Journal of Computational Science xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Journal of Computational Science

journal homepage: www.elsevier.com/locate/jocs

# Computational intelligence optimization approach based on particle swarm optimizer and neutrosophic set for abdominal CT liver tumor segmentation

Ahmed M. Anter[a,c,*], Aboul Ella Hassenian[b,c]

[a] Faculty of Computers and Information, Beni-Suef University, Benisuef, Egypt
[b] Faculty of Computers and Information, Cairo University, Cairo, Egypt
[c] Scientific Research Group in Egypt, (SRGE), Egypt[1]

ARTICLE INFO

*Article history:*
Received 31 December 2016
Received in revised form
28 November 2017
Accepted 9 January 2018
Available online xxx

*Keywords:*
Meta-heuristic
Particle swarm optimization
Segmentation
Neutrosophic set

ABSTRACT

In this paper, an improved segmentation approach for abdominal CT liver tumor based on neutrosophic sets (*NS*), particle swarm optimization (PSO), and fast fuzzy C-mean algorithm (FFCM) is proposed. To increase the contrast of the CT liver image, the intensity values and high frequencies of the original images were removed and adjusted firstly using median filter approach. It is followed by transforming the abdominal CT image to *NS* domain, which is described using three subsets namely; percentage of truth *T*, percentage of falsity *F*, and percentage of indeterminacy *I*. The entropy is used to evaluate indeterminacy in *NS* domain. Then, the *NS* image is passed to optimized FFCM using PSO to enhance, optimize clusters results and segment liver from abdominal CT. Then, these segmented livers passed to PSOFCM technique to cluster and segment tumors. The experimental results obtained based on the analysis of variance (ANOVA) technique, Jaccard Index and Dice Coefficient measures show that, the overall accuracy offered by neutrosophic sets is accurate, less time consuming and less sensitive to noise and performs well on non-uniform CT images.

© 2018 Elsevier B.V. All rights reserved.

## 1. Introduction

Segmentation is a critical and essential process and is one of the most difficult tasks in image processing. Automatic segmentation of CT liver tumor is a very challenging task, due to various factors, such as the low-level contrast and blurry edged images, irregularity in the liver shape and size between the patients and the similarity with other organs of almost same intensity like spleen and stomach. Also, liver parenchyma is stretched over 150 slices in a CT image and different from patients, indefinite shape of the lesions and low intensity contrast between lesions and similar to those of nearby tissues make automatic liver and lesions segmentation difficult [1,2]. Among various image segmentation techniques, traditional segmentation methods have certain drawbacks, which cannot be used for accurate result and time computation.

Fuzzy theory has been applied to image segmentation, which retains more information than that of the hard segmentation methods. Fuzzy C-means (FCM) is a fuzzy clustering method allowing a piece of data to belong to two or more clusters. The FCM algorithm obtains segmentation results by using fuzzy classification [3]. In some applications such as CAD systems, we should consider not only the truth and falsity membership, but also we want the indeterminacy membership. It is hard for classical fuzzy set to solve such problems [3,4]. As a generalization of fuzzy logic, neutrosophic logic introduces a percentage of 'indeterminacy' due to unexpected parameters hidden in some propositions and carries more information than fuzzy logic [5].

Many problems in medical images have been solved by considering bio-inspired meta-heuristic optimization algorithms such as Social Spider Optimization (SSO), Ant Colony Optimization (ACO), Crow Search Optimization (CSO), and particle swarm optimization (PSO). Computational bio-inspired algorithms have been used in situations where conventional techniques cannot find a satisfactory solution or they take too much time to find the solution [42]. Therefore, this paper introduces a very powerful optimization method, both in terms of speed and optimal convergence, which can be con-

* Corresponding author at: Faculty of Computers and Information, Beni-Suef University, Benisuef, Egypt.
*E-mail address:* sw_anter@yahoo.com (A.M. Anter).
[1] http://www.egyptscience.net.

https://doi.org/10.1016/j.jocs.2018.01.003
1877-7503/© 2018 Elsevier B.V. All rights reserved.

Please cite this article in press as: A.M. Anter, A.E. Hassenian, Computational intelligence optimization approach based on particle swarm optimizer and neutrosophic set for abdominal CT liver tumor segmentation, J. Comput. Sci. (2018), https://doi.org/10.1016/j.jocs.2018.01.003

sidered for a wide variety of segmentation problems in medical images.

In this paper, we present an automatic liver tumor segmentation approach based on neutrosohic sets (*NS*), fast fuzzy c-means clustering algorithm (FFCM) and particle swarm optimization algorithm (PSO). To increase the contrast of the CT liver images median filter approach is used to adapt intensity values and remove high frequencies from the original images. It is followed by transforming the abdominal CT image to *NS* domain which is described by using *T*, *I*, and *F* components. The entropy is used to measure and evaluate the indeterminacy in *NS* domain. Then the *NS* image is passed to FFCM clustering algorithm guided by PSO to enhance, optimize cluster results and segment abdominal CT image in less time consuming with high accuracy. To demonstrate the performance of this new approach, a methodical and statistical comparisons with two other techniques for CT image segmentation are carried out.

The remainder of this paper is organized as follows. Section 2 discusses the related works. Section 3 recalls some preliminaries of the fuzzy c-means, particle swarm optimization and neutrosophic sets that are relevant to this paper. The hybrid proposed *NS*-PSOFFCM approach is discussed in Section 4. Experimental results and analysis with details are discussed in Section 5. Finally, conclusion and future work are discussed in Section 6.

## 2. Related work

Many algorithms and several researches have been proposed to address the problems of image segmentation in general and in medical imaging in particulars. For example, Siri and Latte [6], proposed a new fuzzy C-means algorithm ($\alpha$-FCM) to segment the image on *NS* domain. The experimental results demonstrate that the proposed approach can segment the images automatically and effectively, but it is very time consuming. Also, Cheng et al. [7], proposed a novel segmentation approach based on neutrosophic theory and modified fuzzy clustering approach. Zhang [8], applied watershed segmentation based on neutrosophic sets to image segmentation and represent the objects as *T* and background as *F*. The blurry edges are gradually changed from objects to background, and there are no clear boundaries between the objects and edges or between the background and edges. The blurry boundaries are defined as *I*. This approach is good for handling a uniform background and objects with blurry edges. Anter et al. [3], improved liver segmentation using neutrosophic sets and FCM. The liver CT images are transformed to *NS* domain. Then the adapted threshold is used using three classes FCM clustering algorithm.

Many problems in abdominal CT images have been solved by considering bio-inspired meta-heuristic optimization algorithm. The main drawbacks of FCM which are the number of clusters needs to be predefined and the results is dependent on the initial selection of the centroids. FCM known to present very slow convergence on hard problems, such as gray-scale CT images. To overcome this shortcoming of FCM, FCM can be guided by computational meta-heuristics algorithms such as PSO algorithm. Alam et al. [9], proposed a hybridized clustering approach for image segmentation using PSO to improve the classical FCM algorithm. The results show that the hybridized clustering approach can provide better effectiveness on image segmentation.

Jing and Bo [10] proposed a fast FCM method together with PSO for image segmentation. The PSO algorithm is an optimization process which automatically determines the number of clusters as well as the center of the clusters. Venkatesan and Parthiban [11] proposed fuzzy C-means and maximum entropy optimized by PSO to segment and detect abnormalities present in the image. The analysis is carried out by comparing the segmentation results and intra/inter cluster distances. Different types of noise has been added to the original image to test the robustness of FCMPSO. The FCMPSO gives accurate results and less time consuming. Hongpo et al. [12] proposed hybrid algorithm using PSO incorporated with FCM algorithm (PSOFCM) to segment sonar images. The results show that the PSOFCM is better than FCM in sonar segmentation images.

Many researchers applied multilevel Otsu threshold using PSO for image segmentation for example, Sathya and Kayalvizhi [13], proposed a multilevel thresholding method based on PSO and compared their method with genetic algorithm (GA) based threshold. The experimental results show that the PSO executed faster and more stable than GA and less parameters than GA. However, a general problem with the PSO and other optimization algorithms is that of becoming trapped in a local optimum, such that it may work in some problems but may fail on others. For this reason researcher tried to select best parameters for PSO to get high accuracy. Ates et al. [43] applied Darwin PSO (DPSO) with multi-level threshold for improving segmentation accuracy but still has problems in time computation.

Chander et al. [44] proposed a new variant of PSO with adapting 'social' and 'momentum' components for image segmentation using optimal multi-level thresholding. The proposed system used iterative scheme to obtain initial values of candidate multilevel thresholds

Zhang et al. [14] illustrated how possibility C-means algorithm (PCM) can be integrated with PSO and provide a significant improvement on the efficiency of the segmentation. The PCM is more accurate as compared to FCM, as it overcomes the relative membership problem of FCM in image segmentation, and has shown good performance in the presence of severe noise and outliers. Experimental results show that the proposed algorithm has a significant improvement on the effect and efficiency of segmentation comparing with the standard FCM clustering algorithm.

Gopal and Karnan [15], proposed an intelligent system to diagnose brain tumor through magnetic resonance imaging (MRI) using FCM clustering algorithm along with intelligent optimization algorithm genetic algorithm (GA), and PSO. The detection of tumor is performed in two phases. In first phase pre-processing and enhancement are applied to remove labels and X-ray marks and to remove high frequency components using median filter. The FCM calculates the adaptive threshold and PSO automatically select initial cluster seed point. Hammouche et al. [16], illustrated that PSO based segmentation is accurate and better than other methods such as GA, ant colony optimization (ACO), differential evaluation (DE), and simulated annealing (SA) in terms of precision, robustness of the results, and running time. Mitra et al. [17], illustrated that the PSO better than GA in terms of time consuming in CPU and fitness value.

Raju and Rao [18] proposed FCM algorithm integrated with PSO for segmenting mammography images. The experimental analysis and performance shows that, FCM along with PSO gives better performance and good accuracy, as compared to other techniques. The computational complexity is largely reduced using the proposed algorithm for image segmentation. Deepa [19] used the FCM clustering algorithm for segmentation which is further enhanced by using PSO algorithm. The proposed FCM clustering algorithm for segmentation and PSO for clear identification of clusters in mammogram images. The result indicates that this system can facilitate the doctors to detect breast cancer in the early stage of diagnosis process. Ozturk et al. [20] presented a dynamic clustering based on PSO (DCPSO). The experimental results show that, the proposed approach automatically determines the optimum number of clusters using binary PSO. Then the centers of the selected clusters are refined by K-means algorithm.

Therefore, the implementing *NS* approach to the segmentation process for CT images may allow achieving both vital and important goals at once. As a result, it is easy to detect that PSO-based

Please cite this article in press as: A.M. Anter, A.E. Hassenian, Computational intelligence optimization approach based on particle swarm optimizer and neutrosophic set for abdominal CT liver tumor segmentation, J. Comput. Sci. (2018), https://doi.org/10.1016/j.jocs.2018.01.003

Download English Version:

https://daneshyari.com/en/article/6874431

Download Persian Version:

https://daneshyari.com/article/6874431

Daneshyari.com