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Brain Tumor Detection Using Hard and Soft Computing Techniques

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Abstract:
Medical image segmentation has great significance in the research in the research field of image segmentation. It is the one way to take out important information from medical images. There are many soft computing and hard computing techniques are there which are used for segment the interested area in medical images. Both has its own advantages and disadvantages. In this paper we provide a new approach to medical image segmentation. we use three approaches with the combination of each other. That approaches are K-mean, Fuzzy C-mean and genetic algorithm. So we divide this paper in three phases. In first phase we apply the K-mean algorithm on the image which segment the interested are but this algorithm not gave the satisfactory result. So on the result of this algorithm we apply FCM after this optimization is done with the help of GA. The experimental result is calculated on the basis of classification accuracy. The result is 90.3%.

Key words*: Medical Image Segmentation, K-means, FCM, MRI, GA*

1. Introduction

To partition a digital image into multiple regions is called image segmentation. It is used to simplify the representation of an image so that analysis of the image will be easier. The main function of segmentation is to find objects and boundaries. [1] [2] It partition the image into homogeneous regions. There are many fields in which image segmentation is used like pattern recognition, artificial intelligence, and medical image segmentation. This paper works in one application of image segmentation that is medical image segmentation.

Segmentation of medical image plays an important role. Because to diagnose a medical image, segmentation is necessary. It is an extremely important step in pathological processes like identification of a region of interest, edge detection and brain tumour detection etc.

There are many types of medical images like x-ray images, MRI (magnetic resonance imaging), CT (computed tomography) images etc. There are many fields in which medical image segmentation is used like in brain tumour detection with the help of segmentation tumour location can be easily identified. Segmentation is also able to segment the lung cancer and also find the abnormal growth in the tissues. For this computed tomography scan is used. Through segmentation the enlargement of liver size can also be measured. By using scanning algorithms of segmentation the ultrasound images can be segmented. In segmentation they scan the muscle fiber because muscle injury is only determined by the shape of fiber. the segmentation results give the discrimination of health fiber.

In this paper the MRI images are used. To work with brain tissues magnetic resonance imaging has very important part. It gives the high resolution and differentiates the soft tissues. Magnetic resonance images have three types that is T1 weighted, T2 weighted and proton density weighted images. MRI scan can produce very detailed images of the brain. This makes MRI ideal for helping to diagnose conditions that affect the brain like brain tumor. MRI is a technique that is based on nuclear magnetic resonance, it is widely used for brain images, because it is a non-invasive technique and it also provides anatomical images of high resolution (\ mm) and excellent accuracy. Thus, MRI allows for high contrast images of different sections of the brain like sagittal (side view of the brain), coronal (frontal view of the brain) and axial (a top view of the brain). [3][4]

2. Related Work

In few years many segmentation approaches and techniques have been developed to segment and detect the tumor location. Those techniques are like fuzzy-k mean algorithm, fuzzy c mean, neural network and genetic algorithm etc. Many segmentation methods are

used to work on the internal tissues of the brain like clustering method, thresholding method, region based and contour based approaches.

2.1. Clustering Approach

In clustering approach the whole image is divided into clusters. It is unsupervised learning approach. It organize the objects or pixels in one group whose pixels and members are similar in some conditions [5][6]. The segmented image result will be depending on the number of clusters. In this paper the mainly used approach is clustering approach. There are many classes of clustering approach. K-means, fuzzy C-means and many hierarchical clustering methods are works on the principle of clustering approach.

2.2. Thresholding Approach

Thresholding is the main function to converting a multilevel image into binary image. Because first it compare the values of pixel and then according to application assigns the value of zero and one. There are mainly two types of thresholding global thresholding and local thresholding when T is constant then it is global thresholding and when T is varying object to object in the image then it is local thresholding. The main function of this approach is to find the optimal threshold value and also find the values in multiple levels [7].when there is need to find the optimal value for threshold then this technique can be applied.

2.3. Region Based Approach

This approach having two types region merging approach (region growing) and region splitting approach. Seed point is required for this approach . because it examines neighboring pixels of initial seed points. Then it determine the pixel neighbors if the pixels neighbors are same then it will add them to the same region and that will be known as region growing or region merging approach. And if the neighboring pixels are not same then it will not add to the same region and the region will start splitting that will be known as region splitting approach. In recent years researcher used two or more elements that constitute a subset of interested area for search [8][9].

2.4. Edge Detection Approach

Edges are important factor for local changes of intensity in an image. This approach mainly works on the region boundaries and edges. The edges which are identified by the edge detection method, many times that are disconnected [10]. For the segmentation the closed region boundaries are must be there in the image. Because closed region boundaries differentiate the one region to other region. Through this any object in the image might be segmented.

2.5. Graph Based Method

It is based on principle of similarity criteria. In the segmentation of the image an object is segmented which is completed different from the image it means the pixels that form the separate segments. This algorithm works on the weights. For calculating the weights grid graph is necessary. By using the grid graph it calculates or initializes the weights. Then it chooses a region in which a edge is selected. From that it calculates the maximum weight and then it compare the two nodes of that object or edge. If the compared nodes are similar than from those two edges only one edge is considered and again from another point weight is recalculated.

2.6. Fuzzy K-Means

K-mean clustering technique is unsupervised clustering method for clusters.

It is basic clustering algorithm because it is simple algorithm and computational complexity is very less. For making the cluster the number of cluster is defined first. After this the centre of cluster is chosen randomly. Then the distance is calculated between the cluster centers to the each pixel. For calculating the distance there are many methods but many a times Euclidian distance is used. The pixels which have less distance are added to the cluster and the cluster centre is reestimated. Then again it calculates the distance between the centroid to the pixel. When the centre is converges then this process is stopped [11][12][13].

Steps for implementing K-Mean:

- Give number of cluster value.
- Chose K cluster centre randomly.
- Calculate the centre of cluster.
- Calculate the Euclidean distance between the centers of cluster to each pixel.
- If the distance is less then it will be added to the cluster.
- If the distance is more then it will move to next cluster.
- Again re estimate the cluster
- Repeat the step until centre convergence.

2.7. Fuzzy C-Means

It is also unsupervised learning algorithm. The main function of clustering algorithm is to combine the similar objects and make a group and to differentiate the dissimilar object. Fuzzy c-means algorithm is most widely used algorithm [14].

This technique works by assigning the membership value.
Membership value is given on the basis of distance calculated from the cluster centre to the data points. If the data points are near to the centre of cluster then the membership value will toward the cluster[15][16][17]. The main function of FCM algorithm is:

- $Z_m = {}^{m}{}_{ij} \|X_i - C_j\|^2$
- K = number of cluster
- C = Total number of pixels
- m = fuzzy degree
- M_{ij} = degree of membership X_i in the cluster j
- C_j = Centre of cluster i
- $\|X_i - C_j\|^2$ = distance between C_j and pixel X_i

The centre point of the cluster is the mean value of all data points. In this cluster, centre is updated iteratively. By this cluster centre is moves from one point to another point.

3. Proposed Work

There are main four parts of proposed work. They are preprocessing of image, segmentation using K-mean, on the result of k-mean again segmentation using FCM and then applied optimization algorithm.
The data base is taken from brain web. In pre-processing of image filtering and sharpening of image is done as there is some noise in original MRI so to reduce that noise filters are used. After that the image is converted from RGB to grey scale.
After pre-processing of image k-mean algorithm is used for segmentation. Then FCM is applied as discussed in above section. Then the optimization is done.

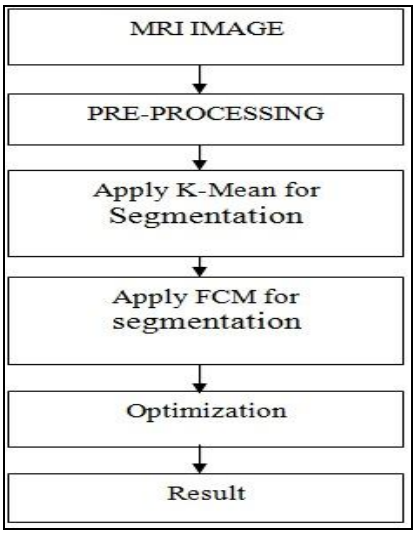

Figure 1: Flow chart of proposed work

4. Database

The MRI Image for this paper is taken from internet. It is available publicly. So anyone can access the images of tumor from internet. There are two types of data base in the internet. One is normal brain database and other is MS lesion brain database. In this paper MS lesion database is taken. Because we have to segment the tumor part only.

5. Our Frame Work

First of all we take MRI image and apply K-mean algorithm through this we take the segmented output. As K-mean algorithm does not work well with global clusters and also difficult to predict the value of k . So we apply fuzzy c-mean algorithm on k mean algorithm. The FCM takes a data set and then it decides the number of clusters. We have to give the iteration count and when it reached to the maximum iteration count it stop the process. But there are some disadvantages of this approach as in this approach we gave the 25 iteration count so it take long time to compute it. If we gave the less iteration count then the segmentation is not properly done so to overcome this approach we use genetic algorithm. Genetic algorithm will decide the number of iteration count according to the requirement. Genetic algorithm will decide the number of iteration count and then FCM will do the segmentation. In our approach through genetic algorithm the iteration count become automatic. As we gave the iteration count through FCM is 25 but by using genetic algorithm the segmentation is done in only 10 iteration counts. So this new approach takes less computational time.
Performance and accuracy of the segmentation is calculated on the basis of sensitivity, specificity and classification accuracy. These parameter are calculate based on the real positive rate, true negative, false positive and false negative.

- **Real positive Rate (RPR)**
  It is calculated when the pixels labeled correctly on the region of interest as positive.

- **Real negative Rate (RNR)**
  It is calculate when the pixels labeled not on the region of interest and labeled somewhere else in the image is classified as true negative.
- **False positive Rate (FPR)**
  It is calculated when pixels are labeled near the region of interest and seems to be true positive that is classified as false positive.
- **False negative Rate (FNR)**
  It is calculate when a unwanted pixel in labeled on the region of interest. That is classified as false negative [18].

The MRI image on which whole operations are done is shown below:

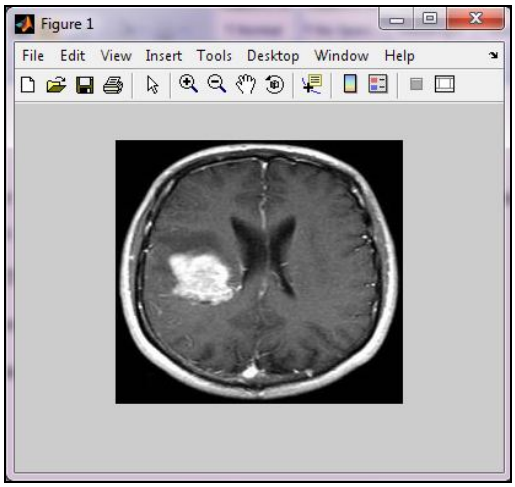

Figure 2: Input image

After performing all operations the final results shown below.

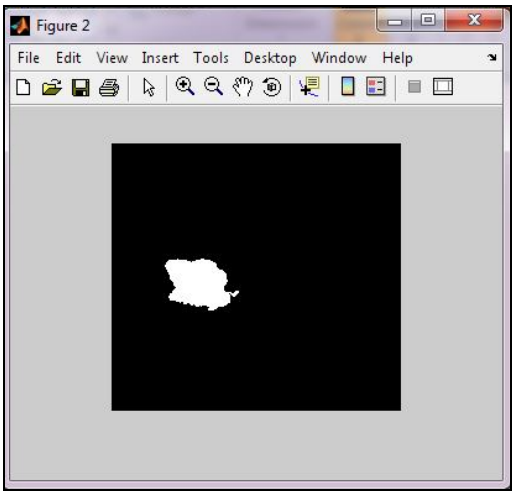

Figure 3: Segmented image

In this paper performance is calculate on the basis of classification accuracy. That is calculated as:
CA= 100*((TP+TN/(TP+FN+TN+FP))
The overall result according to classification accuracy is 90.3%.

6. References

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