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Review of Watershed segmentation used for Brain Tumor Detection from Digital MR Images

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ABSTRACT
The Medical image processing is the most challenging and emerging field now a days. Processing of MRI images is one of the part of this field. this paper proposes a method for detection of brain tumor from Magnetic Resonance Images. In the process of detection of tumor from MR Image, segmentation plays important role for partitioning an image into different sub region with homogeneous properties. Marker based Watershed segmentation is used for segmenting the tumor from MR image. Pre-processing the image makes it ready for applying the watershed segmentation. Pre-processing includes image resizing, conversion to gray and applying gradient magnitude etc. Information about the gray level, edges and contrast is extracted from gray scale image and these parameters are used for segmentation using watershed. Connected component analysis extracts the regions which are not separated by boundary after region boundaries have been detected thus tumor area and eccentricity are calculated using CCA.

Keywords **-** Brain Tumor, Connected Component Analysis (CCA), Magnetic Resonance Imaging (MRI), MR Image, MATLAB, Sobel mask and Marker based Watershed segmentation.

I. I INTRODUCTION

The brain and the spinal cord are the most vital parts of our body. They are made up of nerve cells (neurons) and supporting cells (Glial cells) that receive and send messages through nerves and control all the parts of our body. A brain tumour is a mass of abnormal tissue growing in any part of the brain. For some unknown reason, some brain cells multiply in an uncontrolled manner and form these tumours. These tumours can arise from any part of the brain, spinal cord or the nerves. Broadly these tumours can be divided into benign and malignant tumours.

Benign tumours grow slowly and never spread to other parts. But as they slowly increase in size they can cause pressure on the normal brain and interfere with mental and bodily functions. Some of the benign tumours known are: meningiomas, pituitary adenoma, craniopharyngioma, epidermoid cysts, neurocytoma, haemangioma, pilocytic astrocytoma, etc. Malignant tumours or cancers are aggressive tumours that grow fast and infiltrate the surrounding brain and sometimes spread to the other parts of the brain or spine. There are various types of malignant brain tumours like High Grade Astrocytoma/Glioma, ependymoma, PNET, medulloblastoma, lymphoma, Germ cell tumours. With aggressive and timely treatment some of these can be cured.

The Magnetic Resonance Imaging method is the best due to its higher resolution than the other methods. Its resolution is approximately 100 microns. MRI is currently the method of choice for early detection of brain tumor in human brain. Generalization of brain screening programs requires efficient double reading of MRI, which allows reduction of false negative interpretations, but it may be difficult to achieve. Computer aided detection systems are dramatically improving and can now assist in the detection of suspicious brain lesions, suspicious masses. The task of manually segmenting brain tumors from MRI is generally time consuming and difficult. An automated segmentation method is desirable because it reduces the load on the operator and generates satisfactory results. The aim of this work is to provide an automated tool which locates the tumor on MR Image and predicts the area of tumor.

II. Literature Review

Brain tumor cells have high proteinaceous fluid which has very high density and hence very high intensity, therefore watershed segmentation is the best tool to classify tumors and high intensity tissues of brain.

Watershed segmentation can classify the intensities with very small difference also, which is not possible with snake and level set method. A

similar method for tumor detection is proposed by Rahul Malhotra, Minu Sethi and ParminderKumar Luthra [3] but multi-parameter extraction was not used. Manoj K Kowar and Sourabh Yadav have proposed a method for brain tumor detection and segmentation using histogram thresholding detects the tumor but the result shown in paper crops excessive area of brain [2]. An efficient and improved brain tumor detection algorithm was developed by Rajeev Ratan, Sanjay Sharma and S. K. Sharma which makes use of multi-parameter MRI analysis and the tumor cannot be segmented in 3D unless and until we have 3D MRI image data set. So, in this paper a relatively simple method for detection of brain tumor is proposed which makes use of multiple-parameter extraction and image segmentation is done using the watershed segmentation with some improvement to avoid over & under segmentation.

III. Proposed Method

The process flow of our proposed method is shown as figure 3.1. The input axial MR Image is loaded into memory. Image resizing & division includes the pre-processing stage. Edges, gray levels and the contrast parameters of the image are extracted at the second stage. Image segmentation is done using watershed and finally tumor area and eccentricity are calculated using connected component analysis.

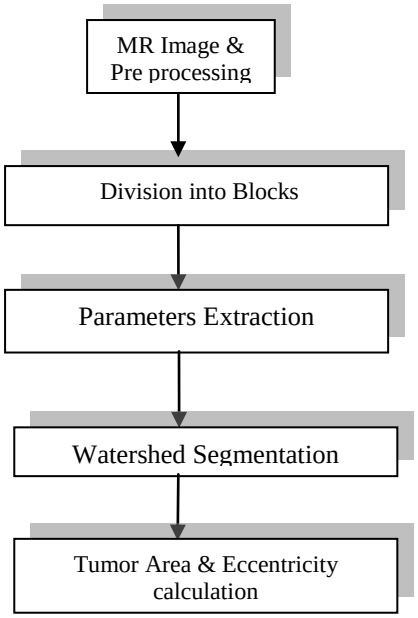

Figure 3.1 Proposed Method

3.1 MR Image & Pre-processing

Axial MR Image is to be loaded as the input. Function rgb2gray is used to convert image into gray scale format. Then image is resized and divided into the blocks. MR image may consist of film artefacts' and thus it requires filter for removing the high intensity component and the above noise. Pre-processing include the input MRI brain tumor image and image filtering. In image filtering, several different filters can be used. So, in this research, average filter is used to smooth the image. The smoothed image is used to operate the next step of the system quickly. Average filter is low pass filter. Average filter is a simple and easy to implement method of smoothing images. The operation of average filter is

$$g(x, y)=1/M \; \Sigma(x,y)\in sF(x,y) \quad (1)$$

Where, S=neighborhood of pixel (x, y) M=number of pixels in neighborhood S

3.2 Parameters Extraction:

Parameter extraction refers to extracting the information of gray level and about the edges from the image. Edge information is used to determine the boundaries of an object. For any gray scale image(m,n), at co-ordinates (m,n), the gradient vector magnitude and angle at which maximum rate of change of intensity level occurs at the specified co-ordinates (m,n) can be computed. Magnitude of the gradients can be computed using the sobel mask.

Contrast information is also to be extracted. Contrast as an image property is usually defined as ratio between the brightest and the darkest spot in the image. MATLAB stores a gray scale image as a single matrix and each element of the matrix corresponding to one image pixel. Contrast is used to characterize the extent of variation in pixel intensity. Malignant tumor cells contain highly proteinaceous fluid, which is represented as high signal intensity on MR images of the brain resulting in high contrast.

3.3 Watershed Segmentation

Geography point of view, watershed is the ridge that divides areas drained by different rivers and catchments basin is the geographical area draining into the river. The basic principle of watershed segmentation is to transform the gradient of a grey level image in a topographic surface, where the values of f (m, n) are interpreted as heights and each local minima embedded in an image is referred as catchments basins as shown in Figure 3.2 If rain falls on the defined topographical surface, then water would be collected equally in all the catchments basins. The watershed transformation can be built up by flooding process on a gray tone image. The basic watershed algorithm is well recognized as an efficient morphological segmentation tool which has been used in a variety of gray scale image processes & video processing applications. However, a major problem with the watershed transformation is that it produces a large number of segmented regions in the

image around each local minima embedded in the image. Over segmentation problem in the morphological watershed segmentation for irregular-shaped objects is usually caused by spurious minima in the inverse distance transform.

A solution to this problem is to introduce markers and flood the gradient image starting from these markers instead of regional minima. The Marker based Watershed Segmentation method possesses several important properties that makes it highly usable for various kinds of image segmentation problems. After extracting the parameters from MR image segmentation can be done which makes use of these extracted parameters and In this paper marker based or controlled watershed segmentation is proposed for segmenting MR image.

The sobel masks in matrix form are as follow:

$$Mx = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \quad My = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 0 \\ -1 & 0 & 2 \end{pmatrix}$$

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

$$M = \sqrt{MX2 + My2} \qquad (2)$$

$$\text{Angle, } \theta = \tan^{-1}(MY/MX) \qquad (3)$$

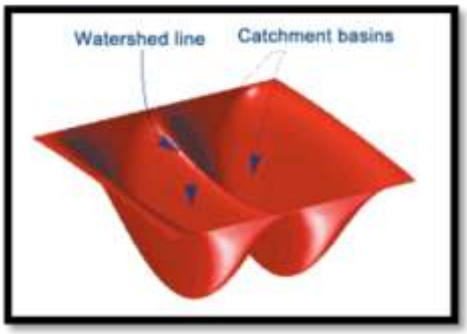

Figure 3.2 Watershed line and catchment basins

3.4 Morphological Operations

Morphological image processing is a collection of nonlinear 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. An origin of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.

3.5 Tumor Area & Eccentricity calculation

Extraction of connected components from a binary image is central to many automated image analysis applications. CCA extracts the regions which are not separated by boundary after region boundaries have been detected. Any set of pixels which is not separated by the boundary is called connected component, the set of connected components partition an image into segments. And finally eccentricity and area calculation of detected tumor is done.The area of the tumor region is calculated by the following equation: Tumor area=Axtotal number of pixel in the tumor region (4) A= V x H (5) Where, A=the area of each pixel H=horizontal dimension of the image V=vertical dimension of the image H=1/horizontal resolution of the image V=1/vertical resolution of the image

IV. CONCLUSION

In this paper a method to detect brain tumor based on watershed segmentation is proposed. Watershed segmentation is dependent on marker which in turn depends upon the selected value of threshold so it is necessary that optimal value of threshold is selected. The area of tumor which is Region of Interest (ROI) can also be calculated.

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Weblinks

[1] http://www.braintumourindia.org/BTF/braintuours.htm
[2] http://www.braintumor.org/
[3] http://www.mathworks.in/