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MORPHLOGICAL ASF AND K-MEANS CLUSTERING SEGMENTATION FOR TUMOR DETECTION

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Abstract— **Image segmentation is important feature detection in digital image processing. Identify the significant tumor presence in brain is the most worthwhile in human beings health precaution. The medical imaging, consider the pixels of particular tumor tissues for segmentation. In this paper, we propose a method to segment the tumor using k-means clustering and morphological alternative sequential filters (ASF). There are many methods proposed but our method identifies the tumor in unique manner. Brain magnetic resonance imaging (MRI) is used to segment the tumor by the combination of k-means clustering and morphological alternative sequential filters. The results are significant for identifying tumor pixels with unique segmentation process.**

Keywords— **Morphological transformations; segmentation; edge detection; k-means clustering; tumor detection**

I. Introduction

Feature detection of MRI brain image is one of important process in medical image processing. Compression and looking the images are the initial stages of identifying the tumor or features of MRI. Although identifying all pixels existing in tumors are executed by segmentation in two dimensional images. The image measurements and orientation are vital for medical imaging. The volumetric analysis of brain tissues includes the detection of tumor. Use of digital image processing to verify the presences of tumor in MRI is one of the interactive or automated essential tools.

For tumor segmentation Sushma Laxman Wakchaure et al [1] propose a framework by applying region-based and boundary-based paradigms. Divide the brain using a method such as symmetry based histogram analysis for medical cases and identify some common and general information on the tumor. The tumor segmentation method using three values such as edge (*E*), gray (*G*), and contrast (*H*) values. Feature Detection of Image is the process of segment an image into various homogeneous regions. Clustering the image for segmentation is to identify the tumor. This is a method [2] of forming a set of patterns into a various number of clusters. The MRI scanned data set used for brain tumor identification by an automated tool and using specific software MATLAB, which detect and segment. Medical imaging technique used to identify or visualize internal structures of the body to check the existence of tumor. So MRI required good contrast between the various soft tissues of the image for identification.

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Particularly images of brain, muscles, the heart, and cancers adopted with other process such as (CT) or X-rays. Gabor feature extraction algorithm [3] with help of k-means Clustering Segmentation. The brain tumor identification with the properties of uncontrolled growth of tissue is in important segmentation which can easily cure if it is at early stage. The graph cut algorithm [4] defined for Boundary or edge detection, thresholding, feature detection, and histogram. The quantitative analysis of brain image is derived by applying the combination of normalized cut and min-cut/max flow methodologies which provides the segmentation analysis. The ground truth labeling is evaluating the tissues of segmented image. Automatic pixel based segmentation will yields the performance improvement.

The application of both standard and some advanced morphological filters to several problems of image enhancement for feature detection [5]. It is important to use, uncover, and feature detection of objects in the inputted images. In shape analysis, the morphological filters plays very important role on image enhancement through geometrical approaches. For the nonlinear image processing the elementary morphological transformations is more suitable. Statistical process for image segmentation based on a geometric prior has been produce clarity to increase robustness and reproducibility [6]. Using a probabilistic geometric model of sought structures and image registration serves both initialization of probability density functions and definition of spatial constraints. The boundary intensity changes of current objects make some unwanted noises in the detection. A generative model proposed by Bjoern et al [7] for tumor appearance in multi-modal image volumes of the brain that provides channel-specific segmentations. This is an important algorithm and to demonstrate the greater performance over usual multivariate EM subdivision. The characterization of time series rainfall data used [8] to identify the behavior in the Malaysian rainfall data for different time periods. A bar with a width of 12 pixels is drawn for each day in the data. Each bar is segmented by a space of 2 pixels. Morphological ASF is performed on the barcode image using line structuring element with increasing length. Connected component-labeling algorithm is adopted for segmentation process with day of rainfall.

The tumor features include ring-enhancement or enhance with disparity agent. The tumor pixel inherits with smooth boundaries, normal space covered and smooth and fully enhance with contrast features. First approach for tumor segmentation we plan to use k-means clustering. Clustering randomly initialize the centroids which determines the membership with help of distance of pixels from centroids.

Re-estimate the centroids for the flexibility of image segmentation, which help the object detection or tumor tissues identification. From the boundary of tissues pixels the segmentation process will be initiated. Secondly morphological alternative sequential filters are adopted for reconstruction of tissues regions.

II. Methodology

A. Morphological Alternative Sequential Filters

Mathematical Morphology is an image process with structuring element which yields geometric shape of object analysis for feature extraction or stifled or well-maintain. Image enhancement, compression, reconstruction, description, digitization, restoration and segmentation are the few applications derived from mathematical morphological operations. It is nonlinear transformations for an image with various structuring elements (8). Dilation operation is adopted to derive the pleasant small dark areas which produce output as much brighter or reduce based on structuring element (SE) size and shape. By combining the above two operations we can produce the opening and closing through changing the sequence. Opening removes the bright regions in the object, so it connects or extends the smaller size by remove the thin connection between two shapes. Closing fills a small region which shows high intensity of neighborhoods, also it joins the surrounding regions. In equation 1 let image I is inputted MRI and SE (Figure 1) is a structuring element. ASF is defined by combining opening following by closing denoted as

$$ASF(I) = (I \circ SE) \bullet SE \quad (1)$$

Sequential process of ASF equation 2 with increasing size of structuring elements interactively, defined as

$$ASF(I) = ((I \circ SE) \bullet SE) \circ SE \quad (2)$$

$$ASF(I) = ASF_1\, ASF_2\, ASF_{3\ldots}\, ASF_n(I) \quad (3)$$

The ASF equation 3 is adopted to produce feature extraction through hierarchy. This segmentation process can be classified into unique layers for a particular structure element respectively. Also it can be applied for feature classification and recognition

0	0	0	0	0
0	0	1	0	0
0	1	1	1	0
1	1	1	1	1
1	1	1	1	1

1	1	1	1	1
1	1	0	1	1
1	0	0	0	1
0	0	0	0	0
0	0	0	0	0

Fig. 1 Structuring Element (SE)

In this paper, multi-scale structuring elements were used to produce the accuracy. This SE has a square shape and its width 5 to keep center pixel as origin that can divide left side and right side and other pixels define a neighborhood centered on the origin. As per morphological characteristics of brain tissue the structuring elements are having 0s and 1s to represent the shape of SE. The MRI slices are contain cerebrum with cerebellum (left side of Fig 1), and cerebellum without cerebrum (right side of Fig 1).

B. K-means Clustering

The k-means algorithm is divide image into k objects based on attributes. It locates the centroids as like Expectation-maximization algorithm for Gaussians. The object attributes assumed from a vector space. This algorithm clustering n data points into k disjoint groups S_j using equation 4, containing pixels which are minimize the sum-of-squares criterion.

$$S = \sum_{j=1}^{k} \sum_{n \in S_j} \left| x_n - \mu_j \right|^2 \quad (4)$$

Where x_n is a vector representing the n^{th} data point and u_j is the centroid of the pixels in data set. Generally k-means clustering is method to segment or to group the objects based on features. Also k should be positive and smaller than n. The segmentation is carried out by Euclidean distances between pixels and the respective centroid. Steps involved in k-means clustering are as follows.

1. Define the value k, which is number of clustering.
2. Start with any centroid for initial partition which segments the pixels into k clusters. Assign the image pixels systematically with following procedures
   a. Consider the first k training pixels as single-element classifications.
   b. Assign every remaining pixel to the cluster with the nearest centroid. After each classification we need recalculate the centroid of the segment the objects.
3. Consider each partition in sequence and calculate its Euclidean distance from the seed of each of the clusters. If a pixel is not closest centroid, switch that pixels to another cluster and update the centroid of the cluster gaining the new sample and the cluster losing the sample.
4. Repeat step 3 until satisfaction is achieved

The execution of K-means clustering, hierarchical clustering, Self organization map and fuzzy c-means clustering are compared by Tamije Selvy et al [9].

The Proposed method by considering the above comparison we designed specifically k-means clustering and morphological alternative sequential filters for tumor segment. Before segment the digital image, the normalization and image enhancement are required for removing the unwanted intensity of pixels. Steps for preprocessing shown in figure 2.There are several approaches for feature detection available such as thresholding, level set, region growing or region splitting, but we proposed method based on k-means with morphological ASF.

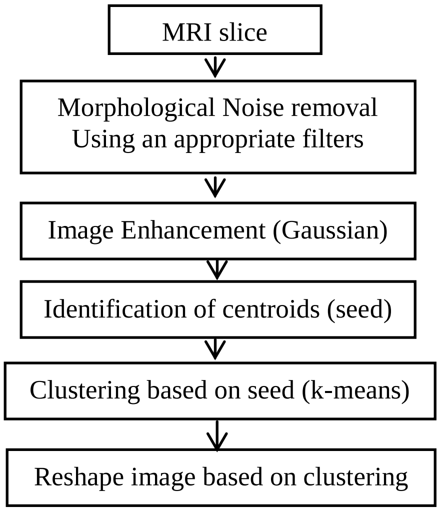


Figure 2: Prepressing of inputted image

The proposed method have two stages, initially the preprocessing the MRI with morphology, Gaussian and k-means clustering, which identify the tumor pixels and produce the segmented area of MRI. Morphological operations applied on MRI and structuring element. Structuring elements are small images (5 x 5) that are used to remove the noise on an input image. Origin of a structuring element is defined as center of figure 1. Noise removal is the first step on the MRI by morphological operations, through that the proper information of images used for process. It is first step preprocessing. After the removal of noise by using an appropriate filters like morphological median filters, opening transformations we use the Gaussian filters for enhance images to improve the pixel clearance for applying k-means clustering. Instead of conventional morphological noise removal filters we apply the opening and sequential approaches with various size of structuring element like cerebrum with cerebellum and cerebellum without cerebrum which are upwards or downwards approach for removing the noise in accuracy. The second step is for image enhancement where we apply Gaussian filters to improve the pixels to clear distance with seeds which we identify as centroids. The pixel improvement includes the increase the contrast of the image by calculating new values of the noise removed image pixel intensity to neighbor high intensities. The region boundary will be decided by the distance with seeds /centroids to fix the closed areas by using clustering.

The k-means clustering will identify Euclidean distances between seeds or centroids and every pixel. The numbers of seeds or centroids are fixed based on overview of enhanced MRI slices. The centroids will be close to region focused if not reassign the seeds then find the distances for each pixel to fix the region of interest (figure 3). Lastly we use the clustered regions to reshape and finalize the segmentation tumor area. Mostly this may have many regions as interest, but in the next stage we have to fix the region which consists of tumor tissue pixels. In the second stage of process we use the morphological alternative sequence filters for identifying tumor pixels in MRI slice using various size of SE

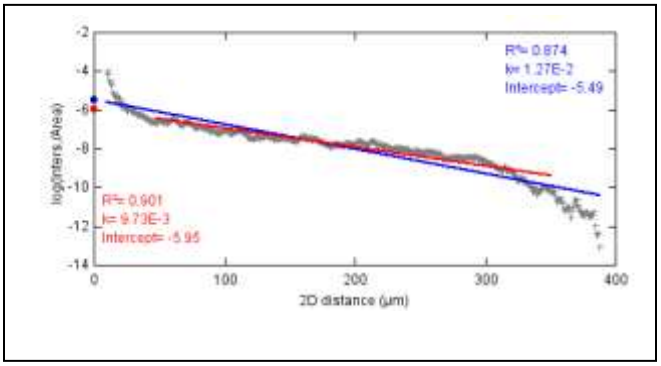


Figure 3: Pixel distance and area graph on identifying regions

TABLE 1: SEED IDENTIFICATION WITH CLUSTERING

	Radius	Inters.	Inters. /Area	Log (Radius)	Log (Inters./Area)
1	10	5	0.016	2.303	-4.14
2	10.835	7	0.019	2.383	-3.964
3	11.67	5	0.012	2.457	-4.449
4	12.505	5	0.01	2.526	-4.588
5	13.34	5	0.009	2.591	-4.717
6	14.175	4	0.006	2.651	-5.061
7	15.01	4	0.006	2.709	-5.176
8	15.845	4	0.005	2.763	-5.284
9	16.68	4	0.005	2.814	-5.387
10	17.515	5	0.005	2.863	-5.261
11	18.35	4	0.004	2.91	-5.578
12	19.185	5	0.004	2.954	-5.444
425	..	..	..		

The above table 1 shows the distance with radius to form the regions which are centroid based comparison. After the preprocessing we identified the region which may have tumor tissues for segmentation. The second stage we apply the morphological opening and closing on sequence manner with various size SE. This following process (Figure 4) includes the feature extraction and identifying the tumor pixels.

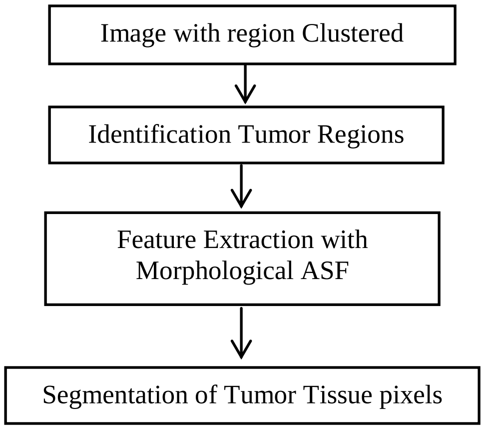


Figure 4: Process of Tumor Detection

After clustering using k-means, we apply the morphological alternative sequential filters which divides the image into regions consisting of tumor pixels. It is necessary to identify the regions which we are looking for. Identification makes difficult in various MRI slices due to the tumor existence format, so we have consider the odd regions over complete preprocessed image. While using morphological ASF process we may remove unwanted pixels in smaller regions. Actually the medical experts are looking for considerable growth of tissues where to be treated. This identification may cause problem of failure to segment the tumor segmentation, but we apply our proposed method very carefully.

III. Results and Discussion

Our proposed method use MRI slice as input image (figure 5)

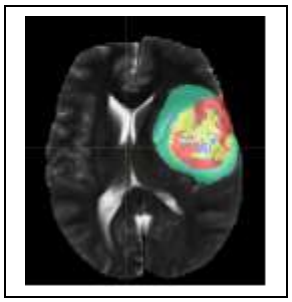
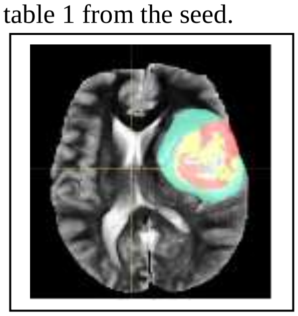


Figure 5: MRI slice with Tumor

Initially brain MRI enhanced by applying the noise removal morphological operators, which eliminate the unwanted pictorial information. Then to smoothen or intensity adjustment by apply Gaussian filters on the noise removed image. Figure 6a shows the enhanced image of the given MRI slice. Enhance image is used for clustering to get region of interest. Overall skeleton is drawn in figure 6b for specific calculation of seeds. Voronoi diagram Figure 7a has been drawn for identifying the regions of interest to partition the tumor tissues. After the selection of pixel which is considered as seed then calculate Euclidean distance for MRI slice to cluster the regions. The distance map (Figure 7b) is shown from the region of interest. The distances with area are shown in table 1 from the seed.



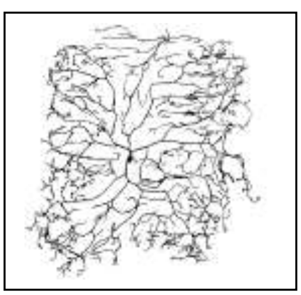


Figure 6a: Enhance MRI Slice 6b. Skeleton network of MRI

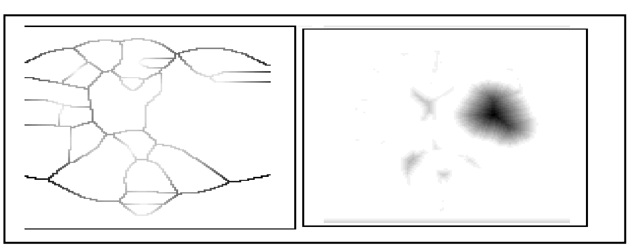
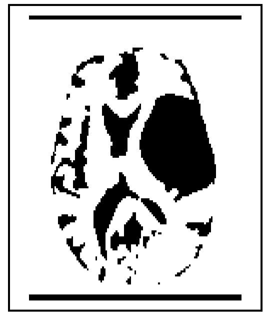


Figure 7a : Vernoi Digram 7b.Distance map for culstering

Using the distance from the seed pixel with remaing neighbooring pixels we derive the culsterd regions with k-means approach. The clusted regions are shown Figure 8a, which has to be selectd for tumor regions. Tumor tissues are focused with surface plots which is shown figure 8b , from this we are easily identify the regions which has to be segmented.



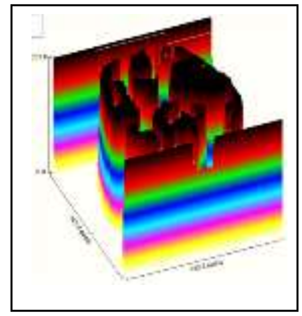


Figure 8a: clusterd region of MRI, 8b: Surface plot for MRI

Identified regions are segmented by applying morpholgocial ASF operators with SE in various sizes. At the last stage we segmenting the tumor tissues from MRI slice which is shown in figure 9. This achieved results are very signicificent regions.

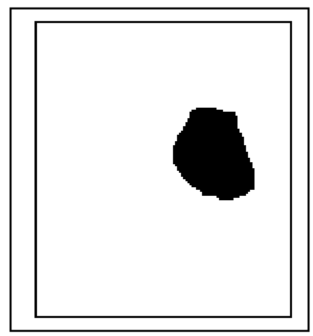


Figure 9. Segmented brian tumor pixels

The complete process are compared with image mean and standard deviations in table 2. This shows the mean and standard deviations are increase while bring the regions with tumor pixels specifically.

TABLE 2: IMAGE COMPRISAN ON VARIOUS STAGES

Image	Area	Mean	Std. Dev.	Peri.	Circ.	AR	Round
MRI slice	17750	45.198	64.658	534	0.782	1.136	0.88
Enhanced	17750	64.319	76.552	534	0.782	1.136	0.88
Cluster	17750	75.41	85.087	534	0.782	1.136	0.88
Segment	17750	90.78	122.101	534	0.782	1.136	0.88

To get more clearity, another type of brian MRI (Figure 10a) we applied which is in gray scale. After the preprocessed the derived image are shown in figure 10b, which is nothing but clusterd regions from given grayscale MRI.The regions are shown graph which shown in figure 11. This has some clear indication of tumor pixels elvation from the normal regions.

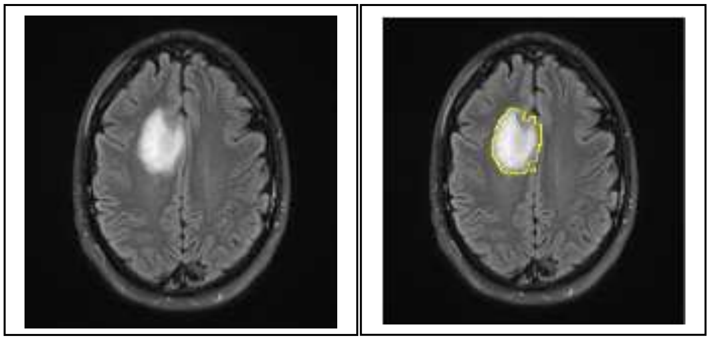


Figure 10a.Gray scale MRI Slice 10 b. Preprocessed MRI

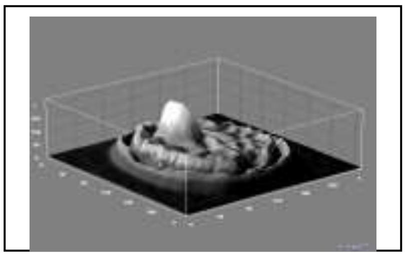


Figure 11. Three-dimensional shaded surface of MRI

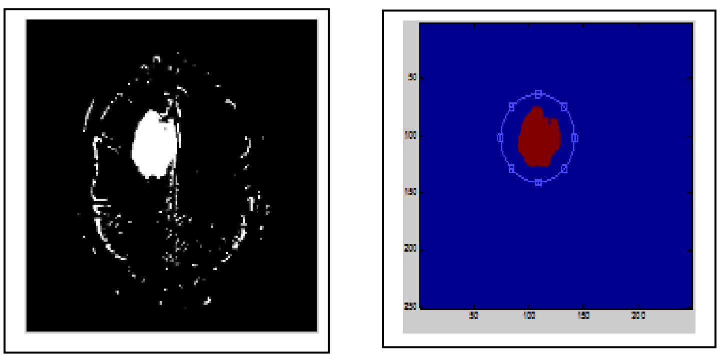


Figure 12a. Clustered regions 12 b. Tumor region selection

The above figure (12 a) shows the regions which are clustered with k-means method, where almost every tumor regions specified. Through the selection of highlighted area of expected tumor regions are shown in figure 12b.

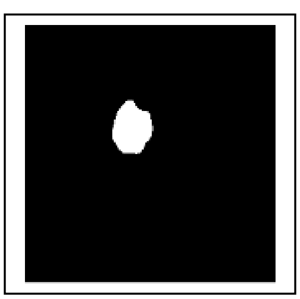


Figure 13 Segmented tumor pixels

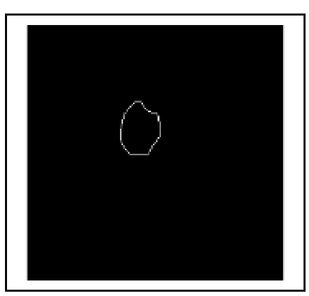


Figure 14 Edges of tumor pixels

At the final stage we achieved the specific tumor tissue pixels segmentation as shown in figure 13. Edges are detected with above figure for more clarity, which shown in figure 14.

IV. Conclusion

Using k-means clustering for segmentation the satisfaction level is not achieved when numbers of data are not so many. The number of tumor area, K, must be determined before we start process, so MRI has to be verified with general look. It may cause some error to identify the smaller tumors in MRI. It is important to initial identification of how tumor to be detected. Various initial assumptions may cause different segmentation. Local optimum is applied in the tumor tissue to classify. Sometimes it is effectively differentiate the various intensity pixels with boundary. Execution time depends on the number of Tumor it increase or reduced. Data mining or machine learning approaches can be useful for detection or vector quantization. Morphological ASF and K-means algorithm is useful for undirected knowledge discovery and is relatively simple with respect to image analysis. Our proposed approach can be extended to detect tumors on the view of brains instead of taking only the slice of MRI, also using texture or color parameters for tumor detection.

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