Discriminating Brain Tumor Segmentation Algorithms & Its Area Calculation

Bhupendra T. Jagatap[#1], Prof. Sanjeev N. Jain[*2]
[#]PG Student, Department of Electronics Eng., SSVPS BSD's COE, Dhule, Maharashtra, India.
[*]Associate Professor, Department of Electronics Eng., SSVPS BSD's COE, Dhule, Maharashtra, India.

Abstract-- *Image Segmentation is the process of partitioning a significant information about the image could be retaken and various analysis could be performed on that segmented image. Brain is the most important and vibrant organ of the human body. The control and coordination of all the other vibrant structure is carried out by the brain. The tumor is made by the uncontrolled multiplication of cell division. Many techniques were developed to detect and segment the brain tumor using multiple segmentation algorithms such as 1) watershed algorithm, 2) k-means clustering, 3) Fuzzy c-means clustering is carried out. This is where the division of the tumor is carried out and the centralization, the perimeter and field is the efficient algorithm that divides its features as are calculated from tumors. To detect brain tumors, scanned MRI images are given as input. The work done here helps to locate the tumor in the medical field and help greatness the patient to the treatment plan. Besides, it also reduces the time for analysis. At the end of the process the tumor is separated from the MR image, its precise position and some features also determined. It is observed that the experimental results of the thresholding and morphological process is very promising in the field of brain tumor segmentation compare with clustering methods.*

Keywords: *Magnetic Resonance Image (MRI), Preprocessing and Segmentation (K-means, Fuzzy c-means, Watershed algorithm), Parameter analysis.*

I. INTRODUCTION

The body is composed of different types of cells. Each type of cell has superior functions. When cells lose the ability to control their extension, they divide also often and without any order. The extended cells form a mass of tissue known as tumor. A tumor is a mass of extended tissue that grows out of control of the everyday forces that regulate magnification. There are two types of tumor first one is benign (non-cancerous) and second one is malignant (cancerous) tumors. The past is described as slow growing tumors. However, the latter is described as growing rapidly tumor and it is able to spread into circumventing brain. The tumor divided in two types its either primary or secondary. If it is a beginning then it is called as primary. If the component of the tumor is spread to another place and extended as its own then it is called as secondary.

CANCER is one of the most serious health disease in the world. The death rate of lung cancer is the highest among all other types of cancer. Lung cancer is one of the most serious cancers in the world, with the smallest survival rate after the analysis, with a gradual increase in the number of deaths every year. The earlier the detection is the higher the chances of successful treatment are estimated 82% of lung Cancer cases in males and 73% in females are caused by cigarette smoking.

The goal of this work is to design a computerised implement for brain tumour quantification utilizing MRI image data sets. This work is a limited part of a quite complicated system. The whole system will when ideally visualize the inside of the organic structure of human body, and make medical doctor able to perform operations inside a patient without open surgery. More specifically the aim for this work is to segment a tumour in a brain. The instruments needed for this could be Computed Tomography (CT scan) and Magnetic Resonance Imaging (MRI). In this paper the MRI image is taken for the complete process. The MRI scan is easier than CT scan for diagnosis. It is not affect the human body. Because it does not utilize any radiation. MRI images based on the magnetic field and radio waves.

II. EXISTING METHOD

2.1 Segmentation by Thresholding

Thresholding method is usually used for image segmentation. This is simple and effective segmentation method for images with different passions. Thresholding is useful in discriminating foreground from the background by selecting a satisfactory threshold value T, the gray level image can be converted to binary image. The binary image should contain all of the important information about the position or shape of the objects of foreground. The advantage of obtaining first a binary image is that it decreases the complexity of the data and make simpler process of classification. The most common way to convert a gray-level image to binary image is to select a distinct threshold value (T). Then all the gray level values below this threshold value (T) will be classified as black (0), and those above threshold value (T) will be white (1). Otsu's method using function computes global image threshold. Otsu's method is based on threshold selection by statistical criteria. Otsu suggested minimizing the weighted sum of within-class changes of the object and background pixels to establish an optimum threshold. Remember that minimization of within-class variances is equivalent to maximization of between class variance. This method gives satisfactory results for histogram images.[1]

The technique basically attempts for finding a threshold value, which enables the classification of pixels into different groups. A major fault of this segmentation mode is that: it generates only two classes. Therefore, this method fails to deal with multichannel images. Besides, it also ignores the spatial characteristics due to which an image becomes noise sensitive and go through intensity in homogeneity problem, which are expected to be found in MRI. Both these features create the possibility for corrupting the histogram of the image. For overcoming these problems various versions of thresholding technique have been introduced that segments medical images by using the information based on local intensities and connectivity.[2] Though this is a simple technique, still there are some factors that can complicate the thresholding operation, for example, non-stationary and correlated noise, ambient illumination, busyness of gray levels within the object and its background, inadequate contrast, and object size not corresponding with the scene presented a new image thresholding method based on the divergence function. In this method, the objective function is constructed using the separation function between the classes, the object and the background. The mathematical representation required is found where this separation function shows a global minimum.[3]

$$\mathrm{Out}(x,y) = \begin{cases} 1 & if \;\; Inp(x,y) > T \\ 0 & else \end{cases} \quad (1)$$

Where,

Inp (x, y) = input image.
Out (x, y) = segmented image.
T = threshold.

2.2 Morphological Filtering

Morphological processing is built with operations on sets of pixels. Binary morphology uses only set membership and the value such as gray level or colors of a pixel. It depend on many times is applied to binary and gray scale images. Binary images can be improved to the operator's specifications. Binary images are images whose pixels have only two possible intensity values. They are normally showed as black and white. Mathematically, the two values are often 0 for black, and either 1 or 255 for white. Binary images are often produced by thresholding a gray scale or color image in order to separate an object in the image from the background. The color of the object is referred to as the foreground color. The rest is mentioned to as the background color.[4]

The morphological operations include filtering a label map such that the boundary of a labeled region either grows or contracts. Sequences of morphological operations can extend manual segmentation by filling in small holes or breaking connections between regions. Thresholding is a different filtering method that is used to label pixels whose grayscale values are in a desired range. Morphological processing is created with operations on sets of pixels. Binary morphology uses only set membership and is indifferent to the value such as gray levels of a pixel. Morphological image processing relies on the ordering of pixels in an image and many times is applied to binary and grayscale images. Binary images consisting of pixels have only two possible intensity values. They are normally shown as black and white. Mathematically, the two values are often 0 for black, and either 1 or 255 for white. Morphological Segmentation details the segmentation for identifying the tumor in the brain. The morphological operations are applied to the grayscale images to segment the abnormal regions. Erosion and dilation are the two fundamental operations in Mathematical Morphology. A combination of these two represents the rest of the processes.[5]

Morphology is the study of shapes and structures from specific image. An organizing element is mainly required for any morphological operation. Morphological operations operates on two images organizing element and input image. Corresponding image that elements are small images that are used to probe an input image for properties of interest. Basis of a structuring element is defined by the center pixel of the structuring element. In morphology, the structuring element defined will pass over a section of the input image where this section is defined by the community window of the structuring element and the structuring element either fits represents the input image's structure is got and suppression of the geometric features of the input image that doesn't fit the structuring element's neighborhood takes place. Two main morphology operations are erosion and dilation where erosion results in the thinning of the objects in the image considered and dilation results in setting of the objects in the image. Dilation uses the highest of all the pixels in the value of all the pixels in the neighborhood of the input image defined by the structuring element and destruction uses the lowest value neighborhood of the input image.[6]

III. PROPOSED METHOD

The proposed system has mainly four modules: pre-processing, segmentation algorithm (K-means, Fuzzy c-means, Watershed algorithm) and morphological operation and parameter analysis. Preprocessing is done by apply filtering. Segmentation is carried out by

Watershed algorithm, Fuzzy Clustering and K-means clustering. And find the exact size of tumor in this techniques; also we had done parameter analysis for both techniques.

A. Proposed Method Block diagram:

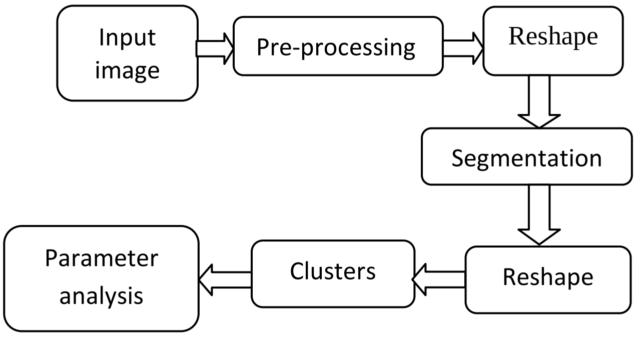

Fig.1 block diagram of proposed method

Preprocessing

Image processing stage is the simplest categories of medical image processing. This stage is used for decreasing image noise, highlighting edges, or displaying digital images. Some more techniques can work in medical image processing of coherent echo signals prior to image generation. These are used to reduce noise and imaging of spectral parameters. Afterthis stage the MRI image is converted into standard image without noise, film articles and labels.

IV. TECHNIQUES

4.1 K-Means Clustering Segmentation

The K-means clustering algorithm is commonly used for segmentation of multi-dimensional data. K-means works by assigning multidimensional vectors to one of K clusters. The goal of the algorithm is to minimal the change of the vectors assigned to each cluster. The cluster centers are differentiated and the vectors are re-assigned using the new cluster centers. K-means clustering is a splitting method. The function K-means partitioning data into K mutually select clusters, and returns the index of the cluster to which it has assigned each observation. Distinct hierarchical clustering, K-means clustering operates on actual observations and creates a single level of clusters. K-means clustering is more suitable than hierarchical clustering for large amounts of data.[7]

K-means gives partition in which objects within each cluster are as near to each other and as far from objects in other clusters as possible. Any one parameter can be chosen from five different distance measures, depending on the kind of data used for clustering. Every cluster in the partition is defined by its member objects and by its centroid, or center. The centroid of each cluster is the point to which the summation of distances from all objects in that cluster is minimized. K-means uses an iterative algorithm that minimizes the addition of distances from each object to its cluster centroid, over all clusters. This algorithm exchanges objects between clusters until the addition can't be decreased further. The result is a set of clusters that compact and well-separated as possible. The details of the minimization can be controlled using several optional input parameters to K-means. Including ones for the starting values of the cluster centroids and for the maximum number of iterations.[5]

Clustering the image is grouping the pixels according to the same characteristics. K-means clustering is to divider into k clusters in that each observation belongs to the cluster with the most proximate mean. K-means clustering is an algorithm to group objects predicated on attributes or features into k number of groups where k is a positive integer. The combination is done by minimizing the Euclidean distance between data and the corresponding cluster centroid. Thus the main thing is that of K-means clustering is to cluster the data.[8]

Mathematical representation

For a given image, calculate the cluster means m,

$$M = \frac{\sum_{i:c(i)=k} xi}{Nk}, k = 1, \ldots, K \qquad (1)$$

Calculate the distance between the cluster centers to each pixel

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

Repeat the above two steps until mean value convergence.[9]

Algorithm

I. Give the number of cluster value such as k.
II. Arbitrarily cull the k cluster centers.
III. Evaluate mean or center of the cluster.
IV. Calculate the distance between each pixel to each cluster center.
V. If the distance is proximate to the center then shift to that cluster.
VI. If not then shift to next cluster.
VII. Re-determine the center.
VIII. Do again the process until the center doesn't move.[10]

4.2 Fuzzy C-means clustering segmentation

The fuzzy logic is a way to processing data by offering partial subscription value for each pixel in the image. The fuzzy set's subscription price ranges from 0 to 1. The fuzzy clustering basically allows a multi-valued argument that, i.e. intermediate values.A fuzzy set member can also be a member of the Anya Fuzzy set in the same image. There is a sudden transition between full membership and non-subscription. The membership function defines the fuzziness of an image and also to define the information contained in the image. These are the three main features included in the basic membership function characterized by. They are supported, boundary. A fully member of the core fuzzy set. The support set has a non-subscription value and the limit is intermediate or partial subscription with a value between 0 and 1. [10]

The fuzzy clustering pattern plays an important role in solving problems in the areas of mandate and fuzzy model recognition. Fuzzy Clustering has been proposed a variety of ways and most of them are based on distance criteria. A widely used algorithm means the fuzzy C (FCM) algorithm. It uses a reciprocal distance to calculate fuzzy weights. The fuzzy C method means the membership load of each cluster is assumed to be in the covers neighborhood after the cluster distributions are considered. Each pixel bet is based on the subscription values of the neighboring pixels. In this algorithm, the data is the limit for each cluster through a subscription function, which represents the fuzzy comportment of the algorithm. [11] During this, they are included with the new subscription, with the spatial function. Replication is deprecated when the maximum difference between the cluster center and the subscription function on the two successive iterations is less than the threshold value. This algorithmis the same as the K-means algorithm in the structure. Fuzzy for improving split results C-mean clustering algorithm. [12]

Mathematical representation

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

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

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

$M = [M_{ij}]$MatrixM^0

2. Calculate the centres vectorR_j,

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

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

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

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.[11]

4.3 Watershed segmentation

In Geography, a watershed ridge that divides areas drained by the River system. Watershed conversion is a morphological gradient based partition technology. The image's gradient map is treated as a relief map, in which different gradient values conform to different heights. If we punch a hole in each local image and immerse the entire map in water, the water level the valleys will grow. When the water meets two different bodies, a dam is created between them. Progress is continued until all points in the map are dissolved. In the end the whole image is divided by dams which are then called watershed and are referred to as sectional areas catchment basins. A catchment basin is the draining geographical area in a river or reservoir. The watershed algorithm applies these ideas to grey scale image processing, a way that can be used to solve a variety of image partitioning problems. The watershed algorithmdividing method in maths was firstly launched by Beucher and Meyer for the Image Division area. [14]

The watershed partition is a gradient based partitioning technique. It considers the shield map of the image as a relief map. It segments the image as a dam. Section areas are called catchment basins. Watershed segmentation solves many kind of image segmentation problem. It is suitable for images that have high intensity value. Watershed is due to segmentation on segmentation. To control the partition, the marker controlled watershed partition is used. The Sobel operator is suitable for locating the edge. In the watershed partition of the marker controlled, the Sobel operator is used to separate the edges of the object. [1]

The sobel masks in matrix form are as follow:

$$M_x = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}, M_y = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 0 \\ -1 & 0 & 2 \end{bmatrix}$$

The equation of gradient magnitude used in marker controlled watershed segmentation is

$$M = \sqrt{Mx^2 + My^2}$$

$$\text{Angle, } \theta = \tan^{-1}\frac{My}{Mx}$$

V. RESULT PARAMETER

Approximate reasoning

In the approximate reasoning step the tumor area is calculated using the binarization method. The image having only two values either black or white (0 or 1). Here 256X256 jpeg images is a maximum image size. The binary image can be represented as a summation of total number of white and black pixels.

$$No\_of\_whitepixelP = \sum_{W=0}^{255}\sum_{H=0}^{255}[f(0)]$$

Where,

P = number of white pixels (width*height) 1 Pixel = 0.264 mm

The area calculation formula is

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

P= no-of white pixels; W=width; H=height.

VI.RESULT AND DISCUSSION

S. no	Parameter	Watershed algorithm	K-means	FCM	GT
1	Area	36.2719	8.2560	**9.1337**	9.1490
2	Perimeter	541.924	139.60	**146.846**	143.67
3	Centroid X	128	113	**113**	113
4	Centroid Y	128	106	**106**	106

Table 1.-Image segmentation experimental result for image1

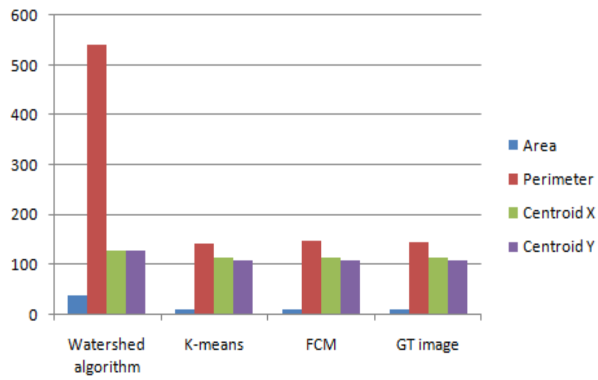

Fig1.-Performance graph for Area, Perimeter and Centroids of all three methods for image1

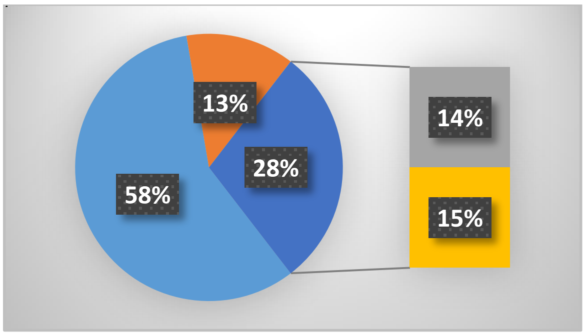

Fig2.-Compairison percentage with GT for image1

S. no	Parameter	Watershed algorithm	K-means	FCM	GT
1	Area	54.1116	12.2838	**12.7378**	12.77
	Perimeter	74.16	180.422	**221.26**	217.1
3	Centroid X	128	109	**109**	109
4	Centroid Y	132	144	**143**	143

Table 2.-Image segmentation experimental result for image2

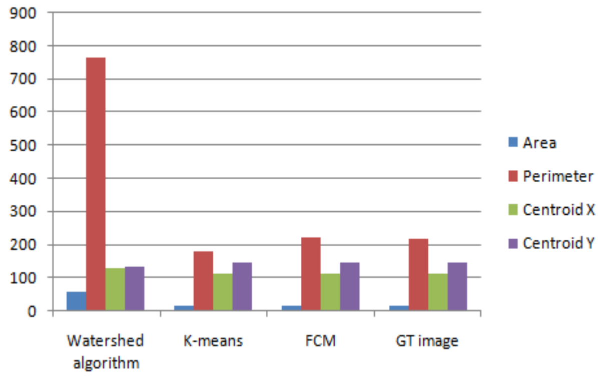

Fig3.-Performance graph for Area, Perimeter and Centroids of all three methods for image2

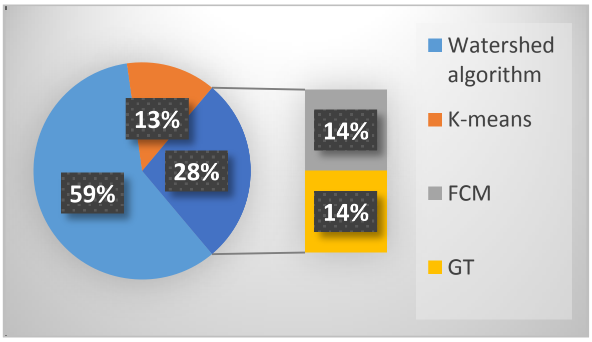

Fig4.-Compairison percentage with GT for image2

VII. CONCLUSION

In this paper, detection of brain tumor we have applied different image segmentation techniques. The results shows that the tumor features are calculated by using K-means clustering, fuzzy C-means clustering, and watershed segmentation methods. Further segmentation utilizing fuzzy C-means gives precise tumor area as compared to segmentation utilizing K-means algorithm and watershed. Besides in thresholding and morphological operations the algorithm involved is less complex, highly accurate in terms of area, perimeter and centroid and easy to understand and implement compared to K-means and fuzzy C-means clustering techniques. Some of features of the tumours are extracted which will be helpful in medical applications. The future works involve the segmentation of more images with more features which helps in classifying different types of tumours.

VIII. REFERENCES

[1] P. S. N. J. Bhagyashri G. Patil, "Cancer Cells Detection Using Digital Image Processing Methods," *International Journal of Latest Trends in Engineering and Technology (IJLTET)*, vol. 3, no. 4, pp. 45-49, March 2014.

[2] R. Mithali , "Brain Tumor Detection and Identification Using K-Means Clustering Technique," *Special Issue Published in Int. Jnl. Of Advanced Networking and Applications (IJANA)*, pp. 14-18, March 2015.

[3] D. M. S. S. A. D. A. P. R. T. Kshitij Bhagwat, "Comparative Study of Brain Tumour Detection Using K means, Fuzzy C Means and Hierarchical Clustering Algorithms," *International Journal of Scientific & Engineering Research*, pp. 626-632, (ISSN) June-2013.

[4] H. V. K. Leela G A, "Morphological Approach for the Detection of Brain Tumour and Cancer Cells," *(Quest Journals) Journal of Electronics and Communication Engineering Research*, pp. 7-12, 2014.

[5] A. B. M. S. B. Meenakshi S R, "Morphological Image Processing Approach Using K-Means Clustering for Detection of Tumor in Brain," *International Journal of Science and Research*, pp. 24-29, (IJSR) August 2014.

[6] C. S. S. M. Rohini Paul Joseph, "BRAIN TUMOR MRI IMAGE SEGMENTATION AND DETECTION IN IMAGE PROCESSING," *International Journal of Research in Engineering and Technology*, pp. 1-5, (IJRET) Mar-2014.

[7] J. J.Vijay, "An Efficient Brain Tumor Detection Methodology Using K-MeansClusteringAlgorithm," *International conference on Communication and Signal Processing*, pp. 653-657, April 2013.

[8] R. D.SELVARAJ, "MRI BRAIN IMAGE SEGMENTATION TECHNIQUES - A REVIEW," *Indian Journal of Computer Science and Engineering*, pp. 364-381, (IJCSE) Oct-Nov 2013.

[9] R. T. a. S. S. K. Sailakshmi Parvathi, "Extraction of Tumor and Cancer Cells of Brain MRI Images by using different Morphological Operations," *International Journal of Emerging Trends in Electrical and Electronics (IJETEE)*, vol. 4, no. 1, pp. 77-79, JUNE 2013.

[10] J.selvakumar, "Brain Tumor Segmentation and Its Area Calculation in Brain MR Images using K-Mean Clustering and Fuzzy C-Mean Algorithm," *IEEE-International Conference On Advances In Engineering, Science And Management (ICAESM)*, pp. 186-190, March 2012.

[11] J. P. a. K. Doshi, "A Study of Segmentation Methods for Detection of Tumor in Brain MRI," *Advance in Electronic and Electric Engineering*, pp. 279-284, (ISSN) 2014.

[12] D. Kesavaraja, "ADVANCED CLUSTER BASED IMAGE SEGMENTATION," *ICTACT JOURNAL ON IMAGE AND VIDEO PROCESSING*, vol. 2, no. 2, pp. 307-317, NOVEMBER 2011.

[13] S. M. Alan Jose, "Brain Tumor Segmentation Using K-Means Clustering And Fuzzy C-Means Algorithms And Its Area Calculation," *International Journal of Innovative Research in Computer and Communication Engineering*, pp. 3496-3501, (IJIRCCE) March 2014.

[14] P. K. Yogita Sharma, "Detection and Extraction of Brain Tumor from MRI Images Using K-Means Clustering and Watershed Algorithms," *International Journal of Computer Science Trends and Technology (IJCST)*, pp. 32-38, (IJCST) Mar-Apr 2015.