Brain Tumour Extraction from MRI Images Using MATLAB

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Abstract — **Medical image processing is the most challenging and emerging field now a days. Processing of MRI images is one of the part of this field. This paper describes the proposed strategy to detect & extraction of brain tumour from patient's MRI scan images of the brain. This method incorporates with some noise removal functions, segmentation and morphological operations which are the basic concepts of image processing. Detection and extraction of tumour from MRI scan images of the brain is done by using MATLAB software.**

Key Words — **MRI, segmentation, morphology, MATLAB.**

I. INTRODUCTION

Tumour is defined as the abnormal growth of the tissues. Brain tumor is an abnormal mass of tissue in which cells grow and multiply uncontrollably, seemingly unchecked by the mechanisms that control normal cells. Brain tumors can be primary or metastatic, and either malignant or benign. A metastatic brain tumor is a cancer that has spread from elsewhere in the body to the brain

Epilepsy is a brain disorder in which clusters of nerve cells, or neurons, in the brain sometimes signal abnormally. Neurons normally generate electrochemical impulses that act on other neurons, glands, and muscles to produce human thoughts, feelings, and actions. In epilepsy, the normal pattern of neuronal activity becomes disturbed, causing strange sensations, emotions, and behavior or sometimes convulsions, muscle spasms, and loss of consciousness [3].

Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique used to produce high quality images of the parts contained in the human body MRI imaging is often used when treating brain tumours, ankle, and foot. From these high-resolution images, we can derive detailed anatomical information to examine human brain development and discover abnormalities. Nowadays there are several methodology for classifying MR images, which are fuzzy methods, neural networks, atlas methods, knowledge based techniques, shape methods, variation segmentation. MRI consists of T1 weighted, T2 weighted and PD (proton density) weighted images and are processed by a system which integrates fuzzy based technique with multispectral analysis [2].

Pre-processing of MRI images is the primary step in image analysis which perform image enhancement and noise-reduction techniques which are used to enhance the image quality, then some morphological operations are applied to detect the tumor in the image. The morphological operations are basically applied on some assumptions about the size and shape of the tumour and in the end the tumour is mapped onto the original gray scale image with 255 intensity to make visible the tumour in the image. The algorithm has been tried on a number of patients MRI data of brain tumour images in.

II. METHODOLOGY

The algorithm has two stages, first is pre-processing of given MRI image and after that segmentation and then perform morphological operations. Steps of algorithm are as following:-

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

All above steps are explained here in detail.

A. Grayscale Imaging

MRI images are magnetic resonance images which can be acquired on computer when a patient is scanned by MRI machine. We can acquire MRI images of the part of the body which is under test or desired. Generally when we see MRI images on computer they looks like black and white images. In analog practice, gray scale imaging is sometimes called "black and white," but technically this is a misnomer. In true black and white, also known as halftone, the only possible shades are pure black and pure white. The illusion of gray shading in a halftone image is obtained by rendering the image as a grid of black dots on a white background (or vice-versa), with the sizes of the individual dots determining the apparent lightness of the gray in their vicinity. The halftone technique is commonly used for printing photographs in newspapers and as MRI image is taken on computer then In the case of transmitted light (for example, the image on a computer display), the brightness levels of the red (R), green (G) and blue (B) components are each represented as a number from decimal 0 to 255, or binary 00000000 to 11111111. For every pixel in a red-green-blue (RGB) grayscale image, R = G = B. The lightness of the gray is directly proportional to the number representing the brightness levels of the primary colors. Black is represented by R = G = B = 0 or R = G = B = 00000000, and white is represented by R = G = B = 255 or R = G = B = 11111111. Because there are 8 bit s in the binary representation of the gray level, this imaging method is called 8-bit grayscale.

Grayscale is a range of shades of gray without apparent color. The darkest possible shade is black, which is the total absence of transmitted or reflected light. The lightest possible shade is white, the total transmission or reflection of light at all visible wavelengths. So because of the above reasons first we convert our MRI image to be pre-processed in grayscale image.

B. High Pass Filter

After that image is given as an input to high pass filter. A high pass filter is the basis for most sharpening methods. An image is sharpened when contrast is enhanced between adjoining areas with little variation in brightness or darkness.

A high pass filter tends to retain the high frequency information within an image while reducing the low frequency information. The kernel of the high pass filter is designed to increase the brightness of the center pixel relative to neighboring pixels. The kernel array usually contains a single positive value at its center, which is completely surrounded by negative values.

C. Median Filter

In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median. This filter enhance the quality of the MRI image.

D. Threshold Segmentation

The simplest method of image segmentation is called the thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale image into a binary image.

The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and et all . k-means clustering can also be used. In computer vision, Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). 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.[1] 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.

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image (see edge detection). Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).[1] When applied to a stack of images, typical in Medical imaging, the resulting contours after image segmentation can be used to create 3D reconstructions with the help of interpolation algorithms like Marching cubes.

E. 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 correspond 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 . There are also many different algorithms to compute watersheds.

Meyer's flooding Watershed Algorithm

One of the most common watershed algorithms was introduced by F. Meyer in the early 90's.

The algorithm works on a gray scale image. During the successive flooding of the grey value relief, watersheds with adjacent catchment basins are constructed. This flooding process is performed on the gradient image, i.e. the basins should emerge along the edges. Normally this will lead to an over-segmentation of the image, especially for noisy image material, e.g. medical CT data. Either the image must be pre-processed or the regions must be merged on the basis of a similarity criterion afterwards.

1. A set of markers, pixels where the flooding shall start, are chosen. Each is given a different label.
2. The neighboring pixels of each marked area are inserted into a priority queue with a priority level corresponding to the gray level of the pixel.
3. The pixel with the highest priority level is extracted from the priority queue. If the neighbors of the extracted pixel that have already been labeled all have the same label, then the pixel is labeled with their label. All non-marked neighbors that are not yet in the priority queue are put into the priority queue.
4. Redo step 3 until the priority queue is empty.
   The non-labeled pixels are the watershed lines.

F. Morphological Operations

Morphological image processing is a collection of non-linear operations related to the shape or morphology of features in an image. According to Wikipedia, morphological

operations rely only on the relative ordering of pixel values, not on their numerical values, and therefore are especially suited to the processing of binary images. Morphological operations can also be applied to greyscale images such that their light transfer functions are unknown and therefore their absolute pixel values are of no or minor interest. Morphological techniques 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:

A morphological operation on a binary image creates a new binary image in which the pixel has a non-zero value only if the test is successful at that location in the input image.

The structuring element is a small binary image, i.e. a small matrix of pixels, each with a value of zero or one:

- The matrix dimensions specify the *size* of the structuring element.
- The pattern of ones and zeros specifies the *shape* of the structuring element.
- An origin of the structuring element is usually one of its pixels, although generally the origin can be outside the structuring element.

III. RESULT AND DISCUSSION

Next figures show the images as an output. i.e grayscale image, high pass filtered image , threshold image, watershed segmented image, Finally input image and extracted tumour from MRI image. For this purpose real time patient data is taken for analysis.As tumour in MRI image have an intensity more than that of its background so it become very easy locate it and extract it from a MRI image.

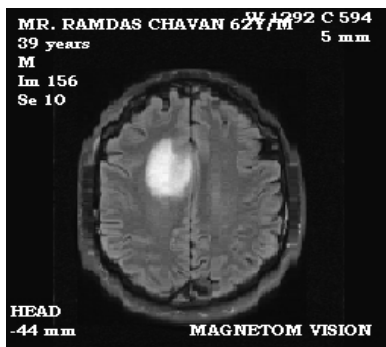Following is the first MRI image which the input to this programme.
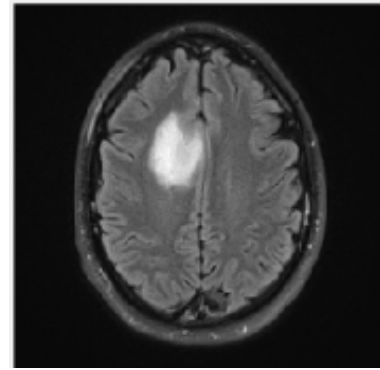

Fig. 1 MRI image of tumour affected brain

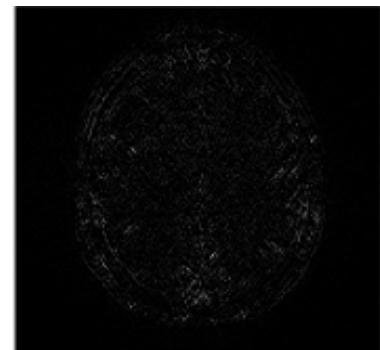Fig. 2 Grayscale image of the fig. 1
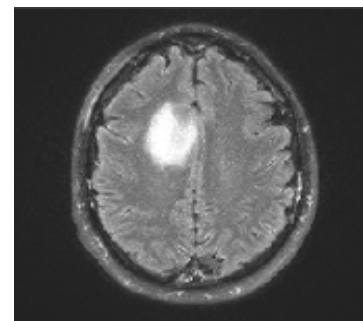

Fig. 3 HPF output of fig.2 image
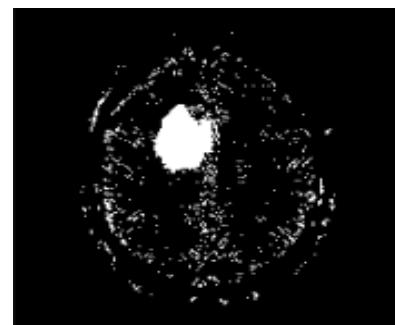

Fig. 4 Enhanced MRI image of fig.3

Fig.5 Threshold segmented image of i/p image
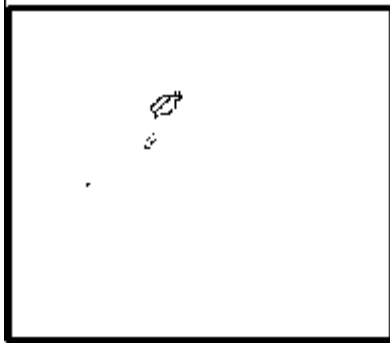
Fig. 6 Watershed segmented image of i/p image

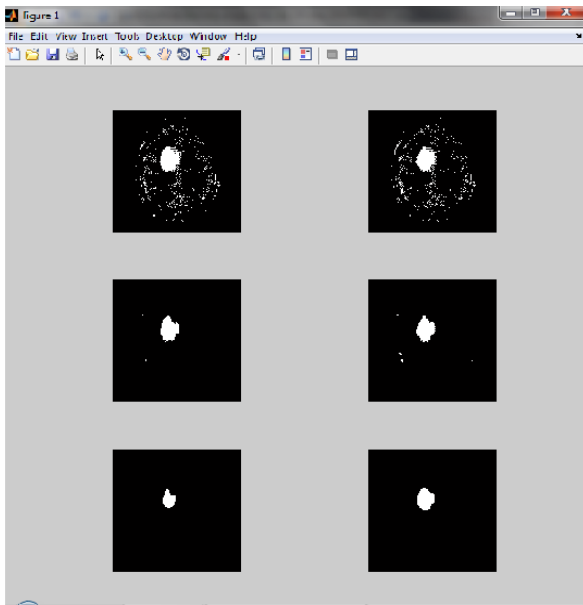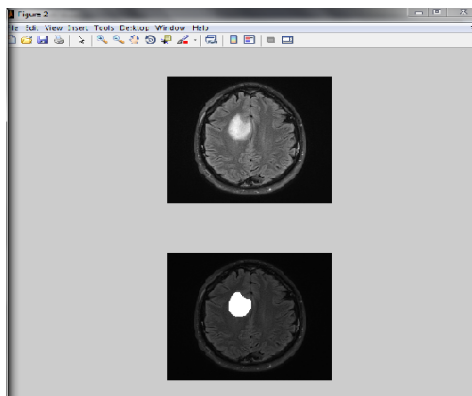Fig. 7 Morphological operation

Fig. 8 Final Extracted brain tumor from MRI image

IV. FUTURE WORK

In future this programme can be done more advanced so that tumour can be classified according to its type. Also tumour growth can be analysed by plotting graph which can be obtained by studying sequential images of tumour affected patient.

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