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# Medical Image Segmentation Using Penalized FCM and Pollination Based Optimization Approach

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***Abstract- Image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). Medical images are very difficult to process because in medical field minute details of image are also matter a lot that's why they need to be divided in such a manner so that their minute details can be easily examined. To divide the image into parts is called as segmentation. In this work image segmentation is used to find the region of interest (ROI). In this process image is divided into different segments. The segments have to be divided on the basis of the similarity. The images used for this has to be segmented in a proper way so that hidden information from medical images can be extracted. The main problem in segmentation is that after segmentation the edges and the logical information from images get dispersed. We will use PFCM, GA & FCM Algorithms.***

***Keywords: Medical Image Segmentation, PFCM, FCM, GA, PBO.***

## I. INTRODUCTION

**1.1 Image segmentation:** 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 analyse. 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 visual 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 colour, intensity or texture.

### 1.2 METHODS OF SEGMENTATION

**1.2.1 Thresholding**: The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image [4]. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and k-means clustering. Recently, methods have been developed for thresholding computed tomography (CT) images. The key idea is that, unlike Otsu's method, the thresholds are derived from the radiographs instead of the (reconstructed) image

**1.2.2 Clustering methods:** The K-means algorithm is an iterative technique that is used to partition an image into K clusters. The basic algorithm is:

1. Pick *K* cluster centres, either randomly or based on some heuristic
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster centre
3. Re-compute the cluster centres by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (i.e. no pixels change clusters)

**1.2.3 Compression-based methods:** Compression based methods postulate that the optimal segmentation is the one that minimizes, over all possible segmentations, the coding length of the data. The connection between these two concepts is that segmentation tries to find patterns in an image and any regularity in the image can be used to compress it. The method describes each segment by its texture and boundary shape. Each of these components is modelled by a probability distribution function and its coding length is computed as follows:

**1.2.4 Histogram-based methods:** Histogram-based methods are very efficient when compared to other image segmentation methods because they typically require only one pass through the pixels. In this technique, a histogram is computed from all of the pixels in the image, and the peaks and valleys in the histogram are used to locate the clusters in the image. Color or intensity can be used as the measure. A refinement of this technique is to recursively apply the histogram-seeking method to clusters in the image in order to divide them into smaller clusters. This is repeated with smaller and smaller clusters until no more clusters are formed. One disadvantage of the histogram-seeking method is that it may be difficult to identify significant peaks and valleys in the image. Histogram-based approaches can also be quickly adapted to occur over multiple frames, while maintaining their single pass efficiency.

 

**1.2.5 Edge detection**: Edge detection is a well-developed field on its own within image processing. Region boundaries and edges are closely related, since there is often a sharp adjustment in intensity at the region boundaries. Edge detection techniques have therefore been used as the base of another segmentation technique. The edges identified by edge detection are often disconnected. To segment an object from an image however, one needs closed region boundaries. The desired edges are the boundaries between such objects. Segmentation methods can also be applied to edges obtained from edge detectors.

**1.2.6 Region-growing methods:** The first region-growing method was the seeded region growing method. This method takes a set of seeds as input along with the image. The seeds mark each of the objects to be segmented. The regions are iteratively grown by comparing all unallocated neighbouring pixels to the regions. The difference between a pixel's intensity value and the region's mean, $\delta$, is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region. This process continues until all pixels are allocated to a region.

**1.3 Artificial Intelligence:** Artificial Intelligent is the study and design of an intelligent agent, where an intelligent agent is a system that perceives its environment and takes actions that maximizes its chance of success. Humankind has given it the scientific name Homo sapiens man the wise because our mental capacities are so important to our everyday lives and our sense of self. The field of artificial intelligence, or AI, attempts to understand intelligent entities. Thus, one reason to study it is to learn more about ourselves. But unlike philosophy and psychology, which are also concerned with intelligence, AI strives to build intelligent entities as well as understand them. Another reason to study AI is that these constructed intelligent entities are interesting and useful in their own right.

## II. ALGORITHM USED

**PFCM:** PFCM- fuzzy Penalized c-means (FPCM) model and algorithm that generated both membership and typicality values when clustering unlabeled data. FPCM constrains the typicality values so that the sum over all data points of typicality's to a cluster is one. The row sum constraint produces unrealistic typicality values for large data sets. In this paper, we propose a new model called Penalized -fuzzy c-means (PFCM) model. PFCM produces memberships and possibilities simultaneously, along with the usual point prototypes or cluster centres for each cluster. PFCM is a hybridization of Penalized. PFCM solves the noise sensitivity defect of FCM, overcomes the coincident clusters problem of PCM and eliminates the row sum constraints of FPCM. The algorithm is an iterative clustering method that produces an optimal c partition by minimizing the weighted within group sum of squared error objective function $J_{FCM}$

$$J_{FCM} = \sum_{k=1}^{n}\sum_{i=1}^{c}(u_{ik})^q d^2(x_k, v_i) \ldots\ldots\ldots\ldots (1)$$

Where $X=\{x^1,x^2, ..., x^n\}\epsilon R^p$ is the data set in the p-dimensional vector space, is the number of data items, c is the number of clusters with $2 \le c<\backslash n$, $u^{ik}$ is the degree of membership of x in the ith cluster, q is the weighting exponent on each fuzzy membership, vi is the prototype of the centre of cluster i, d2 (xk,vi) is a distance measure between object xk and cluster centre vi. A solution of the object function JFCM can be obtained via an iterative process, which is carried as follows:

- set values for c, q, and e,
- initialize the fuzzy partition matrix ,
- set the loop counter b =0
- Calculate the c cluster centers

$$v_i^{(b)} = \frac{\sum_{k=1}^{n}(u_{ik}^{(b)})^2 x_k}{\sum_{k=1}^{n}(u_{ik}^{(b)})q} \ldots\ldots\ldots\ldots (2)$$

Calculate the membership

$$u_{ik}^{(b+1)} = \frac{1}{\sum_{j=1}^{c}\left(\frac{d_{ik}}{d_{jk}}\right)^{2/(q-1)}} \ldots\ldots\ldots\ldots (3)$$

**FCM Algorithm:** Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method (developed by Dunn in 1973 and improved by Bezdek in 1981) is frequently used in pattern recognition. It is based on minimization of the following objective function:

$$J_m = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^m \left\| x_i - c_j \right\|^2$$

where *m* is any real number greater than 1, $u_{ij}$ is the degree of membership of $x_i$ in the cluster *j*, $x_i$ is the *i*th of d-dimensional measured data, $c_j$ is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center.

**PBO:** A scheme for the feature level fusion of two behavioural biometrics speech and signature using fusion method weighted sum is proposed. Feature reduction is performed using modified feature selection algorithm based on Pollination based optimization which has never been applied to the problem earlier. The modified algorithm is applied to the fusion method to search the feature space for optimal and best feature subset. This optimization is first time used to extract features of speech and signature biometric modalities after fusing. Multimodal offline database of text independent speech and signature has been collected from 40 users

## III. RELATED WORK

This paper presented that Segmentation of MR brain images using FCM improved by artificial bee colony (ABC) algorithm was proposed by Taherdangkoo, M. IN [2010] [1]. Segmentation of medical images, particularly magnetic resonance images of brain is complex and it is considered as a huge challenge in image processing. Among the numerous algorithms presented in this context, the fuzzy C-mean (FCM) algorithm is widely used in MR images segmentation. Recently, researchers have introduced two new parameters in order to improve the performance of FCM algorithm, which are calculated using neural network in a complex and time consuming manner.

This paper described that Image Segmentation Using FCM Optimized by Quantum Immune Clone Algorithm was proposed by Yu Li in [2014] [2]. The traditional Fuzzy C-Means (FCM) clustering algorithm is usually based on the image intensity, so the segmentation results are unsatisfactory when the images are impacted by noise. Considering this shortcoming, in this paper the FCM objective function is improved by adding two kinds of spatial information: the relative position information and the intensity information of the neighbourhood. Moreover, Quantum Immune Clone algorithm (QICA) is used to optimize the spatial impact factors in the objective function.

This paper discussed that A robust fuzzy clustering technique with spatial neighbourhood information for effective medical image segmentation: An efficient variant of fuzzy clustering technique with spatial information for effective noisy medical image segmentation was proposed by Beevi, S.Z. in [2010] [3]. Segmentation is an important step in many medical imaging applications and a variety of image segmentation techniques do exist. Of them, a group of segmentation algorithms is based on the clustering concepts. In our research, we have intended to devise efficient variants of Fuzzy C-Means (FCM) clustering towards effective segmentation of medical images. The enhanced variants of FCM clustering are to be devised in a way to effectively segment noisy medical images. The medical images generally are bound to contain noise while acquisition.

This paper presented that Novel Fuzzy C-Means Segmentation Algorithm for Image with the Spatial Neighbourhoods Was proposed by Chuan Long Li [2012] [4]. The fuzzy c-means (FCM) algorithm is one of the most widely used method for data clustering, the standard FCM is not effective by itself to segment the image, as it fails to deal with the significant property of images, such as noise and intensity in homogeneity. In this paper, we propose a novel fuzzy c-means image segmentation algorithm. Its effectiveness is due to two mechanisms. The first mechanism is the replacement of the Euclidean distance traditionally used to measure similarity of the image pixels by a novel similarity measure which is considered spatial neighbourhoods using Gaussian kernel, and thus our method becomes less sensitive to the noise of the image. The second mechanism is not requirement of any similarity penalty term in FCM's objective function as some FCM's variants to reduce the influence of noise on the result of image segmentation, in addition, our method needs no requirement of setting parameter according to the image, and thus our method is more general and robust for image segmentation.

This paper concludes that Pollination based optimization for colour image segmentation was proposed by Gaganpreet in [2010] [5]. Colour image segmentation is a process of partitioning an image into disjoint regions, *i.e.* into subsets of connected pixels which share similar colour properties. Region extraction in colour images is a difficult process. I have proposed a new optimization method Pollination Based Optimization (PBO) to select best optimal clusters in colour images. The methodology consisted of four steps: colour space conversion, generation of candidate colour cluster centres using

## IV. PROBLEM FORMULATION

Medical images are very difficult to process because in medical field minute details of image are also matter a lot that's why they need to be divided in such a manner so that their minute details can be easily examined. To divide the image into parts or we can say that segments the technique is called as segmentation. In this work image segmentation is used to find the region of interest (ROI). In this process image is divided into different segments. The segments have to be divided on the basis of the similarity. The images used for this has to be segmented in a proper way so that hidden information from medical images can be extracted. The main problem in segmentation is that after segmentation the edges and the logical information from images get dispersed.

## V. PROPOSED WORK

Image segmentation is done to divide image into various segments to exact hidden information and logical data from the input image. In this process various approaches has been used. In this research work main motive is to use medical images for segmentation purposes. To process segmentation the different steps has been carried out. In these steps the statically histogram of the image has to be find out for extraction of intensity level of particular image at each and every pixel set. in second step the clusters has been form on the basis on histogram using k-mean clustering approach which computers neighbour pixel values and develop different pixels into different clusters. When clustering is done image has been used for segmentation process using penalized fuzzy c mean clustering (PFCM) approach for segmentation. To achieve better results of segmentation the coefficients extracted by PFCM has been optimized using Genetic Algorithm (GA). In GA it evaluated fitness function on the basis of chromosomes and genes. On the basis of fitness crossover and mutation off springs has been find out. The fit values have been used and all other has been discarded. After this parameter analysis has been done by computing PSNR and MSE from the input and segmented image.

## VI. RESULTS AND DISCUSSIONS

In this work image segmentation is used to find the region of interest (ROI). In this process image is divided into different segments. The segments have to be divided on the basis of the similarity. When clustering is done image has been used for segmentation process using penalized fuzzy c mean clustering (PFCM) approach for segmentation. To achieve better results of segmentation the coefficients extracted by PFCM has been optimized using Genetic Algorithm (GA).


Fig 6.1 GUI showing the Image Segmentation Process

This figure represents the graphic user interface designed for image segmentation system. In this various graphic user interface control buttons have been used for image segmentation. These buttons performs various tasks for image segmentation. In this various axes and edit boxes have been used for handling the various operations of image segmentation.


Fig 6.2 Representation of Input Image for Image Segmentation

This figure represents the input image that has been selected for image segmentation process. This image has been pre-processed and undergoes the operation of image segmentation process.


Fig 6.3 Representation of conversion of image from RGB to Gray

This figure represents the image that has been converted from true colour image to gray scale image. The luminance of the image has been converted by using three true colours of the image that are red, green and blue.


Fig 6.4 Representing image Segmentation using FCM approach

This figure represents the image segmented by using the FCM approach. This approach computes the objective function value for image segmentation process. The objective function of FCM uses the gray level pixel values intensity for image segmentation process. On the basis of the objective function and the clusters the centre values have been computed that helps for image segmentation.


Fig 6.5 Representing image Segmentation using PFCM approach

This figure represents the image segmentation using PFCM approach. The FCM approach is very much noise sensitive. In the PFCM approach different parameters and NEM algorithm is used for maximizing the spatial domain features. In this figure the penalty factor is computed and added to objective function of PFCM.


Fig 6.6 Representation of the optimization of image Segmentation using PBO approach

This figure represents the image that has been segmented by using PFCM approach that has been optimized by using the different PBO approach. In the PBO approach the fitness function has been used that computes the particle best and global best for whole image. The global best value is best value for image segmentation approach.

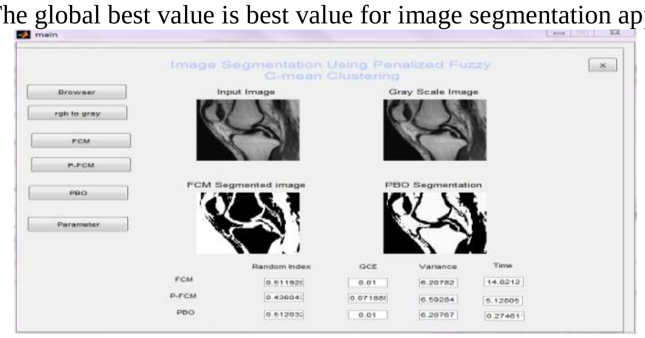


Fig 6.7 Parameter analysis for different approaches

This figure represents various parameters for image segmentation. In this image various parameters have been evaluated for performance evaluation of purposed work. The parameter random index, GCE, and variance have been computed. These parameters have been essential for image segmentation process.

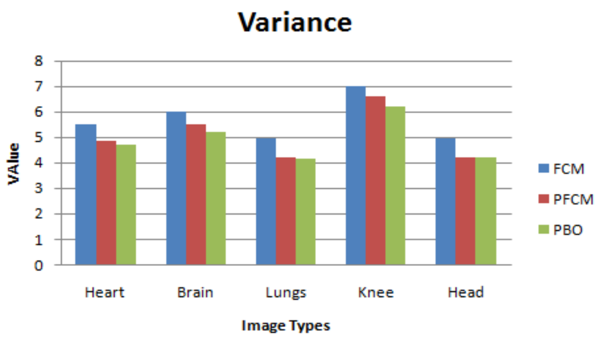


Fig 6.8 Representation of variance

Fig 6.8 represents variance which shows how far a images are spread out. A variance of zero indicates that all the images are identical. Variance is always non-negative: a small variance indicates that the data points tend to be very close to the mean (expected value) and hence to each other, while a high variance indicates that the data points are very spread out around the mean and from each other.

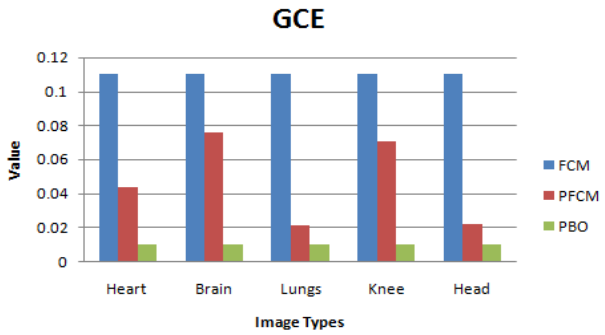


Fig 6.9 Representation of GCE i.e. generalized coefficient error

Fig 5.9 represents a graph which explains the GCE. D. Martin proposed several error measures to quantify the consistency between image segmentations of differing granularity. This error measure is not symmetric and encodes a measure of refinement in one direction only. Global Consistency Error (GCE) forces all local refinements to be in the same direction.

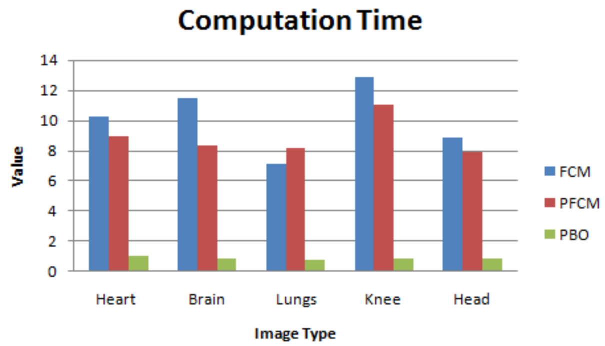


Fig 5.10 Graph representing computation time

Fig 5.10 represents Computation time which is (also called "running time") the length of time required to perform a computational process. Representation a computation as a sequence of rule applications, the computation time is proportional to the number of rule applications. In a logic-gate version of a quantum computer, the computation time for a single "quantum parallel" computation is proportional to number of unitary transformations performed.

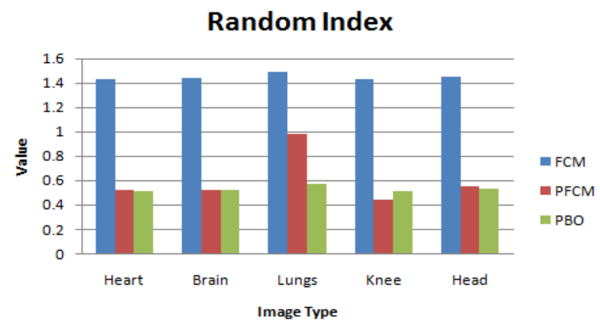


Fig. 6.11 Graph representing random index

Fig 6.11 represents random index which means in statistics, and in particular in data clustering, is a measure of the similarity between two data clustering. From a mathematical standpoint, Rand index is related to the accuracy. The Rand index has a value between 0 and 1, with 0 indicating that the two data clusters do not agree on any pair of points and 1 indicating that the data clusters are exactly the same.

## VII. CONCLUSIONS

Image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image [4]. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and k-means clustering. Recently, methods have been developed for thresholding computed tomography (CT) images. The key idea is that, unlike Otsu's method, the thresholds are derived from the radiographs instead of the (reconstructed) image. Various approaches has been used. In this research work main motive is to use medical images for segmentation purposes. In these steps the statically histogram of the image has to be find out for extraction of intensity level of particular image at each and every pixel set. in second step the clusters has been form on the basis on histogram using k-mean clustering approach which computers neighbour pixel values and develop different pixels into different clusters. When clustering is done image has been used for segmentation process using penalized fuzzy c mean clustering (PFCM) approach for segmentation. To achieve better results of segmentation the coefficients extracted by PFCM has been optimized using Genetic Algorithm (GA). In GA it evaluated fitness function on the basis of chromosomes and genes. On the basis of fitness crossover and mutation off springs has been find out. At last the parameters can be concluded using PSNR and MSE for both the types of images.

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