

Analysis of Degenerated Tissue in Temporal Lobe of Human Brain using image segmentation Techniques

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Abstract—Degenerated Tissue in temporal lobe may cause diminished speech and memory difficulty. The principal of our Research work is automatic detection of degenerated tissues due to any disease in the temporal lobe. Fully automatic based Histogram Thresholding Segmentation technique is applied for detection of the tissue from particular Magnetic Resonance Imaging (MRI) Scan of brain images. After that, This research paper propose the use of most powerful classifier techniques such as support vector machine that separate tissues into two classes specifically normal and abnormal tissue. Then we evaluate the volume of the tissue to identify its size.

All proposed techniques will be implemented on MR image of temporal lobe using MATLAB 7.9.0(R2009b) platform.

Keywords- Temporal lobe; Histogram; Thresholding; MRI; Classification.

I. INTRODUCTION

Medical image processing and analysis is one of the blessings of technique and science to detect degenerated tissue. The main advantage of medical imaging is to make diagnosis as possible as noninvasive way in the treatment planning and clinically diagnosis. There are various types of medical imaging technologies based on noninvasive approach like Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and X-Ray etc. MRI is best suitable high quality medical imaging technology rather than others to collect perfect internal information of the body organ for clinical diagnosis.

Many disorders of brain exist these days. Degenerated tissue is one of them that is spreading at an alarming rate.

Brain is control center by receiving, interpreting, and directing sensory information throughout the body. Temporal lobe is one of the four lobes that located just above ears that control auditory and visual memories, language, some hearing and speech, language, and some behavior. Any pathological change or abnormal growth in the tissue is called degenerated tissue. Any disorder in temporal lobe may cause diminished speech and memory difficulty. The field of medical science is enduring tremendous improvement in the past decade. Early and accurate detection of degenerated tissue is a most problematic and vital task due to complex and intricate structure of brain in the advance medical image analysis.

We propose a system to detect degenerated tissue due to any disease in the temporal lobe. For this reason, fully automatic based histogram Thresholding techniques[1] are used. Fully automatic segmentation reduces the overhead of physician from the burden of manual segmentation. After that, tissue is classified under two categories either Normal or Abnormal (Degenerated) Tissue. This work has been done using Support Vector Machine[5] that is semiautomatic brain tissue classification technique. Then abnormal tissue's image is further investigated for extracting useful information from segmented image with the presence of some noises. Then volumetric calculations are carried out on extracted degenerated tissue to identify its size.

This paper is organized into four sections. Section1 gives the general information of our research work. Section2 describe the methodology of proposed system. section3 illustrated the results of simulation of methodology. Section4 concluded our research work with fulfilling the goal of this paper.

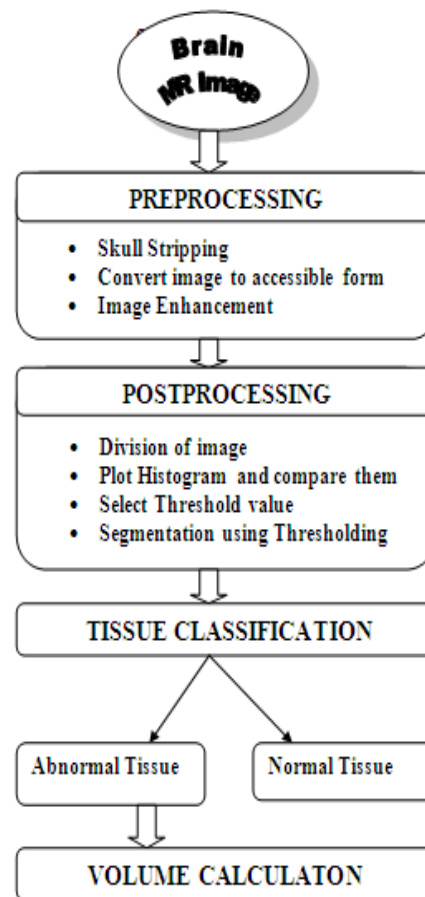
II. METHODOLOGY

T1 Axial weighted contrast images Using 1.5T MRI Scanner are acquired. The identification of normal and abnormal tissue of the brain image is referred at the symmetry that it is demonstrates in the axial and coronal images. Asymmetry in an axial MR brain image strongly indicates abnormality. Structurally, brain is divided into two hemispheres explicitly left and right hemisphere. According to neuroscience perspective, these hemispheres are symmetrical in terms of shape and structure.[2]

Our proposed system is partitioned into five phases specifically preprocessing, post processing, classification, feature extraction, volume calculation. The architecture of methodology is illustrated in figure 2.



Figure (1) symmetrical structure of Brain



Figure(2) flow chart of methodology

A. Data Acquisition

The normal and temporal lobe affected 20 patients brain MR images are acquired on a 1.5T using T1, T2-weighted axial contrast images. The other specifications of image are thickness of image slice-0.5 cm, and image format- JPEG or GIF.

B. Preprocessing

The image of brain acquired through MRI is imported using command '**imread ()**' in MATLAB. Then image is converted into accessible form. After converting accessible form, non brain regions are removed, is called skull stripping.[9] It is an essential step in preprocessing which has been done with the help of command '**imopen ()**' morphological operator. Then increasing contrast of the image using command '**histeq ()**'.Histogram equalization[8] is contrast enhancement technique that stretch out intensity value along total range of values. Here we are concerned only with temporal lobe of brain, so image is cropped as lower half part of brain.

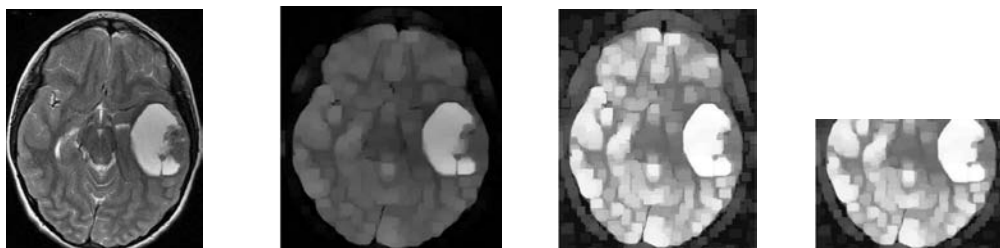


Figure 3: (a) Original Image (b) Skull Stripped Image (c) Enhanced contrast Image (d) Cropped Image

C. Postprocessing

1. Division of image

After applying preprocessing, both hemisphere of brain is separated along its central axis shown in figure 4(a). The following algorithm is applied to achieve this task[8]:

- Number of rows and columns is stored as variable A and B using command 'size ()'.
- Number of columns is divided by 2 and assigned into some other variable C.
- Image will be half of input image using command 'imcrop ()' with range [0 0 C A].
- For other half of the image, range is considered as [C 0 B A].

2. Plot histogram and compare them

Histogram is graph representation between scale of pixels and pixel intensity of the image. Where horizontal axis depicts the scale of pixel intensity present in image and vertical axis shows the pixel intensity. After plotting histogram of both side of brain using 'imhist ()' are shown in Fig.4 (a), compare them by performing difference operation on these histograms is shown in Fig4 (b). Finally this is detection of degenerated tissue in temporal lobe. In Fig.4 (b) it is apparent that histogram of right hemisphere has more deviation around 250 as compared to left hemisphere. Thus it shows the occurrence of degenerated tissue on this side.[8]

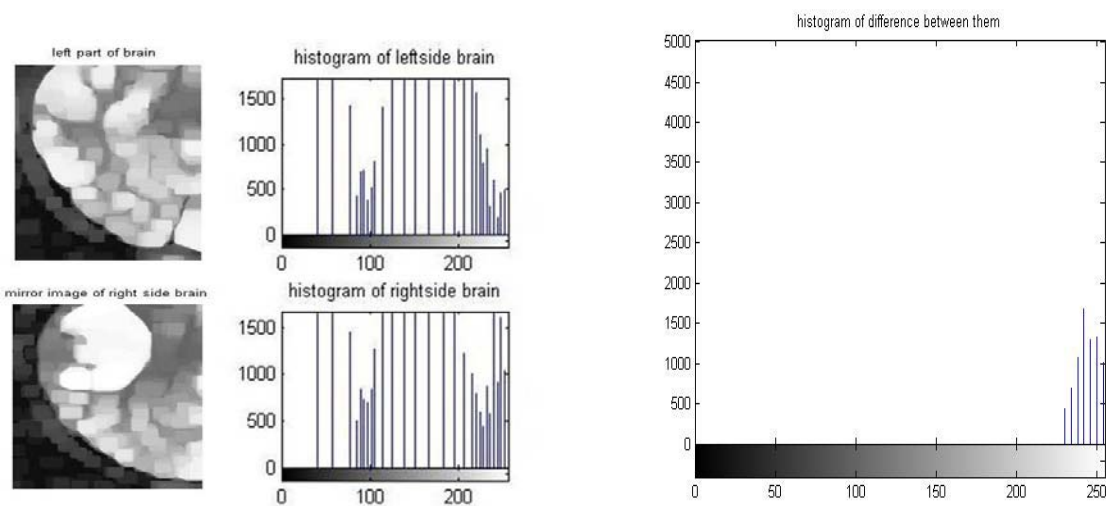


Figure 4: (a) Division of image with histograms

(b) Difference between two histograms

3. Select threshold value

To select peak value of histogram from difference between both sides of brain, is considered as threshold value for initial segmentation.

4. Initial segmentation using threshold value

Global Thresholding method is simple and effective technique that is most recurrently used for segmentation. Threshold segmentation is technique of converting gray scale image into binary image. To accomplish this task by following algorithm:

- A zero matrix of same size of input image is declared as Z.
- For comparing each pixel value of input image matrix with threshold value using „for loop’ by from 1:1: A as outer loop and column from 1:1: B as inner loop.
- If the pixel value is greater than threshold value, value of Z matrix is stored as 0(black) otherwise 255(white).[4]

$$Z(i, j) = 0 \text{ if } Y(i, j) < T$$

$$Z(i, j) = 1 \text{ if } Y(i, j) \geq T$$

Where Z(i,j) is segmented binary image, Y(i, j) is input image and T is threshold value based on this image segmentation is to be done.

- Matrix Z is show using command 'imshow'.

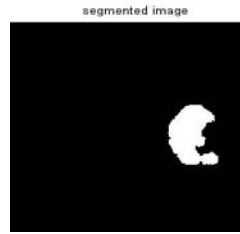


Figure 5 : Segmented Image

D. Tissue classification

Support Vector Machine (SVM) has been used for tissue classification into two classes namely Normal and Abnormal tissue. It is based on Concept of hyper plane that describe decision boundaries. The main purpose of SVM is transformation of input space into higher dimension space in such a way where hyper plane separates with maximal distance from the nearest training data[5].

In case of Linear separable data, Training data can be described by

$$W^T X + b \geq 0 \text{ for } Y_i = +1 \quad (1)$$

$$W^T X + b < 0 \text{ for } Y_i = -1 \quad (2)$$

Training data sets can identified into two classes +1 and -1 represents normal and abnormal tissue respectively by hyper plane

$$F(x) = W^T X + b = 0. \quad (3)$$

Where w is weight vector and b is a constant.

Mathematically, maximal margin hyper plane can be found by following constraint:

$$\text{Minimize } 1/2 \|w\|^2 \text{ such that } Y_i(W^T X + b) - 1 \geq 0 \quad \forall i \quad (4)$$

This is a non linear optimal separable data with single global minimum; the optimal hyper plane is to maximize the following objective function,

$$\sum_{i=1}^l a_i - 1/2 \sum_{j=1}^l Y_i Y_j a_i a_j K(X_j X_j) \quad (5)$$

$$\text{Subject to } \sum_{i=1}^l a_i Y_i = 0 \text{ and } a_i \geq 0 \quad (6)$$

This is karush-kuhn-Tucker (KKT) theorem by discovered Lagrange multipliers. And the solution of w is

$$w = \sum_{i=1}^l a_i X_i Y_i \quad (7)$$

MATLAB Optimization toolbox has been used for solving this optimization problem.

- 1) *Performance Measurement*: performance of the classifiers for analysis is measured by error rate. and this error rate can be defined in terms of confusion matrix as follows[6]:

TABLE I. CONFUSION MATRIX

Actual Output	Expected Output	
	Normal	Abnormal
Normal	TN	FP
Abnormal	FN	TP

True Positive (TP): abnormal cases are correctly classified.

True Negative (TN): normal cases are correctly classified.

False Positive (FP): abnormal cases are incorrectly classified.

False Negative (FN): normal cases are incorrectly classified.

Sensitivity, Specificity, Accuracy can be defined with help of confusion matrix as follows:

Sensitivity: is the measurement that a diagnostic test is positive (abnormal) when patient has degenerated tissue.

$$\text{Sensitivity} = \frac{TP}{TP + FN}$$

Specificity: is the measurement that a diagnostic test is negative (normal) when patient does not have degenerated tissue.

$$\text{Specificity} = \frac{TN}{TN + FP}$$

Accuracy: is the measurement that a diagnostic test is correctly classified.

$$Accuracy = \frac{TP+TN}{TP+TN+FP+FN}$$

In this paper, we considered 20 patients data in which 10 patients are suffering from disease of temporal lobe. and remaining are normal patients. Table II shows the classification rate of optimization toolbox.

TABLE II. CLASSIFICATION RATE OF THE CLASSIFIER

	Normal	Abnormal	Specificity	Sensitivity	Accuracy
Normal	9	0	90.09%	100.00%	95%
Abnormal	1	10			

E. Volume Calculation

Volume can be calculated by multiplying area by the thickness of image slice. we have defined the thickness of image slice in 1.5T MRI is 0.5cm.[7]and area can be calculated using ImageJ software by free hand area selection operator which is based on irregular polygon .

$$\text{Area} = h * w$$

Where h is the average height of each sides of irregular polygon and w is the total sum of difference between X coordinates of each side of the polygon. So,

$$\text{Volume of degenerated tissue} = \text{Area} * 0.5$$

TABLE III. VOLUME OF THE DEGENERATED TISSUES OF TEMPORAL LOBE

Input Data	Total Area in cm2	Total volume in cm3
Data set-1	0.025	0.0125
Data set-2	0.018	0.009
Dataset-3	0.016	0.008
Dataset-4	0.018	0.009
Dataset-5	0.031	0.0155
DataSet-6	0.14	0.07
DataSet-7	0.21	0.105
DataSet-8	0.147	0.0735
DataSet-9	0.27	0.135
DataSet-10	0.257	0.1285

III. RESULT

20 patients data used in this study were collected on two different clinical 1.5T MRI Scanner. 10 patients are suffering from disease of temporal lobe, and remaining are normal patients. in this paper ,we are considered that patient, is having disease in right temporal lobe of the brain. Results are obtained after implementation as illustrated in previous section. Here we summarize the result in form of table as following:

TABLE IV. SUMMARY OF PATIENT INFORMATION

Identical both hemisphere's histogram	No
Degenerated tissue	Present
Affected side of brain	Right
Area of the tissue using IMAGEJ software	0.025cm2
Volume of the tissue	0.0125cm3

A. Performance Analysis:

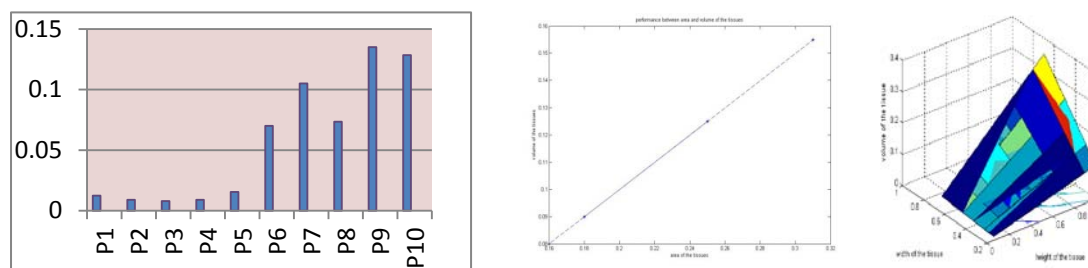


Figure 7: (a) Dataset vs volume of the tissue (b) Area vs Volume of the tissue (c) Graph among Height,width and volume of the tissue.

IV. ACKNOWLEDGMENT

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