Different Type's of Brain Tumor Detection Using Various Techniques

Niharika B. Bawdhankar , Shraddha S. Deshpande
MCA, Jawaharlal Nehru Engineering College,www.jnec.org
MGM Campus, N-6, CIDCO, Aurangabad, Maharashtra 431003
MCA ,JNEC, niks20081992@gmail.com
MCA ,JNEC ,deshpande.shraddha19@gmail.com

ABSTRACT:

Brain tumor analysis is done by doctors but its grading gives different conclusions which may vary from one doctor to another. So for the ease of doctors, a research was done which made the use of software with edge detection and segmentation methods, which gave the edge pattern and segment of brain and brain tumor itself. Medical image segmentation had been a vital point of research, as it inherited complex problems for the proper diagnosis of brain disorders. In this research, it provides a foundation of segmentation and edge detection, as the first step towards brain tumor grading. Current segmentation approaches are reviewed with an emphasis placed on revealing the advantages and disadvantages of these methods for medical imaging applications. The use of image segmentation in different imaging modalities is also described along with the difficulties encountered in each modality.

Keywords
Brain tumor, MRI images, image processing, Edge detection, segmentation.

I. INTRODUCTION

Brain tumor is an abnormal growth of cells inside the skull. Normally the tumor will grow from the cells of the brain, blood vessels, nerves that emerge from the brain. There are two types of tumor which are- benign(non-cancerous) and malignant (cancerous) tumors. The former is described as slow growing tumors that will exert potentially damaging pressure but it will not spread into surrounding brain tissue. However, the latter is described as rapid growing tumor and it is able to spread into surrounding brain. Tumors can damage the normal brain cells by producing inflammation, exerting pressure on parts of brain and increasing pressure within the skull. Figure 1 shows the presence of tumor in the brain.

Radiologists examine the patient physically by using Computed Tomography (CT scan) and Magnetic Resonance Imaging (MRI). MRI images showed the brain structures, tumor's size and location. From the MRI images the information such as tumors location provided radiologists, an easy way to diagnose the tumor and plan the surgical approach for its removal.

MRI's use radiofrequency and magnetic field to result image's human body without ionised radiations. Imaging plays a central role in the diagnosis of brain tumors. On MRI, they appear either hypo (darker than brain tissue) or iso tense (same intensity as brain tissue) on T1-weighted scans, or hyper intense (brighter than brain tissue) on T2-weighted MRI. In medical, doctors don't have method that can be used for brain tumor detection standardization which leads to varying conclusions between one doctor to another .Edge-based method is by far the most common method of detecting boundaries, discontinuities in an image and segmentation. The parts on which immediate changes in grey tones occur in the images are called edges. Edge detection techniques transform images to edge images benefiting from the changes of grey tones in the images. As a result of this transformation, edge based brain segmentation image is obtained without encountering any changes in physical qualities of the main image .This image processing consist of image enhancement using histogram equalization, edge detection and segmentation process to take patterns of brain tumors, so the process of making computer aided diagnosis for brain tumor grading will be easier.

MRI (Magnetic Resonance Imaging)

MRI is commonly used in the medical field for detection and visualization of details in the internal structure of the body. It is basically used to detect the differences in the body tissues which have a considerably better technique as compared to computed tomography [23]. Thus, this technique become a special technique especially for the brain tumor detection and cancer imaging [23]. Basically, for comparison, CT uses ionizing radiation while MRI uses strong magnetic field to align the nuclear magnetization that follows by changes the alignment of the magnetization by radio frequencies that can be detected by the scanner. The signal produced can be further processed later to gain extra information of the body [23]. This paper provide a review of image-based tumor detection. The authors then review imagebased tumor detection, commenting on techniques applied for color detection and shape detection. They provide their insights and perspectives on future research directions in imagebased tumor detection.

BACKGROUND ON TUMOR DETECTION

Nowadays, brain tumor has become one of the main cause for increasing mortality among children and adults [23]. Based on some researches, it has been found that the number of people suffering and dying from brain tumors has been increased to 300 per year during past few decades [23]. Figure 1 shows the incidence of brain tumor in various age groups. International Journal of Information Technology Convergence and Services (IJITCS) Vol.4, No.1, February 2014 3 Figure 1: Brain tumor age distribution

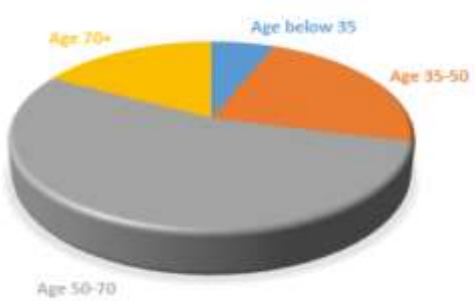


Figure 1: Brain tumor age distribution

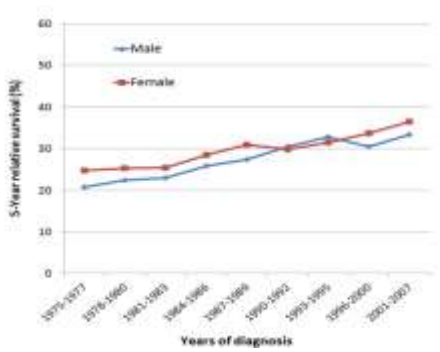
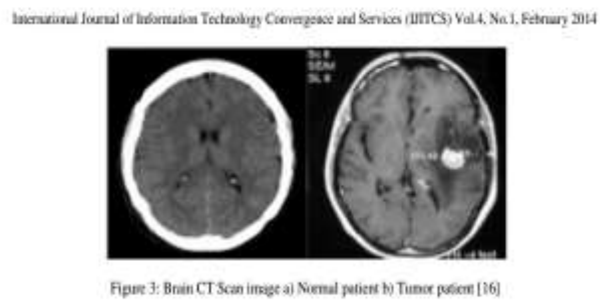


Figure 2: 5-Year brain tumor survival rate over years [24]

According to Nagalkar and Asole [16], CT-Scan technique usually used for monitoring the images of damaged brain part. The images of the CT Scans are shown in the form of gray scale images as the equipment for CT scans support this form of image color and for easy detection of tumor from the image [16]. For example, in the parietal section of the head scanned using CT scans, the Cerebrum part is shown in the form of the gray color while the veins and arteries parts in the form of creamish white color [16]. Any clotting that exist in the brain that show any kind of damage can be detected as dark gray in color. The process of extraction of parameters are basically like taking out per pixel information and then plotting it [16]. For an image obtained from CT-Scan, the images are shown in this manner; tumor appears white and brain damaged cells shown in black color, thus the binary values of the pixel showing the brain damaged cells are 0 and showing the tumor are 1, thus by extraction process, further analysis can be done such as checking and plotting in MATLAB [16]. The patient with damaged brain can be differentiated from normal patient by using this technique. In addition, tumor can also be detected clearly based on the image results [16].



February 2014 4 Figure 3: Brain CT Scan image a) Normal patient b) Tumor patient [16]

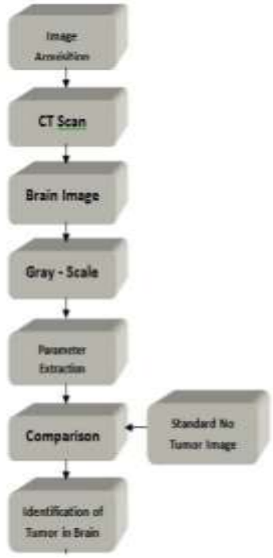


Figure 4: Basic flowchart to determine existence of tumor [16]

Additionally, this technique has been practiced to determine tumor patient's response to treatment since long time ago. The radiologist has made series of cross-sectional diameter measurements for indicator lesions purposes by using axial, incremental CT image data. Later, these measurements will be compared with the previous measurement scans [25]. Nevertheless, the measurement of lesion diameter does not represent the exact assessment of tumor size due to some factors, such as:

Irregular lesions

The lesions that grow other than sphere shape may not adequately represented by diameters' changes;

Different measurement between inter-observer and intra-observer

Referred to the image selection used for the measurement and the location of lesion boundary;

Different levels of scanning results collected from various diagnoses

The lesions may not be captured exactly at the same spot from one diagnosis to another. Hence, it affects the lesion's image in which causes comparisons between examinations

On the other hand, with the ability to provide single breath-hold scans and overlapping reconstructions, the spiral CT is capable to improve the image lesions at reproducible levels from different diagnosis [25]. Even so, these lesions' measurements are still a subjective task and yet open for variability as described in previous factors (a) and (b). What follows is a summary of several approaches to the problems involved in nodule detection. Therefore, the researchers have divided these approaches into two groups of methods which are [25]: (a) The process of detecting the pulmonary vasculature in order to help the detection of pulmonary nodules (if vasculature is successfully removed from the image, then only nodules should remain). (b) The process of detecting objects in the CT image volume to distinguish between nodules and other structures.

3. PROPOSED METHODOLOGY

3.1. Image Acquisition

Images obtained or used should be of MRI scans and these scanned images are displayed in a two dimensional matrices which will have the number of pixels as its elements. Images are stored in Matlab and converted (if not already) to be displayed as a gray scale image of size 256*256 [23]. The size is important to reduce processing time or to be large enough to be considered for proper processing. The values of the gray scale image would range from 0 to 255, where 0 represents total black color and 255 shows pure white color [23]. Anything in between shows a variety of values representing the intensities of gray color .

Figure 7: Block diagram of the Proposed Tumor Detection

3.2. Pre-processing

Pre-processing generally means removing noise and improving or altering image quality to suit a purpose. For this study, only commonly used enhancement and noise reduction techniques were implemented [23]. The image enhancement that the study is interested in should yield the result of more prominent edges and a sharpened image, noise will be reduced thus reducing the blurring or salt paper effect from the image that might produce errors [23]. After image enhancement, image segmentation will be applied. This step is vital as the improved and enhanced image will yield better results when detecting edges and improving the quality of International Journal of Information Technology Convergence and Services (IJITCS) Vol.4, No.1, February 2014 6 the overall image. Edge detection will lead to determining and understanding the outline shape of the tumor. The following steps will be exemplified in the preprocessing stage [23]:

(a) Noise Removal: there is a wide range of filters available to be used to remove the noise from the images. Linear filters present on Matlab with simple line of code can also serve the purpose such as Gaussian and averaging filters. Salt and pepper noise is a common noise present in original captured images. Average filters for example, can remove these noise but with the sacrifice of sharpness of image. Median filter is also another example of a filter used to remove the noise like salt and pepper. In the median filter value of pixel is determined by the median of the values of its neighboring pixels [17]. This filter however, is less sensitive to the outliers [23].

(b) Any filter able to remove the noise present in the original image could be used for this purpose. However, in tumor detection, the sharpness of the edges, obtained from the sudden change of intensity, is a focal point and should be kept preserved. The next step will help improve the sharpness of the edges [23].

(c) Image Sharpening: sharpening is generally achieved by using high pass filters. After applying low pass filters (noise removing step), we now need to sharpen the image to ensure edges are kept. This is important as edges will detect and highlight the tumor for us. Gaussian filter (a high pass filter) is used to enhance the boundaries of the objects. It is widely used and the paper proposes to imitate [23].

3.3. Edge Detection

Edge detection is the most vital part in tumor detection. It is used to determine the boundaries of the object. In this step, canny edge filter is used. “Five steps in canny filter: 1.Filters out noise in original image 2.Smoothing the image using filters 3.Finding the edge directions with library of orientation 4. Relate to a direction that can be traced in an image 5.After edge directions are known, non-maximum suppression is done to thin out of remove edges based on threshold values determined.” [18] The two main

purpose of using canny filter is [30]:
1. Control the amount of detail which appears in the edge image.
2. Suppress noise.

3.4. Modified Histogram Clustering

Histogram is one of the powerful techniques in image enhancement. The histogram of an image represents the relative frequency of occurrence of the various gray levels based on their individual values . This is useful in stretching low-contrasting images. Clustering in which similar neighbored bins are grouped together and finally thresholding is set in order to detect the tumor. One of the method in histogram clustering is the histogram values are plotted and the threshold value is fixed based on the gray level values and pixels in the image. To obtain this, we first plot the values and take a guess on the best value to use. The white parts of the image will have the maximum value of 255 and the black parts will translate to the value zero. Based on the values of the tumor, (certain studies keep first guess values to be at 128 as threshold value) the tumor image is processed. The values should be tested for various data sets of tumor images to identify the closest threshold value and the results are displayed later. Certain researches have specified that beyond the 132 mark, tumor is not detected clearly anymore . Later, the tumor part is International Journal of Information Technology Convergence and Services (IJITCS) Vol.4, No.1, February 2014 7 extracted via the morphological operators by taking and specifying the region of interest (ROI) and displaying it clearly.

3.5. Morphological Operators

Morphological operation involves dilation and erosion. Dilation combines two sets using vector addition. Erosion combines two sets using vector subtraction and is the dual operator of dilation [31]. Both are not invertible transforms. Morphological techniques called "opening-by-reconstruction" and "closing-by-reconstruction" to "clean" up the image is used. These operations will create a gap between the high and low intensity objects and enhance it to locate images. The enhanced maxima inside each object that can be located using imregionalmax Opening is an erosion followed by a dilation, while opening-by-reconstruction is an erosion followed by a morphological reconstruction

4. EXPERIMENTS

The data is first presented according to example pictures of the image processes involved in the system. As discussed in the previous design part, the image used is of grayscale MRI brain scans. First we acquire the images and pre-processes it under a median filter. These are some of the examples the images:

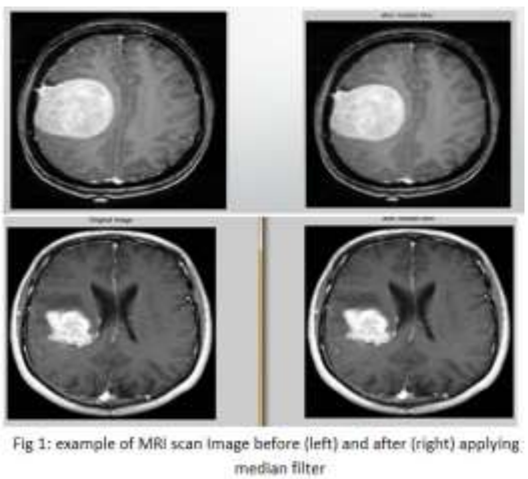


Figure 8: Images before (left) and after (right) median filter

Next the edges of the images are specified with the sobel edge detection. The images processed are as follows: International Journal of Information Technology Convergence and Services (IJITCS) Vol.4, No.1, February 2014

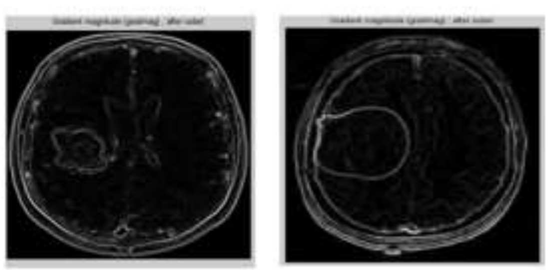


Figure 9: Images after sobel edge detection algorithm is app

Later the images would go through a Modified Histogram Clustering - Color Threshold technique to identify the position of the tumor. According to various MRI scan images, the threshold values of the image's HSV for the tumor happens to be common and lies between these values:

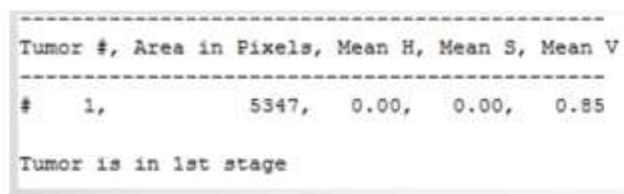
Table 1. Threshold values applied

HSV	High (%)	Low (%)
Hue	35	0
Saturation	75	0
Value	100	70

The values are set as a threshold and applied with convolution with the original image to determine the location of the tumor.

Figure 10: After applying modified threshold clustering technique

Through the syntax of bwlabel() on Matlab, each block of image found is subjected to a value of label. This allows us to gain property information about the block using the improps() syntax. The area can be found and displayed.



```
---------------------------------------------
Tumor #, Area in Pixels, Mean H, Mean S, Mean V
---------------------------------------------
#    1,          5347,   0.00,   0.00,   0.85

Tumor is in 1st stage
```

Figure 11: Display of results

Next we segment out the tumor subject from the original image. For this purpose, we use a watershed technique. The technique uses a series of algorithm that allows segmentation of high color contrast. The result of the imposed technique is as follows:

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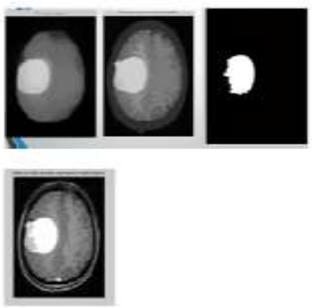

Figure 12: Watershed segmentation technique outcome

We used 50 neuroimages to optimize our system and 100 out-of-sample neuroimages to test our system. The proposed tumor detection and localization system was found to be able to accurately detect and localize brain tumor in magnetic resonance imaging. The proposed system achieved an error rate of 8% in identifying and localizing tumors. We used a median filter for preprocessing because it yields a noise removed image that is still closely similar to the original image. In tumor detection, tampering too much with the intensity of color and contrast may lead to less accurate segmentation. This is because the tumor detection technique used in this study mainly focuses on the color contrast of tumors as its main feature. According to previous studies, the median filter is also the most useful filter for MRI scan images because it deals best with salt and pepper noise without tampering too much with the color contrast. In the color clustering technique, the intensity of the grey color contrast in tumor and the background brain sets the threshold value. This technique is used mainly because the color contrast is the only recognizable feature of a tumor. Even doctors rely solely on this feature to detect tumor from MRI scans. Watershed segmentation is an important part of the project. It uses an opening-closing reconstruction technique which is basically the enhancing and dimming of foreground and background images. The contrast is then elevated. Reconstructing would highlight the high intensity objects. The reason for using this method is because tumor is detected according to grey color contrast or intensity. Watershed technique is suitable as it segments based on this feature. According to the experiments and results obtained, the system records an 8% error. These errors are solely false positive errors. This means that images without tumors end up with detected blobs. The errors usually happen when the original images supplied are not grayscale images. The noise of the RGB or HSV conversion might have produced the error.

Figure 14: Error in modified threshold clustering

The shows the detection of the skull as a form of tumor as well. Therefore it detects the patient to have a metastasis level tumor or a cancer of level 2 or above.

```
Tumor #, Area in Pixels, Mean H, Mean S, Mean V
-----------------------------------------------
#   1,        5699,   0.00,   0.00,   0.88

Tumor has metacized to second stage, needs immediate attention!

#   2,        4346,   0.00,   0.00,   0.89

Tumor has metacized to second stage, needs immediate attention!

#   3,         263,   0.00,   0.00,   0.93

Tumor has metacized to second stage, needs immediate attention!
```

Figure 15: Error in detection

From the same error example as before, it shows that the program recognizes 3 areas of tumor. These areas are the example of the false positive errors recorded.

Future Work

I intend to continue the work on this system, so in the following lines I will present some future research that I want to do. First, hopefully, I will have more images and real ones. When the acquisition of these images will be done, I want
to use both feature extracted from images and patient information in order to get an accurate classification of the images in normal and abnormal. In my opinion, the classification would be better performed after the segmentation method and the segmentation results to be used in classification. The results of the segmentation could also be used to detect the size or the location of the tumor in the brain. Also, this location could probably lead to interesting patterns when more images are studied

5. CONCLUSION

We propose an automatic brain tumor detection and localization framework that can detect and localize brain tumor in magnetic resonance imaging. The proposed brain tumor detection and localization framework comprises five steps: image acquisition, pre-processing, edge detection, modified histogram clustering and morphological operations. After morphological operations, tumors appear as pure white color on pure black backgrounds. We used 50 neuroimages to optimize our system and 100 out-of-sample neuroimages to test our system. The proposed tumor detection and localization system was found to be able to accurately detect and localize brain tumor in magnetic resonance imaging. This system achieved an error rate of 8%. The preliminary results demonstrate how a simple machine learning classifier with a set of simple image-based features can result in high classification accuracy. The preliminary results also demonstrate the efficacy and efficiency of our five-step brain tumor detection and localization approach and motivate us to extend this framework to detect and localize a variety of other types of tumors in other types of medical imagery.

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