Brain Tumor Extraction Based on a Hybrid Clustering And Level Set

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***Abstract*—Medical image processing is the most demanding physical and emerging field in present. Tumor can be defined as unusual growth of the tissues or cells in the brain. Brain tumors are divided into two main categories that are primary or metastatic, and either malignant or benign. Magnetic Resonance Imaging (MRI) is an more highly developed medical imaging technique used to produce high quality images of the parts contained in the human body. The watershed method has the drawback that it is very much sensitive to local minima, because at each minima, a watershed is created. If there is an image with noise, this will affect the segmentation. In this project presents an efficient image segmentation approach using K-means clustering technique integrated with Fuzzy C-means algorithm. It is followed by thresholding and level set segmentation stages to provide an correct brain tumor detection. The proposed technique can get advantange of the K-means clustering for image segmentation in the appearance of minimal computation time. In addition, it can get advantages of the Fuzzy Cmeans in the aspects of accuracy. The accuracy was evaluated by comparing the results with the ground truth of each chemically treated image. The experimental results clarify the effectiveness of my proposed approach to deal with a higher number of segmentation problems via improving the segmentation quality and accuracy in minimal execution time is done by using MATLAB software.**

***KEYWORDS*-**Image Processing, MRI, Watersheild Algorithm, Segmentation, K-means clustering, Fuzzy C means Algorithm.

I. INTRODUCTION

Digital Image processing is an emerging field in which doctors and surgeons are getting different easy pathways for the analysis of complex disease such as cancer, brain tumor, breast cancer, kidney stones, etc. The detection of brain disease is a mass of tissue that grows out of control unaccept normal forces that regulates growth. Brain tumor is a group of abnormal cells that grows inside of the brain or around the brain. Tumors can directly destroy all healthy brain cells. For segmentation of tumor cells several methods have been proposed which differentiate the tumor region from normal region on the basis of intensity because brain tumor cells have very high density and hence every high intensity due to high protein containing fluid. Segmentation is a crucial step in image processing tasks. Contours in image are due to discontinuities of the reflectance function, and Discontinuities of the boundaries of the object or the depth. Intensity function is the characteristics counted by the contours are characterized by the discontinuities. That's what, the principle of contours detection is related to the study of the derivatives of the intensity function presented in the image. The contours are characterizing by the different boundaries of the objects, and separately defined as a transition mechanism between two regions of different characteristics available in parallel or simultaneously to within a single digital image. From general point of view segmentation is the partitioning of an image into a set of homogeneous and significant regions having a single label and common or similar properties. Many algorithms were thus proposed during the last decades. Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body. From these high-resolution images, we can derive detailed anatomical information to examine human brain development and discover abnormalities. MRI consists of T1 weighted, T2 weighted and PD (proton density) weighted images and are processed by a system which integrates fuzzy based technique with multispectral analysis In this paper, a new technique is implemented to extract the suspicious region in the Segmentation of MRI Brain tumor. So, this detection technique can be useful for further consideration of medical practitioners. Hence, proper detection of tumor is important for that treatment The entire system for tumor detection is developed and simulated using MATLAB R2013b on an Intel Core i5, 2.30 Ghz CPU on a 64-bit Operating System with 4.00GB installed memory(RAM).

II. EXISTING TECHONOLOGIES

The algorithm has two stages, first is pre-processing of given MRI image and after that segmentation and then perform morphological operations. Steps of algorithm are as following:-

Give MRI image of brain as input.Convert it to gray scale image.Apply high pass filter for noise removal. Apply median filter to enhance the quality of image.Compute threshold segmentation.Compute watershed segmentation.Compute morphological operation. Finally output will be a tumour region.

2.1 THRESHOLD SEGMENTATION

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image. The key of this method is to select the threshold value (or) values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and et all k-means clustering can also be used. In computer vision, Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. When applied to a stack of images, typical in Medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes.

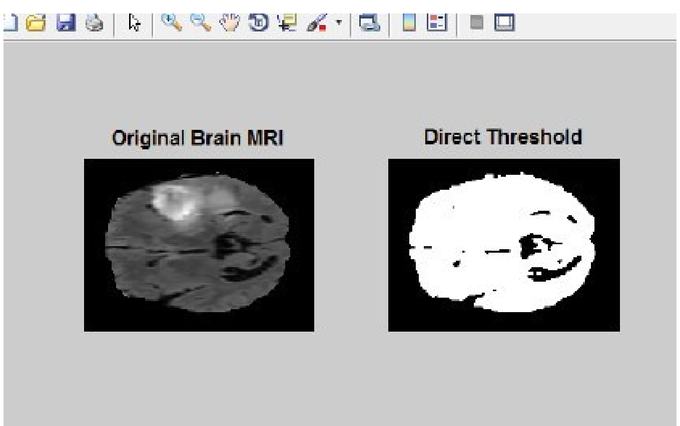

Fig -1 : Loss of tumor contours and intricacies to direct thresholding (Input image v/s Output Threshold=180)

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2.2 WATERSHELD

Watershed method comes under edge based segmentation. The term watershed is the geographical one. In geography, a watershed line is defined as a line separating the two catchment's basins. The rain that falls on either side of the watershed line will flow into the same lake of water. This idea can be fruitfully cashed in the digital images. The image gradient can be viewed as terrain. The homogeneous regions in the image usually have low gradient values. Thus, they represent valleys while the edges represent the peaks having high gradient values which relates directly as extraction of tumor from MRI Images. Watershed is an efficient morphological segmentation tool. The aim of watershed is to search the areas having high intensity gradients (watersheds) that divide neighbored local minima (basins).Watershed suffers from the problem of over segmentation (large number of segmented regions around each local minima in the image). A solution is to introduce markers .The markers are connected component of an image. There are internal markers and external markers where internal markers are used for the actual object to be extracted and external marker are used extracting background. This method can be used mainly for the problems where adjacent objects are there in an image and we have to separate them using image processing operations. Thus this method can be effectively used so that proper detection of the region of interest can be achieved.

2.3 MORPHOLOGICAL OPERATION

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. According to Wikipedia, morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest. Morphological techniques probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. Some operations test whether the element "fits" within the neighbourhood, while others test whether it "hits" or intersects the neighbourhood: A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image. The structuring element is a small binary image, i.e. a small matrix of pixels, each with a value of zero or one:

The matrix dimensions specify the size of the structuring element.

The pattern of ones and zeros specifies the shape of the structuring element.

III. PROPOSED METHOD

The proposed method consists of preprocessing, segmentation, feature extraction and area estimation.

Preprocessing is done by filtering process where the noise in the image is removed usually by use of averaging or mean filter with default structuring element size of 3x3. After denoising, the image is segmented separately using three methods, namely - K-means, Fuzzy C-Means and Adaptive K-means clustering algorithms. Feature extraction is done by thresholding along with region growing and level set contouring. Use of Fast-bounding box method for region growing is optional. Finally area of tumor is auto-calculated along with validation with respect to ground truth images obtained via BRATS (an open source brain tumor database for training) and accuracy of the system is calculated.

3.1 GENERALIZED BLOCK DIAGRAM

The generic block diagram of the proposed system encapsulates all the steps in a nutshell, starting with image acquisition, preprocessing, segmentation by different clustering techniques,

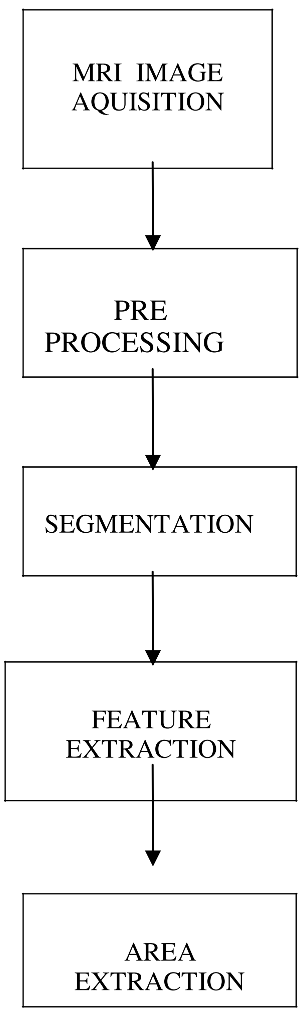


Fig -2: Generic Block Diagram of Proposed System

3.1.1 Preprocessing Stage

After acquisition of MRI Image, the raw data needs to be pre-processed for noise removal and deletion of unwanted data. For example, the skull lining in MRI is free from tumor and should be removed beforehand to reduce processing time of algorithms on skull area. Moreover, smoothening of image is preferred to suppress background information and make the active area stand out from the entire image. Gaussian and High pass filtering cause sharpening of edges and are not desired for extraction of a homogeneous region. Mean and median filtering are widely used for this process. The averaging or mean filter uses a 3x3 mask for smoothing of image which is moved laterally throughout the image and the center pixel is replaced by mean of values in the window. However, this does not remove salt and pepper noise and results in low noise removal. Median filtering is a non-linear filtering technique, which on the other side replaces the center pixel value with the median of set of values in the window, which effectively removes white noise and smoothes the image throughout.

3.1.2 Clustering Stage

Pixel clustering is a fast and accurate method of image segmentation. Apart from primitive methods like Mean Shift (MS), Expectation Maximization (EM-GM), Watershed Algorithm, K-means and Fuzzy C-means clustering are very robust and efficient means of image segmentation. This involvedselection of random centroids throughout the image and calculation of distance from each centroid.Based on a threshold, clusters of pixels are formed thereby segmenting the image.

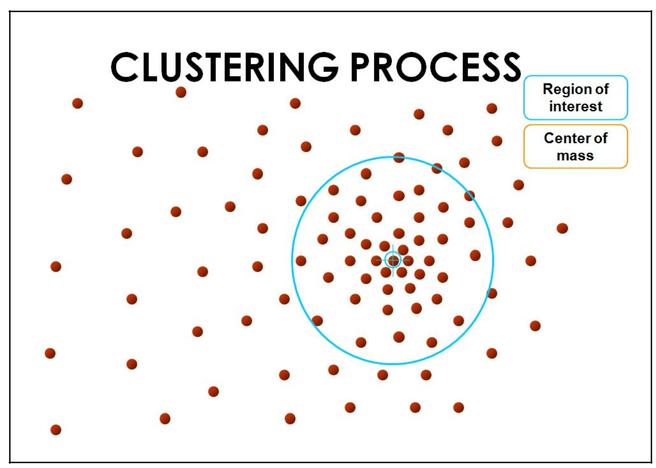


Fig-3: **Clustering of pixels with random centroid and distance calculated using Euclidean distance**

3.2 SPATIAL FUZZY CLUSTERING MODEL

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. A more efficient algorithm is the new FCFM. It computes the cluster center using Gaussian weights, uses large initial prototypes, and adds processes of eliminating, clustering and merging. In the following sections we discuss and compare the FCM algorithm and FCFM algorithm.

Spatial Fuzzy C Means method incorporates spatial information, and the membership weighting of each cluster is altered after the cluster distribution in the neighborhood is considered. The first pass is the same as that in standard FCM tocalculate the membership function in the spectral domain. In the second pass, the membership information of each pixel is mapped to the spatial domain and the spatial function is computed from that. 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.

The fuzzy c-means (FCM) algorithm was introduced by J. C. Bezdek.The idea of FCM is using the weights that minimize the total weighted mean-square error:

$$J(w_{qk}, \mathbf{z}^{(k)}) = \sum_{(k=1,K)} \sum_{(k=1,K)} (w_{qk}) \| \mathbf{x}^{(q)} - \mathbf{z}^{(k)} \|^2$$

$$\sum_{(k=1,K)} (wqk) = 1$$

$$w_{qk} = (1/(D_{qk})^2)^{1/(p-1)} \Big/ \sum_{(k=1,K)} (1/(D_{qk})^2)^{1/(p-1)}, \quad p > 1$$

The FCM allows each feature vector to belong to every cluster with a fuzzy truth value (between 0 and 1), which is computed using Equation.The algorithm assigns a feature vector to a cluster according to the maximum weight of the feature vector over all clusters.

3.3 A NEW FUZZY C-MEANS IMPLEMENTATION

3.3.1 ALGORITHM FLOW

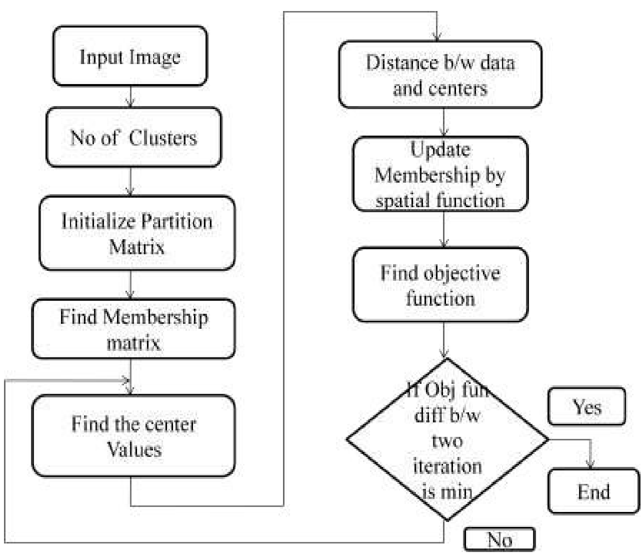


Fig-4: Flowchart For Fuzzy C-Means Algorithm

3.3.2 INITIALIZE THE FUZZY WEIGHTS

In order to comparing the FCM with FCFM, our implementation allows the user to choose initializing the weights using feature vectors or randomly. The process of initializing the weights using feature vectors assigns the first K_{init} (user-given) feature vectors to prototypes then computes the weights by Equation .

3.3.3 ELIMINATING EMPTY CLUSTERS

After the fuzzy clustering loop we add a to eliminate the empty clusters. This step is put outside the fuzzy clustering loop and before calculation of modified XB validity. Without the elimination, the minimum distance of prototype pair used in Equation may be the distance of empty cluster pair. We call the method of eliminating small clusters by passing 0 to the process so it will only eliminate the empty clusters. After the fuzzy c-means iteration, for the purpose of comparison and to pick the optimal result.

3.3.4 MORPHOLOGICAL PROCESS

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. Morphological operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to grey scale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest.

Morphological techniques probe an image with a small shape or template called a **structuring element**. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels.

A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image.The **structuring element** is a small binary image, i.e. a small matrix of pixels, each with a value of zero or one:

The matrix dimensions specify the *size* of the structuring element.The pattern of ones and zeros specifies the *shape* of the structuring element. An *origin* of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.

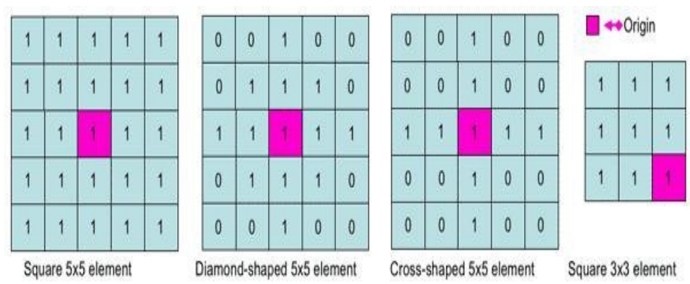
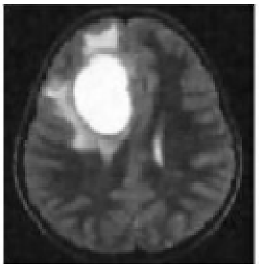
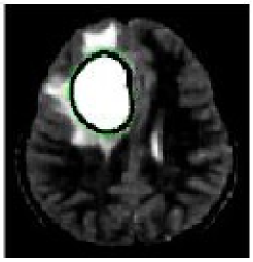


Fig-5: Examples of simple structuring elements

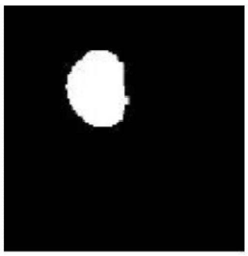
A common practice is to have odd dimensions of the structuring matrix and the origin defined as the centre of the matrix. Structuring elements play in morphological image processing the same role as convolution kernels in linear image filtering.



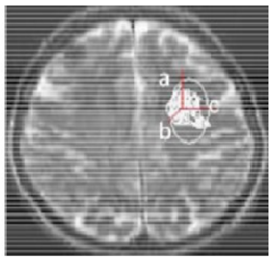
6a). Original image



6b). KIFCM



6C). Segmented image



6d). Diameter calculation

Fig-6(a,b,c,d): comparision for original and segmented image

When a structuring element is placed in a binary image, each of its pixels is associated with the corresponding pixel of the neighbourhood under the structuring element. The structuring element is said to **fit** the image if, for each of its pixels set to 1, the corresponding image pixel is also 1. Similarly, a structuring element is said to **hit**, or intersect, an image if, at least for one of its pixels set to 1 the corresponding image pixel is also 1.

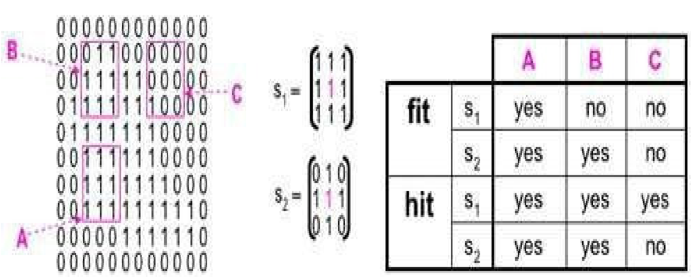


Fig-7: Fitting and hitting of a binary image with structuring elements s_1 and s_2.

IV.CONCLUSION

The existing techniques for MRI of brain image brain tumor segmentation and detection have been discussed. Th advantage of thresholding method is that, it firstly obtains a binary image which reduces the complexity of the data and the process of recognition and classification become easy. The main disadvantage is that, thresholding technique is implemented on image having only two values either black or white. It cannot be applied to multichannel images. The watershed method has the drawback that it is very much sensitive to local minima, because at each minima, a watershed is created. If there is an

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