performing multilevel segmentation of real life and medical images has been presented. The multilevel segmentation problem has been formulated as an optimization problem and solved using this method. It has been found from the results that the PM effectively yields better-segmented results than that of performing segmentation after converting the image into grayscale. The method can be modified to classify various diseases from the features of segmented results.

Acknowledgment

The authors gratefully acknowledge the authorities of Jayamukhi Institute of Technological Sciences and VIT University for the facilities offered to carry out this work.

References

[1] Guo Dong and Ming Xie. (2005). Color Clustering and Learning for Image Segmentation Based on Neural Networks, IEEE Trans on Neural Networks, 16(4), 925- 935. https://doi.org/10.1109/TNN.2005.849822.
[2] Tahir Sag and Mehmet Cunkas. (2015). Color image segmentation based on multi-objective artificial bee colony optimization, Applied Soft Computing, 34 (C), pp. 389-401. https://doi.org/10.1016/j.asoc.2015.05.016.
[3] D. Welfer, J. Scharcanski, D.R. Marinho. (2010). A coarse-to-fine strategy for automatically detecting exudates in color eye fundus images, Medical Imaging Graph, 34, 228 – 325. https://doi.org/10.1016/j.compmedimag.2009.10.001.
[4] S. Ali, D. Sidibé, K.M. Adal, L. Giancardo, E. Chaum, T.P. Karnowski, F. Mériaudeau. (2013), Statistical atlas based exudate segmentation, Comput. Medical Imaging Graph, 37, 358–368. https://doi.org/10.1016/j.compmedimag.2013.06.006.
[5] B. detection Harangi, by A. Hajdu. Fusing (2014). Automatic contours exudate detection by fusing multiple active contours and region wise classification, Comput. Biol. Med., 54, 156- 171.
[6] Kavitha, D., Shenbaga Devi, S. (2005). Automatic detection of optic disc and exudates in retinal images, in: Proceedings 2005 International Conference on Intelligent sensing and information processing, 501-506. https://doi.org/10.1109/ICISIP.2005.1529506.
[7] Foracchia, M., Grisan, E., Ruggeri, A. (2004). Detection of optic disc in retinal images by means of a geometrical model of vessel structure. IEEE Transactions on Medical Imaging, 23, 1189–1195. https://doi.org/10.1109/TMI.2004.829331.
[8] Madhusudhan M., Malay N., Nirmala S.R., Samerendra D. (2011) Image Processing Techniques for Glaucoma Detection. In: Abraham A., Mauri J.L.,Buford J.F., Suzuki J., Thampi S.M. (eds) Advances in Computing and Communications. ACC (2011). Communications in Computer and Information Science, Springer, Berlin, Heidelberg, 192, 365–373. https://doi.org/10.1007/978-3-642-22720-2_38.
[9] D.J. Gawkrodger (2002), Dermatology: an illustrated colour text. Elsevier Health Sciences.
[10] Mirjalili. S (2016), a Sine Cosine Algorithm for Solving Optimization Problems, Knowledge-Based Systems, 1-14.
[11] Rakoth Kandan, S., and Sasikala Jayaraman, (2016). Self-Adaptive Dragonfly Based optimal Thresholding for Multilevel Segmentation of Digital Images, Journal of King Saud University - Computer and Information sciences.