

# Segmentation of Brain Tumor in Magnetic Resonance Images using Various Techniques

Sneha Dhurkunde<sup>1</sup>, Shailaja Patil<sup>2</sup>P.G. Student, Dept. of Electronics & Tele-communication Engineering, SES's R. C. Patel Institute of Technology,  
Shirpur, Maharashtra, India<sup>1</sup>Associate Professor, Dept. of Electronics & Tele-communication Engineering, SES's R. C. Patel Institute of  
Technology, Shirpur, Maharashtra, India<sup>2</sup>

**ABSTRACT:** Image Segmentation is the process of partitioning a digital image into non-overlapping distinct regions, so that significant information about the image could be recovered and various analysis could be performed on that segmented image. In this paper, we present an efficient brain tumor segmentation methods, that can detect tumor and locate it in the brain MRI images. The method uses computer aided method for segmentation (detection) of brain tumor based on the three segmentation methods namely K-means clustering, fuzzy C-means clustering, thresholding with morphological operations. K-Means clustering and fuzzy C-means clustering techniques are used for the purpose of segmentation of brain tissue classes which is considered efficient and effective for the segmentation of an image. And thresholding with morphological operations method allows the segmentation (detection) of tumor tissue with high level accuracy and reproducibility comparable to clustering segmentation methods. At the end of the process the tumor is extracted from the MR image, its exact position and some features also determined. It is observed that the experimental results of the thresholding with morphological operations is a very promising in the field of brain tumor segmentation compare with clustering methods.

**KEYWORDS:** Image segmentation, K-means clustering, Fuzzy C-means clustering, Thresholding with Morphological operations, Feature extraction, Approximate reasoning.

## I. INTRODUCTION

The body is composed of many types of cells. Each type of cell has special functions. When cells lose the ability to control their magnification, they divide too often and without any order. The extra cells form a mass of tissue called a tumor. A tumor is a mass of tissue that grows out of control of the mundane forces that regulate magnification. There are two types of tumor which are benign (non-cancerous) and malignant (cancerous) tumors. The former is described as slow growing tumors that will exert potentially damaging pressure but it will not spread into circumventing brain tissue. And the latter is described as rapid growing tumor and it is able to spread into circumventing brain. The tumor may be primary or secondary. If it is an begining, then it is called as primary. If the component of the tumor is spread to another place and grown as its own then it is called as secondary.

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 complicated system. The whole system will when ideally 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. The instruments needed for this could be ultrasound, Computer Tomography (CT Scan) and Magnetic Resonance Imaging (MRI). 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 not affect the human body. Because it doesn't utilize any radiation. It is predicated on the magnetic field and radio waves. A good segmentation process leads to the right decision and provides a good and right treatment.

Segmentation is an important process in most medical image analysis. Image segmentation is the process of partitioning a digital image into multiple sets of pixels. Complex medical processes cannot be done without image processing techniques. Structures like tumor, brain tissue and skull cannot be identified without image segmentation.

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Clustering to Magnetic Resonance (MR) brain tumors maintains efficiency. 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 was developed by MacQueen in 1967 [6]. This is an algorithm to group objects predicated on attributes or features into k number of groups where k is a positive integer. And Fuzzy C-means (FCM) technique was originally introduced by Jim Bezdek in 1981 [7]. This is the clustering algorithm which sanctions one piece of data may be member of more than one clusters. Utilizing thresholding with morphological operations efficient brain tumor segmentation is withal carried out in [8] [18]. This is the efficient algorithm where segmentation of tumor is carried out. Morphological processing is constructed with operations on sets of pixels. Morphology is utilized to transform an image into another image by eliminating undesirable features. This is done by probing the input image with another image of certain shape and size called as structuring element. In this paper, we compare the clustering algorithms i.e. K-means and fuzzy C-means clustering with thresholding with morphological operations. In this method we fixated on segmentation of brain tumor detection. The developing platform for the detection is MATLAB. Because it is facile to develop and execute. At the terminus, we are providing systems that detect the tumor shape and its area.

Paper is organized as follows. Section II describes review of the related work i.e. automatic brain tumor detection using region growing method and expectation maximization algorithm. Section III describes the different techniques such as K-means clustering, fuzzy C-means clustering and thresholding with morphological operations. Section IV presents experimental results showing results of tumor detected and results are compared with one another.. Finally, Section V presents conclusion.

## II. RELATED WORK

Image Segmentation in [1][2][3] is needed to extract complex information from images. From last few years many researchers in medical field they made some significant survey of image segmentation. Nishant Verma et al [4] presented that region growing method is region predicated image segmentation. Region growing is a magnificent segmentation method. Region predicated geometric active contour models are much immune to noise in the MRI resulting in poor segmentation process. Here the intensity of the similar image is bunched into one region utilizing 4-connected or 8-connected neighborhood. In this the intensity belong to the similar seed, it belongs to one region and process is repeated. 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.

Dalila Cherif et al [5] presented that expectation maximization algorithm is an iterative process to obtain maximum likelihood estimates of parameters in statistical model. It is utilized to estimate the parameters of different classes in an image. Normal or abnormal classification is to conduct more parameters such as mean, variance and weight of each tissue type. Extraction of these parameters are carried out utilizing maximum likelihood principle. But the algorithm is very intricate. In our work, the algorithm is thresholding with morphological operations, we have implemented is very unsophisticated, computationally rapid compared to other segmentation techniques and accuracy of tumor detection and segmentation is also high. The methodology and how segmentation process is carried out explained in detail in the following sections.

## III. METHODS

### A. Segmentation using K-means and Fuzzy C-means clustering

The main motive of this system is to show the tumor area. The system framework is shown in Fig. 1 with detailed internal architecture for the detection of the brain tumor from MR images.

Following are the steps of brain tumor detection.

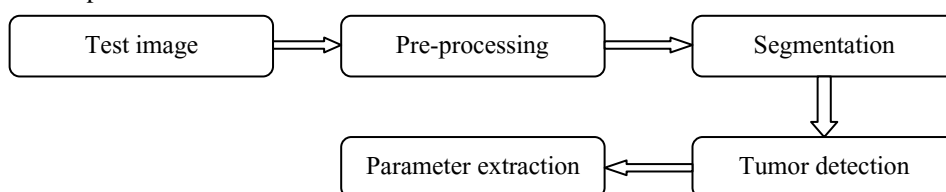


Fig. 1. Block diagram

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## 1. Pre-processing

In this process image is enhanced and noise is abstracted from the image. All unwanted text-noise will be abstracted. It performs filtering of noise and other artifacts in the image and sharpening the edges in to the image. Conversion of RGB to grey scale image and reshaping additionally takes place. For understanding the function of median filter, we integrated the salt and pepper noise artificilly and abstracting it utilizing median filter. The possibilities of advent of noise in modern MRI scan are very less. It may come due to the thermal effect.

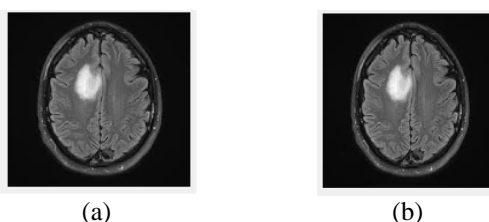


Fig. 2. Pre-processing (a) Input image and (b) De-noised image

## 2. Segmentation using K-means clustering

Clustering the image is grouping the pixels according to the some characteristics. K-means is the one of the unsupervised learning algorithm for clusters. The value 'k' stands for the number of cluster seeds initially provided for the algorithm. K-means clustering is an algorithm to group objects predicated on their attributes or features into k number of groups where k is a positive integer. The grouping is done by minimizing the Euclidean distance between data and the corresponding cluster centroid. Thus the main motive of K-means clustering is to cluster the data points.

### Mathematical representation

For a given image, calculate the cluster means m,

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

Calculate the distance between the cluster center to each pixel is given by,

$$D(i) = \arg \min \|x_i - M_k\|^2, i = 1, \dots, N$$

Repeat the above two steps until mean value convergence.

### Algorithm

1. Contribute the number of cluster value as 'k'.
2. Arbitrarily decide the 'k' cluster centers.
3. Calculate the mean or center of the cluster.
4. Calculate the distance between each data pixel to each cluster center.
5. If the distance is proximate to the center of the cluster then shift to that cluster.
6. Otherwise shift to next cluster.
7. Re-estimate the center of the cluster.
8. Reiterate the process until the center doesn't move.

## 3. Segmentation using Fuzzy C-means clustering

The fuzzy C-means algorithm has been widely utilized in cluster analysis, pattern recognition and image processing etc. Fuzzy C-means (FCM) is a data clustering technique in that each data point belongs to a cluster to some degree that is specified by a membership grade. It is a method that shows how to group data pixels that populate some multidimensional space into a specific number of different clusters. The membership value of the fuzzy set is from 0 to 1 range. Fuzzy clustering is necessarilly a multi valued logic that sanctions intermediate values i.e., member of one fuzzy set can additionally be member of other fuzzy sets in the same image. The membership function defines the fuzziness of an image and to define the information contained in the image.

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## Mathematical representation

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

$$Y_m = \sum_{i=1}^N \sum_{j=1}^c M_{ij}^m \|x_i - R_j\|^2$$

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  $R_j$ ,

$$R_j = \frac{\sum_{i=1}^N x_i \cdot M_{ij}^m}{\sum_{i=1}^N M_{ij}^m}$$

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

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

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

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

## 4. Feature Extraction

In image processing, feature extraction is a particular form of dimensionality reduction. The input data is transformed into the set of features is called feature extraction. The feature extraction is extracting the cluster which shows the soothsaid tumor at the output. 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 coefficient 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.

## 5. Approximate Reasoning

In the approximate reasoning, the tumor area is calculated by utilizing the binarization method. 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.

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

Where,  $f(0)$  = (digit 0) black pixels,  
 $f(1)$  = (digit 1) white pixels

Number of white pixels is given by,

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

The tumor area is given by,

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

1 Pixel = 0.264 mm

## B. Segmentation using Thresholding with Morphological Operations

Each image is pre-processed and applied thresholding with morphological operations to segment and detects the tumor that which explained in detail in the following sub sections. In this method image pre-processing is also carried out. It abstracts the noise and high frequency artifact present in the image. This process is also used a median filter to remove the noise.

### 1. Histogram Equalization

This method conventionally increases the contrast of many images, especially when the utilizable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better spreaded on the histogram. The method is secondary in images with backgrounds and foregrounds that are both bright or both dark. The continuous probability density function and cumulative probability distribution functions are calculated. The equation is utilized to calculate the cumulative probability distribution function. The frequency of occurrence of each gray value is calculated and the image is converted in to a more utilizable form. From the histogram equalization the output image, we can shows that the contrast of the image is enhanced. The cumulative probability distribution function is given by,

$$f_u(u) = \int_0^u P_u(u) du$$

Here  $u$  is the image pixel value where each pixel has a continuous probability density function.  $P_u(u)$  is the continuous probability density function,  $f_u(u)$  is cumulative probability distribution function.

### 2. Thresholding

The output image of threshold is a binary image. Thresholding makes the binary images from grey scale level by turning all pixels less some threshold to zero and all pixels more that threshold to one. If  $g(x, y)$  is a thresholded version of  $f(x, y)$  at some threshold  $T$ , then

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

### 3. Segmentation using morphological operations

Morphological operation was developed for binary images and was later elongated to gray scale functions and images. The fundamental morphological operators are erosion, dilation, opening and closing. After converting the image in the binary format some morphological operations are applied on the converted binary image. The purport of the morphological operators is to separate the tumor part of the image. The portion of the tumor in the image is visible as white color which has the highest intensity than other regions of the image. Some of the commands utilized in the morphing are imerode which is utilized to erode or shrink an image and imdilata which is utilized for dilating i.e. expanding an image. After segmentation and thresholding some percent of noise will be there, in order to abstract this noise two paramount morphological operations opening and closing have been utilized.

### 4. Tumor detection

The cluster with high intensity pixels are isolated from the MRI image which forms the tumor image. Some of the features like as area, centroid and perimeter are calculated of the tumor image.

## IV. EXPERIMENTAL RESULTS

The Experiment of detection of tumor is carried out using three methods such as K-means clustering algorithm, fuzzy C-means clustering algorithm, thresholding with morphological operations in MATLAB. Segmentation using thresholding with morphological operation, the tumor is extracted from the brain MR image, its exact position is located. In table and graph shows GT means ground truth image referred to as reference image.

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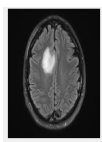
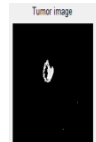


Test Image	K-means clustering	FCM clustering	Thresholding with Morphological operations
			

Table 1. Detection of brain tumor using three methods

Table 1 shows the detection of brain tumor using K-means clustering algorithm, fuzzy C-means clustering algorithm methods and thresholding with morphological operations. The above results shows that in thresholding with morphological operations the exact tumor area is located compared to both these clustering methods.

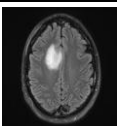
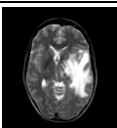
Test image	Parameters	K-means clustering	FCM clustering	Thresholding with morphological operations	GT
 Fig. 3	Area	15.484	17.981	<b>19.697655</b>	19.782
	Perimeter	289.4214	307.08	<b>340.977705</b>	341.91
	Centroid X	228	226	<b>226</b>	226
	Centroid Y	211	212	<b>210</b>	210
 Fig. 4	Area	25.2255	30.078	<b>32.340808</b>	31.943
	Perimeter	59.69849	5.4142	<b>1142.011327</b>	973.84
	Centroid X	324	319	<b>331</b>	333
	Centroid Y	282	280	<b>279</b>	279

Table 2. Features of brain tumor

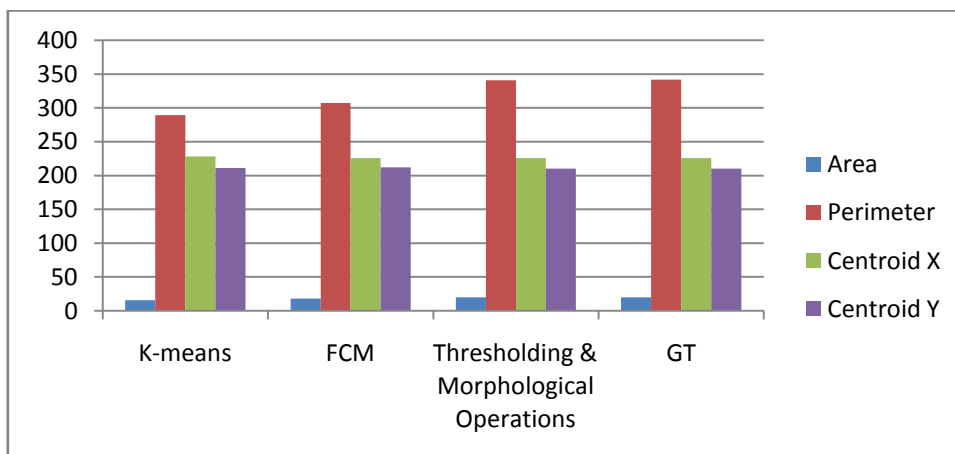


Fig. 5. Performance analysis of Fig. 3 in table 1

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Finally features of the brain tumor such as area, perimeter and centroid are extracted and compared with one another. The results in table 2 and graph also shows that the tumor features of thresholding with morphological operations are more accurate than the K-means clustering and fuzzy C-means clustering methods.

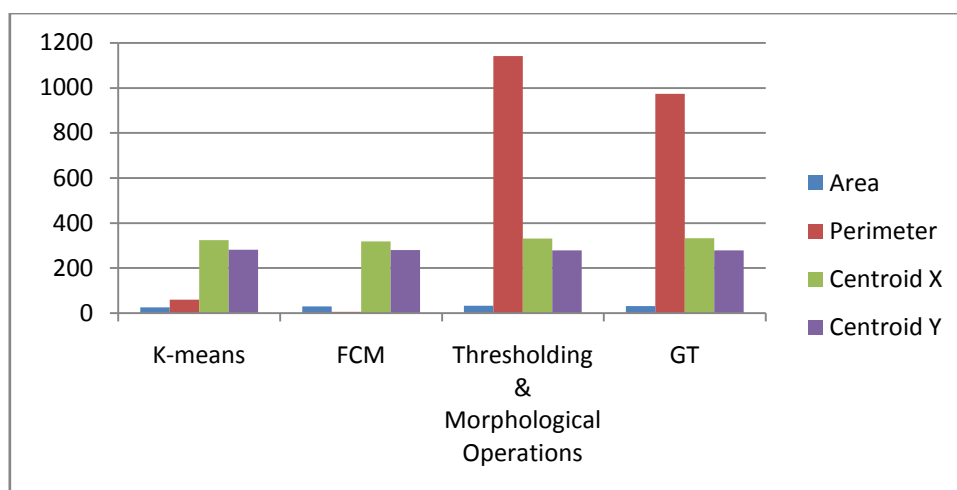


Fig. 6. Performance analysis of Fig. 4 in table 1

### V. CONCLUSION

In this paper we presented a method for Image segmentation, image pre-processing using median filter, image enhancement using histogram equalization, Segmentation using clustering methods such as K-means clustering, fuzzy C-means clustering and thresholding with morphological operations then the detection of tumor. Some of the features of the tumors are extracted which will be helpful in medical applications. Also we had compared all three techniques with the parameters such as area, perimeter and centroid of brain tumor. In this analysis thresholding with morphological operation technique is giving better accuracy than both clustering methods. Above we had mentioned the comparison table of all three methods. The future works involve the segmentation of more images with more features which helps in classifying different types of tumors.

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