

Brain Tumor Detection using Artificial Neural Network

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Abstract—The imaging plays a central role in the diagnosis of brain tumors. An efficient algorithm is proposed in this paper for brain tumor detection based on digital image segmentation. Brain tumor may be considered among the most difficult tumors to treat, as it involves the organ which is not only in control of the body. We proposed an Artificial Neural Network Approach for Brain Tumor Detection, which gave the edge pattern and segment of brain and brain tumor itself. This paper outlines extensive lab work for artificial neural network based Brain tumor detection using MR images. The present method detects tumor area by darkening the tumor portion and enhances the image for detection of other brain diseases in human being. The present work demonstrates that the method can successfully detect the brain tumor and thereby help the doctors for analyzing tumor size and region. The algorithms have been developed on MATLAB version 7.6.0 platform. **Keywords:** Brain tumor, MRI images, Edge detection, segmentation, Artificial Neural Network

1. INTRODUCTION

A tumor is a mass of tissue that grows out of control of the normal forces that regulates growth (Pal and Pal, 1993). Brain tumors are abnormal and uncontrolled proliferations of cells. An inferior or metastatic brain tumor takes place when cancer cells extend to the brain from a primary cancer in a different component of the body. The computationally efficient method runs orders of magnitude faster than current state of the art techniques giving comparable or improved results. Our quantitative results indicate the benefit of incorporating model aware affinities into the segmentation process for the difficult case of brain tumor. This paper expresses a wellorganized technique for automatic brain tumor segmentation for the removal of tumor tissues from MR images. A well acknowledged segmentation trouble within MRI is the task of category voxels according to their tissue type which take account of White Matter (WM), Grey Matter (GM), Cerebrospinal Fluid (CSF) and occasionally pathological tissues like tumor etc. A brain tumor is an intracranial mass produced by an uncontrolled growth of cells either normally found in the brain such as neurons, lymphatic tissue, glial cells, blood vessels, pituitary and pineal gland, skull, or spread from cancers primarily located in other organs. There are more than 120 types of brain and central nervous system (CNS) tumors. Today, most medical institutions use the World Health Organization (WHO) classification system to identify brain

tumors. The WHO classifies brain tumors by cell origin and how the cells behave, from the least aggressive (benign) to the most aggressive (malignant).

There are three common types of tumor:

- [1] Benign tumor
- [2] Pre-Malignant tumor
- [3] Malignant tumor

[1] **Benign Tumor**:- A benign tumor is a tumor is the one that does not expand in an abrupt way; it doesn't affect its neighboring healthy tissues and also does not expand to non-adjacent tissues. Moles are the common example of benign tumors.

[2] **Pre-Malignant Tumor**:- Premalignant Tumor is a precancerous stage, considered as a disease, if not properly treated it may lead to cancer.

[3] **Malignant Tumor**:- Malignancy is the type of tumor that grows worse with the passage of time and ultimately results in the death of a person. Malignant is basically a medical term that describes a severe progressing disease. Malignant tumor is a term which is typically used for the description of cancer.

The tumor cell is present within skull and grows within skull is called primary tumor. Malignant brain tumors are primary brain tumors. The tumor presents outside the skull and enter into the skull region called secondary tumor. Metastatic tumors are examples of secondary tumors [4]. The tumor takes up place in the skull and interferes with the normal functioning of the brain. Tumor shifts the brain towards skull and increases the pressure on the brain. Detection of tumor is the first step in the treatment [1]. Figure 1 (a) Normal human brain (b) Brain tumor image

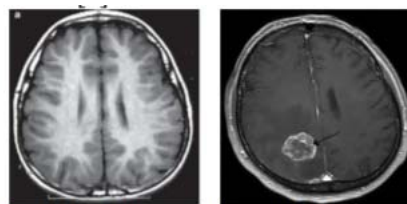


Figure 1 (a) Normal human brain (b) Brain tumor image

Brain contains more number of cells that are interconnected to one another. Different cells controls different parts of the body. Some cells control the leg movement. Likewise others cell of the brain controls other parts in the body. Brain tumors may have different types of symptoms ranging from headache to stroke, so symptoms will vary depending on tumor location. Different location of tumor causes different functioning disorder[3].

The general symptoms of brain tumor are:

- 1) Persistent headache
- 2) Seizures
- 3) Nausea and vomiting
- 4) Eyesight, hearing and/or speech problems
- 5) Loss of sensation in arm.
- 6) Walking and/or balance difficulties.
- 7) Problems with cognition and concentration

Magnetic Resonance Imaging (MRI) is widely used in the scanning. The quality of image is high in the MRI. The quality of image is main important in brain tumor. MRI provides an unparallel view inside the human body [6]. In MRI we can see detailed information exordinary compared to any other scanning like X-ray, C.T scans. The contrast of tumor cell is high compared to normal brain cell.

Treatment techniques for the brain tumor are as follows:

- [1] Surgery
- [2] Radio therapy
- [3] Chemotherapy

In the surgery process doctor remove as many as tumor cells from the brain. Radiotherapy is the common treatment used for brain tumors, the beta rays or gamma rays are passed into the brain and applied on the tumor and kill tumor cells. Chemotherapy is one of treatment for brain cancer [2]. In this we are using medicine which controls the tumor cells to reach blood and blood barriers. In chemotherapy the medicine stops the growth of tumor cells and stops the growth normal brain cells. So, in chemotherapy treatment the patients face significant side effects. The proposed system is an efficient system for detection of tumor and classification for given MRI images .The method of detection and classification work is carried out during the process is explained. This method is developed in MAT Lab simulation environment in order to check for applicability of proposed method.

2. LITERATURE REVIEW

The image segmentation & edge detection approaches were studied under 5 categories. These are as follows:

i. Thresholding approaches

ii. Region growing approaches

iii. Genetic Algorithm approaches

iv. Clustering approaches

v. Neural network approaches.

Several authors suggested various algorithms for segmentation. Chunyan Jiang, Xinhua Zhang, WanjunH, Christoph Meinel [11] paper presents an automatic image segmentation method using thresholdingtechnique. This is based on the assumption that adjacent pixels whose value (grey level, color value, texture, etc) lies within a certain range belong to the same class and thus, good segmentation of images that include only two opposite components can be obtained. Jaskirat K., Agrawal S. &Renu V. paper [8] presented thresholding and edge detection being one of the important aspects of image segmentation comes prior to feature extraction and image recognition system for analyzing images. It helps in extracting the basic shape of an image, overlooking the minute unnecessary details. In this paper using image segmentation (thresholding and edge detection) techniques different geo satellite images, medical images and architectural images are analyzed. To quantify the consistency of our results error measure is used.

N. Lee, A. F. Laine, and T. R. Smith [5] this paper addresses the classical problem of detecting low-level structure in images, or image segmentation. This problem involves the identification of local areas (regions) in an image that are homogeneous and dissimilar to all spatially adjacent regions. Homogeneity may be measured in terms of color, texture, motion, depth, etc., but for the purposes of this paper it is measured by gray level similarity [9]. Sudipta Roy, Samir K. Bandyopadhyay proposed a method based on histogram thresholding [10]. They follow a concept that there is a uniform background and objects are irregularly placed on it.

Zhang presented the analysis and comparison of these evaluation methods are performed according to the classification and assessment criteria for methods and performance metrics proposed in that survey. The results reveal the advantages and limitation of these new methods, and provide additional understanding about the evaluation procedure. This review presents also some novel procedures for image generation under different conditions. Aaron Lefohn, Joshua Cates, Ross Whitaker [7] proposed the basics that thresholding approaches segment scalar images by creating a binary partitioning of the image intensities. It attempts to determine an intensity value, called the threshold, which separates the desired classes. Image pre-processing including converting RGB image into grey scale image then passing that image to the high pass filter in order to remove noise is done and finally the last we get enhanced image for post-processing that will include watershed segmentation and thresholding as well as morphological operation.

3. PROPOSED METHOD

Segmentation is a process of identifying an object or pattern in the given work space. The main objective of the digital image segmentation is the partition of an image into mutually exclusive and exhausted region such that each region of interest is spatially contiguous and the pixels within the regions are homogeneous with respect to a predefined criterion. The steps are as follows:-

[1] Image Acquisition:- Images are obtained using MRI scan and these scanned images are displayed in a two dimensional matrices having pixels as its elements. These matrices are dependent on matrix size and its field of view. Images are stored in MAT LAB and displayed as a gray scale image of size 256*256. The entries of a gray scale image are ranging from 0 to 255, where 0 shows total black color and 255 shows pure white color. Entries between this range vary in intensity from black to white. For the implementation of this application we need to have the images of different patients in our database in order to identify their condition. The MRI image is stored along with our main file from various sources. Various class of MRI image is considered

[2] Pre-processing:- In this phase image is enhanced in the way that finer details are improved and noise is removed from the image. The first step is to get the MRI image and application of pre-processing steps. There are various methods which come under this step; we will be dealing with only grey scale and filters. Basically preprocessing is done to remove noise and blurring as well as ringing effect in order to get the enhanced and much clear image for our purpose. The filter which we have used is median filter but as we are working on image samples that are required for the medical purpose. The median filter has to be passed with mask for better image, to achieve this we are using sobel operator.

[3] Image Enhancement:- The enhancement is needed in MRI to increase its contrast. Contrast between the brain and the tumor region may be present on a MRI but might not be clearly visible through the eyes of human eyes. Thus, to enhance contrast between the normal brain and tumor region, a high pass filter is applied to the digitized and smoothen the MRI which results in better and enhanced image with fairly visible contrast.

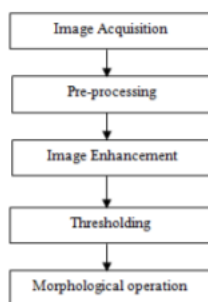


Figure 2 Steps for Brain tumor detection

[4] Thresholding:- Threshold segmentation is one of the simplest segmentation methods. The input gray scale image is converted into a binary format. The method is based on a threshold value which will convert gray scale image into a binary image format. The main logic is the selection of a threshold value. Some common methods used under this segmentation include maximum entropy method and k- means clustering method for segmentation [10].

[5] Morphological operation:- After converting the image in the binary format, some morphological operations are applied on the converted binary image. The purpose of the morphological operators is to separate the tumor part of the image. Now only the tumor portion of the image is visible, shown as white color. This portion has the highest intensity than other regions of the image.

Some of the commands used in morphing are given below:

- [1] Strel: For creating morphological structuring element;
- [2] Imerode (): Used to erode(Shrink) an image.
- [3] Imdilate (): Used for dilating (filling, expanding) an image.

PROPOSED ALGORITHM FOR DETECTING BRAIN TUMOR Input:

MRI Modality Type	Type of Tumor	Volume metric function (%)			
		S	FPVF	FNVF	J
CET & FLAIR	NET, FET & RET				
CET 1	FET 1	98.5	0.5	0.3	88.5
CET 2	FET 2	96.2	0.7	0.5	84.7
CET 3	FET 3	92.5	1.5	0.8	86.5
CET 4	FET 4	95.6	0.6	0.7	89.6
CET 5	FET 5	92.2	0.5	0.6	87.5
CET 6	RET 1	95.6	0.2	0.5	80.5
CET 7	RET 2	92.4	1.5	0.7	78.5
CET 8	RET 3	97.5	0.3	0.4	76.5
CET 9	RET 4	91.5	2.1	1.3	75.7
CET 10	RET 5	96.4	0.2	0.3	77.5
FLAIR 1	NET 1	98.7	0.9	0.7	76.7
FLAIR 2	NET 2	91.4	2.5	1.9	83.5
FLAIR 3	NET 3	98.5	2.8	3.1	80.5
FLAIR 4	NET 4	94.5	1.9	2.3	85.5
FLAIR 5	NET 5	95.5	1.3	2.4	81.5

Input: MR image of human brain.

Output: Tumor portion of the image.

Step 1:- Read the input grayscale image of brain.

Step 2:- Converts input color image in to grayscale image.

Step 3:- Resize this image in to 200 × 200 image matrix.

Step 4:- Filters the multidimensional array with the multidimensional filter.

Step 5:- Computes a global threshold that can be used to convert an intensity image.

Step 6:- Compute watershed segmentation by MAT Lab command watershed.

Step 7:-Compute the morphological operation.(imerode, imdilate and strel).

Step 8:- Store the size of the step 8 image into var1 and var2.

Step 9:-For i=1:1:var1 do

For j=1:1:var2 do

If step8 image (i,j)== 1 do step2 image (i,j) = 255

Else do Step2 image (i,j) = step2 image (i,j) * 0.3

End If End of inner for loop

End of outer for loop.

Step 10:- Show only tumor portion of the image by remove the small object area.

Step 11:- Compute edge detection using edge detection technique.

EXPERIMENT AND RESULTS

The image segmentation performance is also carried out by four parameters namely, similarity index(S), false positive volume function (FPVF), false negative volume function (FNVF) and Jaccard index in our experiment. For a given image, suppose that P_i and Q_i represent the sets of pixels belong to class i in manual and in automatic segmentation, respectively. $|P_i|$ denotes the number of pixels in P_i . $|Q_i|$ denotes the number of pixels in Q_i .

The similarity index S is defined as:

$$S = \frac{(|2|P_i \cap Q_i|)}{|P_i| + |Q_i|}$$

(1) Similarity index $S > 80\%$ indicates an excellent similarity.

Where, FET denotes the Full enhanced tumor; RET the ring-enhanced tumor, NET the enhanced tumor. The false positive volume function (FPVF) represents the error due to the misclassification in class i and the false negative volume function (FNVF) represents the error due to the loss of desired pixels of class i , they are defined as follows:

Table 1: Image segmentation results of enhanced tumors and non-enhanced tumor on images.

$$FPVF = \frac{(|Q_i| - |P_i \cap Q_i|)}{|P_i|} \quad (2)$$

$$FNVF = \frac{(|P_i| - |P_i \cap Q_i|)}{|P_i|} \quad (3)$$

Higher value of S , and lower value of FPVF, FNVF gives better segmentation result. The Jaccard index between two volumes is represented as follows,

$$J = \frac{|P_i \cap Q_i|}{|P_i \cup Q_i|} * 100 \quad (4)$$

4. CONCLUSION

Brain Tumor Segmentation methods are an active research area with increasing interest to improve treatment and diagnosis of patients. The brain tumor detection and classification is successfully implemented by using the image processing tool box in MAT Lab. The graphical user interface of MAT Lab is user friendly. The proposed method may be applied for detecting other cancers like breast cancer etc. Relevance of these approaches is the direct medical application for segmentation and edge detection. We have reviewed the techniques of the MRI image enhancement in terms of tumor pixels detected. We have studied several digital image processing methods and discussed its requirements and properties in brain tumor detection .This paper gives enhanced information about brain tumor detection and segmentation. As diagnosis tumor is a complicated and sensitive task; therefore, accuracy and reliability are always assigned much importance. The marked area is segmented and the assessment of this tool from the radiologist, whom the project is concerned with, is positive and this tool helps them in diagnosis, the treatment procedure and state of the tumor monitoring.

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