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Research Article

DETECTION OF BRAIN TUMOR FROM MRI OF BRAIN

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ABSTRACT

Tumor segmentation from magnetic resonance imaging (MRI) data is an important but time consuming manual task performed by medical experts. Magnetic resonance imaging (MRI), computed tomography (CT), digital mammography, and other imaging processes give an efficient means for detecting different type of diseases. Here a method is proposed for detection of brain tumor from MRI of brain.

INTRODUCTION

The automated detection methodology have deeply improved knowledge of normal and diseased examination for medical research and are a important part in diagnosis and treatment planning when the number of patients increases (TamijeSelvy *et al.,* 2011). Among all the medical image modalities, Magnetic Resonance Imaging (MRI) is the most frequently used imaging technique in neuroscience and neurosurgery for these applications. The brain abnormality detection and segmentation on MRI images is a very difficult and vital task which is used in surgical and medical planning and assessment. The difficulty in brain image analysis is mainly due to the requirement of detection techniques with high accuracy within quick convergence time. Automating this process is a challenging task because of the high diversity in the appearance of abnormal tissues among different patients and in many cases almost similar with the normal tissues. The detection process of any abnormalities in the brain images are a two-step process. Initially, the abnormal MR brain images are detected from different type of MRI images, finally, the abnormal portion is extracted (image segmentation) to perform volumetric analysis and classified for treatment planning varies for different types of abnormalities which verify the success rate of the treatment given to the patient. Standard x-rays and computed tomography (CT) can initially be used in the diagnostic process. However, MRI is generally more useful because it provides more detailed information about tumor type, position and size. For this reason, MRI is the imaging study of choice for the diagnostic work up and, thereafter, for surgery and monitoring treatment outcomes (Laurence *et al.,* 1998).

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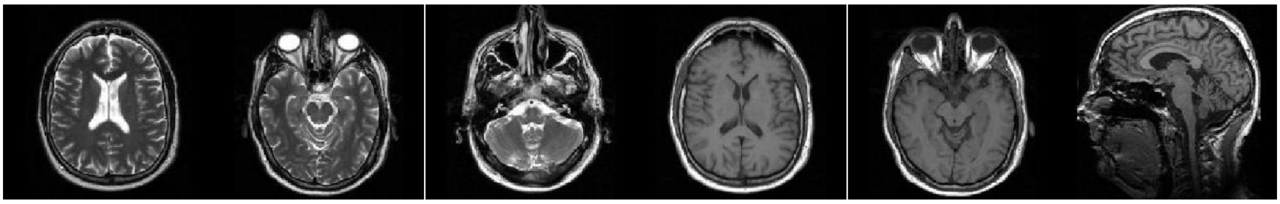
Brief Review

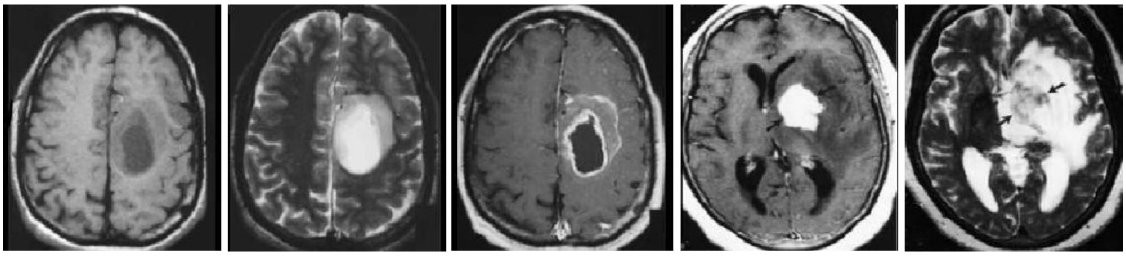
A magnetic resonance imaging instrument or MRI Scanner (Magnetic Resonance Imaging, 1998) uses powerful magnets to polarize and excite hydrogen nuclei i.e. proton in water molecules in human tissue, producing a detectable signal which is spatially encoded, resulting in images of the body (Aria Tzika *et al.,* 2011). MRI mainly uses three electromagnetic fields they are : i) A very strong static magnetic field to polarize the hydrogen nuclei, named as the static field, ii) A weaker time varying field(s) for spatial encoding, named as the gradient field, iii) A weak radio frequency field for manipulation of hydrogen nuclei to produce measurable signals collected through RF antenna. The variable behaviour of protons within different tissues leads to differences in tissue appearance. The different positioning of MRI of brain with T1 and T2 weight is shown below. (Figure 1, igure 2 and Figure 3)

or malignant tumor and other different considerations. Brains tumors are the solid portion permeate the surrounding tissues or distort the surrounding structures (Roger *et al.,* 2002). There are different type of brain tumor they are i) Gliomas, ii) Medulloblastoma, iii) Lymphoma, iv) Meningioma, v) Craniopharyngioma, vi) Pituitary adenoma.



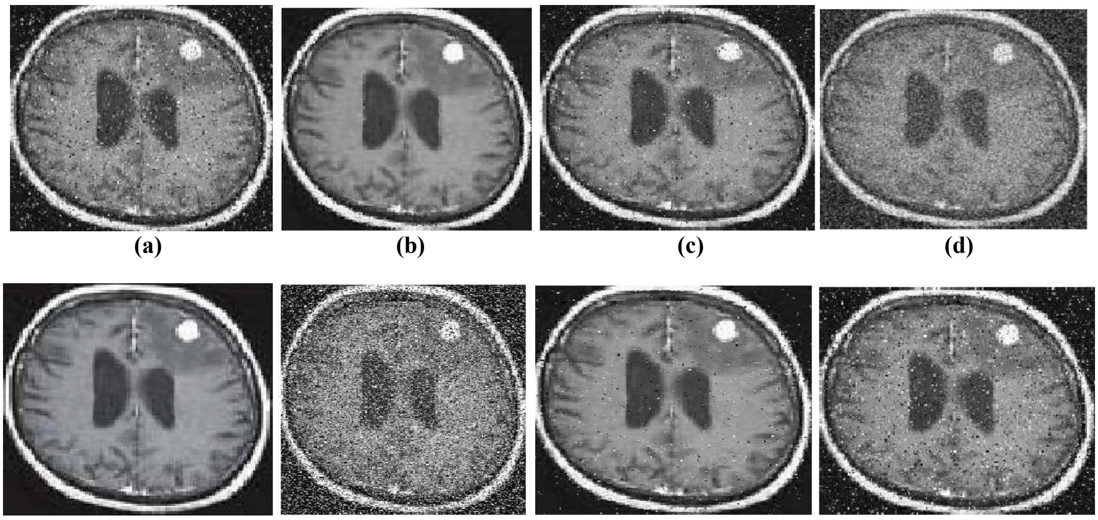
(a) (b) (c) (d) (e) (f)

Figure 1. MRI of brain cited by http://www.mr-tip.com/serv1.php?type=isimg. T2 weighted MR image (a) brain shows cortex, lateral ventricle, and falxcerebri, (b) brain shows eyeballs with optic nerve, medulla, vermis, and temporal lobes with hippocampal regions, (c) head shows maxillary sinus, nasal septum, clivus, inner ear, medulla, and cerebellum. T1 weighted MR image (d) brain shows cortex, white and grey matter, third and lateral venticles, putamen, frontal sinus and superior sagittal sinus, (e) brain shows eyeballs with optic nerve, medulla, vermis, and temporal lobes with hippocampal regions,(f) brain shows cortex with white and grey matter, corpus callosum, lateral ventricle, thalamus, pons and cerebellum from the same patients



(a) (b) (c) (d) (e)

Figure 2. a) Axial T1-weighted with tumor, b) T2-weighted with central positioning tumor, c) Contrast enhanced T1-weighted image showing ring formed tumor, d) Contrast enhanced T1-weighted image with high grade oligodendro glioma e) T2-weighted image with high grade oligodendro glioma from the same patient



(a) (b) (c) (d)

(e) (f) (g) (h)

Figure 2. a) original MRI image, b) original MRI with 50% noise, c) median filter, d) Min-Max Median Filter, e) Center Weighted Median Filter, f) Adaptive Median Filter, g) Progressive Switching Median Filter, h) Average Filter

A brain tumor is a mass of cells that have grown and multiplied uncontrollable i.e. a brain tumor is an uncontrolled growth of solid mass formed by undesired cells either normally found in the different part of the brain such as glial cells, neurons, lymphatic tissue, blood vessels, pituitary and pineal gland, skull, or spread from cancers mainly located in other organs (The Essential Guide to Brain Tumors, 2012). Brain tumors are classified based on the type of tissue involved in the brain, the positioning of the tumor in the brain, whether it is benign tumor

Proposed Method

Automated system (detection) of brain tumor through MRI is basically called Computer-Aided Diagnosis (CAD) system. The CAD system can provide highly accurate reconstruction of the original image i.e. the valuable outlook and accuracy of earlier brain tumor detection. It consists of two or more stage. In the initial stage pre-processing has required after that stages post-processing i.e. segmentation are required.

Then detection strategies and other information, feature extraction, feature selection, classification, and performance analysis are compared and studied. Pre-processing techniques are used to improvement of image quality and remove small artefacts and noise for the accurate detection of the undesired regions in MRI. Post-processing is used to segment with different strategy the brain tumor from the MRI of brain images. In this paper, here focus on the appearance of tumors in MRI images, the grade of tumors and some general information which will be useful in the detection, segmentation and interpretation of brain tumors from MRI images. The basic system is made up of individual modules and each individual module is associated with its own techniques. The major modules of this work are image database, pre-processing, feature extraction, classification and image segmentation. The MRI slides can be gathered from several diagnostic centers and hospitals. For experimental analysis images available in the public domain are utilized that are utilized by several research organizations those are conducting similar research. Pre-processing mainly involves those operations that are normally necessarily prior to the main goal analysis and extraction of the desired information and normally geometric corrections of the original actual image. These improvements include correcting the data for irregularities and unwanted atmospheric noise, removal of non-brain element image and converting the data so they correctly reflected in the original image.

Segmentation is the process of partitioning an image to several segments but the main difficulties in segmenting an images are i) Noise, ii) Blur Low Contrast, iii) The bias field (the occurrence of smoothly varying intensities within tissues) , iv) The partial-volume effect (a voxel contributes in multiple tissue types) . Image filtering and enhancement stage is the most obvious part of medical image processing. This pre-processing stage is used for reducing image noise, highlighting important portions, or displaying obvious portions of digital images. Some more techniques can employ medical image processing of coherent echo signals prior to image generation and some of the images are hanging from clip hence they may produce noise. The enhancement stage includes resolution enhancement; contrast enhancement. These are used to suppress noise and imaging of spectral parameters. After this stage the medical image is converted into standard image without noise, film artefacts and labels. Methods such as use of standard filters to more advanced filters, nonlinear filtering methods, anisotropic nonlinear diffusion filtering, a Markov random field (MRF) models, wavelet models, non-local means models (NL-means) and analytically correction schemes. These methods are almost same in terms of computation cost, de-noising, quality of de-noising and boundary preserving.

In the proposed methods we used standard deviation to select the threshold intensity of the image. Ultimate selection of threshold has done by multiplying a constant value with the threshold intensity of the image using standard deviation.Colour models or colour spaces, indicate the colours in a benchmark way by using a coordinate system and a subspace in which each colour is represented by a single point of the coordinate system. The largely common colour spaces used in image processing [24, 25] methods are Gray, Binary form, RGB, HSV, HIS etc. Gray form are used in all binarized method, i.e. most of the segmentation technique used binarization methods original MR Brain image is a gray-level image may be inadequate to maintain fine description then pseudo colour conversion are need. Each gray value maps to an RGB item. To obtain more useful features and enhance the visual density, some of the method may applies pseudo-colour transformation, a mapping function that maps a gray-level pixel to a colour level pixel by a lookup table in a predefined colour map. An RGB colour map contains R, G, and B values for each item. But most of the segmentation applied on the gray image the RGB to gray conversion is needed.

Algorithm

Input: MRI of Brain Image.

Output: Binarizes MRI of Brain Image.

Step1: Take an MRI image I(x,y).
Step2: If it is color image then convert it into gray scale image $I_g(x,y)$.
Step3: Calculate standard deviation of the image and store the intensity value in T_S.
Step4: calculate the threshold value by product of standard deviation and a predefine constant H, i.e.
Threshold intensity value $T= T_S*H$.
Step5: Scan left to right and top to bottom, each pixel of the gray image $I_g(x,y)$.
Step6: Find a binary image I_B from the gray image $l_g(x,y)$ in the following way,

$I_B(x,y) =$	1	$l_g(x,y) >= T$
$I_B(x,y) =$	0	$l_g(x,y) < T$

Step7: I_B is the output binary image.

We use binarization technique of MRI of brain that so MRI of brain is used as an input. As the binarization technique can be applied only to grayscale images. We convert RGB image to its corresponding grayscale image. A RGB image has three components red, green and blue and converts it into on component i.e. gray value which lies between 0 to 255 intensity values.

Then we calculate the standard deviation of the matrix elements (image pixels).Thus by using standard deviation we select the random intensity values as the standard deviation values will be less than 100 and hence we multiplied the deviated value by a constant value. Here we choose this constant value H=3. Although H=3 is choosen, in few images H= 2.5 also produce good results .Here we also gives a comparative study why we choose constant H equal to 3.

Here we use visual inspection as well as quantative measurement to choose the constant. Visual inspection may be biased but together with quantative measurement [8] such as ME, RAE, Precision, Recall, F-measure and visual are very effective. Thus after getting the threshold intensity we compare each pixel of the gray image to find out whether it is greater than or less than the threshold intensity value.

If the pixel intensity is greater than the threshold value then that pixel value is set to 1 otherwise it is set to 0. Thus the whole image is transformed into 0 or 1 i.e. a binary image is generated from the gray image where the foregrounds are marked as 1 and backgrounds are marked as 0.

Algorithm for abnormal region identification

Input: A MRI image of Brain.
Output: Abnormal region identification with centroid

Step1: Read Image (Gray image or Colour Image)
Step2: Convert it to Gray Image (I_{GRAY}) form RGB.
Step3: Remove noise by using median filter of image I_{GRAY}. The processing Image is I_{pro}.
Step4: Set L=I_{pro}
Step5: Compute standard deviation of I_{pro} using formula above. Let it S_d.
Step6: Using this S_d perform intensity map as follows.
[m , n]= size[L] // *size of image is calculated*

For i=1 to m

For j=1 to n
If L(i,j) >S_d Then

setL(i,j)=255

Else
setL(i,j)=0

End If

End For

End For
Step7: Recompute the standard deviation of image L. Let it S_{dnew}.
Step8: Compute average intensity of the pixels those are above the S_{dnew} as follows.
Set count ← 0
Set I_{sum} ← 0
For i=1 to m

For j=1 to n
If I(i,j) >S_{dnew} Then

set count =count +1*// pixel count.*
End If
End For

End For

Step9: Average intensity, $I_{average}$ =I_{sum}/count. // *average intensity calculation.* Step10: Take this average intensity as Threshold value to find tumor section.

For i=1 to m

For j=1 to n

If I(i,j) >$I_{average}$ Then set I(i,j)=255

Else
setI(i,j)=0;

End If
End For

End For

Step11: Label the connected components of image I with 8 connected neighbourhoods. Let it be I_{label}. Step12: Measure properties of image regions of labelled image I_{label} and compute number of pixels inregions.

Step13: Remove the components from Labelled image I_{label} is not a member and having pixels less than some predefined value. Let the processed image is H.

Step14: Create „Sobel" horizontal edge emphasizing filter (2-D filter) predefined as a correlation kernel.

Step15: Compute the gradient magnitude of image H as follows. Gradient magnitude=$\sqrt{I_x^2 + I_y^2}$

Where I_x is obtained by filtering the image H by „Sobel" filter created in Step14. I_y is obtained by filtering image H by transpose of „Sobel" filter created in step14.

Step16: The step 13 gives the Tumor region and Step15 gives the border of Tumor region.

RESULTS

The proposed algorithm is used to detect the location or position the abnormal regions, centroid of the abnormal regions, and border of the abnormal regions and the perimeter of the detected abnormal regions. The output of the segmented abnormal regions and border of the Abnormal regions are plays a vital role in the diagnosis and treatment planning of brain abnormal regions. The proposed method gives very reasonable results for different kind of MRI images.

Conclusion

The proposed algorithm shows an effective method for segmentation of the brain tumors from the 2 dimensional MRI images. We have proposed to detect presence of brain tumor based on thresholding technique. The segmentation of the brain is also being done while detecting the presence of the tumor. We also find the centroid of the tumor and perimeter of the tumor. In this paper we have developed an automatic image based method to detect tumors in 2-D MRI head scans. Experimental results on 30 data sets show that the proposed method performed Automatic Detection of Brain Tumor from MRI Scans. Future research scope in segmentation of medical MRI image will lead towards improving the accuracy, minimizing the computational procedure also minimize the manual interaction.

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