MRI BRAIN TUMOR IMAGE SEGMENTATION USING VARIOUS CLUSTERING TECHNIQUES

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Abstract— Brain tumor is a disconnected magnification of brain cells within the brain. In this paper, we present an efficient brain tumor segmentation methods, that can detect tumor and locate it in the brain MRI images. The result of the clustering algorithm and its domain efficiency are calculated through the algorithms. In this paper, two clustering algorithms namely K-means clustering and fuzzy C-means clustering algorithm are implemented and the performance is analysed predicted on their clustering result quality. The comportment of both the algorithms depends on the number of data points as well as number of clusters. The execution time for each algorithm is analysed and results are compared with one another.

Keywords— Image Segmentation, K-means Clustering, fuzzy C-means Clustering, Feature extraction, Approximate Reasoning.

I. INTRODUCTION

The brain is the anterior most part of the central nervous system. Along with the spinal cord, it composes the Central Nervous System (CNS). In the field of medical science an eccentric cell magnification inside the brain is kenned as tumor. Human brain is the most sensitive part of the body. It control muscle forms of kineticism and interpretation of sensory information like visual perception, sound, touch, taste, pain etc. Since the position of the tumor is not fine-tuned thus it can be composed in any component of the brain or human body. Depending upon the place of origination tumor can be categorized into primary tumors and secondary tumors. If the tumor is originated inside the skull then the tumor is kenned as primary brain tumor otherwise if the tumor' s origination place is somewhere else in the body and moved towards brain then such tumors are called secondary tumors.

The aim of this work is to design an automated implement for brain tumor quantification utilizing MRI image data sets. This work is a minute and modest part of a quite intricate system. The whole system will when consummated visualize the inside of the human body, and make surgeons able to perform operations inside a patient without open surgery. More specifically the aim for this work is to segment a tumor in a brain. This will make the surgeon able to optically discern the tumor and then facilitate the treatment. The instruments needed for this could be ultrasound, Computer Tomography (CT Scan) and Magnetic Resonance Imaging (MRI). MRI is fundamentally utilized in the biomedical to detect and visualize finer details in the internal structure of the body. This technique is rudimentally used to detect the differences in the tissues which have a far better technique as compared to computed tomography (CT). In this paper the MRI scanned image is taken for the entire process. The MRI scan is more comfortable than CT scan for diagnosis. It is predicated on the magnetic field and radio waves. It is not affect the human body. Because it doesn't utilize any radiation.

Image segmentation is commonly utilized in the field of image processing. Segmentation is the method which extracts an image into its element regions or objects. It can classify region of interest in image or explain the data. One of the commonly used applications of segmentation is in medical images in order to diagnose diseases. In image processing lot of techniques are available, in that image segmentation is commonly used in medical field, and it is used to extract the information from complex medical images. Generally by using classification we can classify the tumor stages, but after that we need to segment the tumor for area calculation [7][1][6]. From last few years many researchers in medical field they made some significant survey of image segmentation. Nishant Verma et al [4] proposed that region growing is region predicated image segmentation. In this the intensity belong to the same seed, it belongs to one region and process is iterated. The drawback of this method is that the seed of the region should be selected manually which effects the segmentation process and it is not automatic segmentation process. Since this technique is noise sensitive, therefore, the extracted regions might have holes or even some discontinuities. Dalila Cherif et al [5] proposed that expectation maximization algorithm is an iterative procedure to find maximum likelihood estimates of parameters in statistical model. It is utilized to estimate the parameters of different classes in an image. But the algorithm is very intricate. Clustering could be a methodology of grouping a group of patterns into variety of clusters specified similar patterns area unit allotted to 1 cluster. Every pattern is diagrammatical by a vector having several attributes. Clustering to Magnetic Resonance (MR) brain tumors maintains efficiency. Clustering is suitable for biomedical image segmentation as the number of clusters is usually known for images of particular regions of the human anatomy. This system analyses various clustering techniques to track tumor objects in Magnetic Resonance (MR) brain images. In this paper, we have to used two clustering algorithms such as K-means clustering and Fuzzy C-means clustering. K-means clustering is an algorithm to group objects predicated on attributes/features into k number of groups where k is a positive integer. And Fuzzy c-means (FCM) is the clustering algorithm which sanctions one piece of data may be member of more than one clusters. In this paper, we compare the clustering algorithms i.e. K-means with fuzzy C-means clustering algorithm. At the end, we are providing systems that detect the tumor shape and its area. This paper aims to develop an automated brain tumor detection in MRI images using segmentation methods.

II. SYSTEM METHODOLOGY

The aim of this system is to detect the tumor image. This system has mainly four modules namely preprocessing, segmentation, Feature extraction, and approximate reasoning. Pre processing is done by filtering. Segmentation is carried out by K-means and Fuzzy C-means algorithms. Feature extraction is by thresholding method and Approximate reasoning is to calculate the tumor area and position in MRI image. Following are the steps of Tumor Detection.

2.1 Pre-processing

It suppresses image noise without reducing the image sharpness and can be applied iteratively. The brightness value of the current pixel in the image is replaced by the median brightness of either 3-by-3 or 4-by-4 neighborhood. Another offered possibility to enhance the contrast of image. Conversion of RGB to grey scale image and reshaping additionally takes place. It uses median filter for noise abstraction. The possibilities of advent of noise in modern MRI scan are very less. It may come due to the thermal effect. For better understanding the function of median filter, we integrated the salt and pepper noise artificilly and abstracting it utilizing median filter.

The median filter is a non linear digital filtering technique, is often used to abstract noise. Median filtering is very widely utilized in digital image processing because, under certain conditions, it preserves edges while abstracting noise. The median filter is mundanely used to reduce noise in an image, remotely like the, mean filter. However, it often does a better job than the mean filter. The median is a more robust average than the mean and so a single very unrepresentative pixel in a neighborhood will not affect the median value significantly.

Fig.1. shows the input image and de-noised image of the MRI scan.

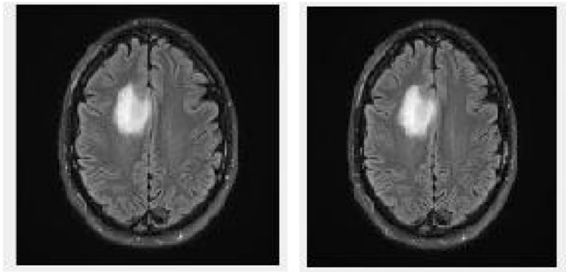

Fig.1. Input image and de-noised image

2.2 K-Means Clustering Segmentation

K-means algorithm and its different variations are the most well-known and commonly used partitioning methods. The value ‘k’ stands for the number of cluster seeds initially provided for the algorithm. This algorithm takes the input parameter ‘k’ and partitions a set of m objects into k clusters. The technique work by computing the distance between a data point and the cluster center to add an item into one of the clusters so that intra-cluster similarity is high but inter-cluster similarity is low. The way to initialize the means was not specified. One popular way to start is to randomly choose k of the samples. This is a simple version of the k-means procedure. It can be viewed as a greedy algorithm for partitioning the n samples into k clusters so as to minimize the sum of the squared distances to the cluster centers.

With the definition of the distance of a data point from the cluster centers, the K-means the algorithm is fairly simple. The cluster centers are randomly initialized and we assign a data point x_i into a cluster to which it has minimum distance. When all the data points have been assigned to clusters, new cluster centers are calculated by finding the weighted average of all data points in a cluster. The cluster center calculation causes the previous centroid location to move towards the center of the cluster set. This is continued until there is no change in cluster centers. The algorithm is withal significantly sensitive to the initial desultorily culled cluster centers. The K-means algorithm can be run multiple times to reduce this effect. K-means is a simple algorithm that has been acclimated to many quandary domains and it is a good candidate to work for a desultorily engendered data points. The results of K-means algorithm is depend on the value of k. Fig.2. shows the flowchart of K-means algorithm.

Mathematical representation

For a given image, calculate the cluster means m,

$$M = \frac{\sum_{i:c(i)=k} x_i}{Nk}, k = 1, \dots, K \quad (1)$$

Calculate the distance between the cluster center to each pixel

$$D(i) = \arg\min\|x_i - Mk\|^2 \ , i = 1, \ldots\ldots, N \qquad (2)$$

Repeat the above two steps until mean value convergence.

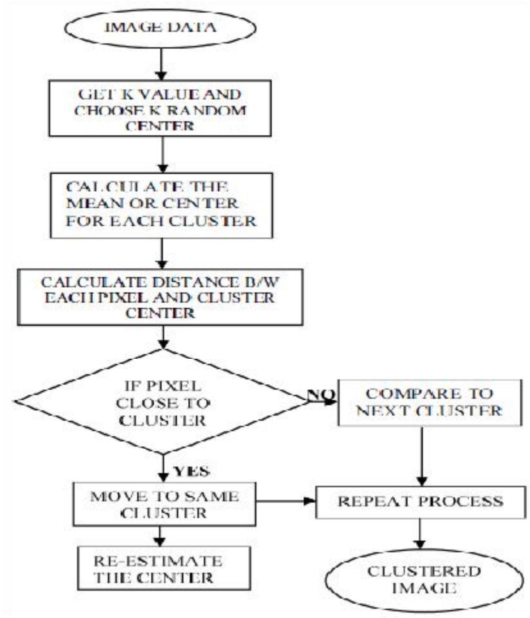

Fig.2. Flowchart of K-means algorithm

Algorithm

1. Choose the number K of clusters either manually, randomly or based on some heuristic.
2. Generate K clusters and determine the cluster's center Calculate mean or center of the cluster.
3. Assign each pixel in the image to the cluster that minimizes the variance between the pixel and the cluster center
4. Re-compute cluster centers by averaging all of the pixels in the cluster.
5. Repeat steps 3 and 4 until some convergence criterion is met.

Fig.3. shows the output for K-means algorithm with five clusters. At the fourth cluster, the tumor is extracted.

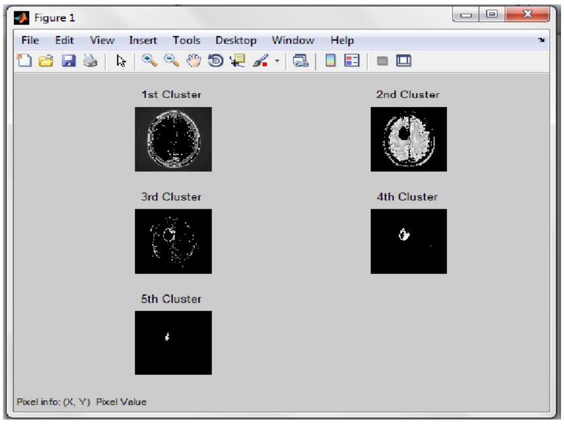

Fig.3. Output image for K-means algorithm for k=5

2.3 Fuzzy C-means clustering segmentation

Fuzzy clustering plays an important role in solving problems in the areas of pattern recognition and fuzzy model identification. A variety of fuzzy clustering methods have been proposed and most of them are based upon distance criteria. One widely used algorithm is the fuzzy c-means (FCM) algorithm. It uses reciprocal distance to compute fuzzy weights. Fuzzy C Means method incorporates the membership weighting of each cluster is altered after the cluster distribution in the neighborhood is considered. Each pixel condition is based on the neighboring pixels of the membership values. In this algorithm, data are limit to each cluster by means of a membership function, which represents the fuzzy comportment of the algorithm. The FCM iteration proceeds with the new membership that is incorporated with the spatial function. The iteration is stopped when the maximum difference between cluster centers or membership functions at two successive iterations is less than a least threshold value. This algorithm is similar in structure to the K-means algorithm. For improving the segmentation results is the fuzzy C-mean clustering algorithm.

Mathematical representation

Fuzzy c-means (FCM) is the clustering algorithm and it is based on reducing the following function

$$Y_m = \sum_{i=1}^{N} \sum_{j=1}^{C} M_{ij}^m \left\|x_{i-}R_j\right\|^2 \qquad (3)$$

Where, m= any real number greater than 1,

M_{ij}=degree of membership of x_i in the cluster j,
x_i = data measured in d-dimensional,
R_j = d-dimension center of the cluster

Algorithm

1.Initialize
$M = [M_{ij}]$ matrix M^0
2. Calculate the centers vectors R_j,

$$R_j = \frac{\sum_{i=1}^{N} x_i . M_{ij}^m}{\sum_{i=1}^{N} M_{ij}^m} \qquad (4)$$

3. The update of membership M_{ij} is given by,

$$M_{ij} = \frac{1}{\sum_{j=1}^{c}\left(\frac{\|x_i - R_j\|}{\|x_i - R_j\|^2}\right)^{\frac{2}{m-1}}} \qquad (5)$$

4.If
$max_{ij}\{|M_{ij}^{K+1} - M_{ij}^{K}|\} < \delta$ then stop, otherwise return to step 2.

Where, δ= termination value or constant between 0 and 1 and K= no of iteration steps.

Fig.4. shows the output for fuzzy C-means algorithm with five clusters. At the second cluster, the tumor is extracted.

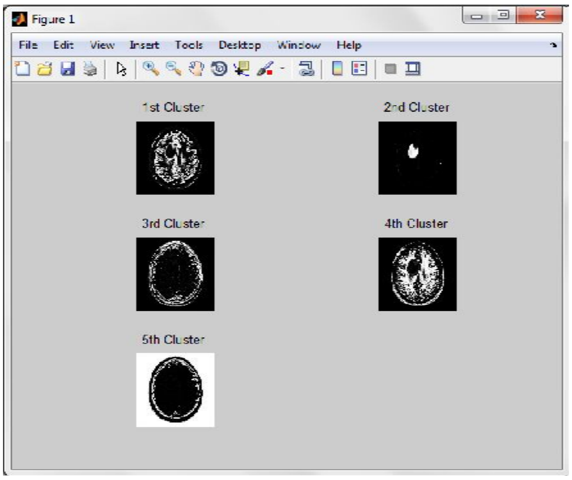

Fig.4. Output image for fuzzy C-means algorithm

2.4 Feature extraction

When the input data to an algorithm is too astronomically immense to be processed then the input data will be transformed into a reduced representation set of features (features vector). Feature Extraction is subsidiary in identifying brain tumor where is precisely located and avails in prognosticating next stage. Transforming the input data into the set of features is called feature extraction. The extracted cluster is given to the thresholding process. It applies binary mask over the complete image. It makes the dark pixel becomes darker and white pixels becomes brighter. In threshold coding, each transform coeficient is compared with a threshold T. If it is less than the threshold value then it is considered as zero. If it is more than the threshold value, it will be considered as one. If g(x,y) is a thresholded version of f(x,y) at some threshold T, then

$$g(x,y) = \begin{cases} 1, & f(x,y) > T \\ 0, & f(x,y) < T \end{cases} \qquad (6)$$

$f(x,y)$ is the input image pixels and $g(x,y)$ is the output image pixels.

2.5 Approximate reasoning

In the approximate reasoning, by utilizing the binarization method, the tumor area is calculated. And the image having only two values either black or white (0 or 1). The binary image can be represented as an addition of total number of white pixels and black pixels.

Image,

$$I = \sum_{W=0}^{255} \sum_{H=0}^{255} [f(0) + f(1)]$$
(7)

$f(0)$=black pixels (digit 0)

$f(1)$=white pixels(digit 1)

Number of white pixels,

$$P = \sum_{W=0}^{255} \sum_{H=0}^{255} [f(1)] \qquad (8)$$

The area calculation formula is given by,

Size of tumor,

$$S = \left[\sqrt{(P)}.0.264\right] mm^2 \qquad (9)$$

1 Pixel= 0.264 mm

III. RESULTS AND DISCUSSION

The Experiment of detection of tumor is carried out using two methods i.e. K-means clustering algorithm and fuzzy C-means clustering algorithm in MATLAB. K-means is a simple algorithm that has been adapted to many problem domains. It can see that the K-Means algorithm is a good candidate for extension to work with fuzzy feature vectors. Therefore the algorithm with fuzzy feature is called the Fuzzy C-Means (FCM) algorithm. Fuzzy C-means clustering algorithm, the tumor is extracted from the brain MR image, its exact position is located. The results show that the tumor area of fuzzy C-means clustering algorithm is more accurate than the K-means clustering algorithm. Fig.5. Shows that the output image for the tumor extracted using K-means algorithm**.** Area is 15.484 mm^2 for the K-means algorithm and processing time for K-means algorithm is 9.14861 seconds.

Fig.6. shows the MR image given as input to the pre-processing and fuzzy C-means algorithm. Here, the area is calculated using the formula by counting the number of white pixels of the brain tumor. Area is 17.9811 mm^2 for the fuzzy C-means algorithm and the processing time is 25.8815 seconds.

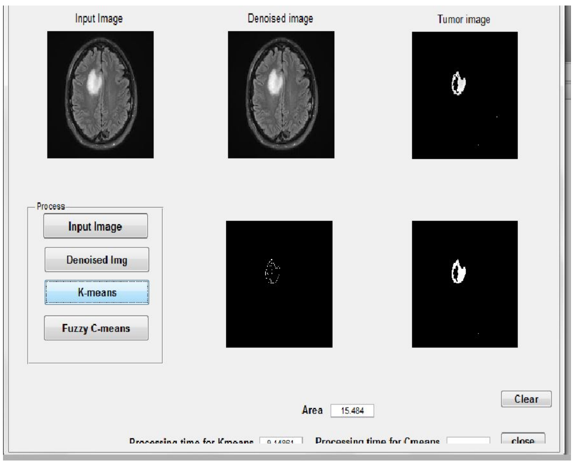

Fig.5. Output image for the tumor extracted using K-means algorithm

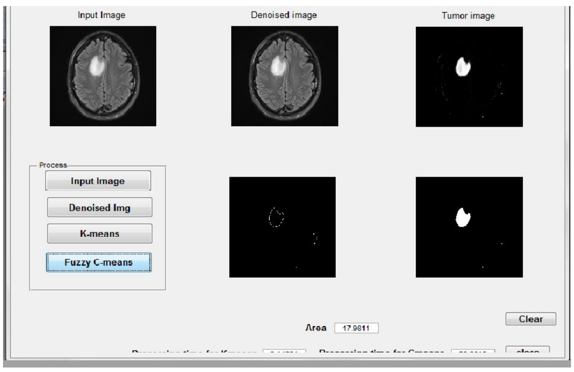

Fig.6. Output image for the tumor extracted using fuzzy C-means algorithm

It is mainly developed for the precise presage of tumor cells which are not soothsaid by K-means algorithm. It gives the precise result for the fuzzy C-means algorithm as compared to the K-means algorithm. The stage of tumor is predicated on the area of tumor. We considered that, if the area is more preponderant than 6 mm^2, it will be the critical position.

CONCLUSION

For detection of brain tumor, MR image is a promising diagnostic tool. Medical image segmentation is a very paramount implement in the medical imaging, which reduces the intricacy in the medical images and makes the analysis more accessible and consequential to understand. In this paper, we presented the clustering methods namely K-means and fuzzy C-means clustering algorithm. The noise present in the MRI input image is abstracted before the K-means and fuzzy C-means segmentation process. The de-noised image is given to the K-means and fuzzy C-means algorithm. Brain tumor image is extracted utilizing these two methods from the MRI image. The output image of fuzzy C Means gives the accurate prediction of tumor which are not predicted by K-means algorithm. Conclusively, segmentation using Fuzzy C-means gives precise tumor area as compared to K-means algorithm.

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