

Tumor Location and size Identification in Brain Tissues Using Fuzzy C- Clustering and Artificial Bee Colony Algorithm

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Abstract—Clustering approach is widely used in biomedical applications particularly for brain tumor detection in abnormal magnetic resonance (MRI) images. Fuzzy clustering using fuzzy C-means (FCM) algorithm proved to be superior over the other clustering approaches in terms of segmentation efficiency. MRI Imaging forms one of the core methods to identify Brain Tumors, and access the existence, size and thickness of the tumor. MRI Images are prone to high noise, as the whole principle works on strong electric fields. We forms the clusters using Fuzzy C-Means clustering and then identify the tumor part by removing the noise part using Artificial Bee Colony algorithm. Many image processing techniques have been proposed for brain MRI segmentation, most notably thresholding, region-growing, and clustering. Since the distribution of tissue intensities in brain images is very complex, it leads to difficulties of threshold determination.

Keywords - Clustering, MR brain tumor, Fuzzy C-means and Segmentation efficiency, Artificial Bee Colony

I. INTRODUCTION

In the analysis of medical images for computer-aided diagnosis and therapy, segmentation is often required as a preliminary stage. Medical image segmentation is a complex and challenging task due to the intrinsic nature of the images [1]. The brain has particularly complicated structure and its precise segmentation is very important for detecting tumors, edema, and necrotic tissues, in order to prescribe appropriate therapy. Magnetic resonance imaging (MRI) is an important diagnostic imaging technique for the early detection of abnormal changes in tissues and organs [1]. It possesses good contrast resolution for different tissues and has advantages over computerized tomography (CT) for brain studies due to its superior contrast properties. Therefore, the majority of research in medical image segmentation concerns MR images [1].

MRI Imaging forms one of the core methods to identify Brain Tumors, and access the existence, size and thickness of the tumor. MRI Images are prone to high noise, as the whole principle works on strong electric fields.

Many image processing techniques have been proposed for brain MRI segmentation, most notably thresholding, region-growing, and clustering. Since the distribution of tissue intensities in brain images is very complex, it leads to difficulties of threshold determination [1].

Therefore, thresholding methods are generally restrictive and have to be combined with other methods like Region growing, Fuzzy C-means (FCM) clustering and Expectation–maximization (EM) algorithms [1].

Region growing extends thresholding by combining it with connectivity conditions or region homogeneity criteria. Successful methods require precise anatomical information to locate single or multiple seed pixels for each region and together with their associated homogeneity. Clustering is the most popular method for medical image segmentation, with Fuzzy C-Means (FCM) clustering and expectation–maximization (EM) algorithms being the typical methods [1]. The applications of the EM algorithm to brain MR image segmentation were reported by Wells and Leemput. A common disadvantage of EM algorithms is that the intensity distribution of brain images is modeled as a normal distribution, which is untrue, especially for noisy images [1].

Clustering is one of the widely used image segmentation techniques which classify patterns in such a way that samples of the same group are more similar to one another than samples belonging to different groups [2]. There has been considerable interest recently in the use of fuzzy clustering methods, which retain more information from the original image than hard clustering methods. Fuzzy C-Means algorithm is widely preferred because of its additional flexibility which allows pixels to belong to multiple classes with varying degrees of membership. But the major operational drawback of FCM technique is time consuming [2].

Our main objective is to find tumour location and size identification in Brain Tissues using Fuzzy C- Means clustering by removing the noise using Artificial Bee Colony Algorithm.

In this research work, the MRI images will not be rotated or any modification in the size of image will not be done after taking the images from MRI machine.

The summary of this research paper is as follows. Section II provides a Literature review. Section III provides proposed Methodology. Section IV provides Experiments and results with large dataset. Section V. provides Conclusions.

II. LITERATURE REVIEW

Shan Shen, William Sandham[10], Malcolm Granat has proposed MRI Fuzzy Segmentation of Brain Tissue Using Neighborhood Attraction With Neural-Network Optimization. In this research work improvised FCM / Modified FCM offers better continuity compared to the traditional FCM algorithm, and simpler computation. Two parameters and control the degree of two factors in the neighborhood attraction. A higher leads to a stronger feature attraction and a higher leads to a stronger distance attraction. Optimized values of these parameters enable the best segmentation results to be achieved.

In this research work, new extensions to FCM are described which consider two influential factors in segmentation, both of which address issues of neighbourhood attraction (values of neighbourhood pixels). One is the feature difference between neighboring pixels in the image; the other is the relative locations of neighboring pixels. Segmentation is therefore decided not only by the pixel intensities themselves, but also by the neighboring pixel intensities and locations. Consideration of these neighboring pixels greatly restrains the influence of noise.

N. Nandha Gopal[11] has proposed an intelligent system is designed to diagnose brain tumor through MRI using image processing clustering algorithms such as Fuzzy C-Means along with intelligent optimization tools, such as Genetic Algorithm (GA), and Particle Swarm Optimization (PSO). The detection of tumor is performed in two phases: Preprocessing and Enhancement in the first phase and segmentation and classification in the second phase. The suspicious region is segmented using two algorithms GA and PSO. New CAD System is developed for verification and comparison of brain tumor detection algorithm. PSO and GA automatically determine the optimal threshold value of given image to select the initial cluster seed point then the clustering algorithm Fuzzy C-Means calculates the adaptive threshold for the brain tumor segmentation. The results are compared with the existing approaches.

Computational result indicates that the Particle Swarm Optimization algorithm improves the performances of the segmentation and can find the optimum solution faster than the other two methods. In comparison analysis, The Accuracy, Error rate & Tumor detection rate, using PSO is found out to be much higher than GA and other existing methods.

M. Shasidhar MRI Brain Image Segmentation Using Modified Fuzzy C-Means Clustering Algorithm. In this paper, the application of modified FCM algorithm for MR brain tumor detection is explored. A comprehensive feature vector space is used for the segmentation technique. Comparative analysis in terms of segmentation efficiency and convergence rate is performed between the conventional FCM and the modified FCM. Experimental results show superior results for the modified FCM algorithm in terms of the performance measures.

Average speed-ups of as much as 80 times a traditional implementation of FCM are obtained using the modified FCM algorithm, while yielding segmentation efficiency that are equivalent to those produced by the conventional technique. Thus, the modified FCM algorithm is a fast alternative to the traditional FCM technique.

Salim Bitam [11] has proposed Introduction We present a survey on bee colony algorithms and we suggest to classify them into two basic models. This classification is according to the bee behaviors criteria. Thereby, the first model represents the algorithms which are based on the foraging behavior in the bee colony. We can enumerate two sub-models in this category. The former is based on the food source searching behavior while the latter is inspired by the nest site searching behavior. In the other hand, the marriage behavior represents the second model of the algorithms inspired by bee life. We can mention here that there are a few studies based on the queen bee evolution but we considered them as an improvement of the genetic algorithms. They rely on the same principle.

A survey on bee colony research activities is presented. Similar bee researches proposed in the literature are unified in the aim to contribute in their organization and to facilitate their application for solving other problems. All recent studies related to this area are briefly described. Definitions, explanations, applications on different problems, comparisons and results of these algorithms are presented.

Kalam Balasubramani has proposed brain MR image segmentation, the popular one is Fuzzy C-Means (FCM) algorithm. FCM is an unsupervised clustering algorithm that outperforms the other clustering algorithms in terms of computational complexity and accuracy of segmentation. The main drawback it faces is in terms of its stability of results (over/under segmentation) with respect to the user provided number of clusters. Applying domain specific knowledge resolves this problem. MR images always contain a significant amount of noise caused by operator, equipment, and the environment. This leads to serious inaccuracies in the segmentation as any changes in pixels intensity such as noise, significantly affect the clustering results. One way to improve accuracy of the results is to use optimization method. Optimization is a technique used to seek values for a set of parameters that maximize or minimize objective functions subject to certain constraints. Artificial Bee Colony algorithm is a novel optimization algorithm inspired by the natural behavior of honey bees in their search process for the best food sources.

Implemented FCM segmentation algorithm and the proposed hybrid (ABC and FCM) segmentation algorithm to detect the tumor and its size using real brain MR images. In the proposed method, ABC algorithm used for optimizing fuzzy clustering process the result obtained shows that ABC algorithm improves the efficiency of FCM segmentation process.

We implemented FCM segmentation algorithm and the proposed hybrid (ABC and FCM) segmentation algorithm to detect the tumor and its size using real brain MR images. In the proposed method, ABC algorithm used for optimizing fuzzy clustering process the result obtained shows that ABC algorithm improves the efficiency of FCM segmentation process.

The improved FCM algorithm is based on the concept of data compression where the dimensionality of the input is highly reduced. The data compression includes two steps: quantization and aggregation [2]. The quantization of the feature space is performed by masking the lower 'm' bits of the feature value. The quantized output will result in the common intensity values for more than one feature vector [2]. In the process of aggregation, feature vectors which share common intensity values are grouped together. A representative feature vector is chosen from each group and they are given as input for the conventional FCM algorithm. Once the clustering is complete, the representative feature vector membership values are distributed identically to all members of the quantization level [2]. Since the modified FCM algorithm uses a reduced dataset, the convergence rate is highly improved when compared with the conventional FCM. The improved FCM algorithm uses the same steps of conventional FCM except for the change in to cluster updating and membership value updating criterions [2].

III. POPOSED ALGORITHM

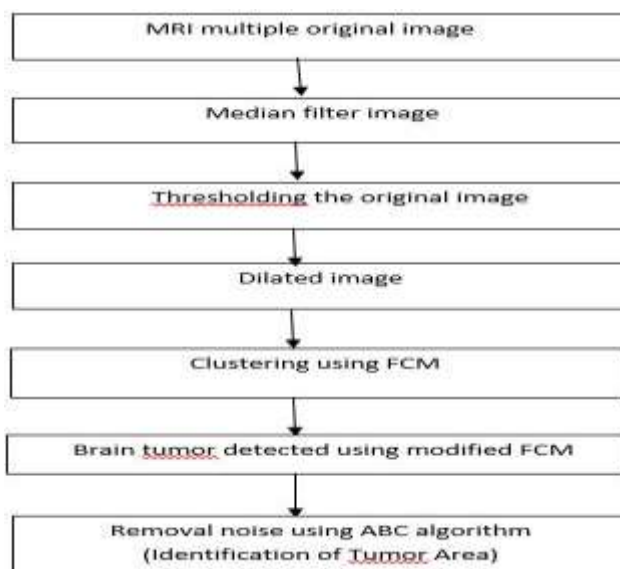


Figure 1 Proposed Algorithm for Tumour detection in MRI Image

A. Original MRI Input Image

A set of MR brain tumor images comprising of four tumor types namely Meningioma, SLE Vasculitis and Metastase are collected from radiologists. The images used are 512*512 or 256*256 gray level images with intensity value ranges from (0 to 255) [4]. Initially, these MRI images are normalized to gray level values from (0 to 1) and the features are extracted from the normalized images. Since normalization reduces the dynamic range of the intensity values, feature extraction is made much simpler [4]. Some samples of the MRI database have been displayed in Fig. 2.



Figure 2(a, b, c) Brain Tumour image

B. Median Filter

Order statistics filter are non-linear spatial filters whose response is based on ordering (ranking) the pixels contained in the image area encompassed by the filter, and then replace the value of the center pixel with the value determined by the ranking result [i]. The best known filter in this category is the median filter, which as its name implies, replaces the value of a pixel by the median of the intensity value in the neighbor-hood of that pixel [i].

The original value of the pixel is included in the computation of the median filters are quite popular because for certain types of random noise, they provide excellent noise reduction capabilities with considerably less blurring than linear smoothing filters of similar size [i]. Median filters are particularly effective in the presence of impulse noise, also called salt and pepper noise because of its appearance as white and black dots superimposed on an image [i].

Although the median filter is by far the most useful order statistics filter in image processing, it is by no means the only one, the median represents the 50th percentile of a ranked set of numbers, but recall from basic statistics that ranking lends itself to many other possibilities [i].

```
I = medfilt1(double(I),5);
```

In this research work, the 5 neighbors in ordered pixel are taken as the neighbors and the middle value of the order pixels is considered as the median and replace all the neighbor pixels with the median. Median filter is used to smooth out the MRI image at some level.

The output achieved after median filter is shown in fig 4.

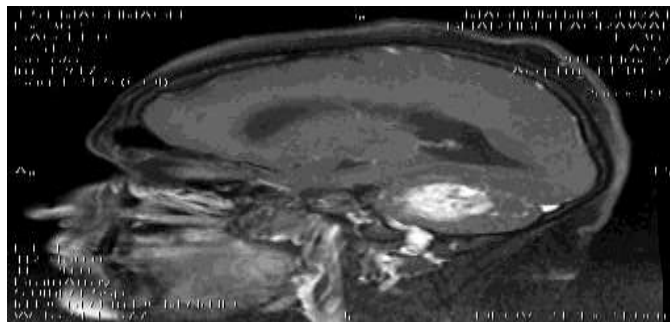


Figure 3 Median Filtered Image

C. Thresholding

Thresholding techniques identify a region based on the pixels with similar intensity values. This technique provides boundaries in images that contain solid objects on a contrast background [i]. Thresholding technique gives a binary output image from a gray scale image. This method of segmentation applies a single fixed criterion to all pixels in the image simultaneously [i]. The key parameter in image segmentation using thresholding technique is the choice of selecting threshold value T. In case of manual thresholding method, the threshold value T can be selected by the user with the help of image histogram. This method is generally accomplished by a tool that allows the user to select the threshold value T based on choice. In case of automatic threshold selection method, the value of T can be chosen based on histogram, clustering, variance, means etc., [i].

By observing the histogram of the database, the thresholding value is considered as 0.60.

```
I_bw = im2bw(I,0.60);
```

This will convert the MRI image into binary image that contains only 0s and 1s. The normalized value greater than or equal to 0.60 will be converted into 1 and the normalized value less than 0.60 is converted into 0. The output achieved after thresholding is as shown in fig 4.

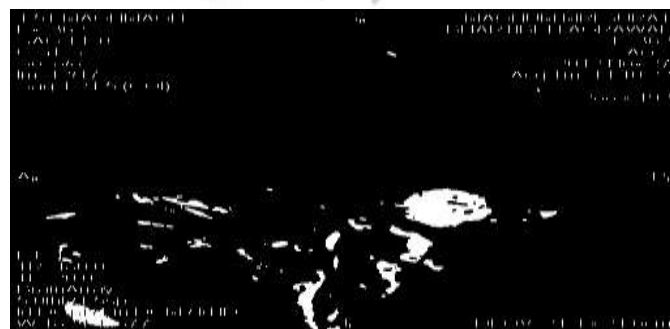


Figure 4 Threshold Image

D. Dilation

Useful background to this description is given in the mathematical morphology section of the Glossary. The dilation operator takes two pieces of data as inputs. The first is the image which is to be dilated [i]. The second is a (usually small) set of coordinate points known as a structuring element (also known as a kernel). It is this structuring element that determines the precise effect of the dilation on the input image [i].

The mathematical definition of dilation for binary images is as follows:

Suppose that X is the set of Euclidean coordinates corresponding to the input binary image, and that K is the set of coordinates for the structuring element.

Let K_x denote the translation of K so that its origin is at x .

Then the dilation of X by K is simply the set of all points x such that the intersection of K_x with X is non-empty.

The mathematical definition of grayscale dilation is identical except for the way in which the set of coordinates associated with the input image is derived. In addition, these coordinates are 3-D rather than 2-D.

In this research work,

```
se = strel('line',11,90);
```

```
I_bw = imdilate(I_bw,se);
```

After performing the different dilate value. One vertical line of 11 points will be consider as the strlen. If any 1 is there in the line, than the middle point is converted into 1. Dilation will help to remove out the small black portion between the white portions. The output achieved after dilate is given in fig 5.



Figure 5 Dilated Image

After the dilation the unwanted region part is removed by covering the 500 pixels group. If the black pixels in 500 matrix are more than white pixels than whole part is converted into black part and vice versa. The output of this step is shown in fig 7.



Figure 1 After Removing Unwanted Regions

E. Fuzzy C-Clustering Technique

Clustering can also be thought of as a form of data compression, where a large number of samples are converted into a small number of representative prototypes or clusters. High dimensional feature space based image segmentation is time intensive than in one dimensional feature spaces [4]. The modified FCM algorithm is based on the concept of data compression where the dimensionality of the input is highly reduced. The data compression includes two steps: quantization and aggregation. The quantization of the feature space is performed by masking the lower ' m ' bits of the feature value [4]. The quantized output will result in the common intensity values for more than one feature vector. In the process of aggregation, feature vectors which share common intensity values are grouped together. A representative feature vector is chosen from each group and they are given as input for the conventional FCM algorithm. Once the clustering is complete, the representative feature vector membership values are distributed identically to all members of the quantization level. Since the modified FCM algorithm uses a reduced dataset, the convergence rate is highly improved when compared with the conventional FCM [4].

Fuzzy C-means (FCM) is a method of clustering which allows one pixel to belong to two or more clusters. The FCM algorithm attempts to partition a finite collection of pixels into a collection of " C " fuzzy clusters with respect to some given criterion [4]. Depending on the data and the application, different types of similarity measures like distance, connectivity, and intensity may be used to identify classes/clusters [4].

Steps of FCM Algorithm:

- Probable Brain Tumor regions
- Multiple regions
- But major drawback is not assurance of actual brain tumor
- Clustering is based upon region
- Noise and brain tumor have equal probability

In this research work, the Fuzzy C-Means clustering is applied on the binary MRI image. This algorithm show the overlapping of clusters which shows that particular pixel can be a part of multiple cluster. After applying the Fuzzy C-Means clustering the output will be achieved is shown in fig 4.



Figure 2 Possible Tumor Region Clustered based upon FCM

The database of the modified FCM is given in the fig 9.

Modified FCM Database

Image Name	X_Cord	Y_Cord	Width	Height	Centroid_X	Centroid_Y	Area
MENINGIOMA0010.jpg	295.5	279.5	78	72	334.4600364	316.0020828	3841
MENINGIOMA0011.jpg	244.5	278.5	129	230	308.1692923	351.7406852	7998
MENINGIOMA0012.jpg	292.5	286.5	79	73	331.9706667	323.5871111	4500
MENINGIOMA0013.jpg	298.5	293.5	70	63	331.6196644	325.3299971	3397
MENINGIOMA0014.jpg	229.5	0.5	75	207	267.9540545	117.2088848	6573
MENINGIOMA0015.jpg	293.5	290.5	96	99	340.2739339	339.9507201	7082
MENINGIOMA0016.jpg	299.5	292.5	83	89	339.4108078	336.2049364	5348

Figure 9 Modified FCM database

In above figure, “X_Cord” shows the x axis coordinate of the rectangle box. “Y_Cord” shows y axis coordinate of rectangle box. “Width “ shows the width from “X_Cord” and “Height” shows the height from “Y_Cord”, “Cetroid_X” and “Cetroid_Y” shows the x and y axis coordinate of the center point. “Area show the number of 1’s or white pixels in the rectangle.

F. Artificial Bee Colony algorithm

Artificial Bee Colony (ABC) is a novel optimization algorithm inspired of the natural behavior of honey bees in their search process for the best food sources, In groups of insects which live in colonies like the ants and bees, an individual only can do simple task on its own, while the cooperative work of colony is the main reason determining the intelligent behavior of them [8]. A colony of artificial bees in ABC algorithm contains three groups of bees: employed, onlooker and scout bees. Employed bees carry with them information about their food sources, its distance and direction from the nest, and the nectar amount of the source; scout bees are searching the environment surrounding the nest for finding new food sources; and onlooker bees waiting in the hive and finding a food source through the information shared by employed bees. In ABC, two key behaviors are defined: recruitment to a nectar source, and abandonment of a source [8].

The search process to discover the best solutions by the artificial bees can be summarized as follow:

1. Employed bees move randomly to find solutions in the search space.
2. Review the information obtained by the employed and scout bees with onlooker bees in colony space (note that at the first yet there is no scout bee).
3. Check the stopping criterion: stop, if satisfied condition, otherwise continue.
4. Selecting scout bees and perform the recruitment process for them.
5. Vocalize of new population of bees.
6. Search neighbourhood using scout bees guide, and also search randomly with some employed bees [8].

The output after applying the ABC is given in fig 10.

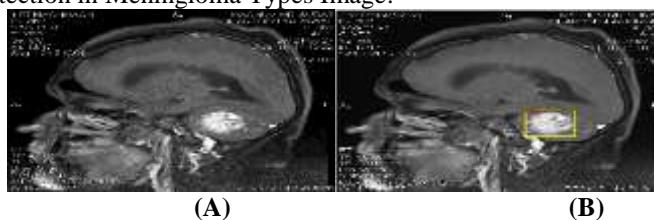


(A)

(B)

Figure 10(A) Wrong Tumor Detection by Modified FCM (B) Exact Tumor from Modified ABC**IV. EXPERIMENTS AND RESULTS****A. Input as JPG Image In Matlab**

A set of MR brain tumor images comprising of three tumor types namely Meningioma, SLE Vasculitis and Metastase are collected from radiologists. The images used are 512*512 or 256*256 gray level images with intensity value ranges from (0 to 255) [4]. Figure Shows Tumor detection in Meningioma Types Image:

**Figure 31 Tumor detection in Meningioma Types Image****B. Comparison of FCM, Modified FCM and ABC Algorithm**

This Research work Tests on total 22 images of three tumor types namely Meningioma, SLE Vasculitis and Metastase, from that 20 images detects exact location of tumor with ABC Algorithm.

Algorithm	Efficiency (%)
FCM	27.27%
Modified FCM	63.63%
Artificial Bee Colony	91.24%

Table 1 Comparison of FCM, Modified FCM and ABC Algorithm**V. CONCLUSION**

In this research work, MRI image contain the noise so that it is difficult to determine the tumor part. After the Artificial Bee Colony algorithm exact brain tumor is detected for every image location and size is given in pixel with the accuracy of 91.24%.

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