Segmenting Brain Tumour Cells using FCM Approach

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Abstract

Tumour segmentation is a major process in medical image processing. It can be divided as primary and secondary type of tumor. Primary level tumor do not affect the surrounding cells, whereas secondary level tumors affect surrounding tissues and also day activities. Segmenting this type of tumor is important in early stage itself. It is just a process of partitioning image into several non-overlapping regions which are in understandable format. Generally, segmentation of brain MRI consists of GM, WM, Cerebrospinal fluid(CSF) as normal brain tissues and tumor tissues as (solid or active tumor, edema, or necrosis). FCM (fuzzy C- Means) is used in segmentation for incorporating the local spatial information with that of function. It is an automatic and unsupervised method which makes use of priori information given by radiology experts. Manual segmentation of brain MRI is possible but it is time consuming and results are varying of between medical experts. Automatic or Semi-automatic segmentation is done which produce more accurate segmentation comprised of tumor volume, size, location of tumor, grade, edema enhancement, growth. In medical diagnosis, these type of segmenting brain MRI are very helpful for clinicans to discover tissues of tumor from normal brain tissues. This paper gives overview of different methods of FCM used in tumor segmentation.

Keywords

Fuzzy C- Means, Priori Information, Brain MRI, Tumor Segmentation, Medical Image Processing.

1. Introduction

In the segmentation of tumor cells, Magnetic Resonance Imaging (MRI) is used instead of CT images as it is more accurate and do not contain any radiation in it. This type of MRI images provide an anatomical structure and abnormal tissues can be identified easily. It allows the clinical experts to effectively identify the tumor tissues in faster way and to monitor the patients. Segmentation is a process by which an image can be divided in to several non-overlapping regions so that every region is homogeneous and their union is heterogeneous. The time consumption for segmenting an image depends on the size of the image. If the size of image is large, then the segmenting time will be high. If the size is small, the it takes less time.Tumor tissues such as solid or active tumor, edema, or necrosis is present. There are two types of tumor persists which is primary brain tumors (which begin in glial tissue) and secondary brain tumor(caused by the cancer cells).

Brain Structure

The major parts of brain are divided in to three types:

- Cerebrum
- Cerebellum
- Brain stem

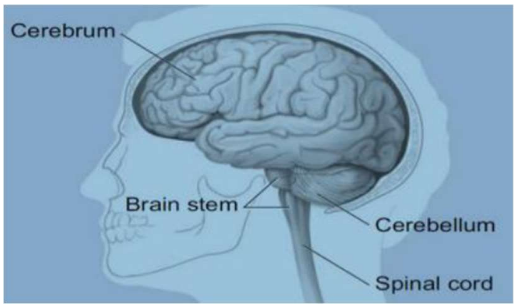

Figure 1: Brain Structure

Cerebrum is the major part which allow to learn, speak, think, emotion, read, write and control entire functionalities. This is divided in to two parts as right and left hemispheres. Right side of hemisphere controls the left side on the otherhand left side of muscles controlled by right side. Second part of the brain is cerebellum which controls day to day activities such as standing, walking and other difficult actions. Brain stem connects with that of spinal cord for breathing, controlling blood pressure, temperature of body, and some other basic functions.

MR Image of Brain

MR images are more accurate than that of CT images so that abnormal tissues can easily be segmented. These images do not produce radiation and so it is safer to human body. It uses computer to create images of brain. Tumors are widely classified as two types such as benign, malignant.

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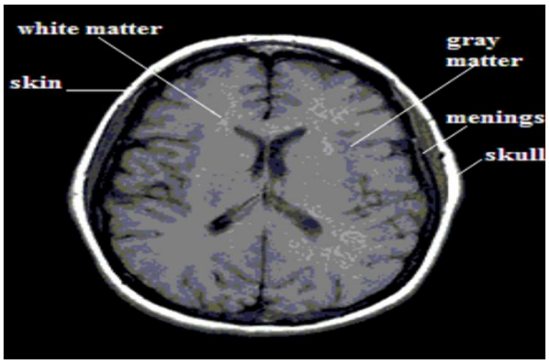

Figure2: Brain MR image

Primary level tumor do not affect the other region of body but it affect cancerous cells whereas secondary tumors affect and spread throughout the body. Therefore, these tumor has to be detected in earlier stage itself through segmentation otherwise it affect brain activity. Manual Segmentation is also possible but it is not accurate and a time consuming one. This also leads to variations in report between two observer for a same image. Therefore, automatic segmentation of cells is done by experts to avoid inaccuracy. It is an interesting factor to do automatic segmentation because there will be no human intervention and it involves things such as tumor location, volume detection, size, similar patterns of growth, extent edema. An automatic segmentation includes soft computing methods such as fuzzy computing.

Segmentation

It is just a process of dividing an image in to more understandable format. Complex images are partitioned to several simple images thereby each pixel is assigned with a label. This process generally captures every part in an image and convert them to computer required manner. There are two ways of segmenting an image. First method is that,discontinuities are detected where the intensity levels are checked according to which the images are segmented. Similarities in given image detected based on prior rules of information.

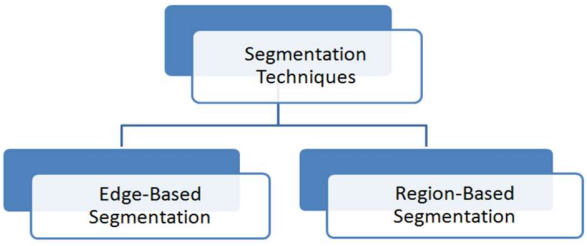

Figure3: Segmentation Methods

Segmentation Based On Edges

Intensity level discontinuities are considered and abrupt changes in this value are noticed. Gray level values are recorded where changes in each level may lead to edge formation. Region of interest obtained, boundary between any two region form edges.An integrated method that segments edges into straight and curved edge segments for parts-based object recognition. Spatial masks used to find gray level at point, curve and line.

Segmentation Based On Region

This method is reverse concept of edges in which partition of images done by continuity. Cluster of regions which possess same gray level intensities formed into group as undetermined remaining pixels are segmented. Region growing is one of method in which overall image is splitted into similar sub region. In splitting & merging, given input is divided to several random regions and merged. Quad tree concept is used to segment it. Water shed is another way there a threshold value is set if gray level crosses that value of information, boundaries are drawn between them. Noise sensitivity is high in this type so that new concept is encountered to overcome disadvantages in it. Peer group which is non-linear filter applied to images reduce noise and smoothing.Floating based rainfall algorithm deals with initial process and multi scale merging for final level of segmentation.

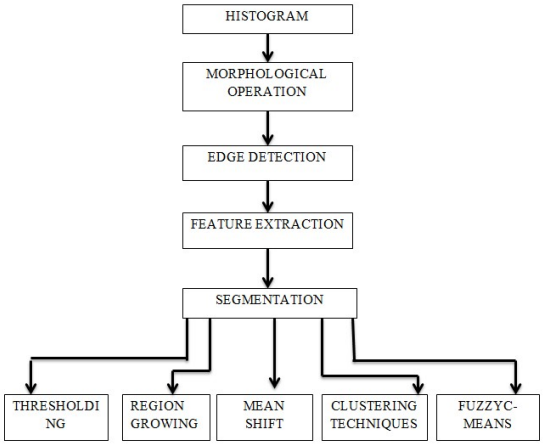

Figure4: Steps in Segmentation

The above diagram shows evolution of steps in segmenting an image. Basically, thresholding is a factor through which limit or level is set. If a value of threshold is 1 then all pixels with the value less than 1 is clustered

as one group of region and values with above 1 are grouped as another region.

2. Literature Review

2.1. Brain Tumor Tissue Segmentation Based On Fuzzy Information Framework

Fuzzy framework of information is used to segment cells of tumor in automatic segmentation. Prior knowledge about the tumor tissues are obtained from radiology experts to deal with different MRI images. In order to obtain accurate results, several multispectral images are compared with each other. Because single MRI cannot be able to provide detailed information about tumor. It comprises an algorithm with following steps:

- Multispectral images have to registered
- Characteristics of tumor has to be described by means of fuzzy
- Operators of fuzzy used in fusion
- Adjustment in region done with fuzzy connectors
- Compare between the results obtained and hand tracings

Segmentation Procedure Overview

In common several types of tumor tissues are available such as glial, benign, and malignant. According to research, glial is very bright when compared to other methods. But it is darker in T1 images. Descriptions are given by experts relative to intensities of various MR data. The '+' symbol indicates high level of intensity which means hyper signal, '_' represents darker image means hypo signal, '+_' indicates darker than hyper signal, '_+' shows signal intensity is higher than hypo signal. '++' denotes intensity higher than hyper signal. In T1 weighted, it is neither dark nor bright.

Table 1: Intensity Levels Chart

Signal Intensity	TISSUES			
	GM	WM	CSF	TUMOR
T1	_ _	_	+ +	- +
T2	+ +	+	_ _	+ +
PD	+ -	+ +	_ _	+ +

2.2. Segmentation on 3-D MRI Images Based on Fuzzy classification

The major concept of 3-D image deals with, detecting abnormal cells in accordance with asymetric region thereby providing spatial relationship between ROIprecise segmentation. Though there are many more methods available in medical diagnosis promising results of patients cannot be obtained due to the irregular process of segmentation. It is still a challenging one because ofvariation in size of tumor cells, location, shapes and difference in intensity levels. Learning based methods are used where they have two types. Supervised learning contains trained datasets which prescribes a prior knowledge of information thereby decreasing risk of finding tumor cells are reduced. It includes k-means clustering, fuzzy and markov methods. Unsupervisedsubjects to non-trained datasets, improving risk factors of detecting tumor. Contour and region based segmentation are applicable in 3-d images. Contour leads to initialize segmentation by selecting suspectable region. Based on visual determination, parameter levels has to be set. Neural networks and deformable models algorithm applied for each slices in 3d. This uses two images which in turn calculates probability map using histogram and morphological operation.

Overview of Method

Initialization & refinement are the two basic steps going to be performed in first process. That means, histogram performed to improve intensity levels and morphological operations appliedto deal with erosion, dilation. Assumption is done with specific gray levels

and also according to shape of image. This detection provides the important steps performed in the second stage, through a parametric deformable model comprised by fuzzy spatial relations.

Segmentation of Brain

Symmetry analysis produces a plane formation of image therefore assuming area for presence of infected tissues in brain can be gathered by detailed prior knowledge which was given by radiology experts comprised with various intensity levels. While processing major step is to remove other unwanted parts in image such as skull, muscles etc. Pixels with similar gray values are combined to form an area where remaining are considered as chance of region for presence of tumor. Comparing symmetry plane with normal image obtains an another portion that is abnormal region.

3. Methodology

Fuzzy C-Means

It is an unsupervised method for analysis of data and do not force object belong one class itself. This allows that a data point can take membership between 0 and 1 and it belong to all group in cluster. Class Center is used in membership function for which data close to that class is having more relationship. The FCM makes use of priori information in segmentation. The major disadvantage in FCM is:

- Sensitivity to noise
- Time consuming

Fast Generalized FCM

It is a combination two FCM which is fast FCM and enhanced FCM. This method overcomes the disadvantages in FCM such as lack of noise sensitivity, robustness, reduction in segmentation time. FGFCM can make use of both gray and spatial information and the time for segmenting an image is based only on gray levels.

Automatic Modified FCM

This method will be able to find number of clusters and provide good quality of segmentation. AMFCM combines spatial information with that of the membership function values. Neighbourhood pixels which are nearer to the class centers are combined together to obtain better segmentation. The first step is to initialize class centers and find out centred region thereby apply c-means algorithm.

Fuzzy Probabilistic c- Means Algorithm

It combines advantages of clustering and fuzzy c-means algorithm. Membership values are calculated with that of gray levels. Noise is major problem accounting in FCM whereas it is encountered and completely avoided in this methods. Each pixel can accommodate in one single cluster of region which states that no one pixel can be able to present in more than one group of cluster. If it persists, then it will be acknowledged as coincident cluster and this issue is entirely avoided in this FPCM. T1 weighted tumors re classified as:

- Non enhanced tumor (darker than white matter)
- Full enhanced without presence of edema (brighter than white matter)
- Edema in full enhance tumors (darker than gray matter)
- Ring-enhanced tumors, which have three sections.

Bias Corrected FCM

Initial step of this method is dealing with inhomogeneties in an image. It aims to label each pixel with unique name thereby forming cluster also with in that of neighbourhood pixels. The neighbourhood effect acts as a common factor for organizing similar pixels to form membership function; such an organizing function is used in equalizing intensity values.

4. Results

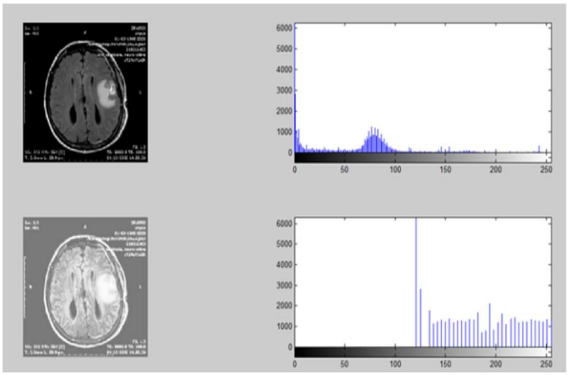

Figure 5: Histogram levels of MR image

It shows the intensity levels of given MRI image through which the overall image intensity are improved.

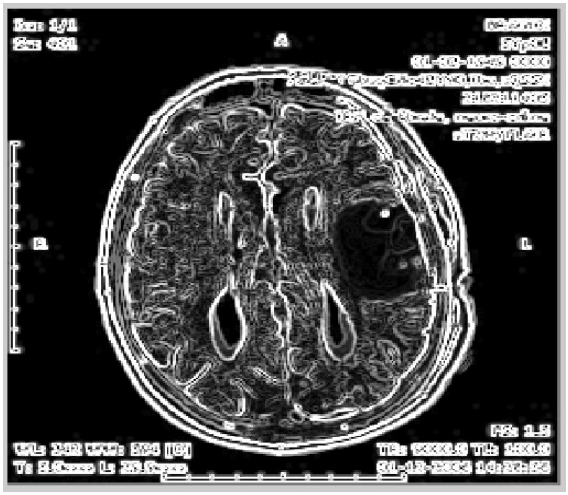

Figure 6 : Tumour Edge Detection

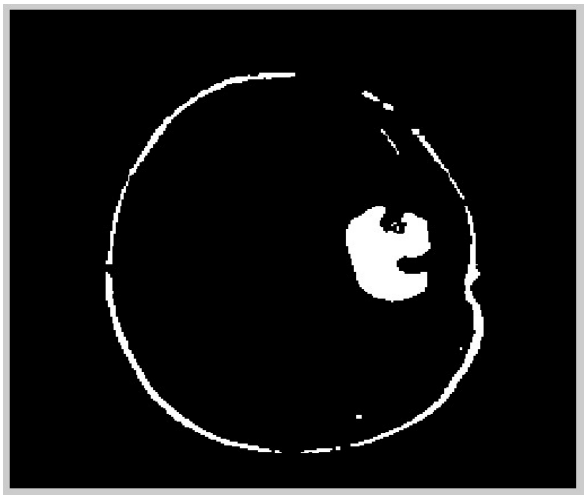

Figure 7 : Segmented tumour

5. Discussion

After dealing with several methods, each algorithm possess several level of accuracy at some critical point. FCM has major issues deals with noise sensitivity and outliers. This will be overcomed in BCFCM where it is insensitive to noise but encounters cluster coincident problem. Automatic FCM rectifies this by means of perfectly grouping each and every cluster in to region. Probabilistic FCM is collection of all of the above characteristics so that it is more optimized, results obtained are nearly perfect according to medical experts. It deals with cluster coincidence, noise sensitivity, gray level variation, inhomogeneites, and membership function. Therefore, PFCM is a step high when compared to all other algorithm.

6. Conclusion

In general, segmenting tumor without manual intervention is a complex task. Besides several methods, FCM is an efficient way of tumor analysis so that experts make use of it for diagnosis process. This paper gives overview of about how FCM is used in tumor segmentation. In future, this FCM can be combined with several other methods to get more accuracy.

References

[1] AE Lefohn, JE Cates, RT Whitaker, Interactive, GPU-based level sets for 3D segmentation. Med. Image Comput. Computer-assisted Intervention Conference - MICCAI. Lect. Notes Comput. Sci. 2878, 564–572 (2003)

[**2]** B Caldairou, N Passat, P Habas, C Studholme, F Rousseau, A non-local fuzzy segmentation method: application to brain MRI. Pattern Recogn.44(9), 1916–1927 (2011).

[**3]** D Weibei, S Ruan, C Yanping, D Bloyet, J Constans, A framework of fuzzy information fusion for the segmentation of brain tumor tissues on MR images. Image Vis. Comput. 25, 164–171 (2007).

[4] F Hoppner, F Klawonn, Improved fuzzy partitions for fuzzy regression models. Int. J. Approx. Reason. 32, 85–102 (2003)

[5] G Mazzara, R Velthuizen, J Pearlman, H Greenberg, H Wagner, Brain tumor target volume determination for radiation treatment planning through automated MRI segmentation. Int. J. Radiat. Oncol. Biol. Phys. 59(1), 300–312 (2004)

[**6]** H Sun, S Wang, Q Jiang, FCM-based model selection algorithms for determining the number of clusters. Pattern Recogn. 37(10), 2027–2037 (2004)

[**7**] J Dunn, A fuzzy relative of the ISODATA process and its use in detecting compact well separated clusters. J. Cybern. 3, 32–57 (1974)

[8] K Michael, K Simon, A Nabavi, M Peter, A Ferenc, R Jolesz, Automated segmentation of MRI of brain tumors. Radiology 218, 586–591 (2001).

[**9**] L Zhu, FL Chung, S Wang, Generalized fuzzy c-means clustering algorithm with improved fuzzy partitions, IEEE Transactions on Systems, Man, and Cybernetics. Part B. Cybernetics 39(3), 578–591 (2009)

[10] M El-Melegy, E Zanaty, W Abd-Elhafiez, A Farag, On cluster validity indexes in fuzzy and hard clustering algorithms for image segmentation, in IEEE International Conference on Image Processing (ICIP'07), Vol.6 (IEEE, San Antonio, TX, 2007), p. VI – 5.