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Journeying of Particle Swarm Optimization in Medical Image Segmentation

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Abstract- **Image segmentation is the problem of partitioning an image into momentous parts. The crucial subject matter of this opinion is to identify the suitable method for image segmentation applied on medical images. Medical images have made a great impact on medicine, diagnosis, and treatment. The most important part of image processing is image segmentation. Many image segmentation methods via Particle Swarm Optimization for medical image analysis have been presented here. In this paper, we have illustrated the latest segmentation methods applied in medical image analysis in Magnetic Resonance Imaging and Computed Tomography image analysis. We present herein a critical appraisal of the current status of PSO for the segmentation of anatomical medical images. We conclude with a discussion of PSO and propose the future of image segmentation methods.**

Keywords: **Particle Swarm Optimization, Medical Image Segmentation**

I. INTRODUCTION

Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super-pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).

Image data is of immense practical importance in medical informatics. Medical images or imaging modalities, such as Computed Axial Tomography (CAT), Magnetic Resonance Imaging (MRI), Ultrasound, and X-Ray, CT (Computed Tomography), PET (Positron Emission Tomography) etc. in standard DICOM formats are often stored in Picture Archiving and Communication Systems (PACS) and linked with other clinical information in EHR clinical management systems. Research efforts have been devoted to processing and analyzing medical images to extract meaningful information such as volume, shape, motion of organs, to detect abnormalities, and to quantify changes in follow-up studies. Automated image segmentation, which aims at automated extraction of object boundary features, plays a fundamental role in understanding image content for searching and mining in medical image archives. In the best of worlds, we wouldlike to have algorithms which can automatically detect diseases, lesions andtumors, and highlight their locations in the large pile of images.

Several general-purpose algorithms and techniques have been developed for image segmentation. They are thresholding method, clustering , Compression based methods, Histogram-based methods, Edge detection , Region-growing methods, partial differential equation (PDE)-based method , variational methods, Graph partitioning methods, optimization algorithm, watershed transformation. To be useful, these techniques must typically be combined with a domain's specific knowledge in order to effectively solve the domain's segmentation problems. However, in this paper we focused on PSO for medical image segmentation for the reason that of its high performance.

The rest of the paper is organized as follows. Section 2 provides the Importance of the Medical Image Segmentation, Section 3 evaluates supported literature for medical segmentation using PSO. Exploration of PSO, and summary of discussing various research and comparative analysis are elaborated in Section 4 and Section 5 concludes with further future enhancements with possible tracks.

II. IMPORTANCE OF MEDICAL IMAGE SEGMENTATION

Segmentation is very vital as a first step in Medical Image Analysis. It causes incorrect analysis of image

finally. Therefore a correct segmentation method is important. The algorithms, called image segmentation algorithms, play a vital role in numerous biomedical imaging applications and also necessary to be a universal algorithm for better understanding the type, location and detection of the various diseases. Normally, ROI is acquired by the proper imaging device like MRI for soft tissues. Image is exhibited to clinicians by a display device like monitor finally. It's so beneficial if the system can report the result of analysis in the text format. Applications of image segmentation are Locate tumours and other pathologies, Measure tissue volumes, Computer-guided surgery, Diagnosis, Treatment planning, Study of anatomical structure and Finding, simplification, classification, recognition Region of Interest (ROI). It may also be noted it was proven in edge detection and localization. The main idea of this present work is the application of PSO based optimization. However for medical image processing the desired result should be highly objective.

III. LITERATURE REVIEW

This section illustrates few recent medical image segmentation methods. Various researchers have been performed Medical Image Segmentation methods. This section compares the summary of various researchers.

Samy Ait-A et.al., described a method that combines Hidden Markov Random Fields and Particle Swarm Optimisation to perform segmentation. Performance evaluation was carried out on sample medical images from the Brainweb database. From the tests we conducted, the HMRF-PSO combination method outperforms Kmeans and threshold based segmentation techniques. Otsu, MOG, and MOGG . Tests conducted have focused on the images from the Brainweb database. A comparison with other segmentation techniques must also be carried out.

L Dhanalakshmi et.al., presented a new algorithm for spatial fuzzy segmentation using modified particle swarm optimization of medical & multimedia data. The algorithm is realized by modifying the scaling parameters in the conventional fuzzy C-means (FCM) algorithm using Modified Particle Swarm Optimization (MPSO). Spatial coordinates depend on filter radius, weight, gradient & threshold. Firstly, the initial parameters in the FCM are replaced by optimized parameters, & thus the corresponding algorithm is derived & called as the SFCM-MPSO. Outcomes of the experiment on both real MR images & Multimedia images demonstrate that the proposed algorithms have better performance when noise & other artefacts are present than the standard algorithms.

Parineeta Suman et.al., proposed a novel method, wherein segmentation will be applied on a fuzzy filtered image. The fuzzy filter applies fuzzy rules to detect regions in the image viz. edge region, homogeneous region, and noisy region by using different gradients, and then filters the noisy region using fuzzy membership rules. The proposed method has been tested on different ultrasound images, and the experimental results demonstrate its effectiveness.

Weng Chun Tan et.al., presented a method of image segmentation and detection technique in human spermatozoa image using a modified Pulse Coupled Neural Network (PCNN). As comparison to conventional PCNN, the modified PCNN is proposed with less number of parameters. Although number of parameters is reduced, the proposed method still has difficulty on choosing parameters value. So, the network is optimized with Particle Swarm Optimization (PSO) where a new fitness function was introduced as Mutual Information also applied Laplacian of Gaussian (LoG) filter on sperm images to detect the centroid of human sperm heads. The results showed that the proposed method was demonstrated promising capability in segmenting Region of Interest (ROI) in a frame and detecting the centroid of sperm head.

Mohammad Majid al-Rifaie et.al., proposed an umbrella deployment of swarm intelligence algorithm, such as stochastic diffusion search for medical imaging applications for identification of metastasis in bone scans and microcalcifications on mammographs, for the first time, the use of the algorithm in assessing the CT images of the aorta is demonstrated along with its performance in detecting the nasogastric tube in chest X-ray. In addition, a hybrid swarm intelligence-learning vector quantisation (LVQ) approach is proposed in the context of magnetic resonance (MR) brain image segmentation. The particle swarm optimisation is used to train the LVQ which eliminates the iteration-dependent nature of LVQ. The proposed methodology is used to detect the tumour regions in the abnormal MR brain images. MR brain images collected from M/s. Devakai Scan Centre, Madurai, India.

Sasithradevi. A et.al., addressed an image segmentation technique based on Bacterial Foraging (BF) and Particle Swarm Optimization (PSO) algorithm and a synergy algorithm for image segmentation is proposed. Initially adaptation is done on BF algorithm by computing the step length using the number of variables in the search space. Further, on exhaustive analysis of BF algorithm, it was revealed that the tumble behavior will lead to random delay in searching optimal solutions and premature

convergence. This synergy algorithm makes use of PSO in providing social information and adaptive BF algorithm in finding new optimal threshold values using elimination and dispersal. The experimental results running on these benchmark images have demonstrated that the proposed method may segment images effectively and ABSO is also a useful tool for image segmentation.

The objective function of Otsu method which is a statistical process, Particle Swarm Optimization with an intuitive algorithm (PSO) by maximizing, the optimal threshold values on a medical image were studied to find. The values obtained were tested with a standard test image and brain magnetic resonance (MR) image exposed on the tumor region in segmentation, Otsu-PSO method performance was monitored by Muhammet Üsame ÖZİÇ et.al.

Saeid Fazli et. al., proposed an efficient and adaptive method for segmentation of lung CT images. The proposed algorithm uses adaptive mean shift method that estimate the bandwidth parameter by using fixed bandwidth estimation. Because of close dependency of kernel density estimation method to the bandwidth parameter, Particle Swarm Optimization algorithm is used to optimize this parameter. This method is achieved better segmentation that can carry out small lung nodules and detecting regions within an CT image. Experimental results on a large dataset of diverse lung CT images prove that the proposed algorithm accurately and efficiently detects the borders and regions of lung images. We use Particle Swarm Optimization algorithm to optimize bandwidthparameter. Based on a large set of lung images, we have shown that our proposed method give better segmentation results compared to other methods.We also present an accurate method to obtain best bandwidth parameter. This method is a good alternative for old estimation and trial and error methods. The developed algorithm can help us to automate lung CT images as thefirst step in analyzing and diagnosing pulmonary diseases.

Fayçal HAMDAOUI et.al., dealt with hardware implementation of PSO algorithm for medical images segmentation using Xilinx System Generator (XSG) and proposed an inteligent technique of segmentation based PSO using the Xilinx System Generator tool. It is a new application in medical image processing that offers an architecture based design for segmentation in this work.

Aiju Li et.al proposed the medical image segmentation based on maximum entropy multi-threshold segmentation optimized by improved cuckoo search algorithm (MCS). The results indicate that the method proposed by the paper can improve the accuracy of medical image segmentation, and have good robustness and good practical value. Maximum Entropy Method, Two-dimensional Maximum Entropy Method , PSOME , MCSME. Simulation results show that MCS-ME can overcome the shortcomings of traditional medical image segmentation method.

Otilio Paulo S. Neto et.al., presented a methodology for automatic segmentation of masses in digital mammograms based on two principles such as Particle Swarm Optimization (PSO) and Graph Clustering. Lastly, the proposed methodology is suitable for being safely integrated to a computer-aided detection tool, providing the specialist with a second opinion at the precocious diagnosing of breast cancer.

E. Setiawati et.al., proposed an image clustering approach for follicles segmentation using Particle Swarm Optimization (PSO) with a new modified non-parametric fitness function. The new modified fitness function use Mean Structural Similarity Index (MSSIM) and Normalized Mean Square Error (NMSE) to produce more compact and convergent cluster. The proposed fitness function is compared to a non-parametric fitness function proposed by previous research. Experimental results show that the proposed PSO fitness function produce more convergent solution than previous fitness function especially on ultrasound images. PSO with contrast enhancement produce closer Region of Interest (ROI) toward to the reference ROI which manually identified by doctor as well as conclude that contrast enhancement can improve the extracted follicular size to be closer toward to the actual follicular size.

Romesh Laishram et.al., attempted to pull out a new and a practical approach for enhancing the underlying delicate architectures of the human brain images captured by a Magnetic Resonance Imaging (MRI) machine in a much better way and presented PSO based optimization of FCM algorithm i.e. PSOFCM and its application in human Brain MRI image segmentation for automatic detection of abnormalities. The segmented image is further processed for edge detection using canny edge detector. The result obtained through PSOFCM yields better edge detected image compared to GAFCM segmentation.

IV. PARTICLE SWARM OPTIMIZATION (PSO) ALGORITHM

PSO was firstly developed by Kennedy and Eberhart in 1995. The researchers adopted due to its optimization accuracy to solve variety of engineering optimization problems. In this decade PSO based approaches are widely efficient in image segmentation

application. PSO is a heuristic global optimization method and also an optimization algorithm, based on swarm intelligence. The concept of PSO is originated from the behavior of particles of swarm and the social interaction between particles. While searching for the food, the birds get scattered or they move together to find the food is the nature of behavior. The birds search for the food from one place to another, the bird which is nearer to food can smell the food. The basic algorithm of PSO consists of n swarm particle, and the position of each of the particle stands for the potential solution. The swarm particle changes its position according to the three principles such as Keep its inertia, Update the condition with respect to its optimal position and Update the condition wit. The methodology implements the PSO algorithm with some image segmentation techniques. It includes four stages. The first stage is to convert the Digital Imaging and Communication in Medicine (DICOM) file format into image file format. The second stage is implementing the PSO algorithm with the change in the value of n. The third stage is based on the elapsed time selecting the best resultant image from the segmented images. The fourth stage is extracting the tumor affected region in medical image .

The Particle Swarm Optimization (PSO) is theoretical in scientific research and engineering, which is based on the swarm intelligence. The searching is carried out by the speed of the particle with no mutation calculation and no overlapping. The optimization of the particle and the most optimist particle can transmit information onto the other particles and the speed is very high and efficient through the new generations. The PSO accepts the real number code, the calculation is very simple, and it easily depicts the direct solution. The number of dimension is equal to the constant of the solution.

Comparative Analysis

This section points up few recent medical image segmentation methods using PSO. Various researchers have been executed on Medical Image Segmentation methods using PSO. This section summarizes the various research outline. Table 1 provides the summary of different researcher's conclusion.

TABLE I. SYNOPSIS OF MEDICAL IMAGE SEGMENTATION BY PSO

Researcher	Image segmentation methods	Medical images
Fayçal HAMDAOUI et.al.,	Particle Swarm Optimization	Medical images
Samy Ait-A et.al.,	Hidden Markov Random Fields (HMRF) Particles Swarm Optimization (PSO) HMRF-PSO K-means Threshold based techniques	Brain web database
Sasithradevi. A et.al.,	Bacterial Foraging (BF) Particle Swarm Optimization (PSO) algorithm	Benchmark images
Muhammet Üsame ÖZİÇ et.al.,	Otsu-PSO	Brain magnetic resonance (MR) image
Saeid Fazli et. al.,	Particle Swarm Optimization	Lung ct images
Romesh Laishram et.al.,	Particle Swarm optimization incorporating Fuzzy C Means Clustering (PSOFCM)	Human brain images captured by a magnetic resonance imaging (MRI)
Weng Chun Tan et.al.,	Pulse Coupled Neural Network (PCNN). Modified Pulse Coupled Neural Network (PCNN). Particle Swarm Optimization (PSO) Laplacian of Gaussian (LoG)	Human spermatozoa image
Mohammad Majid al-Rifaie et.al.,	Hybrid Swarm Intelligence-Learning Vector quantisation (LVQ) Particle Swarm Optimisation	Magnetic resonance (MR) brain image
Otilio Paulo S. Neto et.al.,	Otsu Particle Swarm Optimization (PSO Graph Clustering.	Digital mammograms
E. Setiawati et.al.,	Particle Swarm Optimization (PSO)	Polycystic ovary syndrome ultrasound images

L Dhanalakshmi et.al.,	Fuzzy C-means (FCM) algorithm using Modified Particle Swarm Optimization (MPSO) SFCM-MPSO	MR images & multimedia images
Parineeta Suman et.al.,	Particle Swarm Optimization	Ultrasound image
Aiju Li et.al.,	Improved cuckoo search algorithm (MCS). Maximum Entropy Method, Two-dimensional Maximum Entropy Method , PSOME , MCSME.	Medical images

From the table, it is undoubtedly demonstrated that PSO is produced good result in medical image segmentation. Also, PSO is integrated with Fuzzy C-Means, PCNN, LVQ, BF, Otsu, ME, and it produced better results than other existing algorithms. Furthermore, PSO contracted with hardware implementation for medical image segmentation using Xilinx System Generator (XSG). In addition to, the fitness function of PSO is modified to produce more compact and convergent clusters by non-parametric fitness function. Consequently, PSO is the perfect optimized method for segmenting medical images. The intend of this article is medical image segmentation. To get better results, PSO can be merged with SVM. The main steps of the proposed approach can be summarized as follows and the proposed algorithm is baptized as Progressive PSOSVM.

The algorithm has the following steps.

Step 1: Read the image.

Step 2: Separate the background using snake optimization method.

Step 3: Extract the features.

Step 4: Enter the most suitable number of clusters.

Step 5: Calculate the elapsed time and select the best resultant image using PSO and SVM and Apply Normalized Cut algorithm to get similarity and dissimilarity between different clusters.

V. CONCLUSION

Enthused by the flocking and schooling patterns of birds and fish, Particle Swarm Optimization (PSO) was invented and then later realized how well their algorithms worked on optimization problems. Particle Swarm Optimization might sound complicated, but it's really a very simple algorithm. Over a number of iterations, a group of variables have their values adjusted closer to the member whose value is closest to the target at any given moment. Imagine a flock of birds circling over an area where they can smell a hidden source of food. The one who is closest to the food chirps the loudest and the other birds swing around in his direction. If any of the other circling birds comes closer to the target than the first, it chirps louder and the others veer over toward him. This tightening pattern continues until one of the birds happens upon the food. It's an algorithm that's simple and easy to implement. The same techniques are followed for medical image segmentation by PSO. This paper recapitulates medical image segmentation with PSO and evaluated the performance against different datasets. The outline helps researchers to select appropriate medical image segmentation method. Also, a new approach is proposed using PSO and SVM with Snake optimization method and Normalized Cut algorithm for betterments which is named as Progressive PSOSVM for image segmentation. As a future work, the proposed approach will be compared with modified approaches such as adaptive chaotic PSO and hybrid kernel support vector machine and Naïve Bayes and Neural networks incorporated with Fzzy.

REFERENCES

[1]. Samy Ait-A et.al., “Medical Image Segmentation Using Particle Swarm Optimization”, International Conference on Information Visualisation (IV), DOI: 10.1109/IV.2014.68, IEEE Xplore 2014.

[2]. L Dhanalakshmi et.al., “A novel method for image processing using Particle Swarm Optimization technique” International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), DOI: 10.1109/ICEEOT.2016.7755326, IEEE Xplore, 2016.

[3]. Parineeta Suman et.al., “Seeded Region Growing Segmentation on Ultrasound Image using Particle Swarm Optimization” IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), DOI: 10.1109/ICCIC.2015.7435715, IEEE Xplore, 2016

[4]. Weng Chun Tan et.al., “Segmentation and detection of human spermatozoa using modified Pulse Coupled Neural Network optimized by Particle Swarm Optimization with Mutual Information” IEEE 10th Conference on Industrial Electronics and Applications (ICIEA), IEEE Xplore, 2015.

[5]. Mohammad Majid al-Rifaie et.al., “Deploying swarm intelligence in medical imaging identifying metastasis, micro-calcifications and brain image segmentation”, IET Systems Biology (Volume: 9, Issue: 6, 12 2015) Page(s): 234 – 244, DOI: 10.1049/iet-syb.2015.0036, 2015.

[6]. Sasithradevi. A et.al., “Synergy of adaptive bacterial foraging algorithm and Particle Swarm Optimization algorithm for image segmentation”, International Conference on Circuit, Power and Computing Technologies (ICCPCT), DOI: 10.1109/ICCPCT.2014.7054778, IEEE Xplore, 2014.

[7]. Muhammet Üsame ÖZİÇ et.al., “Detection of Tumor With Otsu-PSO Method On Brain MR Image” IEEE 22nd Signal

Processing and Communications Applications Conference (SIU 2014), 2014.
[8]. Saeid Fazli et. al., "Automated Lung CT Image Segmentation Using Kernel Mean Shift Analysis "Iranian Conference on Machine Vision and Image Processing (MVIP), 2013, DOI: 10.1109/IranianMVIP.2013.6780017, IEEE Xplore, 2014.
[9]. Fayçal HAMDAOUI et.al., "Real Time Implementation of Medical Images Segmentation Based on PSO"International Conference on Control, Decision and Information Technologies (CoDIT), DOI: 10.1109/CoDIT.2013.6689516, IEEE Xplore, 2013
[10]. Aiju Li et.al., "Medical Image Segmentation Based on Maximum Entropy Multi-threshold Segmentation Optimized by Improved Cuckoo Search Algorithm", International Congress on Image and Signal Processing (CISP), DOI: 10.1109/CISP.2015.7407926, IEEE Xplore, 2016
[11]. Otilio Paulo S. Neto et.al., "Automatic segmentation of masses in digital mammograms using particle swarm optimization and graph clustering", International Conference on Systems, Signals and Image Processing (IWSSIP), DOI: 10.1109/IWSSIP.2015.7314189, IEEE Xplore, 2015
[12]. E. Setiawati et.al., " Particle Swarm Optimization on follicles segmentation to support PCOS detection" International Conference on Information and Communication Technology (ICoICT), DOI: 10.1109/ICoICT.2015.7231453, IEEE Xplore, 2015
[13]. Romesh Laishram et.al., "A Novel MRI Brain Edge Detection Using PSOFCM Segmentation and Canny Algorithm" International Conference on Electronic Systems, Signal Processing and Computing Technologies, DOI: 10.1109/ICESC.2014.78, IEEE Xplore, 2014.
[14]. S. Mahalakshmi et.al., "Detection of Brain Tumor by Particle Swarm Optimization using Image Segmentation", Indian Journal of Science and Technology, Vol 8(22), DOI: 10.17485/ijst/2015/v8i22/79092 September 2015.
[15]. Gundeep Bajwa et. al., "Medical Image Segmentation based on PSO-PFC", International Journal of Computer Applications (0975 – 8887) , Volume 126 – No.10, September 2015.
[16]. Fahd Mohsen et.al., "A New Image Segmentation Method based on Particle Swarm Optimization", International Arab Journal of Information Technology, Volume 9 – No.5, September 2012.
[17]. Devraj Mandal et.al., "Robust medical image segmentation using particle swarm optimization aided level set based global fitting energy active contour approach", Journal of Engineering Applications of Artificial Intelligence, ACM digital Library, Volume35, Pages 199-214 , October, 2014 .
[18]. R. Harikumar et.al., "Performance Analysis of Medical Image Segmentation and Edge Detection using MEM and PSO Algorithms", Applied Mathematics & Information Sciences: An International Journal, 9, No. 6, 3235-3243 , 2015.
[19]. Dilpreet Kaur et.al., "Intelligent Medical Image Segmentation Using FCM, GA and PSO", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (5) , 6089-6093, 2014.