Brain Tumor Extraction using Marker Controlled Watershed Segmentation

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***Abstract* - Imaging plays a central role in the diagnosis & treatment of brain tumor. Automated brain tumor detection from MRI Images is one of the most challenging tasks in today's Medical Imaging research. Magnetic Resonance Images are used to produce images of soft tissues of human body. Various segmentation techniques are proposed to find out tumored region in brain MRI images. In this paper marker based watershed transform, is used for segmentation before that some preprocessing techniques are used for noise removal and then with some simple morphological operations are found the tumor region with matlab.**

***Keywords* - MRI, Watershed, Brain Tumor, MCWS, SOM**

I. INTRODUCTION

Radiology is a branch of medicine which uses imaging technology to diagnose lesions and conditions that affect the body. Recently it is widely used for treatment of various diseases. Brain tumor are second leading cause of cancer in children under 15 years and young adult up to age of 34.These tumors are also the second fastest growing cause of cancer death among humans older than 65[1][2][3]. MRI (Magnetic Resonance Imaging) is new modality used in medical science to produce high quality images of parts contained in human body.

An MRI scanner uses a magnetic field and radio waves to create detailed images of human body. Recently MRI scans are widely used in everyday clinical routine. However although increasing popularity of MRI imaging techniques the assessment of lesions in a brain area is one of the most challenging task of recent days medical imaging[1][2][11].

Due to complex structure of different tissues such as White Matter (WM), Gray Matter (GM) & Cerebrospinal Fluid (CSF) in brain images extraction of useful feature is a fundamental task [1]. The crucial problem in automatic assessment of brain tumor is image segmentation. It is challenging task due to complexity and large variations of anatomical structures of human brain. So far, various methods for brain segmentation are developed. These methods which are used are based on thresholding [3], clustering methods [4], fuzzy set method [5] region growing [8][14], and edge detection [7] and so on. Choice of particular depends on particular problem. In this paper an algorithm is used which depends on Marker Controlled Watershed method with marking region of interest as well as background in gray images.

This paper is organized as follows: Section 2 presents the related work done by researchers so far today. Section 3 gives brief idea of MRI modality. Section 4 explores idea related to Gradient Image Calculation & Marker Controlled Watershed Segmentation; Section 5 gives algorithm, experimental results of brain tumor segmentation and section 6 gives final conclusion and future scope related to this topic.

II. RELATED WORK

In last 20 years several techniques have been developed by researchers to identify anatomical brain structures.

J.Fan, Yau , Elmagarmid and Aref's [3][13] paper presents an automatic image segmentation method using thresholding technique. This is based on assumption that adjacent pixels whose values (gray level, color level, texture etc) lies within a certain region belong to same class and thus, good segmentation of images that include only two opposite components can be obtained. V. Dey , Y. Zhang , M. Zhang proposed a new method based on histogram thresholding[3]. The main goal of segmentation is to partition an image into different regions. In this approach we have to find out initial seed points. The regions are iteratively grown by comparing all unallocated neighboring pixels to this regions [3][11]. The next method proposed is clustering based. It organizes the objects into groups of some features, attributes or characteristics. Hence cluster contains groups of similar objects [3][9][18]. Another clustering technique is K-means algorithm has a fast speed which allows it to run on large data set. But main disadvantage is that it does not produce same result with each run [1][10][16][17]. N. Valliammal and Dr. S.N. Geethalakshami have discussed their method on Discrete Wavelet Transform associated with the K-means clustering for efficient plant leaf image segmentation [3][18]. Next to this method is based on soft computing that is self organizing map (SOM). This method is based on Artificial Neural Network [3][19]. Another proposed method is morphological watershed segmentation, but major problem with this method is that it produces over segmentation [1][2][15]. A new marker based watershed algorithm which requires less processing time and minimizes over segmentation problem up to large extent has been proposed in this paper.

Despite the fact that lots of methods for brain tumor segmentation has already been proposed. There is still no common solution to brain image segmentation.

III. MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging is a medical imaging technique used to visualize detailed internal structures. It uses magnetic radiation [6]. It provides real-time view and three-dimensional views of organs (mostly soft-tissue). It provides good soft tissue contrast, making excellent visualization of soft-tissue structures like brain, spine, muscles, and joints. The MRI machine operates in multiple planes; hence the images can be captured in multiple body planes without changing the physical positions of the patient under scanning. MRI findings are based on compilation of sequences that are an ordered combination of RF and gradient pulses designed to acquire the data to form the image [1][2][11].

IV. PROPSED METHODOLOGY

A. The Gradient Magnitude Calculation

The gradient magnitude is used often to pre-process a gray-scale image prior to use of the watershed transform for segmentation [1][2][12][15]. The gradient magnitude image has high pixel values along object edges and low pixel values everywhere else. So in this method, first the gradient magnitude of the gray-scale image is computed using the linear filtering method. For any gray scale image (x, y), at co-ordinates (x, y), the gradient vector magnitude and angle at which maximum rate of change of intensity level occurs at the specified coordinates (x, y) can be computed using the equation (1) and (2).

$$g(x,y)=\sqrt{(g1^2(x,y)+g2^2(x,y))} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\alpha(x,y)=\tan^{-1}\frac{g_2(x,y)}{g_1(x,y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$H_1=\begin{pmatrix}-1 & 0 & 1\\ -2 & 0 & 2\\ -1 & 0 & 1\end{pmatrix}, H_2=\begin{pmatrix}-1 & -2 & -1\\ 0 & 0 & 0\\ 1 & 2 & 1\end{pmatrix} \quad \ldots\ldots\ldots\ldots (3)$$

Where $g_1(x, y)$ and $g_2(x, y)$ are the gradients in the x and y directions. Magnitude of these gradients is computed using the Sobel mask H_1 and H_2, which are defined by Eqn. (3).

B. Marker Controlled Watershed Segmentation (MCWS)

Watershed method comes under the edge-based Segmentation. The term watershed is a geographical one. In geography, a watershed line is defined as the line separating 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. The watershed transform is often preferred to separate the touching objects in an image [1][2].

The watershed transform finds the catchment basins and watershed ridge lines in an image by treating it as a surface. 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 and 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 that image. A solution to sort out this problem is to introduce markers and flood the gradient image starting from these markers instead of regional minima. The watershed-transform based segmentation works better if the foreground objects and the background locations are marked already [10][11][15].

V. ALGORITHM

1. *Read the color image of brain first.*
2. *Convert it into gray scale image.*
3. *Perform edge detection using Sobel operator and calculate the gradient magnitude.*
4. *Perform the watershed method without marker addition to the ROI and background and find tumored region.*
5. *Add the markers for region of interest that want to segment using morphology operation "opening by reconstruction" and "closing by reconstruction".*
6. *Calculate regional maxima of reconstructed image.*
7. *Clean the edges of segmented image using morphological technique.*
8. *Compute background markers.*
9. *Compute watershed transform.*
10. *Display the result.*

VI. RESULTS

The set of color MRI images of different views are used as input images as shown in figure 1. After applying edge detection using Sobel Operator gradient images can be obtained as shown in figure 2. Then we can directly apply Watershed Method without Markers and the results are shown in figure3 and Figure 4 gives Marker Controlled watershed segmented images of tumor. Final colored image after superimposition between watershed and original images are shown in figure 5. From the experimental results it is found that MCWS method gives more accurate results as compared to other segmentation techniques.

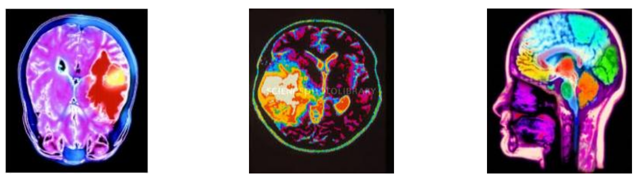

Fig. 1 Input Images of Brain

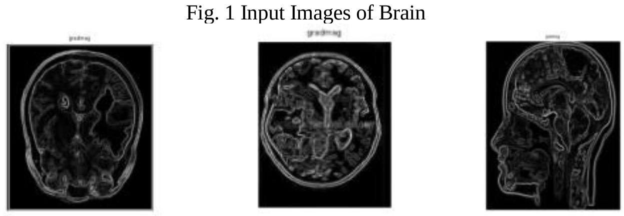

Fig.2 The gradient magnitude and edge detection using Sobel technique

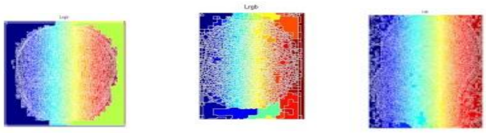

Fig. 3 Watershed transform without marking objects

Fig. 4 Watershed transform after marks the ROI and background

Fig. 5 Final colored image after superimposition between watershed and original images

VII. CONCLUSION

Tumor area is an important diagnostic indicator in treatment planning and results assessment for brain tumor. The measurement of tumor area using manual method is tedious, labour intensive and time consuming. The Proposed segmentation method is experimented with MRI scanned images of Human brain for locating tumor region. This technique gives efficient results as compared to previous researches. It is easy to execute and can be managed easily.

With this technique in future we can calculate various attributes of tumored region such as area, volume etc. We also can extend this method to 3D color imaging. We can classify the tumor in malignant or benign type with experimenting this method on large data sets.

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