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REVIEW ARTICLE

A REVIEW ON BRAIN TUMOR DETECTION USING SEGMENTATION

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Abstract— Brain tumor is an abnormal mass of tissue in which some cells grow and multiply uncontrollably, apparently unregulated by the mechanisms that control normal cells. The growth of a tumor takes up space within the skull and interferes with normal brain activity. So detection of the tumor is very important in earlier stages. Various techniques were developed for detection of tumor in brain. This paper focused on survey of well-known brain tumor detection algorithms that have been proposed so far to detect the location of the tumor. The main concentration is on those techniques which use image segmentation to detect brain tumor. These techniques use the MRI Scanned Images to detect the tumor in the brain. Differences between some well-known techniques are also considered in this paper.

Key Terms: - Brain tumor MRI; Segmentation; Canny; Sobel; Clustering

I. INTRODUCTION

1.1 Brain tumor

A **brain tumor** [1] – [11], or tumor, is an intracranial solid neoplasm . They are created by an abnormal and uncontrolled cell division, usually in the brain itself, but also in lymphatic tissue, in blood vessels, in the cranial nerves, in the brain envelopes. Brain tumors may also spread from cancers primarily located in other organs. . A tumor can cause damage by increasing pressure in the brain, by shifting the brain or pushing against the skull, and by invading and damaging nerves and healthy brain tissue. The location of a brain tumor influences the type of symptoms that occur. This is because different functions are controlled by different parts of the brain. Brain tumors rarely metastasize (spread) to other parts of the body outside of the central nervous system (CNS). The CNS[5] includes the brain and spinal cord.

1.2 Diagnose

Identifying a brain tumor usually involves a neurological examination, brain scans, and/or an analysis of the brain tissue. A neurological examination is a series of tests to measure the function of the patient is nervous system and physical and mental alertness. A brain scan is a picture of the internal structures in the brain. A specialized machine takes a scan in much the same way a digital camera takes a photograph. The most common scans used for diagnosis are as follows:

MRI (Magnetic Resonance Imaging) [1] is a scanning device that uses magnetic fields and computers to capture images of the brain on film. It does not use x-rays. It provides pictures from various planes, which permit doctors to create a three-dimensional image of the tumor. The MRI detects signals emitted from normal and abnormal tissue, providing clear images of most tumors.

CT or **CAT scan** [5] (Computed Tomography) combines sophisticated x-ray and computer technology. CT scan shows a combination of soft tissue, bone, and blood vessels. CT images can determine some types of tumors, as well as help detect swelling, bleeding, and bone and tissue calcification. Usually, iodine is the contrast agent used during a CT scan.

A **biopsy** [5] is a surgical procedure in which a sample of tissue is taken from the tumor site and examined under a microscope. The biopsy will provide information on types of abnormal cells present in the tumor. The purpose of a biopsy is to discover the type and grade of a tumor. A biopsy is the most accurate method of obtaining a diagnosis.

1.3 Segmentation

Image segmentation [6] is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

In case of medical image segmentation the aim is to:

- Study anatomical structure
- Identify Region of Interest i.e. locate tumor, lesion and other abnormalities
- Measure tissue volume to measure growth of tumor (also decrease in size of tumor with treatment)
- Help in treatment planning prior to radiation therapy; in radiation dose calculation

Using segmentation in medical images is a very important task for detecting the abnormalities, study and tracking progress of diseases and surgery planning.

1.4 Detection of Brain tumor

In recent years a great effort of the research in field of medical imaging was focused on brain tumors segmentation. The automatic segmentation has great potential in clinical medicine by freeing physicians from the burden of manual labeling; whereas only a quantitative measurement allows to track and modeling precisely the disease.

MR is generally more sensitive in detecting brain abnormalities during the early stages of disease, and is excellent in early detection of cases of cerebral infarction, brain tumors, or infections. MR is particularly useful in detecting white matter disease, such as multiple sclerosis, progressive multifocal leukoencephalopathy, leukodystrophy, and post-infectious encephalitis.

After scanning of brain, detection of the Brain tumor from the brain scanned images (MRI Scan) is performed. This detection helps to obtain the location and size of the tumor. Segmentation is the most important method to obtain the useful information from the MRI image of the scanned brain.

1.4.1 Using edge based segmentation

Edge based segmentation is the most common method based on detection of edges i.e. boundaries which separate distinct regions. Edge detection method is based on marking of discontinuities in gray level, color etc., and often these edges represent boundaries between objects. This method divides an image on the basis of boundaries. Numbers of edge detecting operators based on gradient (derivative) function are available.

For brain tumor detection various edge detection operators are used which are sobel edge detection, prewitt edge detection operator and canny edge detection operator.

a) Sobel edge detection

Sobel edge detection uses sobel operator [11]. Sobel operator is a gradient operator. Gradient corresponds to the first derivative. The Sobel operator performs a 2-D spatial gradient measurement on an image. Typically it is used to find the approximate absolute gradient magnitude at each point in an input grayscale image. The Sobel edge detector uses a pair of 3x3 convolution masks, one estimating the gradient in the x-direction (columns) and the other estimating the gradient in the y-direction (rows). A convolution mask is usually much smaller than the actual image. As a result, the mask is slid over the image, manipulating a square of pixels at a time. The actual Sobel masks are shown in Figure 1.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Fig.1 Sobel Mask (adapted from [11])

The magnitude of the gradient operator is calculated by:

$|G|= (G_x^2+G_y^2)^{1/2}$

eq.1 (adapted from [11])

b) Canny edge detection

Canny edge detector algorithm [6] first involves the the smoothing of image. That is removal of noise from the image. Then gradient of the image is computed by feeding the smoothed image through convolution operation with the derivative of the Gaussian in both the vertical and horizontal directions.

After this, non maximum suppression is applied. The purpose of this step is to convert the blurred edges in the image of gradient magnitude to sharp edges. This is basically done by preserving all local maxima in the gradient image and deleting everything else.

c) Prewitt edge detection

The Prewitt operator [6] uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives - one for horizontal changes, and one for vertical. If we define **A** as the source image, and $\mathbf{G_x}$ and $\mathbf{G_y}$ are two images, which at each point contain the horizontal and vertical derivative approximations, the latter are computed as[6]:

$$\mathbf{G_x} = \begin{bmatrix} -1 & 0 & +1 \\ -1 & 0 & +1 \\ -1 & 0 & +1 \end{bmatrix} * \mathbf{A} \quad \text{and} \quad \mathbf{G_y} = \begin{bmatrix} +1 & +1 & +1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} * \mathbf{A}$$

Fig.2 (adapted from [6])

Where $*$ denotes the 2-dimensional convolution operation. The vertical edge component is calculated with kernel G_x and the horizontal edge component is calculated with kernel G_y. The gradient magnitude is defined by:

$$\mathbf{G} = \sqrt{\mathbf{G}_x{}^2 + \mathbf{G}_y{}^2}$$

Eq.2 (adapted from [6])

1.4.2 Using Clustering Method

The K-means algorithm [6] is an iterative technique that is used to partition an image into *K* clusters. The basic algorithm is:

1. Pick *K* cluster centers, either randomly or based on some heuristic
2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center
3. Re-compute the cluster centers by averaging all of the pixels in the cluster
4. Repeat steps 2 and 3 until convergence is attained (e.g. no pixels change clusters)

In this case, distance is the squared or absolute difference between a pixel and a cluster center. The difference is typically based on pixel color, intensity, texture, and location, or a weighted combination of these factors. *K* can be selected manually, randomly, or by a heuristic.

1.4.3 Using Region growing method

The first region-growing method was the seeded region growing method. This method [6] takes a set of seeds as input along with the image. The seeds mark each of the objects to be segmented. The regions are iteratively grown by comparing all unallocated neighboring pixels to the regions. The difference between a pixel's intensity value and the region's mean, δ, is used as a measure of similarity. The pixel with the smallest difference measured this way is allocated to the respective region. This process continues until all pixels are allocated to a region.

II. RELATED WORK

Brain tumor [1] – [11] is a serious and life-threatening disease because of its invasive and infiltrative character in the limited space of the intracranial cavity. Brain tumor is curable and treatable if it is diagnosed in earliest stages of disease. Diagnosis of brain tumor is done by specialist called neurologist. MRI scan of the brain is obtained to study the abnormalities of brain if occur any. In order to locate the location and size of the tumor precisely, further techniques are applied to the scanned images. Reviews of such techniques are discussed in this section.

Jun Kong, et al. proposed a technique in 2006[3]. A novel approach for segmenting brain tissues is proposed in this year. The algorithm is composed of four stages. In first stage de-noising of image is done using versatile wavelet based filter. In next stage, watershed algorithm is applied to brain tissues as an initial segmenting method. Next the procedure of merging process is applied for over segmentation regions using fuzzy clustering algorithm. At last, re-segmentation process is applied. This is done for some regions which are not partitioned completely. Minimum Covariance Determinant estimator is used to detect the regions and kNN classifier is used to partition them.

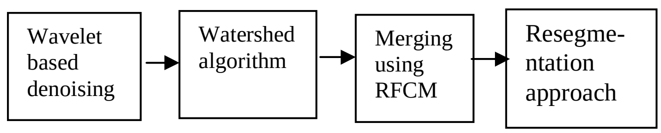

Fig.3 Segmenting brain tissues(adapted from [3]).

In 2009 Riries Rulaningtyasand Khusnul Ain [4] found the best method for detecting the brain tumor by studying among the three algorithms. They studied three techniques Prewitt, Sobel and Robert[4]. From the three methods of edge detection, they found that Sobel method is more suitable for edge detection of brain tumor. This method has a little mean and standard deviation value. A pair of 3x3 convolution masks, one estimating the gradient in the x-direction (columns) and the other estimating the gradient in the y-direction (rows) is used. The mask is slid over the image, manipulating a square of pixels at a time. In this way efficient edge detection is obtained by this method.

Fig.4 Image obtained using Robert operator (adapted from [4])

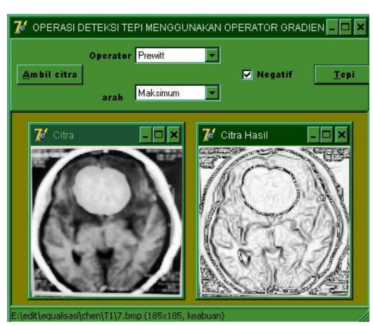

Fig.5 Image obtained using Prewitt operator (adapted from [4])

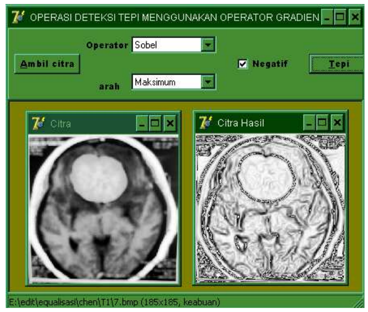

Fig.6 Image obtained using Sobel operator (adapted from [4])

Sobel operator gives good performance image, with edge line between brain tissues and tumor tissues are sharper than other three methods edge detection.

Xie Mei, Zhen Zheng, Wu Bingrong, Li Guo proposed a new method in 2009 [2]. They studied canny edge detection algorithm. This algorithm detects the weak edge of the brain, then labelling all the 8-connected edge with a different number and classifying them with that edge. The size of all the 8-connected edge circumference being different, So histogram is plotted according to the size of the edge, At last, sole weak edge is detected by the histogram segmentation. This way the deformable edge such as brain tumor is detected.

T.Logeswari, M.Karnan [1] in 2010 describes segmentation method consisting of two phases. In the first phase, the MRI brain image is acquired from patient's database, In that film artifact and noise are removed. After that Hierarchical Self Organizing Map (HSOM) is applied for image segmentation. The HSOM is the extension of the conventional self-organizing map used to classify the image row by row. In this lowest level of weight vector, a higher value of tumor pixels, computation speed is achieved by the HSOM with vector quantization.

In 2011 Sarbani Datta, Monisha Chakraborty demonstrates a method [8] that can be successfully used to detect the brain tumor. This helps in determining the size and location of tumor. Edge based technique and color based segmentation are used. Edge-based segmentation has been implemented using operators e.g. Sobel, Prewitt, Canny and Laplacian of Gaussian operators. The color-based segmentation method has been accomplished using K-means clustering algorithm. The developed algorithm shows better result than Canny based edge detection.

In the same year (2011) Subhranil Koley and Aurpan Majumder [7] presents an algorithm for brain MRI segmentation to detect the location of the tumor. Segmentation using CSM based partitional K-means clustering algorithm is applied. It is a self merging algorithm. The noise effect is less. This approach is simple and less complex in computation. The computation time is also very less.

Sharma, et al. [9] in 2012 provide an efficient algorithm for detecting the edges of brain tumor. To determine the exact location and size of tumor, digital imaging techniques are applied on scanned MRI images. A methodology that has been proposed follows certain steps. Firstly, brain image is acquired by obtaining MRI of

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Author(s)	Year	Paper Name	Technique	Results
Manoj K Kowar, Sourabh Yadav	2012	Brain Tumor Detection and Segmentation Using Histogram Thresholding	Histogram based method	Segmentation of brain, detects tumor and also its physical dimension
Pratibha Sharma, Manoj Diwakar, Sangam Choudhary	2012	Application of Edge Detection for Brain Tumor Detection	Morphological operation is applied to MRI image of brain, watershed segmentation for verification of region	Clear and accurate edges of brain tumor obtained efficiently
Sarbani Datta, Dr. Monisha Chakraborty	2011	Brain Tumor Detection from Pre-Processed MR Images using Segmentation Techniques	Edge based segmentation (sobel, prewitt, canny & laplacian of Gaussian), color based segmentation (k-means clustering)	Detects the tumor, identifies the region of tumor
Subhranil Koley and Aurpan Majumder	2011	Brain MRI Segmentation for Tumor Detection using Cohesion based Self Merging Algorithm	Cohesion based self merging based partitional k-means algorithm	In less computation time locates the tumor, noise effect is less
T.Logeswari, M.Karnan.	2010	An Enhanced Implementation of Brain Tumor Detection Using Segmentation Based on Soft Computing	Hierarchical self organizing map applied for segmentation	Target area segmented and monitors the tumor, achieve computation speed
Xie Mei, Zhen Zheng, Wu Bingrong, Li Guo	2009	The Edge Detection of Brain Tumor	Canny edge detection algorithm, 8-connected labelling is used	Deformable edge that is brain tumor is detected
Riries Rulaningtyas and Khusnul Ain	2009	Edge detection for brain tumor pattern recognition	Edge detection method (Robert, Prewitt, Sobel)	Sobel method is suitable for edge detection of brain tumor
J. Kong, J. Wang, Y. Lu, J. Zhang, Y. Li, B. Zhang	2006	A novel approach for segmentation of MRI brain images	Wavelet based filter, water shed algorithm, fuzzy clustering algo and finally re-segmentation process using k-NN classifier	Provides efficient segmentation of MRI brain images

IV. Conclusion and Future Directions

In this review various methods and techniques that are being used to detect the brain tumor from scanned MRI images of brain are evaluated. A comparative study is made of various techniques. After evaluation of well-known techniques it is clearly shown the various methods which can detect the tumor efficiently and provide accurate results. Brain is scanned, that is, MRI image of the brain is obtained which is noise free. This work will be extended for new algorithm for brain tumor detection which will provide more efficient results than existing methods in near future. Computational time will also be considered to compare this technique efficiently.

References

[1] T.Logeswari and M.Karnan, “An Enhanced Implementation of Brain Tumor Detection Using Segmentation Based on Soft Computing”, IEEE International Conference on Signal Acquisition and Processing, pp. 243-247, 2010.

[2] X. Mei, Z. Zheng, W. Bingrong, L.Guo, "The Edge Detection of Brain Tumors", IEEE, pp. 477-479, July 2009.

[3] J. Kong, J. Wang, Y. Lu, J. Zhang, Y. Li, B. Zhang, "A Novel Approach for Segmentation of MRI Brain Images," IEEE Mediterranean Electrotechnical Conference, pp. 525-528, May 2006.
[4] Riries Rulaningtyas, Khusnul Ain, “Edge detection for brain tumor pattern recognition”, IEEE, International conference, 2009.
[5] “National Brain Tumor Society”. [Accessed] April 1, 2013 [Online] [Available]http://www.braintumor.org/patients-family-friends/about-brain tumors/brain-tumor-faq.html..
[6] “Brain Tumor, Image Segmentation” [Accessed] April 1, 2013, [Online] [Available] http://en.wikipedia.org/wiki/.
[7] Subhranil Koley, Aurpan Majumder, “Brain MRI Segmentation for Tumor Detection using Cohesion based Self Merging Algorithm”, pp. 781-785, IEEE, 2011.
[8] Sarbani Datta, Dr. Monisha Chakraborty, “Brain Tumor Detection from Pre-Processed MR Images using Segmentation Techniques”, IJCA, 2nd National Conference- Computing, Communication and Sensor Network, 2011.
[9] Pratibha Sharma, Manoj Diwakar, Sangam Choudhary, “Application of Edge Detection for Brain Tumor Detection”, International Journal of Computer Applications, pp. 21-25, November 2012.
[10] Manoj K Kowar, Sourabh Yadav, “Brain Tumor Detection and Segmentation Using Histogram Thresholding”, International Journal of Engineering and Advanced Technology, pp. 16-20, April 2012.
[11] W. Gao, L. Yang, X. Zhang, H. Liu, “An Improved Sobel Edge Detection”, IEEE, 2010.

Authors Bibliography

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