International Journal of Electrical and Electronic Engineering & Telecommunications

ISSN 2319 – 2518 www.ijeetc.com
Vol. 4, No. 3, July 2015

Research Paper

RETINAL BLOOD VESSEL SEGMENTATION BY FCM CLUSTERING AND ARTIFICIAL BEE COLONY OPTIMIZATION

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Blood vessel segmentation from the retinal image is useful in detecting ocular disorders and laser surgery, the work done till the date for segmentation of blood vessels are satisfactory in some cases, still leave room for improvement, especially in abnormal retinal images. Clustering and pattern analysis are the new technique which are widely used now a days for medical image processing. This paper proposes a method of blood vessel segmentation from the retinal images using a soft clustering method known as Fuzzy C Means clustering (FCM) which assigns membership values to the pixels instead of separating the pixels as in hard clustering problems and the clustering is optimized using recently developed swarm based algorithm Artificial Bee Colony (ABC) optimization.

Keywords: Fundus camera, Clustering, Fuzzy C means, Artificial bee colony optimization

INTRODUCTION

Eyes suffers from many disorders such as Diabetic retinopathy, retinal vein occlusion, glaucoma, macular degeneration due to such diseases a patient suffering may lose his sight, the patient might not notice until it becomes too severe. Early diagnoses of such diseases are necessary. Current methods used in detection of such diseases are manual and requires trained ophthalmologists, also retinal morphology can b important indicator of such diseases, hence segmentation of blood vessels from the retinal image taken from fundus camera is an important task, the low-contrast images at the retina results in narrow blood vessels of the retina which are difficult to extract. Accurate segmentation of blood vessels is necessary. Segmentation can simplify screening of retinopathy by reducing the number of inaccurate decisions taken by the doctors in micro aneurism detection. Detecting abnormalities is critical for early treatment as they are in most cases indication of potentially sight-threatening retinopathy.

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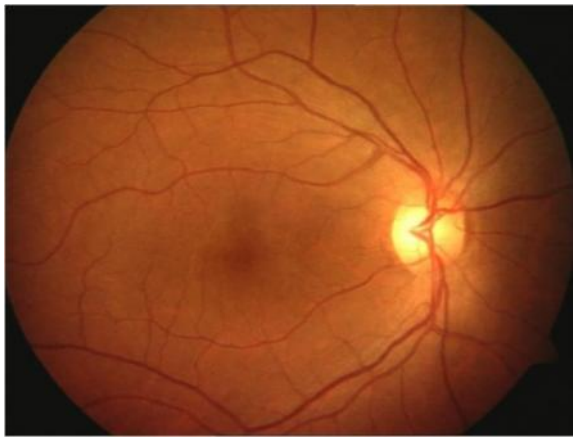
Figure 1: Retinal Image from Fundus Camera



There are three basic approaches for automated segmentation of blood vessels (Chaudhuri *et al.*, 1989): they are thresholding method, tracking method and machine trained classifiers. In the first method, many different operators are used to enhance the contrast between vessel and background, such as Sobel operators, Laplacian operators, Gaussian filters modeling the gray cross-section of blood vessel. Then the gray threshold is selected to determine the vessel. This gray threshold is crucial, because small threshold induces more noise and gray threshold causes loss of some fine vessels, adaptive or local threshold is used. Vessel tracking is another technique for vessel segmentation, whereby vessel centre locations are automatically sought along the vessel longitudinal axis from a starting point to the ending point.

The Fuzzy C-Means clustering is one of the soft clustering method. Dunn proposed the FCM for the first time in 1973 and Bezdek in 1981 improved the FCM, but the drawback of FCM are, FCM suffers from local optima, earlier selection of number of clusters, Euclidian distance measured can unequally weight underlying factors. To overcome such drawback fuzzy clustering algorithms based on bio-inspired methods have been introduced. One such bio-inspired method is The Artificial bees colony (ABC) algorithm, which is a new population-based optimization algorithm developed by Karaboga (2005).

RELATED WORK

A paper published by Radha and Bijee Lakshma (2013), retinal image analysis using morphological process and clustering technique in which Retinal image analysis through efficient detection of exudates and recognizes the retina to be normal or abnormal. The contrast image is enhanced by curvelet transform. Hence, morphology operators are applied to the enhanced image in order to find the retinal image ridges. A simple thrasholding method along with opening and closing operation indicates the remained ridges belonging to vessels. The clustering method is used for effective detection of exudates of eye. Here the threshold value is assumed which is not always the criteria.

The paper published by Benadict Raja and Ravichandran (2011), on “Blood Vessel Segmentation for High Resolution Retinal Images”. They proposed parallel method which has an infrastructure (network of computer) to segment a high resolution image and the new data partition scheme reduces the idle time of the participating nodes and enables parallel computation; therefore the speed of segmentation is increased. The use of enhancement/threshold based segmentation

algorithm further enhances the speed and accuracy of segmentation.

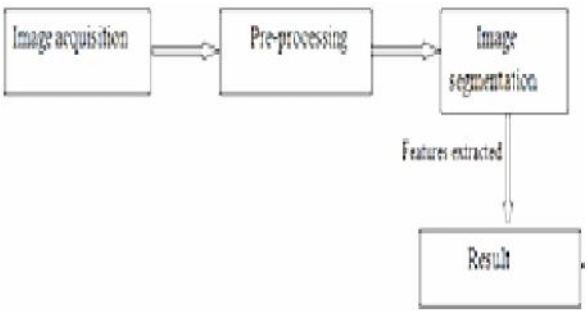
A paper published by Reza Kharghanian and Alireza Ahmadyfard (2012), "Retinal Blood Vessel Segmentation Using Gabor Wavelet and Line Operator". In which they proposed a method for segmenting blood vessels from retinal images. they extract two sets of features for image classification: features based on Gabor wavelet and line operator. At each pixel of retinal image we construct a feature vector consisting of the pixel intensity, four features from Gabor wavelet transform in different scales and two features from orthogonal line operators and compare the result of classification using two classifiers: Bayesian and SVM.

PROPOSED SYSTEM

Retinal blood vessel extraction presented involves

1. Fundus image acquisition
2. Preprocessing
3. Image segmentation

Figure 2: Block Diagram Steps Involved in Blood Vessel Segmentation



Module 1: Fundus Image Acquisition

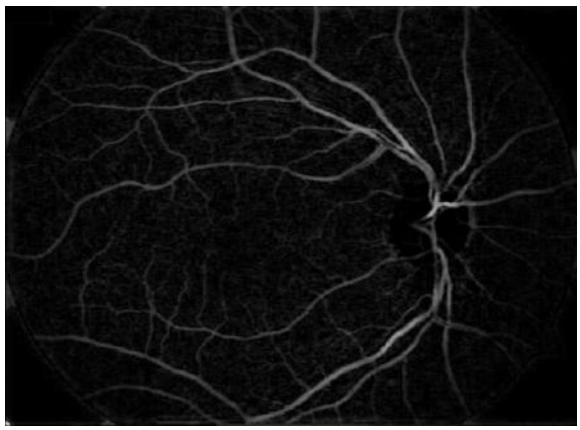
Fundus photography also called fundography (http://en.wikipedia.org/wiki/Fundus_photographs) is the creation of a photograph of the interior surface of the eye, including the retina, optic disc, macula, and posterior pole (i.e., the fundus). The images obtained are in the JPEG format.

Module 2: Pre-Processing

Pre-processing reduces noise in the image which could be the result technician or patient. This helps to improve the quality later on when the image is segmented. Since we require only blood vessel the presence of optic disc region should be found and removed. We have to create a mask to remove the out noise or unwanted region outside the eye.

Once this is done the image is set to proper contrast level by choosing the image in proper color region, we are utilizing the green component of the image since the pixels contrast are enhanced in it the result of the pre-processed image is given below and this image is converted to gray scale for segmentation.

Figure 3: Pre-Processed Image



Module 3: Image Segmentation

Segmentation is the processes of subdividing an image into its constituent regions or objects

that have similar features according to a set of predefined criteria. The features involved are intensity histogram, mean, variance, energy, texture, etc., the level of detail to which the subdivision is carried depends on the applications or the problem being solved. Here we are using Fuzzy C-Means (FCM) clustering along with Artificial Bee Colony (ABC) algorithm with few modification to ABC.

Fuzzy C-Means Clustering

Fuzzy C-Means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method is frequently used in pattern recognition. Basically this algorithm works by assigning membership to each data point corresponding to each cluster centre on the basis of distance between the cluster and the data point. More the data is near to the cluster centre more is its membership towards the particular cluster centre. The iterative unsupervised Fuzzy C-Means (FCM) algorithm is the most widely used clustering algorithm for image segmentation. Most of the medical images are processed and segmented by pattern recognition and clustering.

Artificial Bee Colony Technique

Despite the simplicity of FCM, it is sensitive to initial states and gets stuck in local optima solutions. In addition, a fuzzy clustering problem is a combinatorial optimization problem.

In order to address these issues, many fuzzy clustering algorithms Artificial Bee Colony optimization is used. The ABC algorithm is inspired from the intelligent foraging behavior of honey bee swarms. Its strength is its simplicity and its robustness. In the ABC algorithm, each food source position represents a solution to a specific problem and the amount of nectar in a food source represents the objective function (the fitness) of the solution. ABC was proposed recently by Karaboga. Since its introduction, the ABC algorithm has been applied to various optimization.

Algorithm Flow and Methodology

The Proposed Method

- Initialize the cluster number C, the real number m, the size of the population SN, the value of limit, the value of MR and the maximum cycles number MCN
- Generate initial population Zi using the equation

$$v_{i,j} = g_{\min} + rand(0, 1) \times (g_{\max} - g_{\min})$$

- Calculate the membership matrix using

$$u_{ik} = \frac{1}{\sum_{j=1}^{c} \left(\frac{d_{ik}}{d_{jk}} \right)^{2/(m-1)}} \quad ...(1)$$

- Evaluate the population using

$$fit_i = \frac{1}{1 + J_i(U, V)} \quad J_i(U, V) = \sum_{j=1}^{c} \sum_{k=1}^{n} u_{jk}^{m} \left\| x_k - v_{i,j} \right\|^2 \quad ...(2)$$

- For each employed bee
- Produce new solution
- Calculate the membership matrix using (1)
- Calculate the fitness using (2)
- Apply the greedy selection process
- Calculate the probability values pi for the solutions by

$$p_i = \frac{f(z_i)}{\sum_{j=1}^{Np} (z_j)} \quad ...(3)$$

- Choose a solution zi depending on pi
- Produce new solution
- Calculate the membership matrix using (1)
- Calculate the fitness using (2)
- Apply the greedy selection process
- If there is abandoned solution then
- Replace that solution with a new randomly produced solution by (6) for the scout
- Assign cycle to cycle + 1
- Memorize the best solution (best cluster centers) achieved yet
- Until cycle = MCN
- Do the segmentation by assigning each pixel to the cluster for which the membership value is higher

Figure 4: Flowchart of the Method

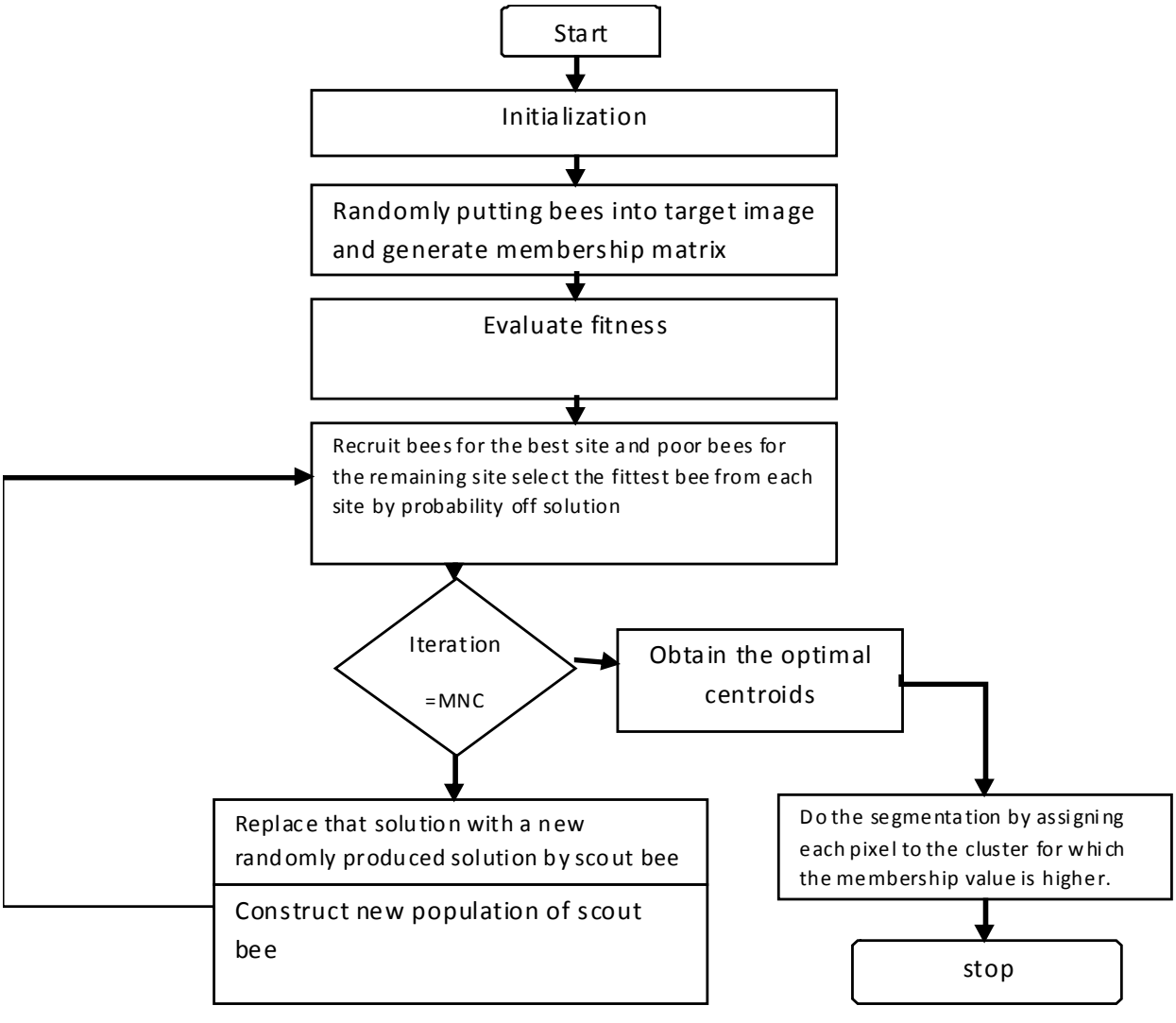


Figure 5: FCM Output

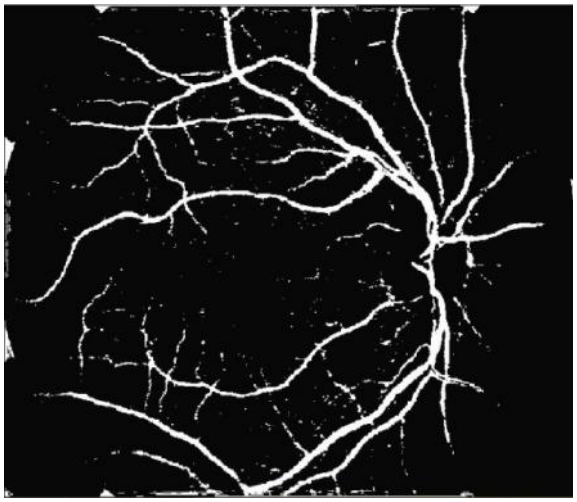
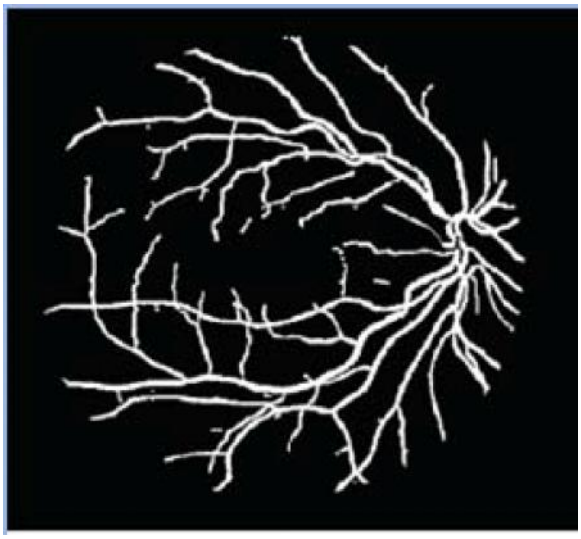


Figure 6: Final Segmented Image



CONCLUSION

In this paper, we have investigated the application of a ABC algorithm to obtain better quality of fuzzy clustering result. And used it to segment the blood vessels from in the retinal image, modification can be applied to improve the exploitation power of the ABC algorithm.

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