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An Automated System for Brain Tumor Detection and Segmentation

Rohan Kandwal
M. Tech Scholar,
CSE Department,
Dehradun Institute of Technology, India

Ashok Kumar
Assistant Professor,
CSE Department,
Dehradun Institute of Technology, India

Abstract – Magnetic Resonance images are used to detect presence of any brain tumor but it is very time consuming and difficult. This paper presents a completely automated way to detect brain tumor. It consist of three stages to detect and segment brain tumor. In the first stage, image preprocessing is done to remove any noise and sharpen image. In second stage, bounding box method using symmetry is used to automatically detect location of tumor in any part of the brain. In the third stage, several post processing operations are used to finally segment the tumor portion from the whole image. Several experiments show that our technique in spite of being completely simple detects tumor correctly.

Keywords – Automatic brain tumor detection, brain tumor, medical image processing, MRI images, MR image segmentation.

I. INTRODUCTION

Brain tumor is caused by an abnormal growth of cell in brain. Normally brain tumor emerges from brain cells, blood vessels or nerves that are present in the brain. Early detection of brain tumor is necessary as death rate is higher among humans having brain tumor [1]. Techniques for brain tumor detection using image processing has been present for few decades. Researchers have proposed many semi-automatic and automatic image processing techniques to detect brain tumors but most of them fail to give effective and precise results due to the presence of noise, inhomogeneity, poor images contrast that occur usually in medical images. Brain tumor segmentation is very difficult due to complex brain structure but early and accurate detection of tumors, edema and necrotic tissues is very important for diagnostic system. Tumors can damage normal brain cells by producing inflammation, exerting pressure on parts of brain and increasing pressure within the skull [2]. Automatic brain tumor detection and segmentation face many challenges. Brain tumor segmentation requires the efficient knowledge of pathology and understanding the intensity and shape of MRI image. The main problem in tumor segmentation arises due each tumor being of different shape, size, location and intensity. Manual detection of brain tumor requires human interaction and is time consuming. Also it depends on the ability of the observer to locate the location, shape and size of the tumor. Thus, a need of completely computer aided system for brain tumor detection is inevitable.

Presently existing algorithms in medical image processing employ partial differential equations, curvature motivated flows and diverse mathematical models. In 1991, Weaver et al. [2] first presented the use of wavelet theory in medical imaging processing by reducing noise in MRI images. H. B. Kekre et al have presented a vector quantization segmentation method to detect cancerous mass from MRI images [3]. Jue Wu and Albert C.S. Chung [4] developed a framework for multi-object segmentation of deep brain structures in medical brain images. Manj6n et al. [5] have analyzed random noise removal filter and adapted to reduce this noise in MR magnitude images. V. Thavavela et al. [6] have proposed a genetic algorithm-based wavelet domain denoising technique. Murugavalli et al. used high speed parallel fuzzy c-mean and neuro fuzzy algorithm for brain tumor segmentation [7]-[8]. There are many other semi-automatic and manual algorithms for brain tumor detection.

A completed automated diagnosis system for brain tumor should consist of multiple phases including noise removal, brain tumor detection and brain tumor extraction. This paper proposes a uses fast boundary boxing algorithm by Baidya Nath Saha et al [9], to develop an automatic computer aided system for brain tumor detection.

This paper is arranged in four parts. Part II explains the proposed methods and steps involved for automated brain tumor detection and segmentation. Part III shows the results and analysis of applying the proposed method on brain tumor images. Part IV covers conclusion. Part V shows the future scope of this paper.

II. PROPOSED METHOD

Given a brain MRI image, the first step enhances the image, in the second step fast bounding box algorithm is used to detect region of interest and in third step post processing operations are used for segmenting tumor. As the result of above steps, we get a final brain tumor segmented image.

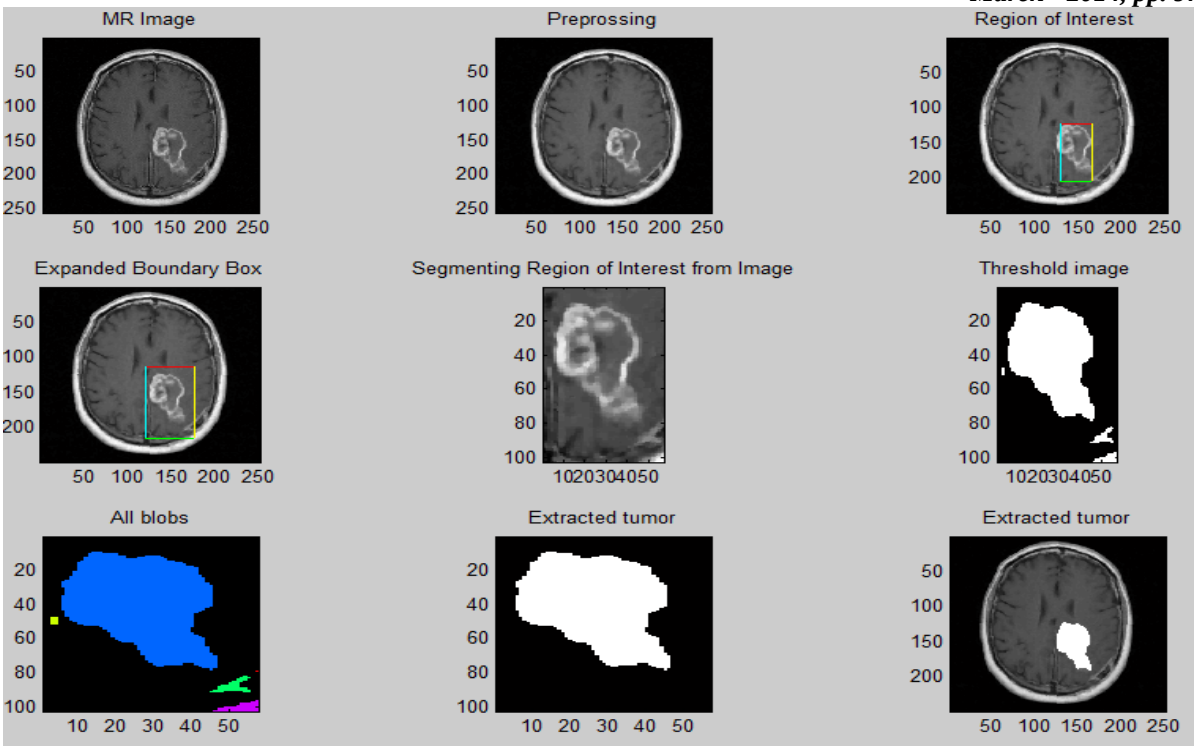


Fig 1. Overview of brain tumor detection

A. Preprocessing

Preprocessing is the first step in our proposed technique. Preprocessing is done reduce noise and enhance the image for further processing. This steps improve image quality and increase surety and accuracy in detecting tumor. Steps involved in preprocessing are as follows:-

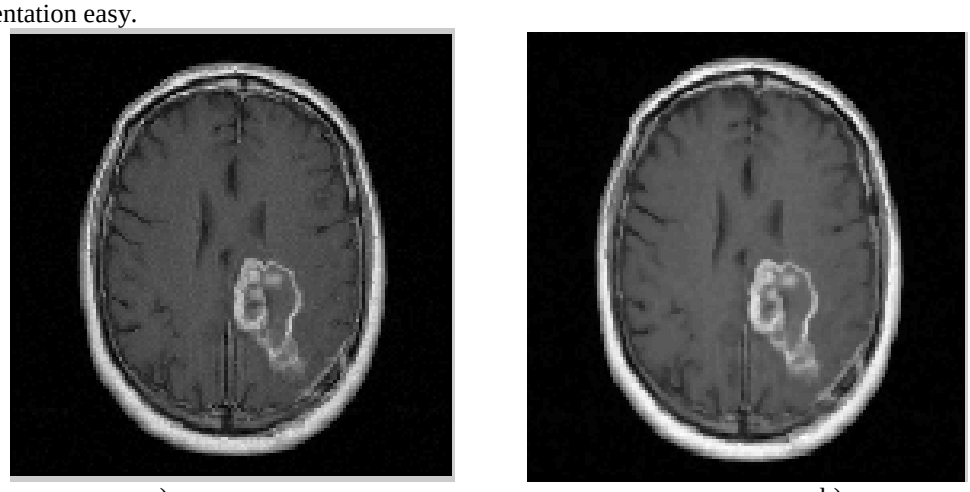
1) Image is converted to grayscale.

$$\hat{f}(x,y) = \underset{(s,t)\in S_{xy}}{\text{median}}\{g(s,t)\}.$$

2) A 3x3 median filter is applied on the image using equation 1 in order to remove noise. (1)
3) The obtained image is then passed to a high pass edge detection filter

1	0	-1
2	0	-2
1	0	-1

4) The detected edges are added to the original image to enhance it edges. This makes tumor detection and segmentation easy.



a) b)

Fig 2. Preprocessing a) Original image b) Enhanced image

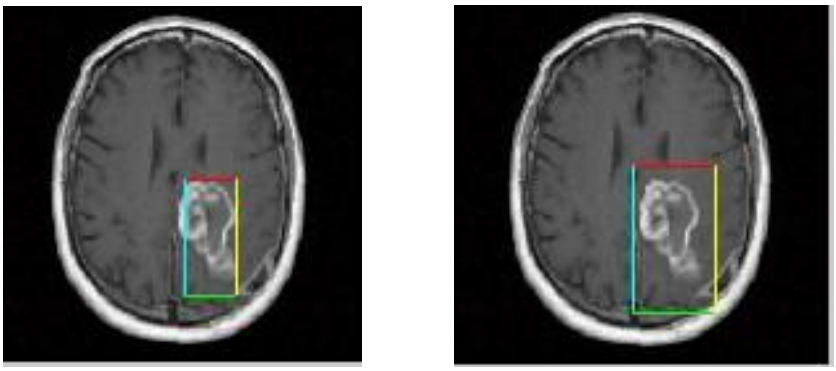
B. Region Of Interest

Our proposed technique uses Fast Bounding Box algorithm to detect the region of interest (ROI). Bounding Box approach is based on an unsupervised change detection method that searches for the most dissimilar region (axis- parallel bounding boxes) between the left and the right halves of a brain in an axial view MR slice.

This change detection process uses a novel score function based on Bhattacharya coefficient computed with gray level intensity histograms.

Steps involved in detecting tumor using Boundary Box method are as follows:-

1) Axis of symmetry on an axial MR slice is found which divides brain in two halves left (I) and right (R).
2) One half serves as test Image and the other half supplies as the reference image.
3) Novel score function is used which identify the region of change with two searches – one along the vertical direction and other along the horizontal direction.
4) Novel score function uses Bhattacharya coefficient to detects a rectangle D which represents the region of interest between images I and R.



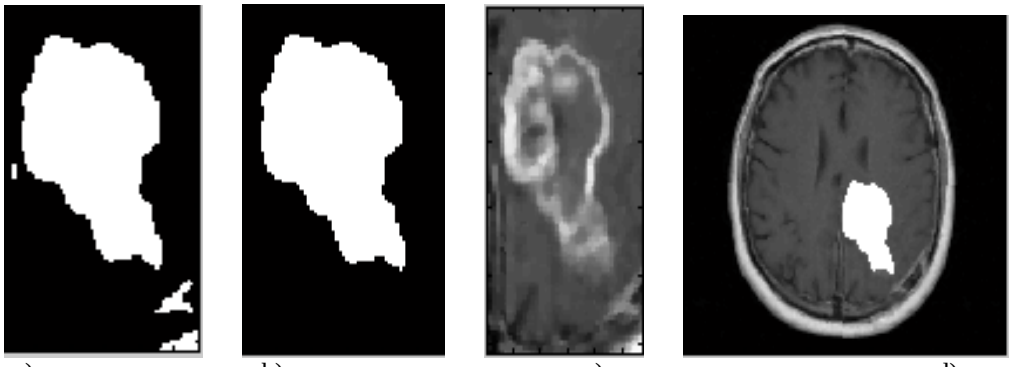
a) b)

Fig 3. Region of Interest a) Original fast bounding box tumor detection b) Enhanced fast bounding box tumor detection

C. Postprocessing

After the ROI is detected, several post processing operations are performed to clearly locate the tumor part in the brain. The basic purpose of post processing is to show only that part of the image D, which has the tumor. Post processing techniques include several mathematical operations and windowing techniques. The basic steps of postprocessing are as follows:-

1) The rectangle box D, detected by fast bounding box algorithm is stretched so that entire tumor is correctly detected.
2) Mean intensity (M) of pixels in D is calculated.
3) Threshold is applied to D above pixel intensity M.
4) Next blobs are detected in the rectangle D.
5) Finally, windowing techniques are used to obtain brain tumor detected image by selecting the blob with maximum area.



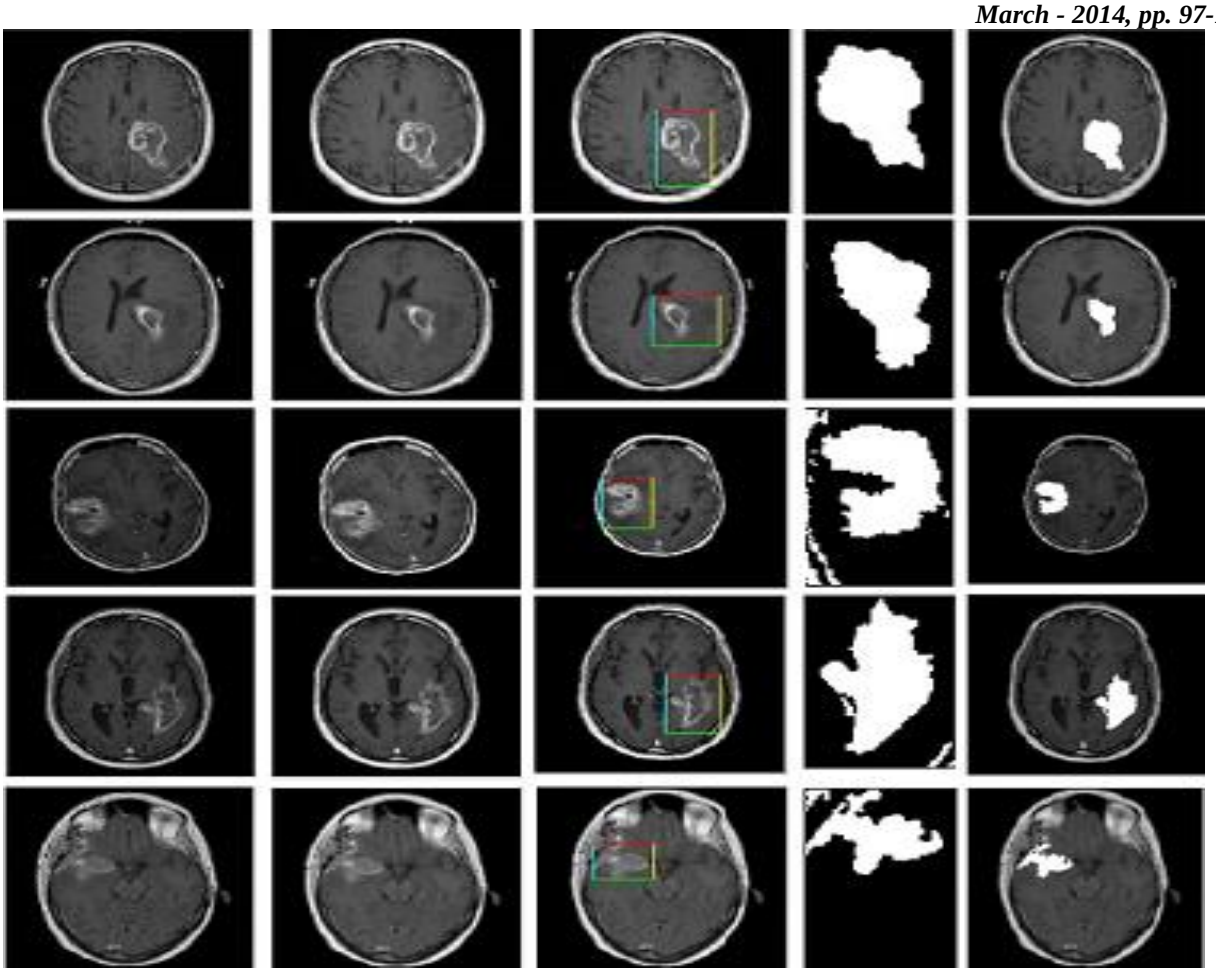
a) b) c) d)

Fig 4. Postprocessing a) Segmented tumor b) Output of mathematical operations c) Output of Windowing d) Tumor extracted image

III. EXPERIMENTAL RESULTS

The test of proposed technique to detect and segment brain tumor is performed using 100 MR images of different patient. The images used for testing are of size 256x256 pixels, eight bits per color channel. Each test image has brain tumor of different size, shape and intensity. Manual inspection is used to check the accuracy of automated segmented tumor area.

Figure 5 shows the experimental results for different MR images containing tumors of different shapes, sizes and intensities.



a) b) c) d) e)

Fig 5. Experimental results a) Original images b) Preprocessed images c) Tumor detected Images d) Segmentation Images e) Tumor extracted images

IV. CONCLUSION

In this paper brain tumor segmentation and detection is done using MR images. The proposed method uses an easy and completely automated way to detect and segment tumor with good accuracy.

Experimental results show that our proposed method produces very good results in enhancing, detecting and segmenting brain tumor from a MR image.

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