A Comparative Analysis of various methods to Segment Sharp and Unsharp Edged Brain Tumors in 2 D MRI

Mukesh Kumar

M.E. (Student)
S.S.C.E.T.
Bhilai,India
E-mail: mgsahu@yahoo.co.in

Kamal K.Mehta

Professor, HOD CSE department
S.S.C.E.T.
Bhilai,India
E-mail:kmehta28@yahoo.com

Abstract— **Segmentation of Brain tumor accurately is a challenging task in MRI. The MRI image is an image that produces a high contrast images indicating regular and irregular tissues that help to distinguish the overlapping in margin of each limb. But when the edges of tumor is not sharped then the segmentation results are not accurate i.e. segmentation may be over or under. This may be happened due to initial stage of the tumors [5]. So , in this paper a modified method of tumor line detection and segmentation is compared with other methods like random walk , traditional seeded region growing method and graph cut method . The main aim of this paper is to determine which method is optimistic , so that it can be used to separate the irregular from the regular surrounding tissue to get a real identification of involved and noninvolved area that help the surgeon to distinguish the involved area precisely. The evaluation parameters used in this paper are segmentation accuracy, execution time, automation level etc. We have implemented our project work in MATLAB 7.6.0.324(R2008a) environment and applied all these to a set of 25 images.**

Keywords— Graph cut method, Gray level, MRI image, Region growing, Random walk, Tumors, Segmentation etc.

I. Introduction

Tumor is part of the soft tissues having some abnormal growth. Brain tumors are of two types Benign and Malignant. Segmentation is a process of identifying an object or pattern in the given work space. In this project we are considering magnetic resonance image as our work space. Actually the MRI produces a high contrast image representing each part very clearly, but sometimes due to be determined accurately so a problem of segmenting it is always there. In these cases the physiologist always need to have keen observation of the anatomical structure. But this process is too much time consuming and if the initial segmentation result is not correct then other consequent results like volume calculation also produces incorrect measurement results.

There are a number of methods for brain tumor segmentation like fuzzy logic approach, neuro fuzzy approach, Random walk, Graph cut method etc, but these all methods can produces unsatisfactory results due to unsharped edge boundaries and also the time to produce desire result is large[6] .

In this paper we are proposing an automatic region growing method to segment the brain tumors and this method is compared with other segmentation method based on typical parameters. So in this method the users don't need to select the seed point manually therefore there is no need of human intervention [2]. In this project work our assumption is that the brain tumor have grown in considerable size and their structure may be of any type like snakelike or circular shaped etc[1].

II. Literature Survey: A review of existing methods

A. *Random Walk Method*

When the boundaries of any object is not cleared in the given image than this method performs efficiently.This method is based on random walk of a particle from one place to another based on the probability calculation; if probability of moving a particle from one to another is greater than the threshold value then both particles are part of the same segment [10]. Here particle is referred as pixel in the image. In this method K seeds are selected by the user based on how many parts of the image is to be segmented like skull portion, Tumor portion etc. These regions are than labeled by the user. All the pixels having a specific gray level are then tested to determine which label they closely belong to, in this way segmentation of medical images is performed. Actually the algorithm Random walk is based on working terminology of electric circuits. It is base on the reality that a random walker first reaches a seed point exactly equals to the Dirichlet problem [9] with edge surroundings at the locations of the seed points and the seed point in the question fixed to unity while others are set to zero. The circuits are represented by graphs. The solution to Dirichlet problem on an arbitrary graph is given exactly by the distribution of electric potentials on the nodes of an electrical circuit with resistors representing

the inverse of the weights. The steps of algorithm are as follows:

(a) Convert the intensities of image pixels into edged weights; it can be expressed by following formula:

$$W_{ij} = \exp(-\beta(g_i - g_j)_2) \qquad (1)$$

Where g_i represent corresponding intensity of pixel I and β represents the free parameter in this algorithm.

(b) Obtain a set of labeled pixels according to the probability calculation.

(c) When all the pixels are passed through the given criteria than final segmentation is obtained.

B. Seeded Region Growing Method

This approach to segmentation examines neighboring pixels of initial "seed points" and determines whether the pixel neighbors should be added to the region. The process is iterated on, in the same manner as general data clustering algorithms. The main goal of segmentation is to partition an image into regions. Some segmentation methods such as "Thresholding" achieve this goal by looking for the boundaries between regions based on discontinuities in gray levels or color properties [7]. Region-based segmentation is a technique for determining the region directly.The basic formulation for Region-Based Segmentation is:

$$\bigcup_{i=1}^{n} R_i = R_0 \qquad (2)$$

Means the segmentation must be complete and every pixel must be in the region. Here Ri is a connected region.

$$R_i \cap R_j = \emptyset \qquad (3)$$

Equation (3) means the regions must be disjoint. So that a clear separation from each other can be found.

$$P(R_i) = TRUE; \text{ For i=1,2,….,n} \qquad (4)$$

Means a pixel may belong to the region when it satisfies the condition that gray level of pixel is in the range of region.

$$P(R_iUR_j) = FALSE \qquad (5)$$

Means regions Ri and Rj are different in the sense of predicate P.

III. Proposed method

In the proposed method we have divide our work in four parts. The work flow graph for this method is as shown in fig1.

A. Skull Removal

This is pre processing step which is required to produce better results. Skull is outer part of the brain surrounding it i.e. the removal of its non-cerebral tissues. The main problem in skull-stripping is the segmentation of the non-cerebral and the intracranial tissues due to their homogeneity intensities. So it may affect the result of seed point selection [8] .Some observations are required to find the range of gray value of

skull portion. Following of the steps which are involved in skull removal process:

(a) First of all find the size of the image and store the no of rows and columns in separate variables.

(b) Perform iteration for half of the columns and all rows.

(c) Process half of image to convert white pixels into the black pixels by setting their gray value to zero.

(d) Same steps is repeated for the remaining column and row.

B. Seed Point Selection

The image obtained after skull removal is taken as input in this part of the project. For the seed point selection our assumption is that tumour's region has grown in considerable size .The following steps are performed to find the seed point:

(a) Convert the given coloured image into the gray image.

(b) First of all count no pixels whose intensities are greater than hundred and less than hundred and store them in separate variables.

(c) Find difference between both variables if difference is small then go to step 'd' else convert the image into negative and again set the intensity of external part of the brain to zero and go to step 'd'

(d) Convert the obtained gray image into the binary image.

(e) Find maximum length and breadth of the brain then

From the center convert the pixels in the area of rectangle shape of size twenty rows and ten columns to black colour.

(f) Find the sum of all rows individually and store it in the array.

(g) Find the sum of all the columns and store the results in another array.

Find the intersection of row and column having maximum sum .This is taken as seed point.

C. Morphological Image Enhancement

This is an extra step in our proposed method. Morphology mainly deals with the contour and structure of the object. So this is used to perform object extraction, noise removal procedure etc [3]. For the same purpose we are applying these operations to enhance the object boundary and to remove the noise from the image . The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. In the morphological dilation and erosion

operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbours in the input image. The rule used to process the pixels defines the operation as dilation or erosion.

One important part in morphological operation is to choose the structuring element. A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighbourhood .Two-dimensional, or flat, structuring elements are typically much smaller than the image being processed. The centre pixel of the structuring element, called the origin, identifies the pixel of interest i.e. the pixel being processed. The pixels in the structuring element containing 1's define the neighbourhood of the structuring element. In our project work we are taking DISK shape as structuring element. In the operation of image dilation and erosion we are considering disk structuring element of varying radii so that the obtained image is free from small unwanted parts. In MATLAB working environment there are two built in functions used for dilation and erosion. These morphological functions position the origin of structuring element, its center element over the pixel of interest in the input image. For pixels at the border of the image, parts of the neighbourhood defined by the structuring element can extend past the border of the image. To process border pixels, the morphological functions assign a value to these undefined pixels, as if the functions had padded the image with additional rows and columns. The value of these padding pixels varies for dilation and erosion operations.

If A and B are two sets then dilation is denoted by A⊕B, is obtained by first reflecting B about its origin and then translating the result by x. So that all x such that A and reflected B translated by x that have at least one point in common form the dilated set [7]. Therefore,

$$A \oplus B = \{x | (\grave{B})x \cap A \neq \acute{\emptyset}\} \tag{6}$$

Where $\grave{B}$ denotes reflection of B. Bx denotes the translation of B by x. In our work MRI are gray images therefore,

$$(f \oplus b)(s,t) = \max\{f(s-x, t-y) + b(x,y) | ((s-x),(t-y) \in Df; @(x,y) \in Db)\} \tag{7}$$

Here, f and b denote images $f(x,y)$ and $b(x,y)$. f is being dilated and b is called the structuring element Df and Db are the domains of f and b respectively. Thus, in dilation we choose the maximum value of $f+b$ in a neighborhood defined by b. If all elements of b are positive, the dilated image is brighter than the original and the dark details are either reduced or eliminated.

Similarly, Erosion of A by B, denoted by A⊖B is the set of all x such that B translated by x is completely contained in A, i.e.,

$$A \ominus B = \{x | (B)x, \subseteq A\} \tag{8}$$

For gray scale images,

$$(f \ominus b)(s,t) = \min\{f(s+x, t+y) - b(x,y) | (s+x),(t+y) \in Df, (x,y) \in Db\} \tag{9}$$

Erosion is thus based on choosing the minimum value of (*f-b*) in a neighborhood defined by the shape of *b*. If all elements of *b* are positive, the output image is darker than the original and the effect of bright details in the input image are reduced if they cover a region smaller than *b*. Therefore, it is concluded that image dilation and erosion operation produces an enhanced and sharpen edge MRI, so that over segmentation and under segmentation can be reduced [7].

B. *Seeded Region Growing Method*

In our project work we have used 8 connected neighbor method to determine whether a pixel should be included in the tumor region or not. This part is same as traditional region growing method.

IV. RESULTS

We have implemented our all methods in the MATLAB 7.6.0.324 and used a set of images to perform the operations and all the results has been evaluated based on three parameters execution time, automation and accuracy. The observation table for a few images are included in the following observation table:

Table I: Results

S. No.	Random walk		Region growing method		Proposed Method	
	Time	Accuracy	Time	Accuracy	Time	Accuracy
I1	3.9061	Good	0.0781	Good	4.2505	Good
I2	2.9371	Over	0.0938	Good	6.3906	Good
I3	2.9844	Good	0.0781	Good	5.3594	Good
I4	2.8057	Over	1.0938	Under	7.3215	Good
I5	0.7344	Over	1.0938	Over	8.5431	Good
I6	2.7188	Over	1.4693	Over	4.8347	Good
I7	1.7969	Over	0.5674	Good	5.3212	Good

In the above observation table the execution time has been measured in seconds. It is cleared that Random walk method and region growing method always need human intervention to get the seed point while in our method this problem is removed up to some extent. It is also clear that segmentation accuracy is greater in our proposed method which can be observed from the figure 2 given below. But our method takes a little more time to give the segmented time; this is due to image enhancement

phase. In the Random walk method the position of the seed point plays a vital role; if seed point is little displaced though it is in the tumor region then after also result is highly inaccurate.
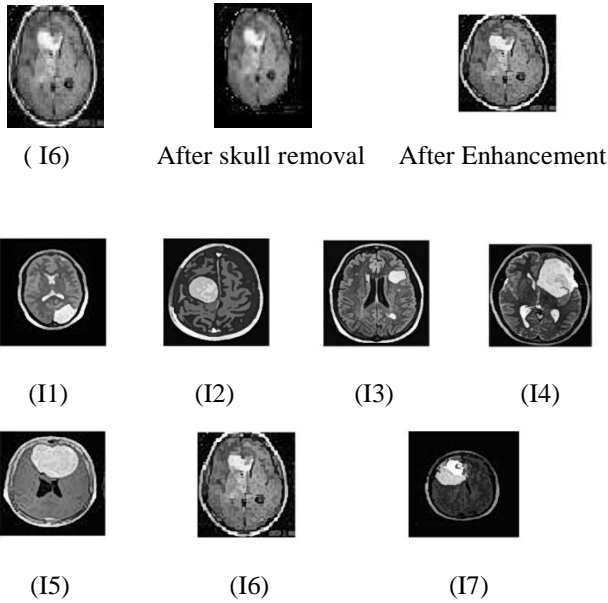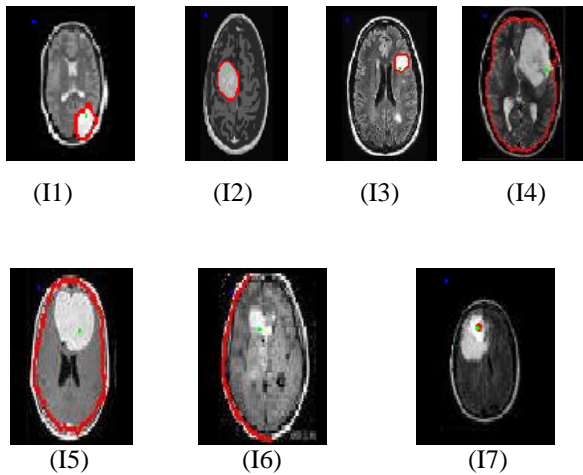

(I6)   After skull removal   After Enhancement

(I1)   (I2)   (I3)   (I4)

(I5)   (I6)   (I7)

Fig 2 Input Image Set

(I1)   (I2)   (I3)   (I4)

(I5)   (I6)   (I7)

Fig 3 Output of Random Walk Method

(I1)   (I2)   (I3)   (I4)

(I5)   (I6)   (I7)

Fig 4 Region growing Method

(I1)   (I2)   (I3)

(I4)   (I5)   (I6)

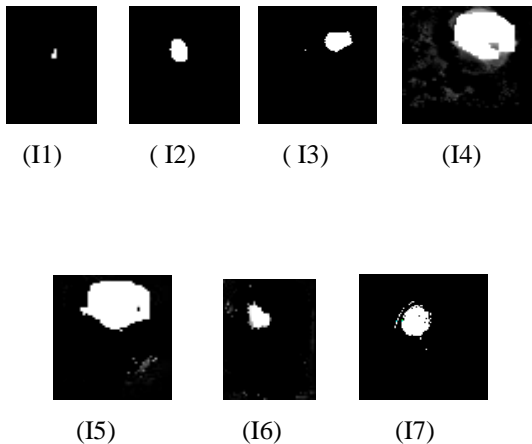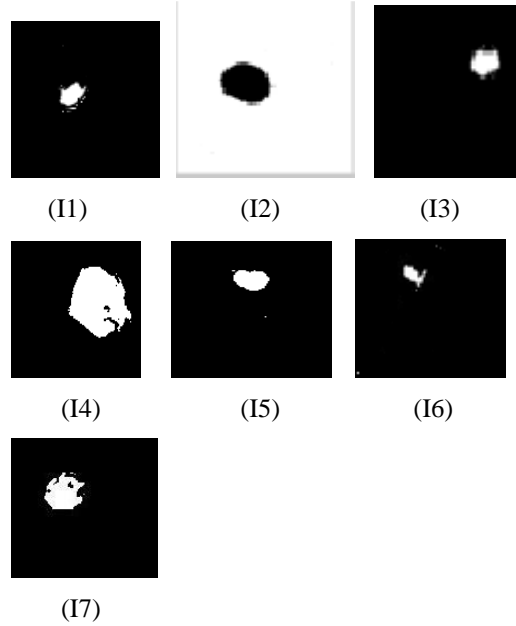(I7)

Fig 4 Output of Proposed Method

V. CONCLUSION AND FUTURE WORK

This is automatic region growing segmentation method for segmentation of brain   tumor in MRI; we proposed a new, robust, fast and fully automatic algorithm. The algorithm needs no prior information or training process. By taking into account both the homogeneous texture features and spatial features of the MRI, we successfully find the seed points and the segmentation   results obtained are very much accurate. There are   only a small amount of pixels which are misclassified. Though, this method is a little time consuming compared to other methods.

So we can say that this method gives better results compared to other methods. The future work is to reduce the total execution time so that along with good result the execution time can be reduced [4]. This work can also be extended for 3D MRI.

References

[1]. R.B. Dubey, M. Hanmandlu, S.K.Gupta,"Semi-automatic segmentation of MRI Brain tumor", ICGST-GVIP, ISSN-1687-398X, Volume 9,4 august 2009.

[2]. Juan shan , H.D. Cheng, Yuxuan wang,"A novel automatic seed point selection algorithm for breast ultra sound images",IEEE,2008

[3]. U. sivarajan ,KJ Jayapragasam , YF Abdul Aziz, K Rahmat ," Dynamic contrast enhancement Magnetic resonanace imaging evaluation of Breast Lesions:A morphological and Quantitive analysis",J Hk coll Radiol,2009

[4].   Sukhvinder singh, Sukhbeer singh,"Parallel image processing concepts",IJCCT vol.1,August 2010.

[5].   E.Konukoglu," Monitoring slowly evolving tumors",IEEE,ISBI 2008.

[6].   Vasant manohar, yuhana gu,"MRI segmentation using fuzzy c means and Finite gaussian mixture models"2003

[7].   "Digital Image Processing", 3/E by Rafael C. Gonzalez ,Richard E. Woods, ISBN-10: 013168728X

[8].   "Skull stripping and automatic segmentation of brain MRI using seed growth and threshold techniques", Intelligent and Advanced Systems, 2007. ICIAS 2007,page 422 – 426, ISBN: 978-1-4244-1355-3

[9].   R.Courant and D.Hilbert, Methods of mathematical physics. John Wiley and sons,1989, vol. 2

[10]. IEEE TRANSCATIONS ON PATTERN ANALYSIS"Random walks for image segmentation",Vol. 28,No. 11,NOV.2006