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Brain Tumor Detection by Image Processing Using MATLAB

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Abstract: Tumor detection and removal is one medical issue that still remains challenging in the field of biomedicine. Early imaging techniques such as pneumoencephalography and cerebral angiography had the drawback of being invasive and hence the CT and MRI imaging techniques help the surgeons in providing a better vision. In this paper, tumor image processing involves three stages namely pre-processing, segmentation and morphological operation. After the acquisition of the source image, it is pre-processed by converting the original image to gray scale in addition high pass filter for noise removal and median filter for quality enhancement is provided which is followed by enhancement stage resulting with historgramic equivalent image. Finally segmentation is done by means of watershed algorithm. The above proposed methodology is helpful in generating the reports automatically in less span of time and advancement has resulted in extracting many inferior parameters of the tumor.

Key words: MRI · CT · MATLAB

INTRODUCTION

Tumor is defined as the abnormal growth of cells. Brain tumor is an abnormal mass of tissue in which cells grow and multiply uncontrollably [1], seemingly unchecked by the mechanisms that control normal cells. The symptoms of brain tumor depend on the tumor size, type and location. Some common symptoms of brain tumor are-Headaches. Nausea and [2]. Vomiting. Changes in speech, vision or hearing. Problems in walking. Seizures or convulsions. Changes in mood, personality or ability to concentrate and problems with memory. A brain tumor is a primary or secondary type depending on its location of origin.

Benign: Benign tumors are non-cancerous mass of cells that grows slowly in the brain. It usually stays in one place and does not spread. Most of the benign brain tumors are detected by CT and MRI scans.

Malignant: A malignant brain tumor is a rapidly growing cancer that spreads to other areas of the brain and spine. Most of the malignant brain tumors are secondary [3] but can be primary too. These tumors are life threatening Image processing methods- The following any one method can used to capture the image of the tumor in brain Computed Tomography (CT) scan. Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) scans, Diffusion Tensor Imaging (DT).

Methodology: MRI/CT images of the brain are processed for the detection of tumor using MATLAB. The block diagram in Figure 1 shows the overall processing technique. The Methodologies employed here are [4].

Algorithm Used for Detection for Tumor:

Step 1: Input the image

Step 2: Convert the RGB image to grey

Step 3: Use the filters for removing noise and perform subtraction operation and form histogramic equivalent for Contrast enhancement.

Step 4: Apply Watershed Segmentation for tumor detection

Step 5: Perform morphological operations for calculating Area, Third moment, Entropy, Mean, Standard Deviation.

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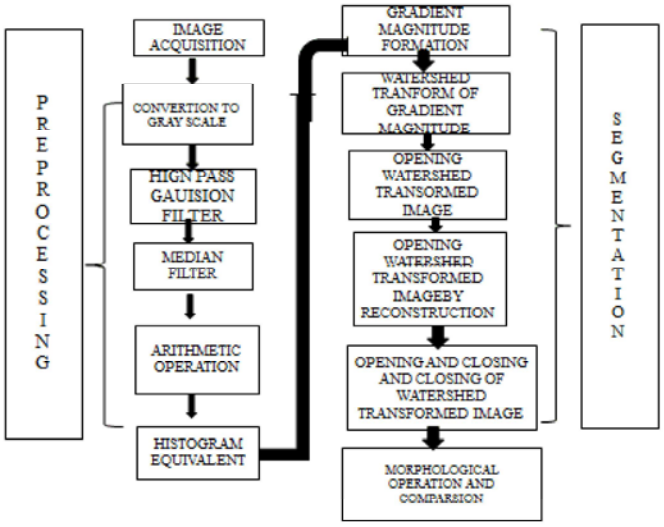

Fig. 1: Block Diagram

Step 6: Tabulate and Compare the parameters calculated for normal and abnormal images.

MATERIALS AND METHODS

The source images were obtained from Stanley Medical College under the guidance of Dr. Valarmathi that includes one normal image of one normal CT and MRI and also one Abnormal CT and MRI.

Schematic of the Study

Pre-processing: Image pre-processing aims to improve the image data by suppressing the undesired distortions and enhances some of the image features that will be helpful in further processing. The goal of Pre-processing is to remove the noise and to provide Contrast Enhancement [5] to improve the image quality. The Figure 2 shows the block diagram for Pre processing. The functions performed by preprocessing process is

- Gray scale conversion
- Noise removal
- Contrast Enhancement

Conversion to Gray Scale: A grayscale image only consists of gray scale values, but MRI images consist of primary colors (RGB) content. A 'Gray' [6]color is one in which the red, green and blue components all have equal intensity in RGB space and so it is only necessary to specify a single intensity value for each pixel, as opposed to the three intensity values needed to be specified for each pixel in a full color image. When MRI/CT images are viewed, they look like black and white but they contain

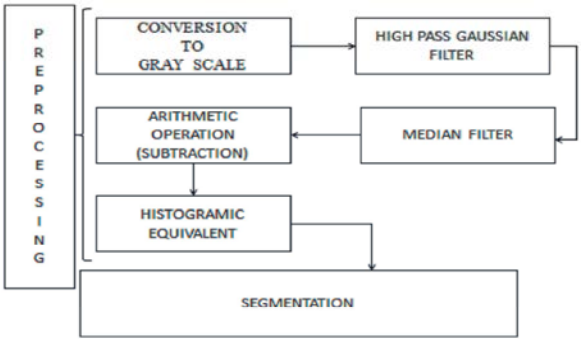

Fig 2: Block-Diagram for Preprocessing

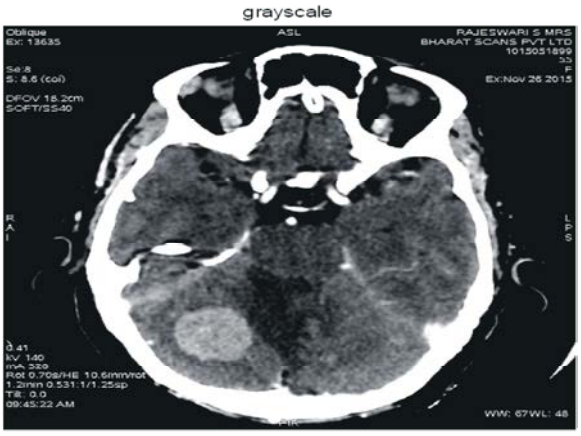

Fig. 3: After applying gray scale

some primary [7] colors (RGB). So, for further processing of MRI/CT brain image, it must be converted to perfect grayscale image. Figure 3 shows the conversion of gray scale image.

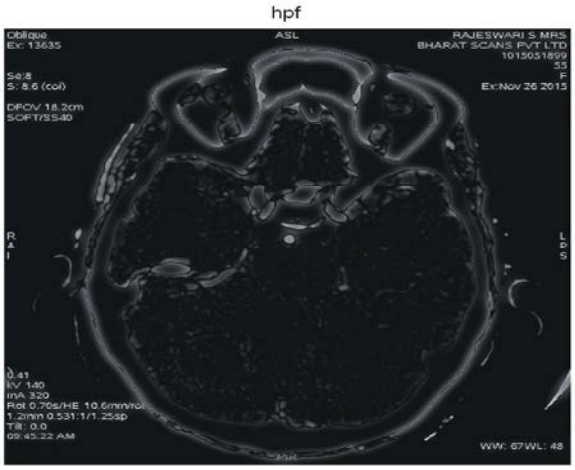

Fig. 4: After applying Gaussian HP filter

Fig. 5: After applying median filter

Filtering: Filtering is a technique used for eliminating the noise present in an image. The median filter that provides median values of the pixels are used because the mean values obtained using averaging filters results in blurring of the image. In MRI, Gaussian and salt and pepper noise are more predominant. Salt and Pepper noise can be eliminated by median filter, whereas Gaussian noise is eliminated by a Gaussian high pass filter.

Gaussian High Pass Filter: It is done to sharpen the image. A high pass filter preserves the high frequency information within an image while reducing the low frequency information, thus emphasizing the transitions in the image intensities. In high pass filtering, the brightness of the centre pixel is increased relative to its neighboring pixels [8]by the kernel of the filter. The kernel array consists of a single positive value at its centre, which is completely surrounded by negative values. Figure 4 shows the after applied Gaussian HP filter image.

Median Filter: The median filter is used to reduce the salt and pepper noise present due to motion artifacts (movement of patient during scan) in the CT/MRI images. It is done for smoothening of CT/ MRI brain image. Here we are using 25x25(CT) and 15x15 (MRI) median filter to eliminate salt and pepper noise. Figure 5 shows the after applied median filter.

Fig. 6: Conversion to double

Fig. 7: Subtracted image

Image Enhancing by Subtraction: Image enhancement provides the details that are obscured and highlight certain features in an image. The fundamental enhancement needed in the CT/MRI images is the contrast enhancement. In this paper we perform subtraction operation and histogramic equivalent formation for enhancing the contrast of CT/MRI brain image. Subtraction operation is performed on a pixel by pixel basis sequentially, one pixel at a time, or in parallel, where all operations are performed simultaneously. Figure 6 and 7 shows after performed enhancement image.

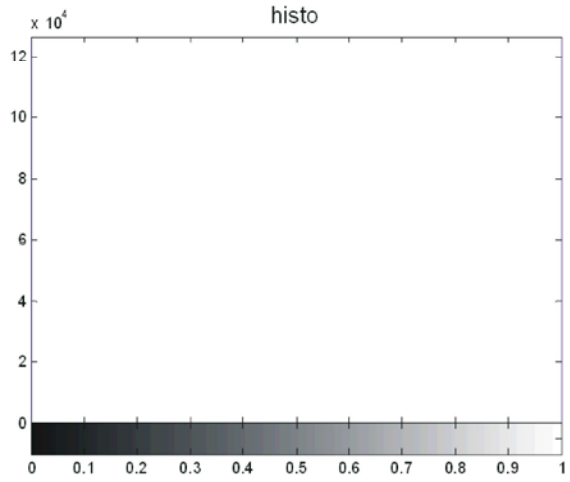

Fig. 8: Histogram plot for subtracted image

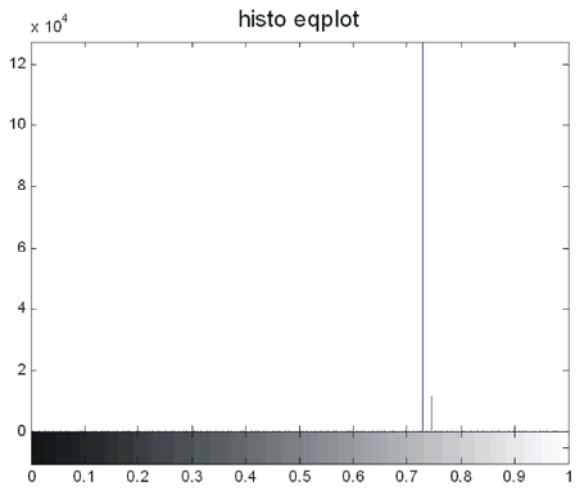

Fig. 10: Histogram equivalent plot for subtracted image (Histogram equivalent plot)

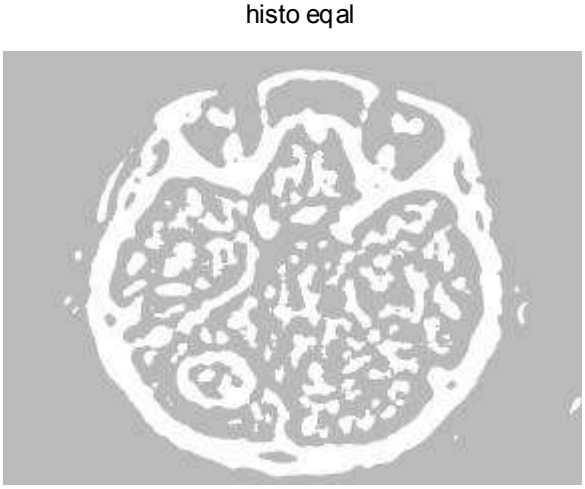

Fig. 9: Histogram equivalent

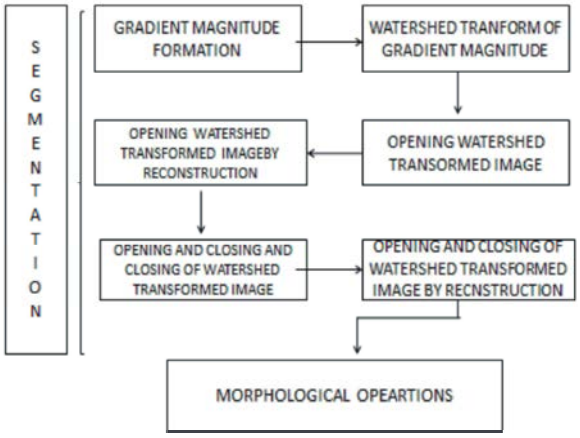

Fig. 11: Block-diagram for segmentation

Forming Histogramic Equivalent: A histogram is a way to graphically represent the distribution of data in a data set and Histogram equalization is a technique for adjusting image intensities to enhance contrast of an image by determining the pixel values. Better contrast is obtained via the histogram of the image, then using histogram equalization that allows the areas with low contrast to gain higher contrast by spreading out the most frequent intensity values from this data one can manipulate an image to meet the required specifications. In order to create a histogram from an image, the mist function is used. Contrast enhancement can be performed by the haste function. At first the gray scale image is taken and its histogram plot is developed as in Figure 8 then by using haste a histogram equivalent for that image is produced as in Figure 9 and its respective plot is shown in Figure 10.

Watershed Segmentation: Image segmentation is stated as the process of assigning a label to every pixel in an image such that Pixels with same label share certain identical visual characteristics. With respect to our paper we are using watershed segmentation. The block diagram of watershed segmentation as shown in Figure 11.

Gradient Magnitude Formation: Gradient is termed to be an increase or decrease in the property of an object. By means of using the Sobel edge masks, imfilter and some simple arithmetic the gradient magnitude is formed. The gradient is high at the borders of the objects and low (mostly) inside the objects.

Watershed Transform: The term watershed refers to a ridge that divides areas based on different pixel intensities followed by converting into RGB image with unique labeling based on intensity values as shown in Figure 13.

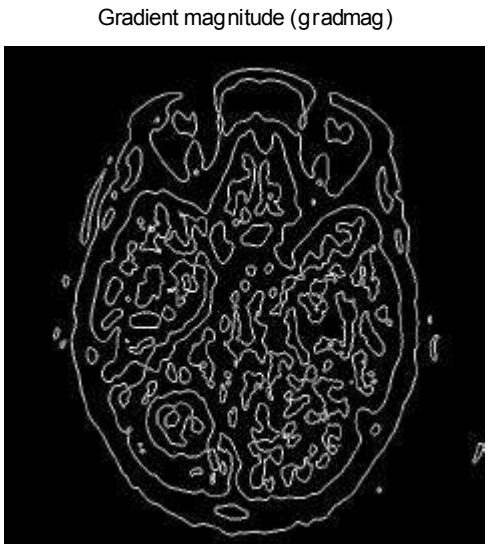

Fig. 12: Gradient magnitude

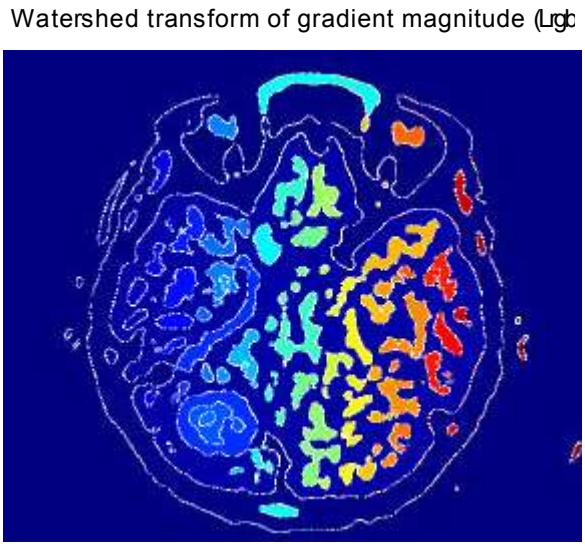

Fig. 13: Watershed Transform

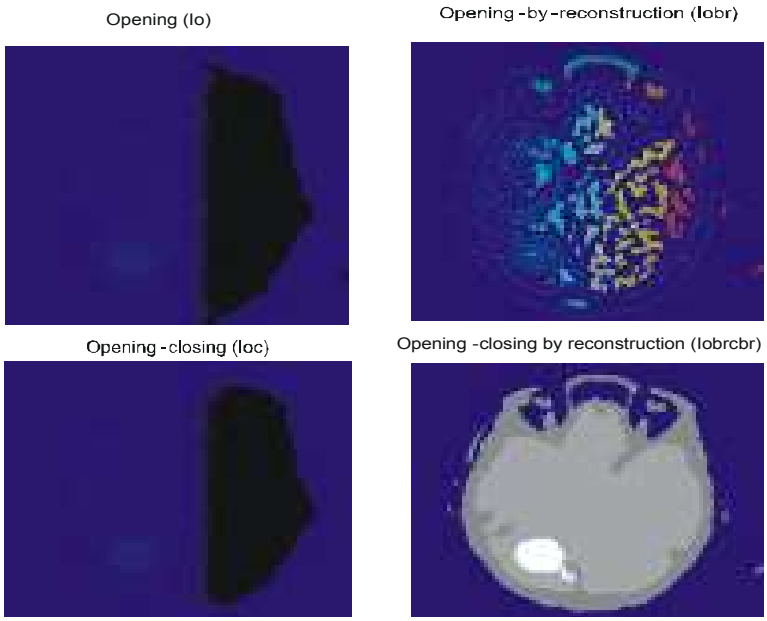

Fig. 14: A- opening, B-open- by-reconstruction, C- opening-closing, D- closing-by-reconstruction.

Marking the Foreground Object: A variety of procedures such as "opening-by-reconstruction" and "closing-by-reconstruction" to "clean" up the image and finally "opening-closing by reconstruction" are performed The above mentioned functions are performed, and that is show in Figure 14 A.

Morphological Operation: Various texture based parameters such as entropy, third moment and intensity based parameters such as mean, standard deviation and finally shape based parameter area of these CT/MR images are extracted and used for further analysis. The parameters are calculated for the segmented images with tumor and without tumor using inbuilt MATLAB functions. The parameters used for this purpose and their importance are as follows,

- Area (A): Calculating the area of a black and white image gives the number of on pixels in the image. If a MR image shows the presence of a tumor it shows it as a white mass.

- Mean (M): The mean of a region gives the average intensity of the pixels in that region.
- Third Moment (ì3): Skewness is a measure of the asymmetry of the data around the sample mean. The Skewness is measured from the histogram plot of the image
- Entropy (e): Entropy is a statistical measure of randomness that relates the appearance or continuity of an object in the input image.
- Standard Deviation (ó): It is a measure of average contrast of the image. Finally the Parameters extracted from the normal CT/MRI and CT/MRI with tumor is tabulated. The results from the tabulation give us the hope to identify the MR image with tumor.

COMPARISON

Finally the calculated parameters values of abnormal CT and MRI image is compared with the normal CT and MRI image and tabulated the results.

Table 1: Morphological Operation Comparison Ct Image

	Condition of the Medical Ct Image	
Parameters	*Noct (Normal)*	*Ct (Abnormal)*
Mean	100.4136	104.2402
Standard Deviation	55.6128	77.3652
Third Moment	14.2830	12.6429
Area	2407604	2072636
Entropy	0.78640	0.9259

Table 2: Morphological Operation Comparison Mri Image

	Condition of the Medical Magnetic Resonance Imag	
Parameters	*Mri(normal)*	*Mri(abnormal)*
Mean	61.200	75.2044
Standard Deviation	64.4156	75.0729
Third Moment	11.2254	11.2149
Area	373098	410794
Entropy	0.9981	0.9986

CONCLUSION

The proposed methodology aims to detect the brain Tumor from CT/MRI brain images. The detected tumorous lesion is then segmented using image processing algorithms and the morphological operations are performed to obtain the vital parameters like Mean, Standard deviation, Third moment, Area, Entropy of the image. The results are depicted in two tabulations, one for CT and the other for MRI. From the obtained numerical results we interpret that the values for abnormal condition is always high. Thus through this thesis an attempt has been made to detect the tumor in brain at an early stage by image processing and tabulating the parameters that would help and assist pathologist by providing detailed analysis of the tumor and in producing accurate results in less span of time.

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