Integration of Contourlet Transform and Canny Edge detector for Brain Image Segmentation

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***Abstract*— This paper proposed a new integrated image segmentation method for MRI brain images. In this method we have used a new transformation called Contourlet Transform which is integrated with canny edge detector. For a better segmentation we have applied an enhancement function on the contourlet coefficients before applying canny edge detector. The experimental results shows that using canny edge detector after enhancing the image by contourlet transform along with an enhancement function, the brain MRI image can be segmented very efficiently which can outperforms other conventional methods.**

Keywords- contourlet transform, image segmentation, mri brain image segmentation, canny edge detection, image enhancement

1. INTRODUCTION

Image segmentation is an important part for many image processing techniques. Medical image processing is one of the most significant and demanding area where image segmentation is used as an essential step for diagnosing many diseases [1-3]. The main purpose of image segmentation is to divide the image into several regions according to the edges [4]. Exact segmentation is a very challenging issue, since there are many noise in a captured MRI image which can lead to an overfitting or falsely segmented image. It will boost up the segmentation performance if the taken image can be enhanced which can clarify the important edges of the gray matter, white mater and CSF in a brain image. Hence, in this paper we have proposed an efficient integrated method in order to detect the brain matters more accurately. As an RGB image can capture more variation data than 2-dimentional image, so we have used RGB MRI image instead of gray level image.

On the following chapters of this paper we have described about our proposed integrated method for medical image segmentation and also gave some experimental results in order to prove the efficiency of our idea.

2. PROPOSED METHOD

The step by step process for segmenting a brain MRI image of our proposed algorithm is shown in Figure 1. At first the input image is gone through a normalization process. After that contourlet transformation is applied to get multi-scaled values. The contourlet coefficients are then enhanced by using an enhancement function which was evaluated from 2 functions, one is sigmoid function and another is tangent function. After applying enhancement function on the coefficients, the whole matrix is then reconstructed through invers contourlet transformation. The enhanced image is then denoised by applying a wiener filter. Finally canny edge detector is used to the enhanced image to get a segmented MRI brain image.

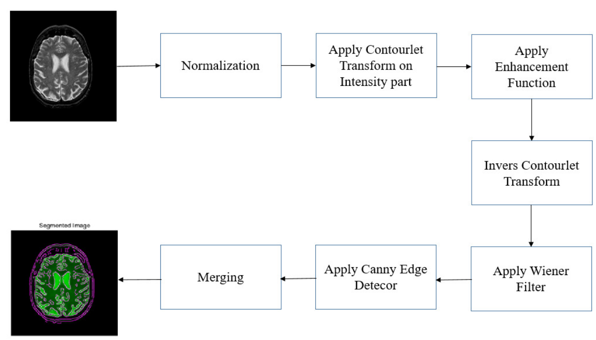


Figure 1: Work-Flow diagram of the proposed algorithm

Basically our proposed method incorporated with six major steps: normalization, Contourlet transformation, enhancement function, inverse contourlet transformation, filtering and canny edge detecting. In the later part of the paper we have explained each and every steps of the integrated process in detail.

3. CONTOURLET TRANSFORM

Contourlet transform overcome the drawbacks of frequently used portable expansions of one-dimensional transformations, such as- Wavelet or Fourier transform, while computing the geometry of image edges. This transform was established by Minh Do *et. al.* [7], where he evaluated a "true" two-dimensional transform that can grab the fundamental geometrical structure which is the vital point in visual data. They created a discrete transform that gives a rare extension for conventional images having steady outline. By using harmonic analysis and vision, they mainly detected two main characteristics of a new image instance that outperforms the divisible two-dimensional wavelet transform, known as directionality and anisotropy. Based on this experiment they have made a new filter bank structure, called contourlet filter bank which can make an adaptable multiscale and directional dissolution for images. After that, sub-band images obtained by the multi-scale dissolution are processed by a directional filter bank to uncover directional subtle elements at every specific scale level [8]. The obtained data from the directional filter bank are the contourlet coefficients.

4. Enhancement Function

In this step, an enhancement function is applied on the output coefficients of the contourlet transform. This function is derived from a sigmoid function along with a tangent function. This function can remove the noisy false edges and enhance the week edges.

After applying this function we applied inverse contourlet transform for the restoration of the enhanced image and for more clarification we have applied wiener filter on the output image.

5. Canny Edge Detection

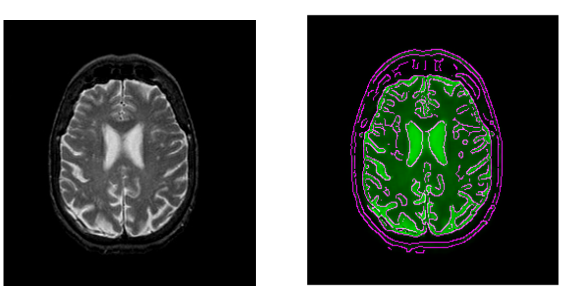
After applying contourlet transform and enhancement function on the normalized image we have applied canny edge detector in this step of the proposed integrated method. The Canny edge detection method works in five steps.

At first a Gaussian filter is used to remove the noise and after that to detect the sharp edges the gradient of the image is calculated. Afterwards, the algorithm works with the thick edges in order to make them thin by using non-maximum suppression. As a next step, this technique sets 2 threshold values according to the edge values in order to make edge region. At the final stage, this method try to remove the false edges which are not connected to a very strong edge by using hysteresis method.

6. EXPERIMENTAL RESULT AND DISCUSSION

In order to conduct all the simulations we have used Matlab R2016b platform on Intel(R) Core(TM) i3 CPU, 3.07 GHz, and 4GB RAM.

The dataset used in this experiment contained T1-weighted MRI brain image with 256 × 256 × 3 pixels scanned in the axial plane, which was collected from Open Access Series of Imaging Studies (OASIS). The first image in figure-2(a) is used for evaluating the performance of our proposed system. The second image in figure-2(b) is the segmented final output image.



(a) (b)

Figure 2: (a) Experimental MRI image sample before applying segmentation; (b) Segmented image after applying proposed method.

7. Comparison to other conventional Approaches

To prove the efficiency of our proposed system, we compared the result with other conventional edge detection approaches such as Sobel, Prewitt, Roberts and otsu methods. The results in figure-3 displays that our proposed method (Contourlet→Enhancement function→Invers Contourlet→Wiener filter→Canny detector) can obtained a better segmentation result than other methods mentioned here.

We can see from figure-3, other methods skipped many visible regions of the brain image and the way they marked the edges is not that much clear and continuous. On the other hand, our proposed integrated method can grab more segmented areas than other algorithms which is the main goal of a segmentation method. Since we have added an enhancing function which is helping the image to enhance the necessary part of the image so that is assisting the edge detecting method successfully marking maximum true edges.

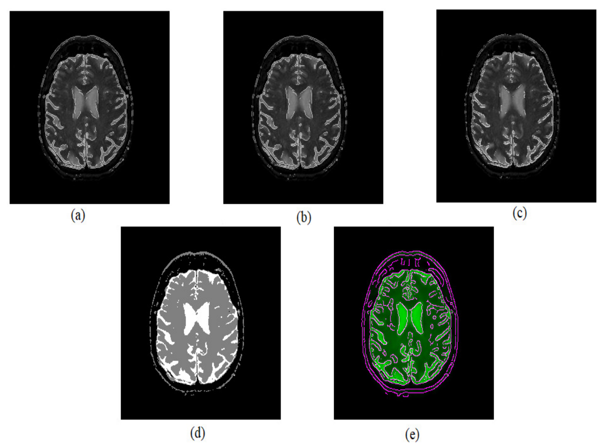


Figure 3: (a) Result of Sobel filter; (b) result of Prewitt filter; (c) result of Roberts filter; (d) result of Otsu method; and (e) result of our proposed method.

8. Conclusion

In this study, we have proposed a new integrated methodology for MRI brain image segmentation based on image enhancement using contourlet transform and canny edge detection technique. Based on the segmentation results showed in figure-3, our proposed architecture surpassed other conventional algorithms.

As a further improvement, we can try to apply more efficient denoising and enhancement techniques to clarify the image in order to grab the actual necessary segmented regions for a batter diagnosis in medical fields.

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