Brain Tumor Detection Using Modified Histogram Thresholding-Quadrant Approach

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Abstract - **In medical image processing brain tumor detection is one of the challenging task, since brain images are complicated and tumors can be analyzed only by expert physicians. So In this paper brain tumor is detected at various levels. First the pre-processing is done by median filter in order to reduce noise and then edge detection is done by using canny filter, then Segmentation is done by means of histogram clustering in which the tumor affected image is divided into quadrants and threshold value is set , based on this value tumor is detected. Secondly the other technique involved is superimposing of the tumor affected with the healthy image. This method does not require any initialization while the others require an initialization inside the tumor. The third method in which, the histogram is calculated and the threshold is fixed. This work is carried in MRI image. The experimental results illustrate the usefulness of the new method.**

Index Terms - Grey Scale Images, Edge Detection, Image Segmentation, Thresholding

I. INTRODUCTION

Our human system is made up of many organs, of all this brain is the first and the foremost controller of the human system. Excess cells growing in an uncontrolled manner in brain is called as brain tumor. In this paper this tumor part is identified by various levels. First the input taken is tumor affected MRI image. Then it is pre-processed by using median filter. Since the reason to choose median filter is it completely removes the noise and makes image very clear, whereas the Gaussian and linear filter does not. The results are displayed in the section 2.2. After this the edge of the image is detected using canny filter. Since the canny filter itself performs the functioning of Gaussian filter which is responsible for smoothening of the image, whereas other filters does not. The next step is the most important which segmentation is the tumor image is divided into four quadrants and in each quadrant the pixel values are taken. Histograms clustering in which grouping of similar values of pixels are done and threshold value is set and is compared with the healthy brain image. Next technique in which the

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tumor affected image is superimposed on the healthy brain image. This will clearly detect the tumor. Then color watershed is used to get the tumor part. Watershed is fully based on intensity and is a powerful tool in tumor segmentation. For segmentation and all the above said process is done with the help of software tool MATLAB. The theoretical explanation of all the above process is given in section 2.1 and the practical results is shown in section 2.2.

II. METHODOLOGY

2.1 THEORETICAL

A conceptually block based approach is used to analyze MRI brain images. In this approach tumor in the brain is detected. The process involved in our methodology is given below,
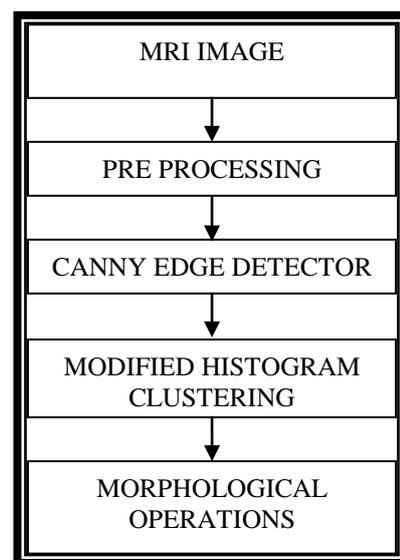

Figure 2.1 Block diagram

It involves pre-processing, edge detection, segmentation by histogram thresholding, Morphological processing. This gives clear view of the tumor. Input image given is MRI and is of size 512x512 is taken and processed.

2.1.1 PREPROCESSING

The pre-processing is used to read the input image into the MATLAB and also to remove the noise present in the image. In this method noise is removed by using median filter. Since it reduces the variance of the intensities in the image and also it is used to preserve edge shapes and the location of the edges. The steps involved in median filter is 1.input the values in decimal numbers2.convert them into binary numbers 3.find the median of all MSBs4.find the median of all LSBs5.continue the procedure of finding the median value till all the values get over 6.write it in the

form starting from MSB to LSB this gives the final median value.

2.1.2 EDGE DETECTION

Edge detection is used to determine the boundaries of the object. This gives the similarity present in the image. In this method to detect the edge canny filter is used. Five steps is followed in canny filter.1.Filters out noise in original image before trying to locate and detect any edges 2.Smoothing the image 3.Finding the edge direction 4.Relate the edge detection to a direction that can be traced in an image 5.After edge directions are known, non maximum suppression has to be applied. Since it uses the Gaussian filter it smoothes the image to good quality. The two main purpose of using canny filter is

1. Control the amount of detail which appears in the edge image.
2. Suppress noise.

2.1.3 MODIFIED HISTOGRAM CLUSTERING

Histogram is one of the powerful techniques in image enhancement. The histogram of an image represents the relative frequency of occurrence of the various gray levels in the image. This is useful in stretching low-contrast levels of images with narrow histograms. Clustering in which similar neighbored bins are grouped together and finally thresholding is set in order to detect the tumor. Thresholding value setting involves three methods; *First method* in which the original healthy brain image pixel values are subtracted from the tumor affected brain image, quadrants wise (i.e.). Image is divided into four quadrants and each quadrant is analyzed individually pixel wise with the original image. It is analyzed in a rectangular approach. *Second method* in which the tumor affected image is superimposed on the original image and the tumor is analyzed. *Third method* in this histogram values are plotted which gives a better output than the above said two methods. In this paper threshold value is fixed based on the gray level values and pixels in the image. First the image in which the values varies between 0 to255. The white has the maximum value of 255 and the black has the value zero. So keeping 128 as threshold value the tumor image is processed. Then the values are changed from 128 to132. Of these 129 produces clear detection of tumor. It is tested for various data sets and the results are displayed in section 3.1. Beyond 132 tumor is not detected clearly also some portion gets diminished. So we finally set 129 as threshold. Then the tumor part is extracted by taking the region of interest (ROI). The threshold image g(x,y) is given as,

$$g(x,y) = \begin{cases} 1 & for\ f(x,y) > T \\ 0 & for\ f(x,y) \leq T \end{cases}$$

1. An initial threshold (T) is chosen; this can be done randomly or according to any other method desired.
2. The image is segmented into object and background pixels as described above, creating two sets:
G1 = {f (m,n):f(m,n)>T} (object pixels)
G2 = {f (m,n):f(m,n)T} (background pixels) (note, f(m,n) is the value of the pixel located in the mth column, nth row)

3. The average of each set is computed.
m1 = average value of G1
m2 = average value of G2
4. A new threshold is created that is the average of m1 and m2
T' = (m1 + m2)/2
5. Go back to step two, now using the new threshold computed in step four, keep repeating until the new threshold matches the one before it.

2.1.4 MORPHOLOGICAL OPERATORS

Morphological operation involves dilation and erosion. Dilation combines two sets using vector addition. The image D= I⊕S is the dilation of image I by structuring element S. E.g. (a, b) +(c, d) = (a+c, b+d) Erosion combines two sets using vector subtraction and is the dual operator of dilation. Both are not invertible transforms. The image E=IΘS is the erosion of image I by structuring element S. E.g. (a, b)-(c, d) = (a-c, b-d). Erosion followed by opening and dilation followed by closing.
Opening involves
　　X¤B= (XΘB) ⊕ B
Closing involves
　　X•B= (X⊕B) Θ B levels on the established route.
Both opening and closing, like dilation and erosion, are dual transforms:
　　$(X•B)^C = X^C¤B$
　　X¤B=(X¤B) ¤B
　　X•B=(X•B) • B
In this tumor is identified by the above process and also it is proceeded to colour watershed management so that the tumor part is viewed clearly.

2.2 PRACTICAL

The analysis is implemented on a INTEL i3 processor with 4 GB RAM. The support analysis software is MATLAB. In order to evaluate the performance of our algorithm, many experiments were conducted on MRI image.
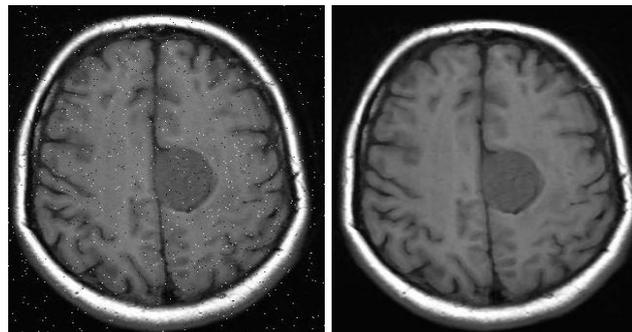
2.2.1 PREPROCESSING

Figure 2.2.1(a) Input image　　Figure 2.2.1(b) Pre-processed image-median filter

In this median filter is used. Before applying median filter it is tested with Gaussian and other linear filters. Among these filters median filter is the one which reduces noise makes the output image similar to that of input image.
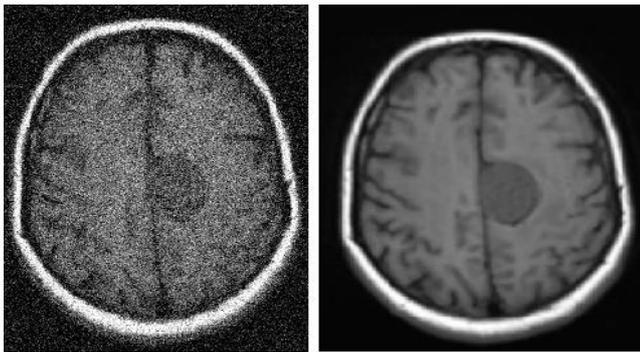
Figure 2.2.1(c) Gaussian filter   Figure 2.2.1(d) Linear filter

2.2.2 EDGE DETECTION

Figure 2.2.2(a) Canny edge detector

2.2.3 MODIFIED HISTOGRAM CLUSTERING – FIRST METHOD

In this threshold is fixed by taking the difference between healthy and tumor affected image.
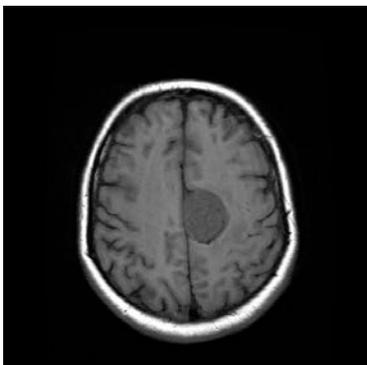

Figure 2.2.3(a) Healthy brain

Figure 2.2.3(b) Tumor image

ROWS	COLUMNS		
157	209	216	255
389	206	220	337
388	353		
153	355	334	338
		339	258

Figure 2.2.3(c) Original image pixel values   Figure 2.2.3(d) Tumor pixel values
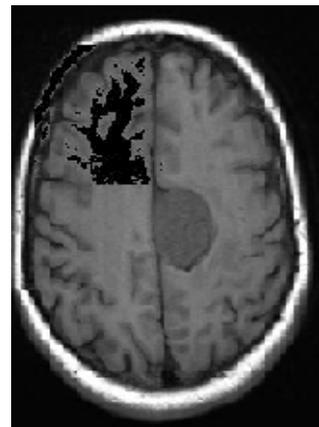
Figure 2.2.3(e) First quadrant   Figure 2.2.3(f) Third quadrant
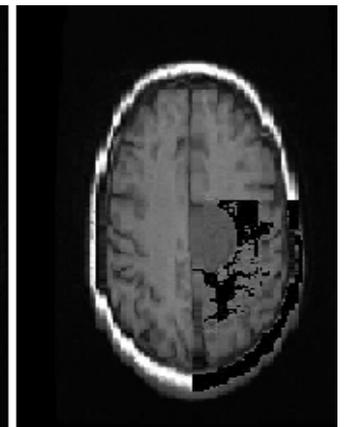
Finally, pixel values are analysed between healthy and tumor affected image and threshold value is fixed. The result is as follows
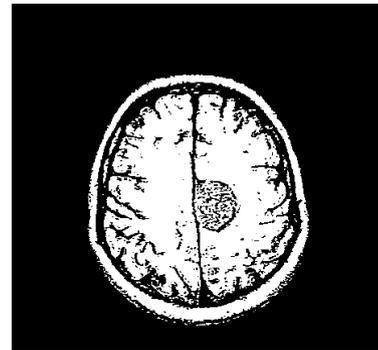
Figure 2.2.3(g) Threshold output

2.2.3.1 MODIFIED HISTOGRAM CLUSTERING – SECOND METHOD
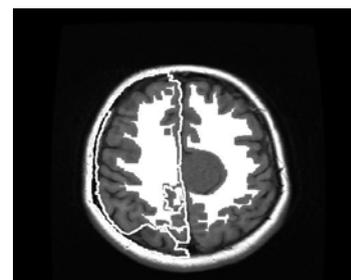
Figure 2.2.3.1(a) superimposed result

2.2.3.2 MODIFIED HISTOGRAM CLUSTERING – THIRD METHOD

Threshold value is set by taking mid of gray level because in the tumor affected image, tumor is shown as white spot. Below shown are for the threshold value 129 for various images.
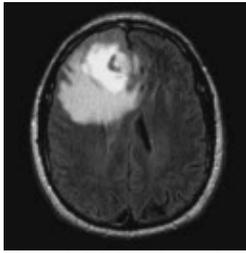

Figure 2.2.3.2(a) Tumor image1

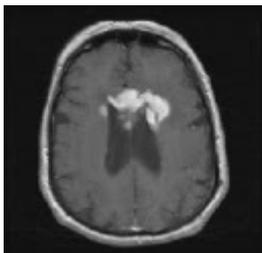Figure 2.2.3.2(b) Threshold image1

Figure 2.2.3.2(c) Tumor image2
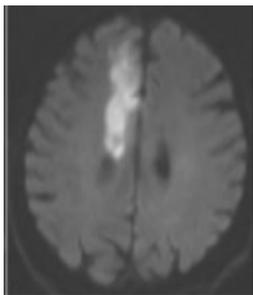

Figure 2.2.3.2(d) Threshold image2

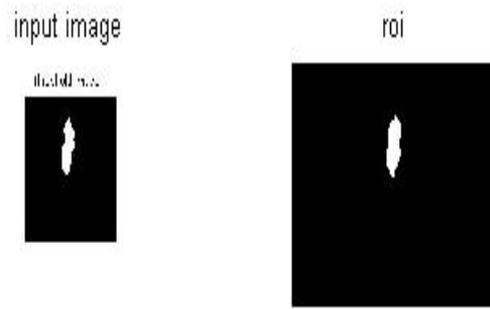Figure 2.2.3.2(e) Tumor image3

Figure 2.2.3.2(f) Threshold image3

Threshold results for various images

Figure 2.2.3.2(g) Threshold -128

Figure 2.2.3.2(h) Threshold-129

Figure 2.2.3.2(i) ROI for Threshold -129

2.2.4 MORPHOLOGICAL OPERATION

In this opening and closing and reconstruction of the image is done. The results are as follows:
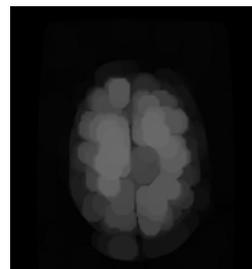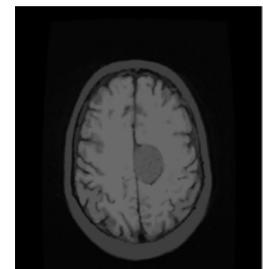

Figure 2.2.4(a) Opening

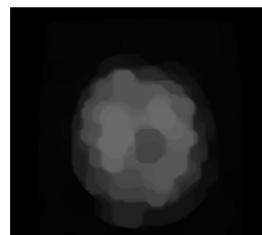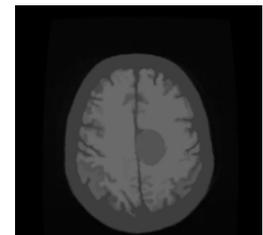
Figure 2.2.4(b) Opening by reconstruction

Figure 2.2.4(a) Closing
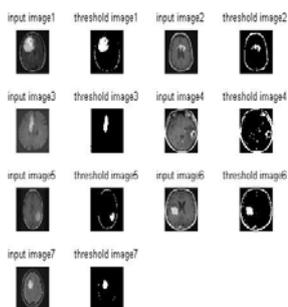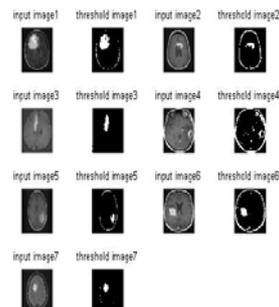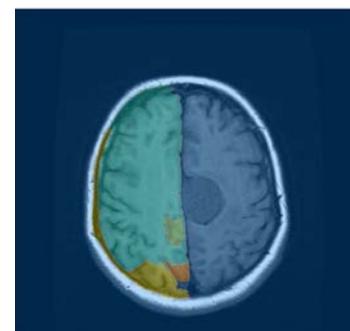

Figure 2.2.4(b) Closing by reconstruction

Figure 2.2.4(e) color watershed segmentation

III. CONCLUSION

The results show that the segmentation by histogram clustering by setting threshold value combined with colored watershed management produce clear results in detection of tumor. This method of segmentation is useful in medical image processing.

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