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Brain Tumor Detection Using Marker Based Watershed Segmentation from Digital MR Images

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Abstract— ***This paper presents a method for detection of brain tumor from Magnetic Resonance Image. Pre-processing the image makes it ready for applying the watershed segmentation. Pre-processing includes image resizing, conversion to gray. Gradient magnitude is to be computed before applying the segmentation and magnitude of these gradients is computed using the sobel mask. Watershed segmentation is used for detecting the tumor. The basic watershed algorithm is well recognized as an efficient morphological segmentation tool 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. A solution to this problem is to use marker based watershed segmentation. Connected component analysis extracts the regions which are not separated by boundary after region boundaries have been detected. Finally tumor area is calculated using connected component analysis.***

Index Terms— ***Connected Component Analysis (CCA), Magnetic Resonance Imaging (MRI), Sobel mask and Marker based Watershed segmentation***.

I. INTRODUCTION

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.

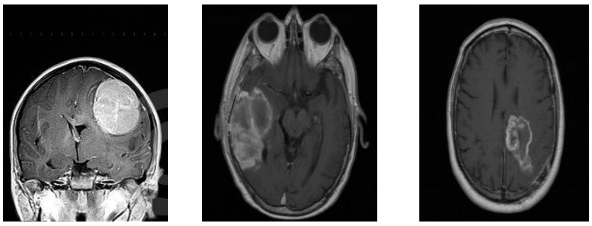

Figure 1 Brain Tumor MR Images

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 [1] 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[4]. So, in this paper a relatively simple method for detection of brain tumor is presented which makes use of marker based watershed segmentation with improvement to avoid over & under segmentation.

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III. PRACTICAL METHODOLOGY

The process flow of our proposed method is shown as figure 2. The input axial MR Image is loaded into memory. RGB to gray conversion & Image resizing includes the pre-processing stage. Gradient magnitude is to be computed after applying sobel mask. Image segmentation is done using watershed and finally tumor area is calculated using connected component analysis.

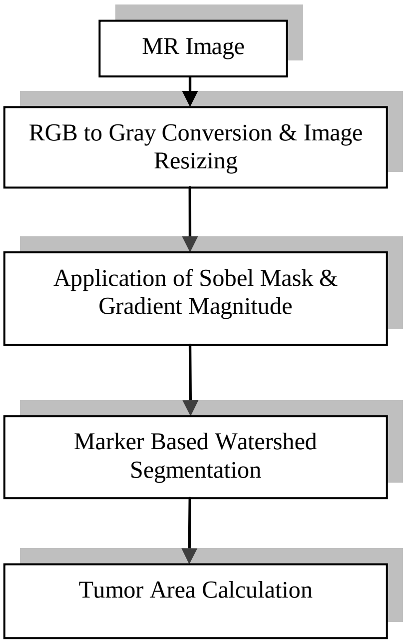


Figure 2 Practical Methodology

A. MR Image & Pre-processing

Axial MR Image is loaded as the input. Loaded image is converted into gray scale format. Then image is resized. MR image may consist of film artifacts but images which we processed are free from noise so there is no need to apply filtering. So the pre-processing stage makes the image ready for further processing.

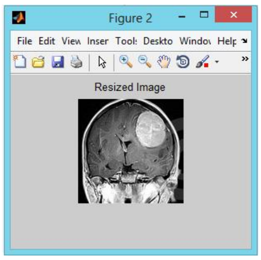


Figure 3 MR Image converted to Gray Scale & resized

B. Application of Sobel Mask & Gradient Magnitude

The gradient magnitude is used often to process a gray-scale image prior to using the watershed transform for segmentation which is computed using the linear filtering method. A gradient is a two dimensional vector that points to the direction in which the image intensity grows fastest. The gradient magnitude gives the amount of the difference between pixels in the neighborhood which gives the strength of the edge. 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 using the equation (1) and equation (2).

$$g(m,n) = \sqrt{(g_1^2(m,n) + g_2^2(m,n))} \quad \ldots..\ (1)$$

$$\alpha(m,n) = \tan^{-1}(g_2(m,n)/\ g_1(m,n)) \quad \ldots..\ (2)$$

Where $g_1(m,n)$ and $g_2(m,n)$ are the gradients in the x and y directions. Magnitude of these gradients is computed using the sobel mask H1 and H2, which are defined by equation (3) given below:

$$H1 = \begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix} \quad \& \quad H2 = \begin{matrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{matrix}$$

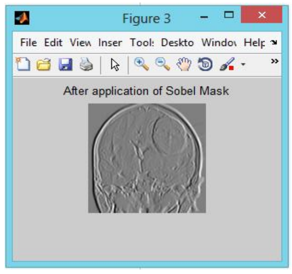


Figure 4 After application of Sobel Mask

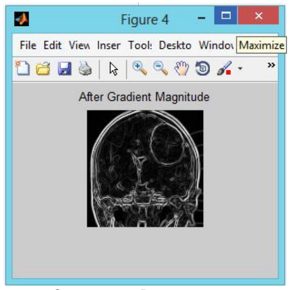


Figure 5 After Gradient Magnitude

C. 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 6. 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.

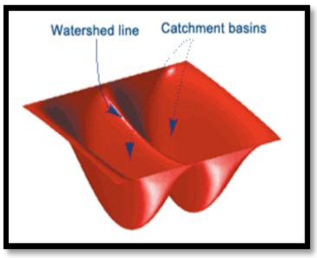


Figure 6 Watershed line and catchment basins

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. In the present method, the internal markers are produced from the gray scale image and then external markers are found by finding pixels that are exactly midway between the internal markers. This is done by computing the watershed transform of the distance transformed image of the internal markers. The gradient image is then modified by imposing regional minima at the location of both the internal and external markers. The next step involves the computation of the watershed transformation of the Marker modified gradient image to produce watershed ridge lines. Finally resulting watershed ridge lines are superimposed on the original image and produce the final segmentation. In this paper marker based or controlled watershed segmentation is proposed for segmenting MR image.

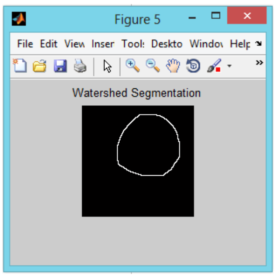


Figure 7 Watershed Segmentation of Input MR Image

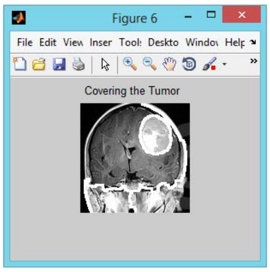
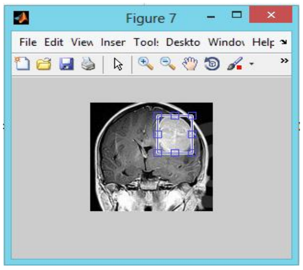


Figure 8 Covering the Tumor

D. Tumor Area Calculation

Extraction of connected components from a gray scale image is central to many automated image analysis applications. The goal of the connected component analysis is to detect the large sized connected foreground region or object. In image analysis, the object is extracted using the connected component labeling operation, which consist of assigning a unique label to each maximally connected foreground region of pixel. 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 thus the area of detected tumor is calculated in pixels using connected component analysis.



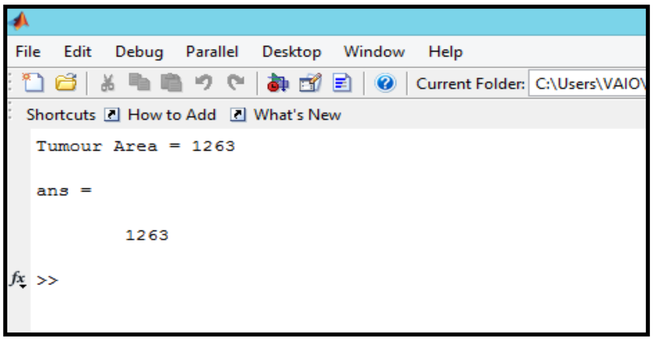


Figure 9 Tumor area calculation

VI. CONCLUSION

In this paper a method to detect brain tumor based on watershed segmentation is presented. 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 is also calculated in pixels using connected component analysis.

VII. ACKNOWLEDGMENT

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REFERENCES

[1] Rahul Malhotra, Minu Sethi and Parminder Kumar Luthra, “Denoising, Segmentation & Characterization of Brain Tumor from Digital MR Images. CCSE Vol. 4, No. 6; November 2011.
[2] Rajeev Ratan, Sanjay Sharma, S. K. Sharma, “Brain Tumor Detection based on Multi-parameter MRI Image Analysis”. ICGST-GVIP Journal, ISSN 1687-398X, Volume (9), Issue (III), June 2009.
[3] Bieniek, A. & Moga. (2000). “An Efficient Watershed Algorithm Based on Connected Components.” *Pattern Recog.*, 33(6), 907-916. http://dx.doi.org/10.1016/S0031-3203(99)00154-5.
[4] Rajeev Ratan, Sanjay Sharma, S. K. Sharma, “Brain Tumor Detection based on Multi-parameter MRI Image Analysis”. ICGST-GVIP Journal, ISSN 1687-398X, Volume (9), Issue (III), June 2009.
[5] Abdel-Halim Elamy, Maidong Hu. Mining “Brain Tumors & Their Growth rates”. 872-875 IEEE Image Processing Society, 2007.
[6] Mark Schmidt, Ilya Levner, Russell Greiner, Albert Murtha and Aalo Bistritz, “Segmenting Brain Tumors using Alignment-Based Features” IEEE Computer Society, Proceedings of fourth International

Conference on Machine Learning and Applications (ICMLA'05) 0-7695-2495-8/05.
[7] S.Karpagam and S. Gowri, "Detection of Glioma (Tumor) Growth by Advanced Diameter Technique Using MRI Data" proceedings of the World Congress on Engineering 2011 Vol. I WCE 2011, July 6 - 8, 2011, London, U.K.

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