Review on Automatic Brain Tumor Detection based on Gabor Wavelet

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ABSTRACT

Medical image analysis is an important bio-medical application, these image analysis techniques are often used to detect abnormalities in human bodies through scan image Magnetic resonance (MR) images are a very useful tool to detect the tumor growth in brain but precise brain image segmentation is a difficult and time consuming process. In this paper we propose a method for automatic brain tumor diagnostic system from MR images. The system consists of three stages to detect and segment a brain tumor. In the first stage, MR image of brain is acquired and preprocessing is done to remove the noise and to sharpen the image. In the second stage, edges are detected by using gabor filter. In the third stage, threshold segmentation is done on the sharpened image to segment the brain tumor and the segmented image is post processed by morphological operations and tumor masking in order to remove the false segmented pixels. experiments show that technique accurately identifies and segments the brain tumor in MR images.

1. INTRODUCTION

Brain tumor segmentation in MR images has been recent area of research in the field of automated medical diagnosis as the death rate is higher among humans due to brain tumor [1]. In automated medical diagnostic systems, MRI (magnetic resonance imaging) gives better results than computed tomography (CT) as MRI provides greater contrast between different soft tissues of human body. Hence MRI is much more effective in brain and cancer imaging [2].

Detection of brain tumor requires brain image segmentation. Manual brain MR images segmentation is a difficult task. It requires plenty of time, non-repeatable task, non-Uniform Segmentation and also segmentation results may vary from expert to expert. An automated brain tumor detection system should take less time and should classify the brain MR image as normal or tumorous accurately It should be consistent and should provide a system to radiologist which is self explanatory and easy to operate.

Automatic brain tumor detection and segmentation faces many issues and challenges. It is a difficult task to segment brain tumor in an automatic computerized system as it involves pathology, physics related to MRI along with intensity and shape analysis of MRI image. The major issue with brain tumor segmentation is that the tumor varies in form of shape, size, location and image intensities. Manual segmentation of brain tumor requires human experts and it takes a lot of time, which makes an automatic system for brain tumor detection and segmentation a desirable method.

An automated diagnosis system for brain tumor detection should consist of multiple phases including noise removal, brain image segmentation and brain tumor extraction. This paper presents a computer aided system for brain tumor detection. Our systems extracts tumor by using three phases, pre processing. edge detection and post processing.

2. PROPOSED METHOD

The workflow of our proposed method is shown in Figure1 Given a brain MRI image, the first step enhances the image, the second step is edge detection with the help of gabor filtering and in the third step post processing using threshold segmentation and morphological operations technique takes place. As a result of these steps, we get a final brain tumor detected image.

2.1 PREPROCESSING

Preprocessing includes three step such as image acquisition, removal of film artificates such as label and mark on MRI by using Brain Extraction Tool(BET) and then passing image through bandpass filter which is nothing but wavelet transform.

Preprocessing of brain MR image is the first step in our proposed technique. Preprocessing of an image is done to reduce the noise and to enhance the brain MR image

for further processing. The purpose of these steps is basically to improve the image and the image quality to get more surety and ease in detecting the tumor
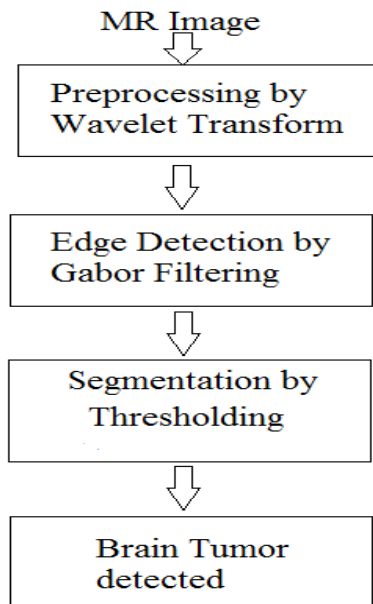

Fig-1: Automatic brain tumor detection system from MR images

Wavelet Decomposition implemented by Bank of filters applied at first row by row and then column by column. at each level four sub-images are generated that are approximation, vertical, horizontal and diagonal component.

wavelets are mathematical functions that decompose data into different frequency components and then study each component with a resolution matched to its scale. The wavelet analysis decomposes a signal into a hierarchy of scales ranging from the coarsest scale to the finest scale. Hence, the wavelet transform, is a better tool for feature extraction from images and required low computation The basic idea of UDWT is simply to apply appropriate low and high pass filters to that data at each level to produce two sequences to the next level. The resultants are not decimated and two new sequences have the same length as the original sequence. The multiresolution is achieved by modifying (upsampling) the filter at each level[3]. The diagram for 2D UDWT is shown fig. 2
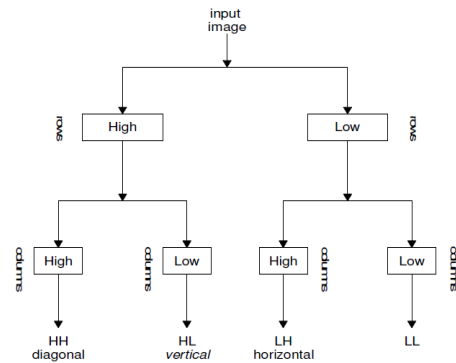

Fig-2: Two-dimensional UDWT

2.2 GABOR WAVELETS

This section presents the Gabor wavelet analysis of the ROIs of a tumor image for extracting the texture features. Because Gabor wavelets capture the local structure corresponding to spatial frequency (scales), spatial localization, and orientation selectivity , they are widely applied in many research areas, such as texture analysis and image segmentation [4-6].

A 2D Gabor filter is a product of an elliptical Gaussian in any rotation and a complex exponential representing a sinusoidal plane wave . The sharpness of the filter is controlled through the major axis and minor axis, which is perpendicular to the wave. The filter can be defined as

$$\varphi(x,y;f,\theta) = \frac{f^2}{\pi\gamma\eta} e^{-\left(\frac{f^2}{\gamma^2}x'^2 + \frac{f^2}{\eta^2}y'^2\right)} e^{j2\pi f x'}$$

$$x' = x\cos\theta + y\sin\theta$$

$$y' = -x\sin\theta + y\cos\theta$$

where f is the central frequency of the sinusoidal plane wave, θ is the rotation angle of both the Gaussian major axis and the plane wave, γ is the sharpness along the major axis, and η is the sharpness along the minor axis. The sharpness values along the major axis γ and along the minor axis η are set to 1.

Image texture features can be extracted by convolving the image M(x,y) with Gabor filters

$$g(x,y;f,\theta) = M * \varphi(x,y;f,\theta)$$

Gabor filters with different frequencies f_i and orientations θ_j are selected to obtain the texture features of the tumor area.

2.3 POSTPROCESSING

After enhancing the brain MR image, the next step of our proposed technique is to segment the brain tumor MR image. Segmentation is done to separate

the image foreground from its background. Segmenting an image also saves the processing time for further operations which has to be applied to the image. We have used segmentation using a global threshold in order to segment the tumor image. The basic steps for global threshold segmentation are as follows:

1) Select a threshold value for the image.

2) Apply the threshold value to enhanced image to convert the image to binary.

3) If a particular pixel value is above the threshold value it is considered as foreground otherwise background.

After segmenting the brain MR image, several postprocessing operations are applied on the image to clearly locate the tumor part in the brain. The basic purpose of the operations is to show only that part of the image which has the tumor that is the part of the image having more intensity and more area.

These postprocessing operations include morphological operations[7]. The basic steps of postprocessing are as follows:

1) The morphological erosion is applied on the segmented brain MR image with 3x3 structuring element using the equation

$$A \ominus B = \{z | (B)_z \subseteq A\}$$

2) The morphological dilation is applied on the eroded brain MR image with 3x3 structuring element using the equation

$$A \oplus B = \{z | (\bar{B})_z \cap A \neq \Phi\}$$

3) Binary tumor masked window is created to segment out the tumor region from the image. Tumor tissue has basically more intensity than the other surrounding tissues of the brain MR image.

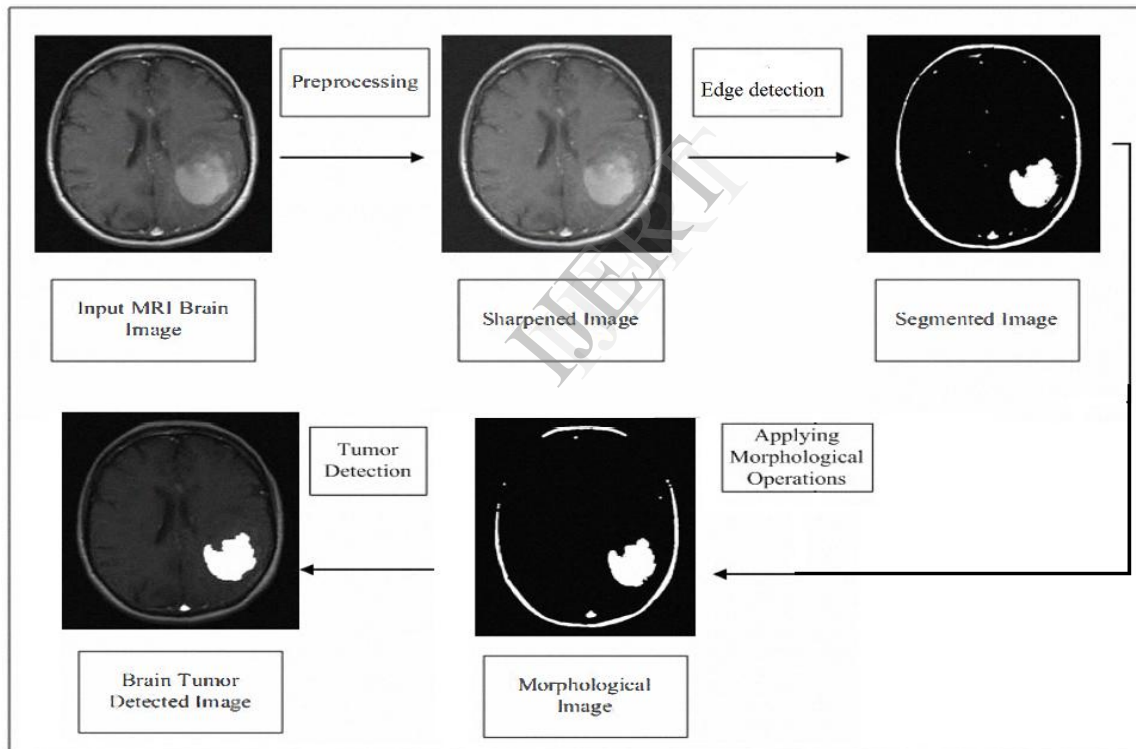4) The final brain tumor detected image is obtained by applying the tumor mask on dilated brain MR image

Fig. 3: Brain tumor detection

3. CONCLUSION

In this paper, we have proposed a new algorithm for segmentation of tumors from MR images. The method uses MR images and employs multiresolution analysis using undecimated wavelet transform. Gabor wavelets are applied to the approximation images and capture the tumor characteristics at all levels of decomposition.

Computation of texture features is then carried out and their peaks are detected. These images are then segmented by using morphological operation to give the final segmented output. The propose method will accurately produces a segmentation of tumor from surrounding brain tissue.

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