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Threshold Based Lung Image Segmentation with Robust Artificial Bee Colony Algorithm Optimization Technique

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Abstract: Image segmentation is a complex task which helps us to extract information for analysis a digital image. Millions of methods are available for image segmentation. Out of that image thresholding is a simple, efficient and frequently adopted method for image segmentation. Thresholding basically divide a digital image into two regions; foreground and background based on the intensity value of the pixels. The key point in image thresholding is on the optimum value of threshold of the digital image. It is an important and crucial task to select the optimum threshold. A false choice of threshold will lead to poor results in image segmentation. Generally optimization algorithms are used to select the optimum threshold value. Artificial Bee Colony (ABC) algorithm is one of the optimization algorithms which are the replica of natural behaviour of honey bees to find abundant nectar amount. This study describes an approach to segment an 8 bit human lung image using artificial bee colony algorithm based thresholding method. The proposed method proves that the uniformity factor in the image segmentation is good relative to other conventional methods.

Key words: Thresholding, image segmentation, RGB to Gray, Artificial Bee Colony Algorithm (ABC), fitness and uniformity

INTRODUCTION

In modern science and real time applications image segmentation is an important process. Image segmentation is a powerful tool which extracts meaningful information from a digital image for further analysis and decision making. Image segmentation is the division of an image into regions or categories which correspond to different objects or parts of objects (Kaur and Singh, 2012). Every pixel in an image is allotted to one of a number of these categories. A good image segmentation has pixels in the same category have similar gray scale of multivariate values and form a linked region, adjoining pixels which are in different categories have unlike values. There are three basic approaches in segmentation, termed thresholding, edge based methods and region based methods (John, 2011; Gonzalez and Woods, 2008; Narkhede, 2013). Image segmentation is having wide spread application like crop disease detection, robotics, satellite communications, medical diagnosis, fingerprint recognition, video surveillance and artificial eyes etc. Plenty of image segmentation methods are available and followed by the earlier researchers. Thresholding is the simplest and most commonly used method of segmentation. For a threshold T, the pixel situated at position (i, j) with grayscale value f(i, j), is owed to group 1 if f(i, j) = T. Otherwise the pixel is owed to group 2. In most cases T is chosen manually by the scientist, from a choice of values of T for best identification of the objects of interest. But manual selection of threshold value will not give assurance to provide good segmentation. Hence applying an optimization algorithm the optimum threshold can be identified (Sezgin and Sankur, 2004).

A two dimensional entropy method is adopted in the research of Zheng *et al*. (2010). This method considered not only spatial information, but also considers the gray information and reduces the computational complexity. (Lin and Wu, 2012) proposed a method for multilevel threshold based segmentation in which concentrates on non deterministic approaches to solve this optimization problem. Osma *et al*. (2012) analyzed with the help of harmony fuzzy search algorithm. In this study clustering problem is modeled as optimization problem.

A performance comparison was discussed by Osman *et al*. (2012). The experimental results of uniformity value is compared with the HCOCLPSO by Lin and Wu (2012) and they stated that the used particles in proposed method is lesser than the existing one. Plenty of optimization methods are available in the recent trends. They are firefly algorithm, particle swarm optimization, cuckoo search algorithm, genetic algorithm, ant colony algorithm and artificial bee colony algorithm etc. A best

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Table 1: Analogy of ABC terminology with optimization problems

ABC terminology	Optimization terminology
Number of food sources	Number of solutions (Population size)
Position of food source	Position of solution
Nectar amount	Fitness value
Maximum generations	Maximum number of iterations

optimization algorithm should provide accurate results with in short span of time. The convergence rate should be always high. The ABC (Artificial Bee Colony) algorithm mimics the food foraging behaviour of bevies of honey bees. It is simple, flexible, robust, easy hybridization and easy to implement. In this paper the threshold based image segmentation of an 8 bit lung image is experimentally verified with artificial bee colony algorithm as an optimization tool.

Artificial bee colony algorithm: Artificial bee colony algorithm is an optimization algorithm based on the smart foraging behaviour of honey bee proposed by Karaboga in 2005. Since 2005 several researchers used ABC algorithm as a powerful tool for optimization problems (Zheng *et al*., 2010). In ABC model the colony consists of three groups of bees; employed bee, onlooker bee and scout bee. The employed bees are connected to particular food sources. The number of employed bees in the colony is identical to the number of food sources around the hive. Employed bees go their food source and come back to hive and dance on this area. The employed bee whose food source has been abandoned becomes a scout and starts to search for finding a new food source. On lookers watch the dance of employed bees and choose food source depending on dances. The resemblance of artificial bee colony algorithm with optimization problems is shown in the Table 1.

Pseudo code of ABC algorithm: The pseudo code for proposed ABC algorithm is illustrated as:

- Initialize the basic parameters of ABC (Food source memory matrix, population size and number of iterations
- From the own memory each employed bee goes to a food source and then evaluates its nectar amount and dances in the drive
- On looker bees select their food source from the dances of employed bees
- The employed bee which has best food source becomes scout bee
- Scout bee starts to find new possible food source
- Abandoned food source are determined and are replaced with the new food sources discovered by scouts
- The new best food source is memorized
- Repeat step 2-7 until a condition is met or for a finite number of iterations

There is some fundamental procedure in ABC optimization from the observation of behaviours of bee. (Ma *et al*., 2011) In general the position of ith food source is represented as $Si = (S_{1i}, S_{2i}, \ldots\ldots, S_{iD})$. Information is shared by the employed bees to return to the hive, onlooker bees go to the region of food source explored by employed bees at S_i based on probability P_i defined as:

$$P_i = \frac{fit_i}{\sum_{k=1}^{FS} fit_k}$$

where, FS is total number of food sources. Fitness value fit_i is calculated by using the equation:

$$fit_i = \frac{1}{1+f(s_i)}$$

where, $f(S_i)$ denotes the objective function considered. The on looker finds its food source in the region of S_i by using the following equation:

$$S_{new} = S_{ij} + r(S_{ij} - S_{kj})$$

Where:

S_{new} = The new food source exploited by onlooker
k = The solution in the neighbourhood of I
r = A random number in the range to 1 to +1
j = The dimension of the problem considered

If new fitness is comparatively better than the fitness value achieved so far, then the bee moves to the new food source, otherwise retains the old one. The information is shared with onlookers after all employed bees complete this process. Each onlooker bee selects its food source according to the probability given above. Hence good food source are well accommodated with onlookers. Every bee will search for a better food source for a certain number of cycles or limit and if the fitness value doesn't improve then that particular bee becomes scout bee.

MATERIALS AND METHODS

It is essential to alter a RGB or colour image into grayscale image to condense the number of pixels for image segmentation. Let us take an image with 256 gray levels of size m×n. Generally the pixel's gray value is considered as particle's position. The optimum threshold value is obtained by using ABC model. It is mandatory to start the iteration with random fitness value. A fitness function is to be defined to update the fitness in each iteration. Based on the employee bee and onlooker bee operations a new population is generated. The entire process is to be repeated if we fail to attain terminal condition. Otherwise the process is terminated with an optimum threshold value. The basic flow chart for an ABC model optimization is given in Fig. 1.

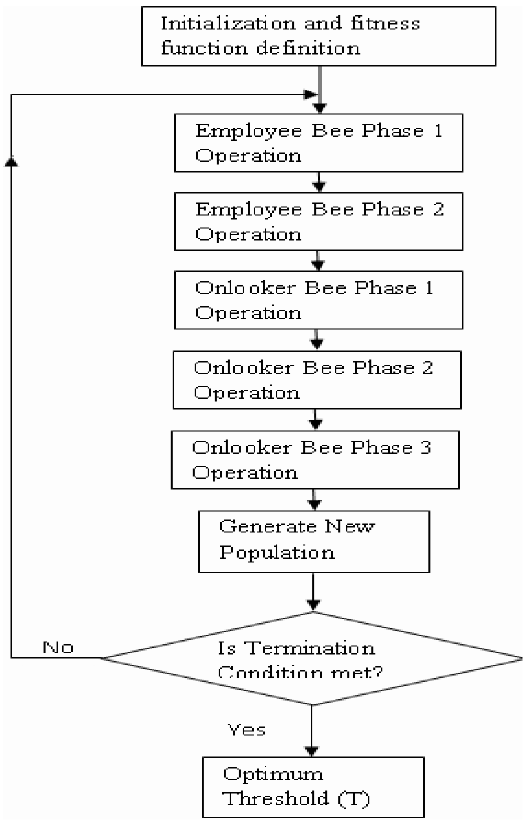

Fig. 1: Flow chart for ABC Model optimization

Once a optimum threshold value was identified the sgmentation process starts. The grandient of each pixel is compared with the optimmum threshold value. If gradient is greater than optimum threshold the pixel value is assigned as 0. Other wise, it is assigned as 1. This process has to be repeated for all the pixels in the image. At the end of this iteration the gray scale image is converted in to binary segmented image. The detailed image segmentation method is shown given in Fig. 2.

Uniformity computation: Uniformity in digital image means unvarying or regular pixels in a segmented image. It is defined as the ratio between the numbers of pixels with correct matching intensity to the total number of pixels in the segmented image. The uniformity helps for the performance estimation for an image through thresholding process. Uniformity value is varies from 0-1. The Uniformity computation measure is given as:

$$u = 1 - 2 * c * \frac{\sum_{j=0}^{c}\sum_{j\in R_j}(f_i - \mu_j)^2}{N * (f_{max} - f_{min})^2}$$

Where:

C = Number of thresholds
R_j = The jth segmented region
f_i = Gray level of the pixel i
i = Mean gray level of the pixel in jth region
N = Total number of pixels in the given image
f_{max} = Maximum gray level of the pixels
f_{min} = Minimum gray level of the pixels

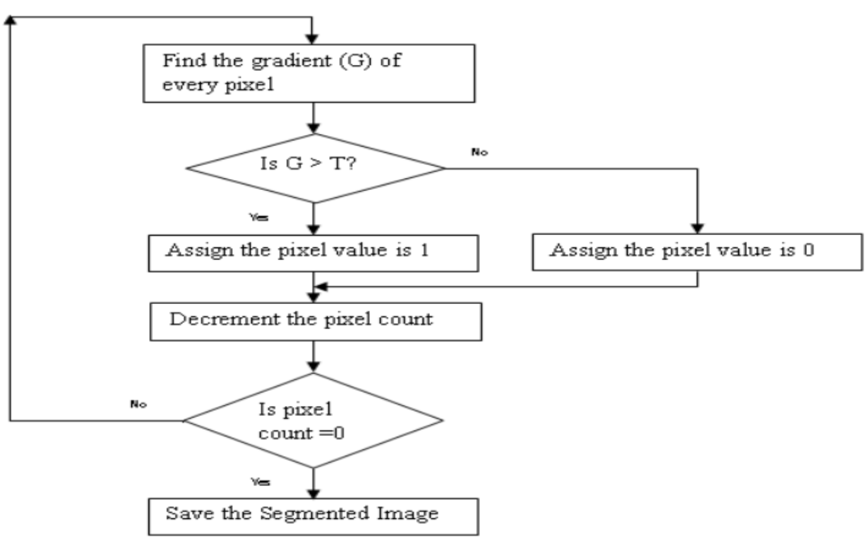

Fig. 2: Flow chart for segmentation

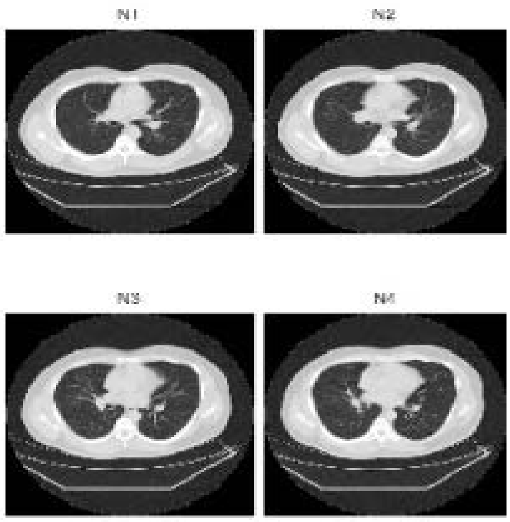

Fig. 3: Input images

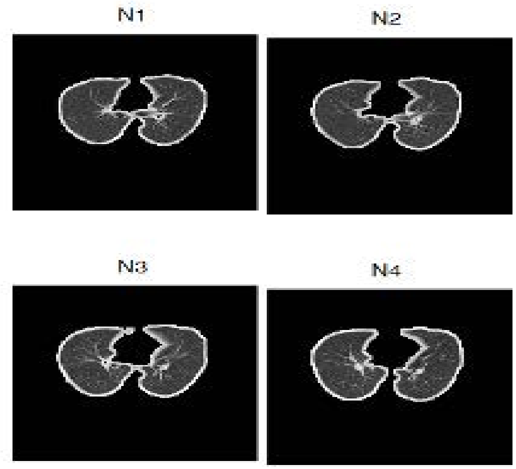

Fig. 4: Output images

Table 2: Comparative results

	Uniformity value	
Input image	Proposed ABC Model	HCOCLPSO
N1	0.982460	0.9645
N2	0.939170	0.9675
N3	0.991886	0.9752
N4	0.993095	0.9776

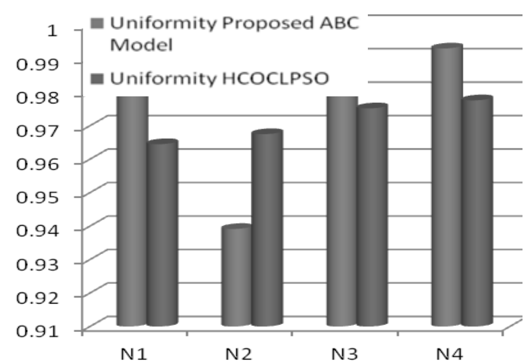

Fig. 5: Graphical view of comparative results

RESULTS AND DISCUSSION

This study describes the experimental results of the proposed method get better results in image segmentation. The proposed technique is implemented in MATLAB. The performance of proposed scheme is evaluated by comparing the result using HCOCLPSO (Alia *et al*., 2009), We have tested our proposed approach using the 8 bit gray scale human lung image.

Figure 3 and 4 shows the input and output images of this proposed technique. Each of the images has certain part is suffered due to disease. The proposed image segmentation technique is applied to all the four input images and the affected part is extracted from the original image which is having high accuracy and uniformity.

Table 1-2 shows the relative outcome with respect to uniformity value of the segmented image. The coding for the proposed ABC model is experimentally verified and weigh against with the existing result of HCOCLPSO (Alia *et al*., 2009) method. The graphical analysis for the relative study between the existing technique and proposed technique is shown in Fig. 5. In the proposed technique the uniformity value is higher than the previous methods. In images N2 the uniformity is low due to failure of edge detection.

CONCLUSION

The presented study, explains consistency value under maximum entropy with ABC model. The noteworthy purpose of this work is to form an optimization model which is used to find the most optimized solution for the change in parts. The final intention of this study is to provide the optimized threshold value. The uniformity value provided in this technique is 0.993095. Moreover the experimental results shown that the proposed method of image segmentation is more accurate and there has been an improvement in the convergent rate. The ABC model shows an acceptable tradeoff between its convergence time and its computational cost. In the ABC case the algorithm does not require initialization as random initial values are employed. However, in order to assure a valid comparison, same initial values are considered for the HCOCLPSO and the ABC method.

Hence, the proposed method has wide spread application in segmenting a particular field from a digital image.

REFERENCES

Alia, M.O., R. Mandava, D. Ramachandram and M.E. Aziz, 2009. A novel image segmentation algorithm based on harmony fuzzy search algorithm. Proceeding of the 2009 International Conference on Soft Computing and Pattern Recognition, December 4-7, 2009, IEEE, Kuala Lumpur, Malaysia, ISBN:978-1-4244-5330-6, pp: 335-340.

Gonzalez, R.C. and R.E. Woods, 2008. Digital Image Processing using MATLAB. 3rd Edn., Prentice Hall, New York.

John, C.R., 2011. The Image Processing Handbook. 6th Edn., CRC Press (Taylor & Francis Group), New York, USA.,.

Kaur, A. and M.D. Singh, 2012. An overview of pso-based approaches in image segmentation. Int. J. Eng. Technol., 2: 1349-1357.

Lin, J.S. and S.H. Wu, 2012. A PSO-based algorithm with subswarm using entropy and uniformity for image segmentation. Proceeding of the 2012 6th International Conference on Genetic and Evolutionary Computing, August 25-28, 2012, IEEE, Taichung, Taiwan, ISBN:978-1-4673-2138-9, pp: 500-504.

Ma, M., J. Liang, M. Guo, Y. Fan and Y. Yin, 2011. SAR image segmentation based on artificial bee colony algorithm. Int. J. Applied Soft Comput., 11: 5205-5214.

Narkhede, H.P., 2013. Review of image segmentation techniques. Int. J. Sci. Mod. Eng., 1: 54-61.

Osman, M.K., M.Y. Mashor and H. Jaafar, 2012. Performance comparison of clustering and thresholding algorithms for tuberculosis bacilli segmentation. Proceeding of the 2012 International Conference on Computer, Information and Telecommunication Systems, May 4-16, 2012, IEEE, Selangor, Malaysia, ISBN:978-1-4673-1550-0, pp: 1-5.

Sezgin, M. and B. Sankur, 2004. Survey over image thresholding techniques and quantitative performance evaluation. J. Electron. Imaging, 13: 146-165.

Zheng, L., G. Li and Y. Bao, 2010. Improvement of grayscale image 2D maximum entropy threshold segmentation method. Proceeding of the 2010 International Conference on Logistics Systems and Intelligent Management, January 9-10, 2010, IEEE, Liaocheng, China, ISBN: 978-1-4244-7 330-4, pp: 324-328.