IMAGE SEGMENTATION FOR MEDICAL IMAGES USING BFO ALGORITHM

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Abstract

Main problem of the medical images is that some contents cannot be seen through naked eyes. These images have to be pre processed and segmented using different segmentation approaches. In this paper different approaches like threshold based and cluster based has been discussed. A new segmentation approach has been purposed that use penalty based c-mean cluster with bacterial forging optimization approach. Experimental demonstration has been done to explain the performance of the approach.

Keywords: segmentation, medical image, multi-fractal algorithm, morphological operator.

1 INTRODUCTION

Image segmentation [1] is process for division of images into multiple segments. Segmentation process provides a simplified image that any individual can analyze image features through naked eyes without performing manual segmentation using hand [2]. Image segmentation is usually related to medical imaging [3], object recognition [4], feature extraction [5] and image compression [6]. Segmentation can be achieved by using various approaches of segmentation. Region based [7], fuzzy based, neural based and clustering based [8] approaches have been used for image segmentation.

In medical image segmentation belongs to extraction of value able information from medical image that has been captured by using various image sensing tools. Image segmentation has been useful for extraction of regions of images that contains tumors, cyst as well as other structures that are bones, brain and vessels [9]. Segmentation could be used for object recognition, occlusion boundary estimation within motion or stereo systems, image compression, image editing, or image database look-up. Bottom-up [10] image segmentation has been utilized for division of medical image into different segments using top-bottom approach. For input image segmentation primarily consider image brightness here, although similar techniques can be used with colour, motion or stereo disparity information.

A. Identifying Regions

- Regions of image segmentation should be uniform and homogeneous with respect to some characteristic, such as gray level, color, or texture.
- Region interiors should be simple and without many small holes.
- Adjacent regions of segmentation should have significantly different values with respect to the characteristic on which they are uniform.

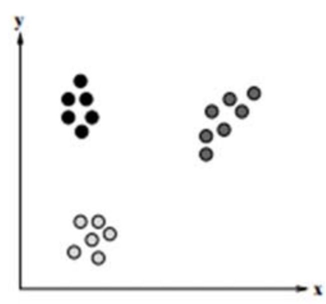

Fig. 1 Cluster division of different regions

Set of points in a Euclidean measurement space that can be separated into three clusters of points. Each cluster consists of points that are in some sense close to one another. Clusters are designated by the all patterns inside the circles.

Boundaries of each segment should be smooth, not ragged, and should be spatially accurate.

Achieving all these desired properties is difficult because strictly uniform and homogeneous regions are typically full of small holes and have ragged boundaries. Insisting that adjacent regions have large deference's in values can cause regions to merge and boundaries to be lost. In addition, the regions that humans see as homogeneous may not be homogeneous in terms of the low-level features available to the segmentation system, so higher-level knowledge may have to be used. The goal of this chapter is to develop algorithms that will apply to a variety of images and serve variety of higher-level analyses.

2. METHDOLOGY

Image segmentation is the process for extraction of hidden pattern from the input image. In the process of image segmentation various operators have been implemented on the image so that image can be processed for feature extraction that can't be seen through naked eyes. Image segmentation basically used in medical image for detection tumors, fractures in different body parts.

In the proposed work image segmentation has been done by using penalized fuzzy c-mean clustering for image segmentation. In this process penalty factor has been used with fuzzy c-mean clustering approach for segmentation of image. Image has been divided into different clusters and center point for a single cluster has been measured. On the basis of a particulars cluster has been modified so that features from medical image can be computed.

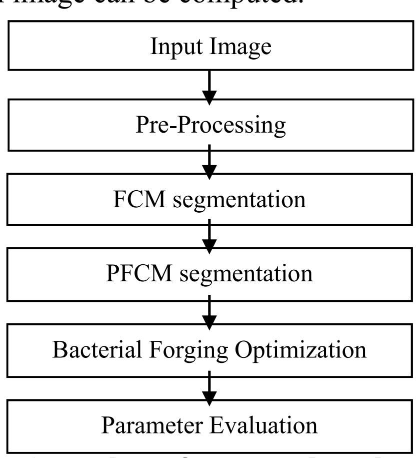

Fig. 2 Flow of Purposed work

This fig represents the steps that have to be carried out for process of the image segmentation of medical images. The steps have been that has been carried out for image segmentation process.

In this process medical MRI image has been taken as input image. The medical image has been preprocessing by converting the image into different gray scale conversion. The gray scale conversion process convert the colored image into gray scale image. That decomposes the image into tree different sub-bands of red, green and blue region. The sum of all these different components have been used for reconstruction of gray scale image

A. PFCM algorithm

As it is clear from the objective function of the FCM approach that there is no information has been used for spatial domain of the image. The image segmented by using FCM is used only information of the gray pixels available in the image. So the FCM is very noise-sensitive approach. To use the spatial information from the medical image the NEM algorithm that is above described has been used in the objective function of the PFCM approach that utilizes the NEM approach to embed the plenty factor in the image. The modified objective function of the PFCM is defined as follows

$$J_{PFCM} = \sum_{k=1}^{n}\sum_{i=1}^{c}(u_{ik})^q d^2(I_k, v_i) + \gamma\sum_{k=1}^{n}\sum_{j=1}^{n}\sum_{i=1}^{c}(u_{ik})^q(1-u_{ij})^q w_{kj} \quad (1)$$

The objective function J_{PFCM} can be minimized in a fashion similar to the standard FCM algorithm. An iterative algorithm for minimizing (1) can be derived by evaluating the centroids and membership functions that satisfy a zero gradient condition. The constrained optimization in (12) will be solved using one Lagrange multiplier.

$$\eta_q = \sum_{k=1}^{n}\sum_{i=1}^{c}(u_{ik})^q d^2(I_k, v_i) + \gamma\sum_{k=1}^{n}\sum_{j=1}^{n}\sum_{i=1}^{c}(u_{ik})^q(1-u_{ij})^q w_{kj} + \lambda\left(1-\sum_{i=1}^{c}u_{ik}\right) \quad (2)$$

Taking the partial derivate of (2) with respect to u_{ik} and setting the result to zero yields

$$\left[\frac{\partial\eta_q}{\partial u_{ik}} = q(u_{ik})^{q-1}d^2(I_k, v_i) + \gamma q(u_{ik})^{q-1}\sum_{j=1}^{n}(1-u_{ij})^q w_{kj} - \lambda\right] = 0 \quad (3)$$

By solving the u_{ik} in the purposed work

$$u_{ik}^{*} = \left(\left(\frac{q(d^2(I_k, v_i + \gamma\sum_{j=1}^{n}(1-u_{ij})^q w_{kj})}{\lambda}\right)\right)^{\frac{-1}{(q-1)}} \quad (4)$$

Since $\sum_{i=1}^{c} U_{ik} = 1, \forall k$ this constraint equation is then employed, yielding

$$\sum_{l=1}^{c}\left(\left(\frac{q(d^2(I_k, v_i + \gamma\sum_{j=1}^{n}(1-u_{ij})^q w_{kj})}{\lambda}\right)\right)^{\frac{-1}{(q-1)}} = 1 \quad (5)$$

By solving the equation (5) the value of the penalty factor has been extracted form the image.

$$\lambda = \frac{q}{\left(\sum_{l=1}^{c}\left(\frac{1}{d^2(I_k,v_i)+\gamma\sum_{j=1}^{n}(i-u_{ij})^q w_{kl}}\right)^{\frac{1}{(q-1)}}\right)^{q-1}} \quad (6)$$

Combining (6) and (4), the zero-gradient condition for the membership estimator can be written as

$$u_{ik}^{*} = \frac{1}{\sum_{l=1}^{c}\left(\frac{d^2(I_k,v_i)+\gamma\sum_{i=1}^{n}(1-u_{ij})^q w_{kj}}{d^2(I_k,v_l)+\gamma\sum_{i=1}^{n}(1-u_{lj})^q w_{kj}}\right)^{\frac{1}{q-1}}} \quad (7)$$

Similarly, taking the equation (2) with respect to v_i and setting the result to zero, the purposed work have

$$v_i^{*} = \frac{\sum_{k=1}^{n}(u_{ik})^q I_k}{\sum_{k=1}^{n}(u_{ik})^q} \quad (8)$$

Which is identical to that of FCM because in fact the penalty function in (1) does not depend upon v_i. Thus, the PFCM algorithm is given as follows

Algorithm Flow of PFCM approach

1. Set the cluster value V_i, fuzzification parameter q, the values of c and ϙ.
2. Calculate membership values using equation (7).
3. Compute the cluster centroids using equation (8).
4. Repeat the step 2 until the stopping criteria has been reached.

When the algorithm has converged, a defuzzification process takes place then in order to convert the fuzzy partition matrix U to a crisp partition. A number of methods have been developed to defuzzify the partition matrix U, among which the maximum membership procedure is the most important. The procedure assigns Object k to the class C with the highest membership

$$C_k = arg_i\{\max(u_{ik})\}, i = 1,2,\ldots,c. \quad (9)$$

With this procedure, the fuzzy images are then converted to crisp image that is segmentation.

B. Bacterial Forging Optimization

After process of segmentation using PFCM approach optimization has been done using nature inspired optimization approach. in the process of optimization best result has been evaluated for purposed system. In the purposed system of image segmentation bacteria's has been initialized as the image center point selected in the PFCM approach. These centers have been optimized by using movement with chemo tactic steps that cover different image pixels for best fitness on the basis of health function. Health function has been acts as the fitness evaluator of the best fit pixel in a cluster so that other neighbor pixels can be eliminated and reproduced based on particular fitness.

On the basis of fitness function elimination of previous bacteria's and new bacteria's has been generated. These best fit bacteria's provide better segmentation.

3. Results

In the purposed work various medical images have been used for image segmentation. In this process different medical image that has been used for extraction of different parameters after segmentation. Segmentation can be used for extraction of hidden relationship between different images.

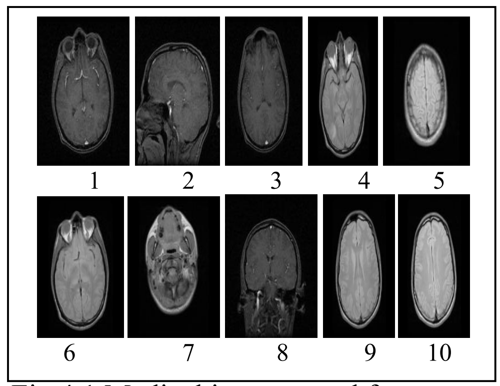

Fig 4.1 Medical images used for segmentation

Fig. 3 Sample images from medical image Dataset

This figure represents the images that have been used for image segmentation. These images are captured from various body parts. The hidden information from these images has to be extracted.

Fig. 4Input Knee Image

Input image that has been used for segmentation to extract features of hybrid segmentation approach.

Fig. 5 Segmented Knee Image

After process of segmentation various parameter have been analyzed for performance evaluation of purposed system. These parameters are Random index, Global Consistency Error and variance.

a) Random Index: The value lies between 0 and 1. 0 values indicate that 2 clusters do no correlate at any point while 1 indicates that the clusters are exactly the same.
b) Global Consistency Error: It encodes refinement in one direction only. It is symmetric.
c) Variations: It is related to the conditional entropies between the class label distributions of the segmentations.

On the basis of these parameters performance of the purposed approach has been measured.

Table 1 Random Index value for different images

Images	)riginal	FCM	PFCM	Hybrid
1	.05842	0.510687	0.519282	0.783235
2	.78147	0.523047	0.522225	1.2014
3	.53057	0.507696	0.534981	0.744038
4	.57981	0.507696	0.534981	0.744038
5	.20927	0.503703	0.282856	0.67699

This table represents value of random index that has been measured for performance evaluation of purposed system.

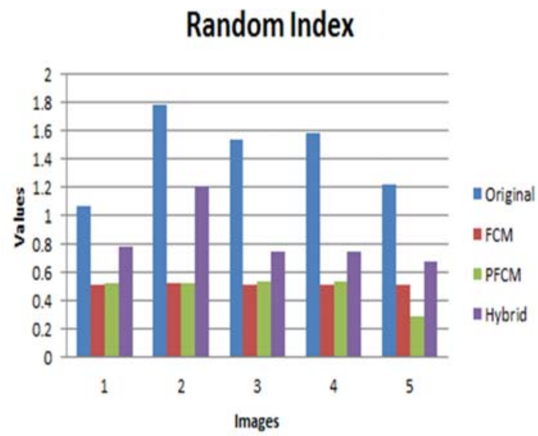

Fig. 6 Random Index for different images

This figure represents value of random index for different images using different segmentation approach.

Table 2 GCE value for different images

Images	)riginal	FCM	PFCM	Hybrid
1	.00068	0.01	0.0433256	0.0088179
2	.00402	0.01	0.0759266	0.0099721
3	.00083	0.01	0.0130535	0.0021600
4	.00352	0.01	0.0130535	0.0021600
5	.00601	0.01	0.0320239	0.0014871

This table represents value of global consistency error that has been measured for performance evaluation of purposed system. Minimum error provides better segmentation results.

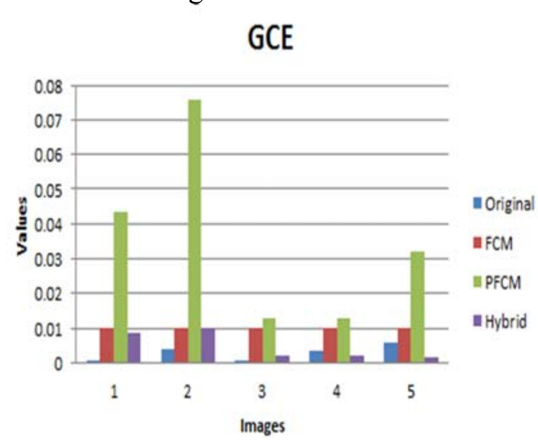

Fig. 7GCE for different images

This figure represents value of global consistency error for different images using different segmentation approach.

Table 3 Variance value for different images

Images	Original	FCM	PFCM	Hybrid
1	0.0713	4.71386	4.85357	4.8085
2	0.6147	5.19672	5.49301	5.82577
3	0.9790	3.8575	3.82883	4.12784
4	0.2754	3.6575	3.72883	4.22784
5	0.4013	6.52607	6.97568	7.10781

This table represents value of variance that has been measured for performance evaluation of purposed system.

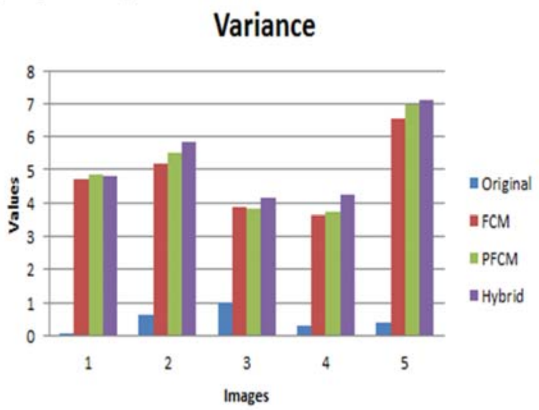

Fig. 8 variance for different images

This figure represents value of variance for different images using different segmentation approach.

4. Conclusion

Image segmentation is used for extraction of features from the images. In this paper medical image segmentation has been done to extract layered information that can't visualized by naked eyes. Hybrid approach has been implemented for extraction of hidden patterns from the medical images. PFCM approach has been used with bacterial forging optimization approach to get best segmentation results. By analyzing performance evaluation parameters we can conclude that purposed approach provide much better results than previous approaches.

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