

Detection And 3d Reconstruction Of Brain Tumor From Brain Mri Images

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Abstract

In the last 20 years we have a number of useful algorithms developed for segmentation of medical image. Each method comes with its own set of features. Daily growth of medical data volume leads to raise human mistakes in their manual analysis and increase the requests to analyze automatically. Therefore applying some tools to collect, classify, and analyze the medical data automatically is necessary to decrease the human mistakes. The analysis and study of the brain is of great interest due to its potential for studying early growth patterns and morphologic changes in the tumour process. Segmentation of anatomical regions of the brain is the fundamental problem in medical image analysis. In this paper brain tumor segmentation method has been developed and validated segmentation on 2D MRI Data. Also detected tumors are represented in 3-Dimensional (3D) view. 3D visualization of tumor yields actual shape and size of the tumors along with their positions. Finally, work was carried over to calculate the area of the tumor of single slice of MRI data set and then it was extended to calculate the volume of the tumor from multiple image MRI data sets. Experimental results for a single MRI slice have been reported.

Key Words- Tumor Segmentation, Morphological operations, MRI Image Slices, 3D visualization.

1. INTRODUCTION

The analysis and study of the brain is of great interest due to its potential for studying early growth patterns and morphologic changes in the tumour process. A brain tumor is

an abnormal growth of cells within the brain or inside the skull, which can be cancerous (malignant) or non-cancerous (benign).

The extraction of 3D objects and its visualization is one of the most important steps in the analysis of the pre processed medical image data, which can help in performing diagnosis, treatment planning, and treatment delivery. Thus in practice, radiation oncologists spend a substantial portion of their time performing the segmentation task manually, using one of the available visualization and segmentation tools [1]. Also, there may be cases where the automatic methods fail or perform poorly. Another consideration is that medical doctors must always have final control over the segmentation [2].

The most common primary brain Tumors are gliomas, wherein 70% are in the group of malignant gliomas (anaplastic astrocytoma World Health Organization (WHO) grade III), glioblastoma multiform (GBM) WHO grade IV) [3]. The GBM is one of the highest malignant human neoplasms. Due to the biological behaviour, gliomas of WHO grade II to IV cannot be cured with surgery alone. The multimodal therapeutic concept involves maximum safe resection followed by radiation and chemotherapy, depending on the patient's functional impairment scale. The survival rate is still only approximately 15 months, despite new technical and medical accomplishments such as multimodal navigation during micro-surgery, stereotactic radiation or the implementation of alkylating substances [4]. The clinical follow-up of tumor volume is essential for an adaptation of the therapeutically concept.

Therefore, the exact volume evaluation is fundamental to reveal a recurrent tumor or tumor

2. RELATED WORK

2.1 Literature review

In this section, we are discussing briefly about the earlier approaches which have been carried out in the field of brain tumor detection.

K Narayanan and Yogesh Karunakar [1] has considered the following actions to build a 3D image based on acquisition of 2D slices. Reading and structuring the initial data (MRI slices) in order to be memorized in their natural sequence, the input data are represented on the slices taken as a result of MR investigations. Image segmentation and identification of zones of interest from the diagnosis point of view; this action is taken into account because it is enough strong and flexible even if the proposed method does not involve a beforehand in identification of the different surfaces with certain density.

S. Ananda Resmi and Tessamma Thomas [2] have considered Skull stripping as a part of pre-processing. Skull stripping is a method of removing the skull and non-brain intracranial tissues like fat, muscle, skin etc., that surround the surface of brain cortex and cerebellum in the brain. Brain Extraction was necessary to avoid the misclassifications of the surrounding tissues, skin and scalp as WM (White Matter) or GM (Gray Matter). By removing these objects, non-brain tissues will be removed and, only soft tissues will remain in the image. Skull stripping was based on the morphological operation known as erosion, using a disc shaped structuring element, which resulted in the removal of thin connections between the brain and non-brain portions. Thus a skull stripped brain mask was obtained and this method was automated for every image slice.

Rajesh C.Patil, A S Bhalchandra [4] has discussed Watershed segmentation a grey-level image may be seen as a topographic relief, where the grey level of a pixel is interpreted as its altitude in the relief. A drop of water falling on a topographic relief flows along a path to finally reach a local minimum. Intuitively, the watershed of a relief corresponds to the limits of the adjacent catchment basins of the drops of water. In image processing, different watershed lines may be computed. In graphs, some may be defined on the nodes, on the edges, or hybrid lines on both nodes and edges. Watersheds may also be defined in the continuous domain.

progress as early as possible.

2.2 Outline of the work

The aim of this paper is to propose a method for detection of brain tumor and its shape using image processing techniques. Brain tumor cells differ from normal cells in a number of ways, which helps in its detection.

Here, a brain tumor segmentation method has been developed and validated segmentation on 2D MRI Data. In this study, after a manual segmentation procedure for the tumor identification, the investigations has been made for the potential use of MRI data for improving brain tumor shape approximation and 2D & 3D visualization for surgical planning and assessing tumor. Firstly, the work was carried over to calculate the area of the tumor of single slice of MRI data set and then it was extended to calculate the volume of the tumor from multiple image MRI data sets.

3. PROPOSED METHOD

The carried out work mainly focuses on detecting tumor from brain MRI image slices using different image processing aspects. Segmentation is used to detect the tumor from the input MRI image slices. Also extending the work in order to find out the exact shape and size of the image, the detected tumor is reconstructed in 3-Dimensional (3D) view. The area and volume of the tumor has been calculated.

3.1 Flowchart of the Proposed Work

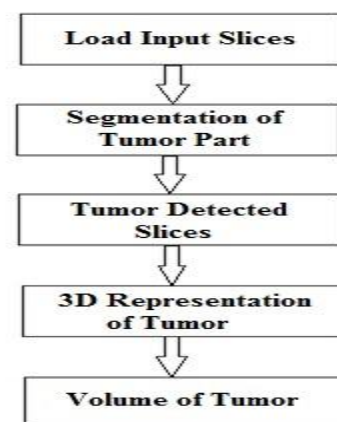


Fig 3.1 Flowchart of the proposed work

Figure 3.1 shows the flowchart of the proposed work. The algorithm works as follows:

Step 1- The input brain MRI image slices are loaded using imread command.

Step 2- The tumor area present in the input image is detected using segmentation technique, which is explained in the section 3.2.

Step 3- The tumor detected slices, which are the output of segmentation are further guided in order to represent the detected tumor in 3D view, which normally helps in finding out exact shape and size of the tumor.

Step 4- The tumor area is represented in 3D view and the volume of tumor is calculated.

3.2 Flowchart for detection of tumor using segmentation

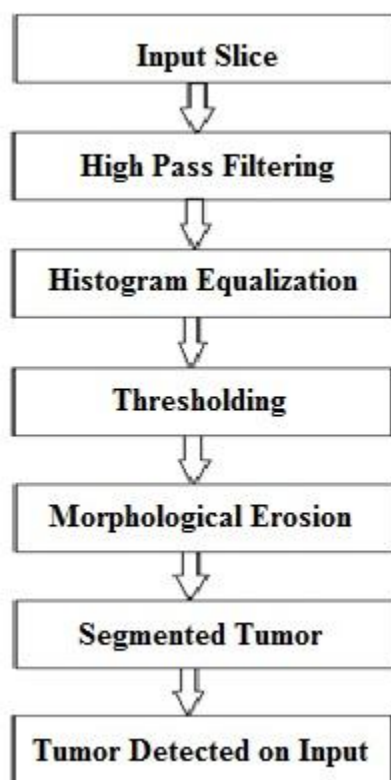


Fig 3.2 Flowchart for Tumor Detection

Figure 3.2 shows the Flowchart for detection of tumor using segmentation. The algorithm works as follows:

Step 1- The input brain MRI image slices are loaded using imread command.

Step 2- High Pass Filtering of the input image slice using unsharp Masking To generate unsharp masks using fspecial function you have to use the following format: $f = \text{fspecial}('unsharp', \alpha)$.

Step 3- Histogram Equalization is performed in order to adjust the contrast of the image using the image's histogram. Histeq is a function which Enhance contrast using histogram equalization.

Step 4- Thresholding is performed in order to separate the objects of interest from the background. A binary image is created by colouring each pixel white or black, depending on a pixel's labels.

Step 5- Erosion is performed in order to remove the pixels from the object boundaries. The number of pixels removed from the objects in an image depends on the size and shape of the structuring element used to process the image.

Step 6- Segmentation is carried out in order to detect the tumor by using Connected Component Labelling (also called pixel based image segmentation).

3.2.1 Procedure

- **High Pass Filtering Using Unsharp Masking**

Unsharp masking is one of the popular ways of image sharpening. In unsharp masking an image is enhanced by enhancing the high frequency components of the image that is mainly enhancing the edges. That is, to increase sharpness in an image we need a good high pass filter. Unsharp masks are generally high pass filters. Unsharp masking is done by adding a fraction of high-pass filtered image to the original image. Unsharp masking increases the sharpness of the edges in the image and thus reduces the blur or the dullness in the image. Result of unsharp masking is shown in fig.4.2.

- **Histogram Equalization**

Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. This method usually increases

the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment,

the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values. The method is useful in images with backgrounds and foregrounds that are both bright or both dark[5]. Result of Histogram equalization is shown in fig.4.3.

• Thresholding

Thresholding is the simplest method of image segmentation [6]. From a grayscale image, thresholding can be used to create binary images, so that objects of interest are separated from the background. During the thresholding process, individual pixels in an image are marked as "object" pixels if their value is greater than some threshold value (assuming an object to be brighter than the background) and as "background" pixels otherwise. Output of thresholding process is shown in fig.4.4.

• Morphology operations

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, we can construct a morphological operation that is sensitive to specific shapes in the input image.

The most basic morphological operations are Dilation and Erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. Result of Morphological Erosion is shown in fig.4.5.

• Connected Component Labelling

In binary images analysis objects are usually extracted by means of the connected

components labelling operation, which consists in assigning a unique label to each maximal connected region of foreground pixels.

If one finds all equivalence classes of connected pixels in a binary image, this is called connected component labelling. The result of connected component labelling is another image in which everything in one connected region is labelled "1" (for example), everything in another connected region is labelled "2", etc.

1. Scan through the image pixel by pixel across each row in order:

- If the pixel has no connected neighbours with the same value that have already been labelled, create a new unique label and assign it to that pixel.
- If the pixel has exactly one label among its connected neighbour with the same value that has already been labelled, give it that label.
- If the pixel has two or more connected neighbours with the same value but different labels, choose one of the labels and remember that these labels are equivalent.

2. Resolve the equivalencies by making another pass through the image and labelling each pixel with a unique label for its equivalence class. Result of segmentation using connected component labelling is shown in fig.4.6.

• Volume 3D

Volume3D uses the orthogonal plane 2-D texture mapping technique for volume rendering 3-D data in OpenGL. Use the 'texture' option to fine tune the texture mapping technique. This function is best used with fast OpenGL hardware.

H = vol3d ('CData', data) Create volume render object from input 3-D data. Use interp3 on data to increase volume rendering resolution. Returns a struct encapsulating the pseudo- volume rendering object. 3D representation of the detected tumor part is shown in fig.4.10.

4. EXPERIMENTAL RESULTS

The proposed method was tested for several slices of brain MRI images. The area of the detected tumor has been calculated for each slice. Later the

tumor has been represented in 3-Dimensional (3D) view by stacking all the slices, and finally the volume of the tumor has been analyzed. Volume of the Tumor is 20.725mm^3 .

The input images are of DICOM (Digital Imaging and Communications in Medicine) format, which is a standard format for medical image analysis.

The proposed method was implemented using MATLAB v7.9.

Original dicom image

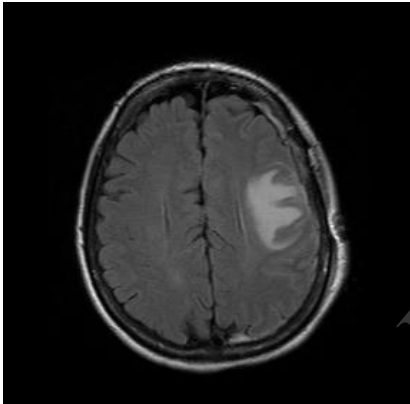


Fig 4.1 Input Slice

High pass filtered image

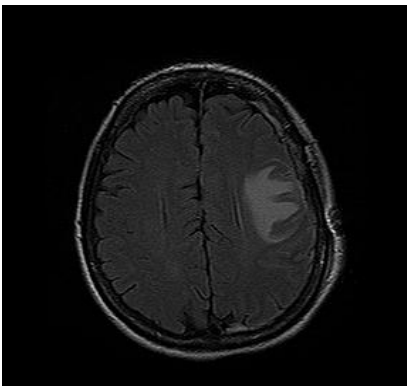


Fig 4.2 High pass Filtered Image

Histogram equalization image

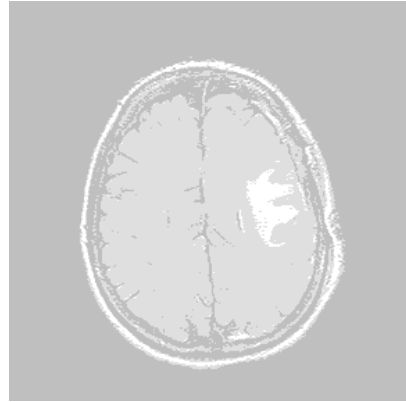


Fig 4.3 Histogram Equalized Image

Thresholded image

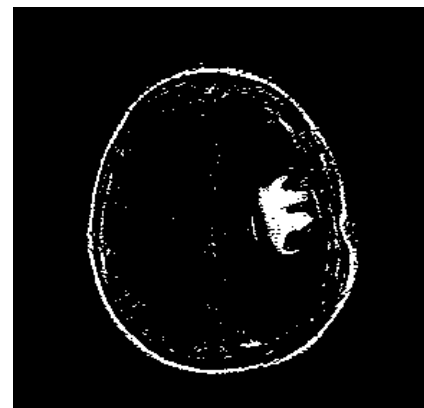
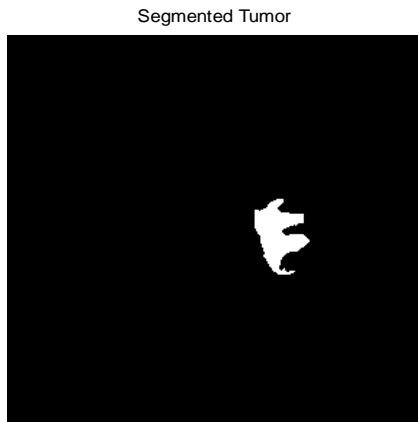
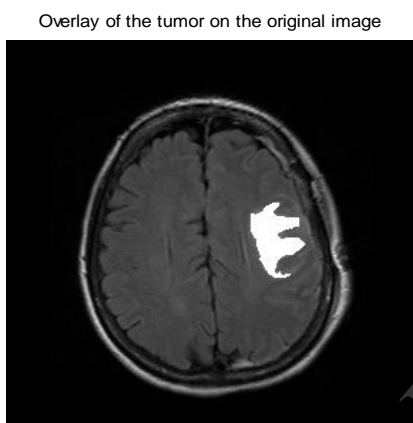
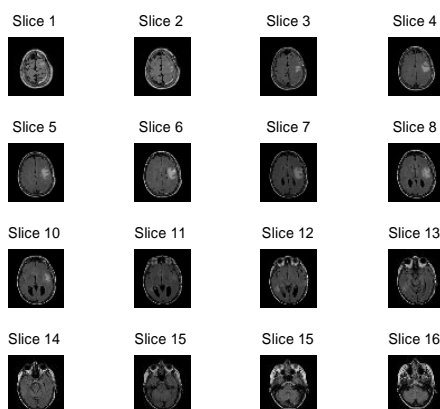
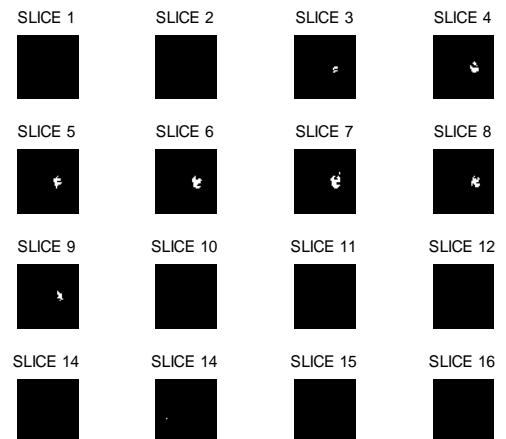
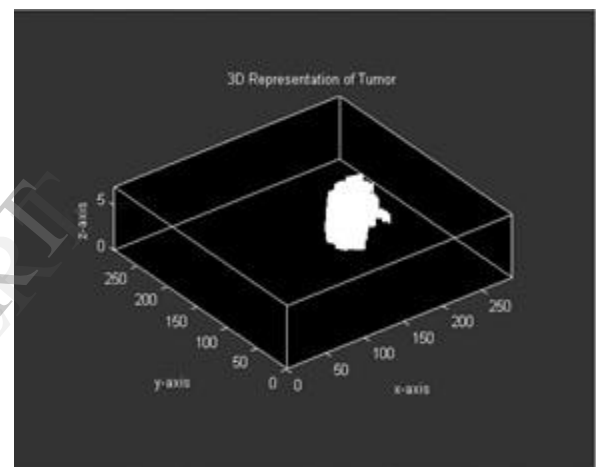


Fig 4.4 Thresholded Image

Morphological Erosion



Fig 4.5 Morphological Erosion

**Fig 4.6** Segmented Tumor Part**Fig 4.7** Detection of Tumor in Original Image**Fig 4.8** Illustration of multiple image view option of input MRI Slices**Fig 4.9** Tumor Detected Slices**Fig 4.10** 3D Representation of Tumor Part

5. CONCLUSION

In this Project work User friendly algorithm for processing the MRI image slices for the reconstruction of Tumors was developed. The algorithm was tested and calibrated using real MRI data. In the application of the algorithm the real data was enhanced and the tumor was extracted from the images in a user friendly way. The 2D extracted tumor images were reconstructed into 3D volumetric data and the volume of the tumor was also calculated.

• Future Work

Further implementation of this project for various parts of the body like throat, pelvic and lung for understanding cancer.

The developed method can be optimizing, in terms of speed of the algorithm for processing larger images.

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