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Hybrid Edge Detection Techniques for MR Image Analysis

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***Abstract*—** *Identifying the boundaries or edges of the tumor is necessary for the segmentation process in order to separate out the tumor from the given MRI image which may help further in proper detection of dimension of the tumor. This paper deals with identification of ROI based on threshold value. Locating discontinuities in an nosy image is cumbersome. In this paper an investigation is performed on different edge algorithms and also an attempt has been made to hybrid the existing edge algorithms to detect the boundaries more accurately and comparison is done based on the time complexity, area of the tumor in pixels, PSNR and MSE. The proposed techniques are checked for different MRI gray scale images to obtain conclusive result using Matlab.*

***Keywords*—** *Edge detection, tumor, PSNR, MSE.*

I. INTRODUCTION

Analyzing the edges of the tumor is an important process to be carried out during segmentation and detection of the tumor in MRI images. MRI provides inner details inside the body obtained in different planes such that it can be diagnosed properly for the detection of tumor. Localization and character of the disease can be evaluated using MRI approach. MRI approach is best suited for the analysis and detection of tumor. The contrast of the images in MRI can be varied with small change in magnetic fields. Measuring the accurate findings of the tumor at the early stage is very time consuming. Varying contrast followed by threshold can be used to highlight MRI image features. Original MRI image which will be in DICOM (Digital imaging and communication) format is converted into gray scale image suffers from noise needs to be eliminated before applying the edge detection algorithm. MSE (Mean square error) and PSNR (Peak signal to noise ratio) are used as the measuring parameter for the quality of image detection. Edge is the property of high intensity pixel and its immediate neighborhood in the images. So, the shape of the image is decided by its edges. Edges are used in image analysis for identifying region boundaries. Brightness and contrast of image is the important property to compute its edges or lines. Image gradient function also applied to calculate edges using different edge detector operators like sobel, prewitt's and Robert's. Segmentation plays a vital role in the field of tumor detection which can be obtained by proper detection of edges. Region of interest is applied first to separate the object from background based on the threshold value selection which is a useful property for proper identification of edges. Linear filters like geometric mean and non-linear filters like median filter is best suitable of removing the noise without affecting the outlined sharpness of image. Each of the edge operators is designed to be sensitive to certain types of lines or edges. Many sequences of MRI like T1contrast, T2 weighted Proton density and Flair images have been used for the analysis of tumor in all angles and in different planes. Edge points define the points of an image having unique intensity from the adjacent ones. The main objective is to obtain the proper edges of the tumor with free from noise which later helps for the segmentation analysis for separating the tumor part.

This paper is organized as follows: The proposed method is described in section II. Experimental results are provided in section III. Conclusion and future scope are discussed in section IV and section V respectively.

II. PROPOSED METHODOLOGY

The proposed method consists of hybrid edge detection algorithms. The sequence of operations is carried out for detection of tumour area in MRI images of brain shown in figure 1.

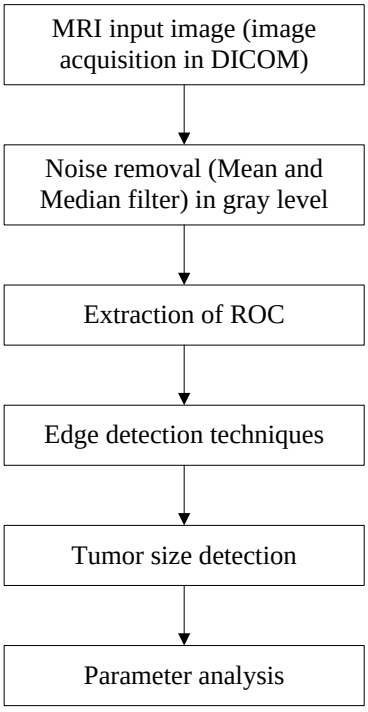


Fig. 1. Steps for tumor detection.

1. MR image sequence is acquired in DICOM format.
2. DICOM image is converted to jpeg format for easy processing which in turn is converted to gray scale image.

Akshath M J and H. S. Sheshadri, "Hybrid edge detection techniques for MR image analysis," *International Research Journal of Advanced Engineering and Science*, Volume 2, Issue 1, pp. 79-83, 2017.

3. Gaussian mean and median filter is used for removal of noise.
4. Region of interest is obtained based on the value of threshold.
5. Apply edge detection algorithms for the median filtered image.
6. Detection of edges in the output image.
7. Analyzing time complexity, PSNR and MSE parameters.

A. Image Acquisition

Standard database for MR images in DICOM format is considered for the research. Further these images are processed and converted into jpeg format for detecting the edge of the tumor conveniently.

B. Image Pre-Processing

Enhancing the image by removing the noise using linear filter like Gaussian mean followed by non-linear median filter helps in further extraction of the boundaries or edges of the image.

$$\text{Gaussian mean}=\left(\prod_{n=1}^{k} x_n\right)^{1/k}$$

Median filter is given by the expression
G (x, y) = median of

$$\sum_{i=-1}^{1}\sum_{j=-1}^{1} f(x-i, y-j)$$

Mean filter replaces the pixel value with the geometric mean of neighboring values. Median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighboring pixels. The pixel is calculated by first sorting all the pixel values from the pattern of neighbor's into numerical order, and then replacing the pixel being considered with median pixel value following the symmetrical property by using 3x3window. Figure 2 shows the original image containing noise and figure 3 is the result of the noise removal using median filter. To remove noise in the image, median filter is best suitable. Median filter removes the outlier without affecting the sharpness of the image.

Fig. 2. Original MRI image.

C. Region of Interest (ROC)

The output of the median filter is selected for extracting the region based on the threshold which bifurcate the object from the foreground. The tumor part is selected as the region shown in figure 4 and threshold value selection in figure 5 respectively.

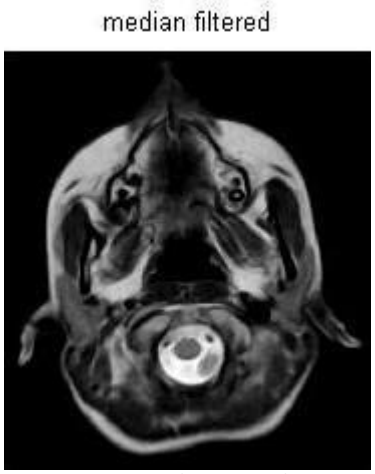


Fig. 3. Image after median filter.

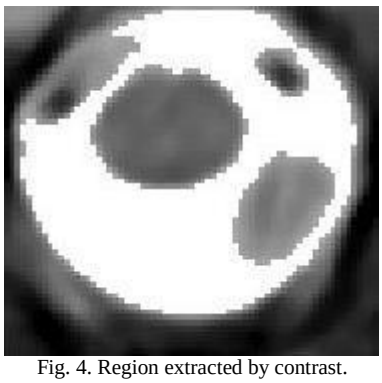
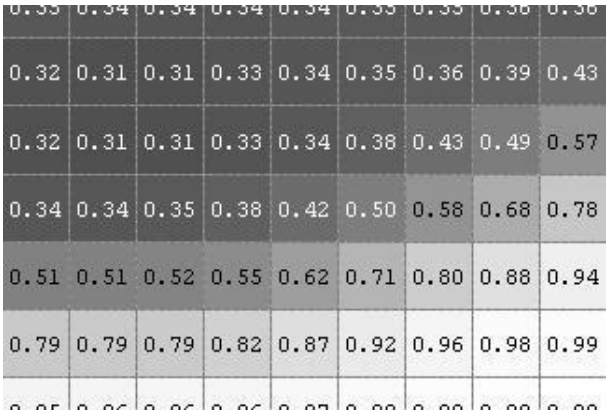


Fig. 4. Region extracted by contrast.



0.32	0.31	0.31	0.33	0.34	0.35	0.36	0.39	0.43
0.32	0.31	0.31	0.33	0.34	0.38	0.43	0.49	0.57
0.34	0.34	0.35	0.38	0.42	0.50	0.58	0.68	0.78
0.51	0.51	0.52	0.55	0.62	0.71	0.80	0.88	0.94
0.79	0.79	0.79	0.82	0.87	0.92	0.96	0.98	0.99

Fig. 5. Threshold value selection.

The boundary which is seen in white is the region of interest where the values of pixels are in the range from 0 to 1. The value of the boundary of white part is taken which separates the tumor from background and is taken as the input for the next stage.

Akshath M J and H. S. Sheshadri, "Hybrid edge detection techniques for MR image analysis," *International Research Journal of Advanced Engineering and Science*, Volume 2, Issue 1, pp. 79-83, 2017.

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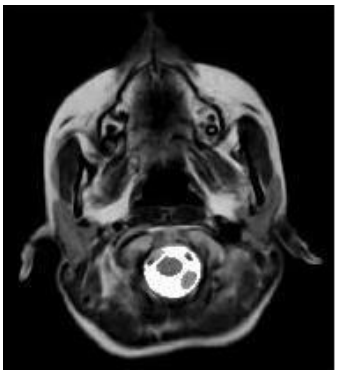


Fig. 6. Contrast image.

D. Edge Detection

Sobel masks is incorporated to detect the edges of image which is obtained by calculating gradient magnitude for 3x3window and maximal suppression is performed to suppress the less amplitude below constant value using threshold hysteresis and finally by incorporating double thresholding the edges of an image is obtained by improving signal to noise ratio and detects image well even in noisy conditions.

$$g_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \qquad g_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

Magnitude:

$$g = \sqrt{g_x^2 + g_y^2}$$

Orientation:

$$\Theta = \tan^{-1}\left(\frac{g_y}{g_x}\right)$$

Fig. 7. Masks used for Sobel operator.

$$G_x = \begin{pmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{pmatrix} \qquad G_y = \begin{pmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{pmatrix}$$

Fig. 8. Masks used for Prewitt's operator.

$$G_x = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \qquad G_y = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$

Fig. 9. Masks used for Roberts operator.

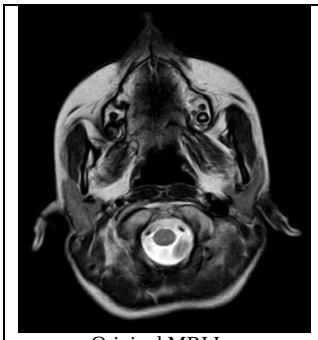
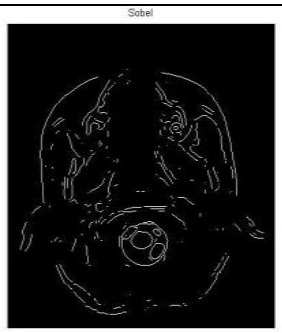
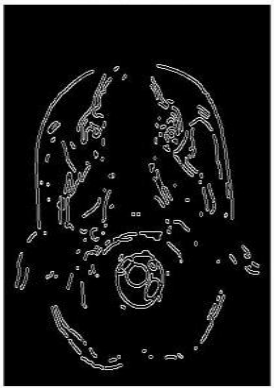
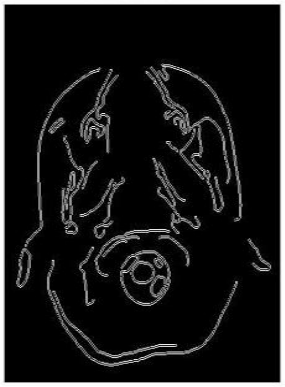
III. Simulation and Results

Comparison is made between sobel and canny and also for the hybrid techniques of these algorithms. The area of tumor is expressed in pixel values. The time complexity, PSNR values and MSE is recorded for the algorithms. PSNR computes the peak signal to noise ratio in decibels between two pixels. The table shows the result of different edge detection techniques. Canny provides the best execution time and hybrid techniques provide better PSNR and MSE and area of tumor is shown in pixels. Area in pixels is found to be 1698. Hybrid technique provides better visualization as shown in table I.

$$MSE = \frac{1}{NxM}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\left[\mathrm{X}(i,j) - Y(i,j)\right]^2$$

$$PSNR = 10\log_{10}\left(\frac{R^2}{MSE}\right)$$

TABLE I. Edge detection results.

 Original MRI Image	 Sobel edge detector
 Canny edge detector	 Prewitt's edge detector
 Robert's edge detector	 Sobel+canny
 canny+sobel	

Akshath M J and H. S. Sheshadri, "Hybrid edge detection techniques for MR image analysis," *International Research Journal of Advanced Engineering and Science*, Volume 2, Issue 1, pp. 79-83, 2017.

TABLE II. Statistical results.

l.No	Type	Time	MSE	PSNR
1	Sobel	0.732sec	0.0973	58.24
2	Prewitt's	0.776sec	0.0974	58.24
3	Robert's	0.597sec	0.0955	58.33
4	Canny	0.478sec	0.1012	58.07
5	Sobel+canny	0.691sec	0.1061	57.87
6	Canny+sobel	0.771sec	0.1045	57.93

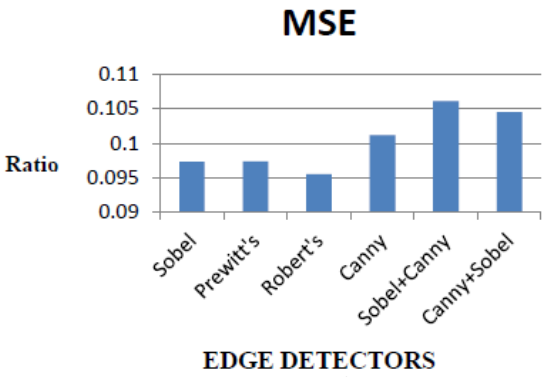


Fig. 10. Comparison of MSE.

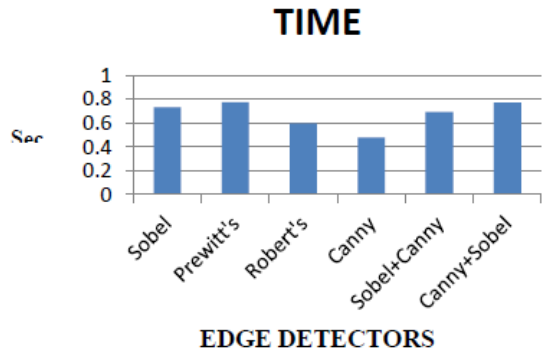


Fig. 11. Comparison of time.

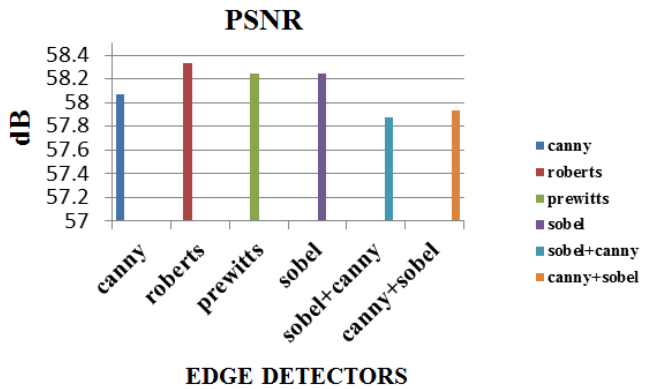


Fig. 12. Comparison of PSNR.

IV. Conclusion

The proposed method would be able to detect the edges for segmenting the tumor part. MRI image in DICOM image is converted into gray level for the removal of noise using Median filters. Hybrid edge detection techniques provide better edge of the tumor visualization and also better PSNR and MSE. The PSNR should be low in decibel for effective edge detected image. Canny gives the best execution time.
The proposed method is checked for 5 MRI image samples.

V. Future Work

The proposed method can be extended for hybrid segmentation techniques which would provide efficient results and would be helpful for diagnosing the tumor accurately.

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Akshath M J and H. S. Sheshadri, "Hybrid edge detection techniques for MR image analysis," *International Research Journal of Advanced Engineering and Science*, Volume 2, Issue 1, pp. 79-83, 2017.