



BRAIN TUMOUR EXTRACTION FROM MRI IMAGES USING MATLAB

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ABSTRACT

Automatic detection of tumors in medical images is motivated by the necessity of high accuracy when dealing with a human life. Also, the computer assistance is demanded in medical institutions due to the fact that it could improve the results of humans in such a domain where the false negative cases must be at a very low rate. Processing of Magnetic Resonance Imaging (MRI) images is one of the techniques to diagnose the brain tumor. This paper describes the strategy to detect and extract brain tumor from patient's MRI scan images. First it takes the name and age of a person and then MRI brain image is used for tumor detection process. It includes pre-processing, segmentation, morphological operation, watershed segmentation and calculation of the tumor area and determination of the tumor location. The user interface of the application is developed using Graphical User Interface (GUI) developing environment of Matrix Laboratory (MATLAB).

Keywords: Brain Tumor, Morphological Operations MRI, Watershed Segmentation.

I. INTRODUCTION

The brain is a soft, spongy mass of tissue which is protected by the bones of the skull, three thin layers of tissue called meninges and cerebrospinal fluid. Sometimes there occurs abnormal growth in brain tissues causing brain tumor. Tumors are categorized basically into two types –

1.1. Benign Brain Tumour

Cells from benign tumours rarely invade tissues around them. They don't spread to other parts of the body. However, benign tumours can press on sensitive areas of the brain and cause serious health problems. Benign tumours can be removed, and they seldom grow back.

1.2 Malignant Brain Tumour

Malignant brain tumours also called as brain cancer. They are likely to grow rapidly and crowd or invade the nearby healthy brain tissue.

MRI is a medical imaging technique used in radiology to form pictures of the anatomy and the physiological processes of the body in both health and disease. MRI scanners use strong magnetic fields, radio waves, and field gradients to generate images of the inside of the body. This software applies Digital Image Processing Technique on MRI scans implemented using MATLAB.

II. METHODOLOGY

The method is given in fig. 1.

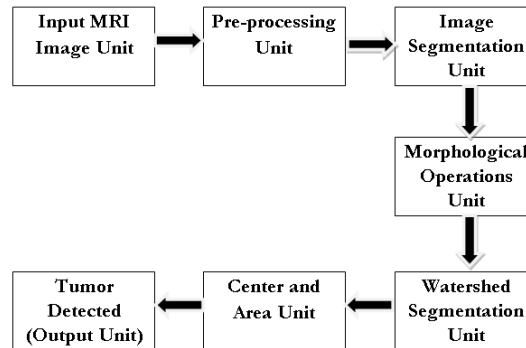


Fig. One. Block Diagram for Brain Tumour Extraction

The major steps to detect a brain tumor from MRI image are given as follows -

- 1) Give MRI image of brain as input.
- 2) Convert it to gray scale image.
- 3) Apply low pass filter for noise removal.
- 4) Apply median filter to enhance the quality of image.
- 5) Compute threshold segmentation.
- 6) Compute morphological operation.
- 7) Finally output will be a tumour region
- 7) Compute watershed segmentation and ridging.
- 8) Calculate tumour area and show its centre.

The first step is to enter the name and age of the patient. Further the GUI asks for the MRI brain image. The program is created in MATLAB which accepts the MRI image in file format and converts it in data format using the functions `uigetfile()` and `imread()`.

2.1 Grayscale Conversion

Red, Green, Blue provides computational complexities and still does not provide guaranteed better results. Therefore Grayscale images are preferred in image pre-processing. The conversion of a RGB to grayscale image is done by using the function `rgb2gray (image)`.

2.2 Preprocessing of Grayscale Image

Pre-processing of MRI images is the primary step in image analysis which performs image enhancement and noise reduction techniques to enhance the image quality. The accuracy and convergence rate of such techniques must be significantly high in order to ensure the success of the subsequent steps. In this work, the importance of such approaches is highlighted in the context of Magnetic Resonance (MR) brain image classification and segmentation. In this work, suitable pre-processing techniques are developed to remove the skull portion surrounding the brain tissues. The experimental results are analysed in terms of segmentation efficiency for pre-processing and distance measure for feature extraction techniques. For the pre-processing following two filters are used :



2.2.1 Low Pass Filter

Firstly image is given as an input to low pass filter to perform smoothening methods. A low-pass filter, also called a "blurring" or "smoothing" filter, averages out rapid changes in intensity. The simplest low-pass filter just calculates the average of a pixel and all of its eight immediate neighbours. The result replaces the original value of the pixel. The process is repeated for every pixel in the image.

2.2.2 Median Filter

Then the image is passed through median filter for noise reduction. The median filter is a nonlinear digital filtering technique which preserves edges while removing noise. Median filter runs through the signal entry by entry, replacing each entry with the median of neighbouring entries.

2.3 Image Segmentation

After pre-processing segmentation is applied to partition the image into multiple segments (sets of pixels, also known as super pixels) to simplify the representation of an image into something that is more meaningful and easier to analyse. Image segmentations 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.

2.3.1 Threshold Segmentation

Thresholding method replace each pixel in an image with a black pixel if the image intensity $I(i,j)$ is less than some fixed constant T (i.e. $I(i,j) < T$), or a white pixel if the image intensity is greater than that constant. Hence this method is based on a clip level (threshold value) to turn a gray-scale image into binary image.

2.3.2 Morphological Operation

Morphological technique is used to probe an image with a small shape or template called a structuring element. The structuring element is positioned at all possible locations in the image and it is compared with the corresponding neighbourhood of pixels. Some operations test whether the element "fits" within the neighbourhood, while others test whether it "hits" or intersects the neighbourhood. It is the collection of nonlinear operations related to the shape or morphology of features in an image.

2.3.3 Watershed Segmentation

Watershed segmentation is a gradient-based segmentation technique. It considers the gradient map of the image as a relief map. It segments the image as a dam. The segmented regions are called catchment basins. Watershed segmentation solves a variety of image segmentation problem. It is suitable for the images that have higher intensity value. Watershed segmentation is caused over segmentation. To control over segmentation, marker controlled watershed segmentation is used.

Next unit calculates the area of the tumor region and locates the centre in the form of rows and columns. The area is specified in pixels. Furthermore with the help of this information the tumor location in terms of brain terminology can be specified. Mainly if the sagittal plane is considered, the location of tumor in the brain can be specified more easily. After all the operations the extracted tumour would be shown in output axes of UI. In output image tumour will be shown in terms of watershed ridges. The watershed segmentation takes random color in the background and in the tumor to separate them.

III. SIMULATION AND TESTING

The project is tested by running main GUI MATLAB file which takes the name and age of the patient into the system and store it via edit boxes as shown in fig. 2.

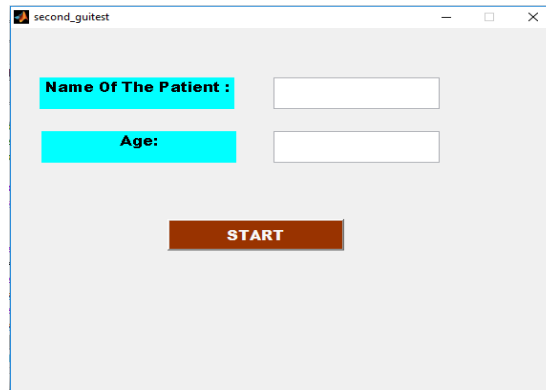


Fig. Two Main GUI of the Application

On pressing the push button Load MRI its callback function is executed which calls another GUI projectmodule.m Simulation of each stage has been separately done for projectmodule.m and results are shown in figure window:

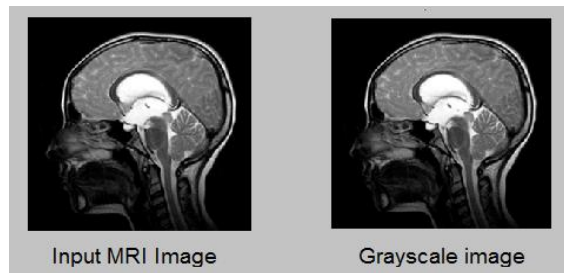


Fig. Three Simulation Step 1 - Grayscale Image

The original MRI image is converted to Grayscale image to reduce computational complexities. In this particular case the image is already in grayscale but the project can work if the image is in RGB format .The following conversion is obtained using the function `rgb2gray (image)` and the simulation result is obtained in figure window as shown in figure three .

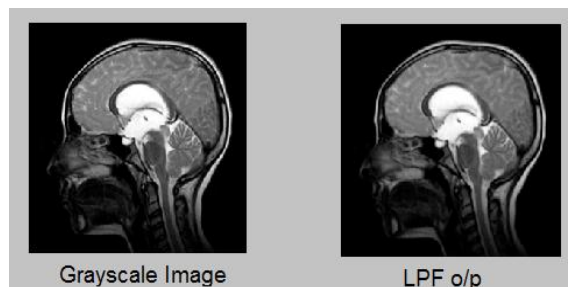


Fig. Four Simulation Step 2 - Output of Low Pass Filter

Second step of simulation is to generate a Low Pass Filtered image of the grayscale output image in previous step. It is clearly seen in figure Four that image is smoothed and this low-pass filtered image looks a little bit blurrier. The reason of wanting a blurrier image is that often images can be noisy – no matter how good the MRI Image is, it always adds an amount of "snow" into the image.

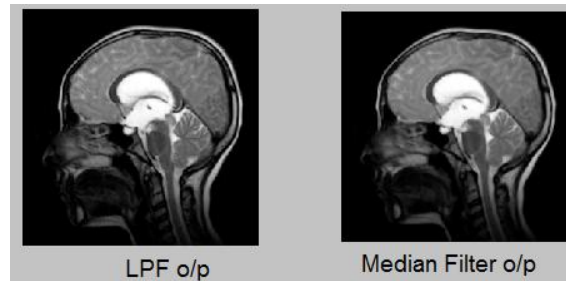


Fig. Five Simulation Step 3 - Output of Median Filter

In next step the LPF output is passed through median filter further enhancing the quality of the MRI image. It can be seen in Figure Five that edges are preserved successfully.



Fig. Six Simulation Step 4 - Output of Threshold Segmentation

Next simulation involves the application of Threshold Segmentation on median filtered output image which replace each pixel in an image with a black pixel if the image intensity $I(i,j)$ is less than some fixed constant T (i.e. $I(i,j) < T$), or a white pixel if the image intensity is greater than that constant.



Fig. Seven Simulation Step 5 - Output of Morphological Operation

In the next step Morphological Image Processing is a done which is a collection of non- linear operations related to the shape or morphology of features in an image. A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value. Morphological operations transform the image. In this erosion is applied to detect the tumor.

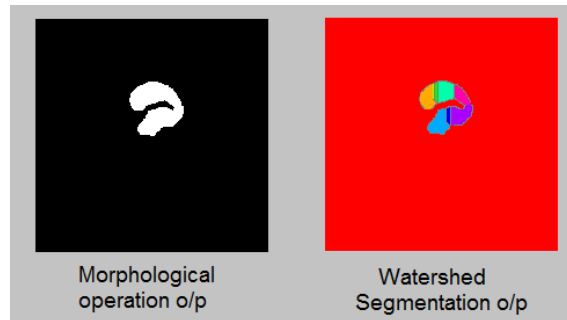


Fig. Eight Simulation Step 6 - Output of Watershed Segmentation

Watershed Segmentation shows a method for gathering pixels of an image on the premise of their intensities. Pixels falling under comparative intensities are assembled together. It is a decent segmentation system for separating an image to partition a tumor from the image. This is shown in Figure Eight.

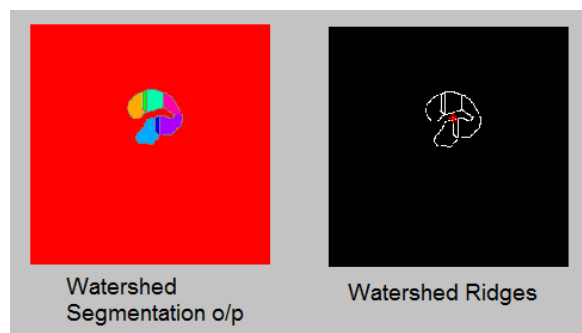


Fig. Nine Simulation Step 7 - Output of Watershed Segmentation

At the bottom of the GUI the area of the brain tumor (in pixels) is shown along with its location in segment no. when the final image of extracted tumor is divided into 16 equal square boxes. Figure Nine represents the output of Watershed Segmentation.



Fig. Ten Simulation Step 8 – Calculation of Area and Centre of Brain Tumour

Finally a message box appears which indicates the part (lobe) of the brain which is affected by the tumor. The Message Box is shown in Figure Eleven.

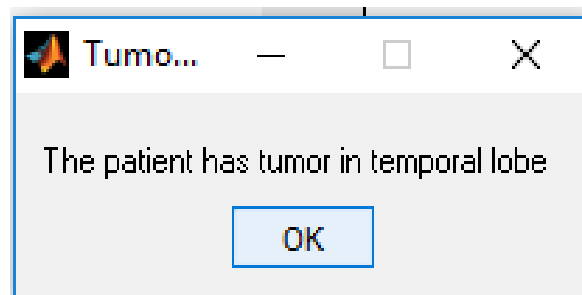


Fig. Eleven Message Box Showing the Affected Part of the Brain

IV. CONCLUSION

In this paper, a brain tumour MRI image is applied to pre-processing and after that tumour is extracted by morphological and watershed segmentation processes. The medical image segmentation has difficulties in segmenting complex structure with uneven shape, size, and properties. In such condition it is better to use unsupervised methods such as edge detection algorithm. For accurate diagnosis of tumor patients, appropriate segmentation method is required to be used for MRI images to carry out an improved diagnosis and treatment. The brain tumor detection is a great help for the physicians and a boon for the medical imaging and industries working on the production of MRI imaging.

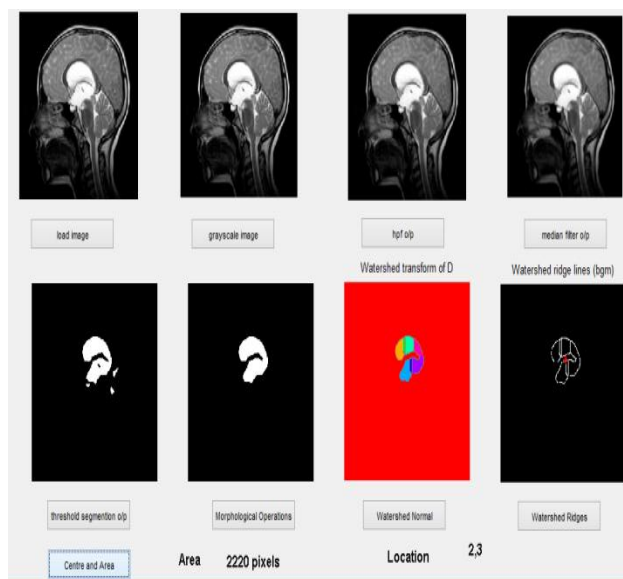


Fig. Twelve Graphical User Interface showing all the steps.

V. FUTURE SCOPE

In near future, a database can be created for different patients having different types of brain tumours and locate them. Tumour growth can be analysed by plotting graph which can be obtained by studying sequential images of tumour affect. Possible extension of the presented work could use more features. It would be beneficial to connect the system to cloud storage of patient's information in hospital. This application can be extended to accessibility and usability through mobile phones. If this application is developed to analyse all types of MRI scans of same patient and result of all scans are integrated, it can suggest appropriate treatment and medication as well.

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BIOGRAPHY

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