International Journal of Data Mining Techniques and Applications
Volume: 05 Issue: 02 December 2016 Page No.118-120
ISSN: 2278-2419

A Study on MRI Liver Image Segmentation using Fuzzy Connected and Watershed Techniques

A.S. Thenmozhi[1] , N. Radhakrishnan[2]
[1]Research Scholar, Mother Teresa Women's University, Kodaikanal
[2]Director, Geo Research Centre, Pammal, Chennai
E-Mail: astthenn@gmail.com, radhakrishnan.nr@gmail.com

Abstract - A comparison study between automatic and interactive methods for liver segmentation from contrast-enhanced MRI images is ocean. A collection of 20 clinical images with reference segmentations was provided to train and tune algorithms in advance. Employed algorithms include statistical shape models, atlas registration, level-sets, graph-cuts and rule-based systems. All results were compared to refer five error measures that highlight different aspects of segmentation accuracy. The measures were combined according to a specific scoring system relating the obtained values to human expert variability. In general, interactive methods like Fuzzy Connected and Watershed Methods reached higher average scores than automatic approaches and featured a better consistency of segmentation quality. However, the best automatic methods (mainly based on statistical shape models with some additional free deformation) could compete well on the majority of test images. The study provides an insight in performance of different segmentation approaches under real-world conditions and highlights achievements and limitations of current image analysis techniques. In this paper only Fuzzy Connected and Watershed Methods are discussed.

Keywords: Segmentation, Liver, MRI Images, Fuzzy Connected, Watershed methods.

I. INTRODUCTION

The segmentation of liver using **Magnetic resonance imaging** (MRI) data has gained a lot of importance in the medical image processing field. In this paper, a survey on liver segmentation methods and techniques using MRI images are presented, recent methods presented in the literature to obtain liver segmentation are viewed. The two main classes of liver segmentation are semi automatic and fully automatic. The liver segmentation evaluation measurements and scoring are shown. The comparative study for liver segmentation methods will be accentuated carefully. In this paper, it is concluded that automatic liver segmentation using MRI images is still an open problem. Various weaknesses and drawbacks of the proposed methods are addressed.

II. ABOUT LIVER SEGMENTATION

Liver image segmentation has played a very important role in medical imaging field. The advances in digital image processing techniques have attracted researchers towards the development of computerized methods for liver analysis. Machine learning techniques combined with image processing techniques provide various semi-automatic and automatic techniques for liver image segmentation. However, liver image segmentation from abdominal images is difficult task due to three main reasons. First is due to low contrast and blurry edges of liver. Second, intensity of pixels in liver region is similar and overlapped with nearby organs and tissues in abdominal image. Third, liver is non-rigid in shape and variant in position and it is very complex. All these facts increase the difficulty of the liver image segmentation task. In this report, we are reviewing segmentation techniques which are mainly automatic in nature. It also highlights the significant contribution of machine learning techniques in biomedical imaging field then we prepare the research project to apply in Ho Chi Minh City, Vietnam. Developing a robust method for liver segmentation from MRI images is a challenging task due to the similar intensity values between adjacent organs, geometrically complex liver structure and the injection of contrast media, which causes all tissues to have different gray level values. Therefore, liver segmentation from medical images is still an open problem. Generally, method and approaches to liver segmentation is semi-automatic or automatic. Semi-automatic liver segmentation methods require a limited user intervention to complete the task. This intervention varies from a manual selection for seed points to a manual refinement of a binary mask for the liver. The term automated means that the liver segmentation process is implemented without any sort of operator intervention. This kind of method is highly appreciated by radiologists since it is free from user errors and biases, and it saves the operator from a potentially hard work and wasted time. The latest achievements in liver segmentation are reviewed in this section.

III. CLASSIFICATION OF SEGMENTATION METHODS

In Fig. 1 shows the various segmentation methods and proposed methods Fuzzy Connected and Watershed. The paper is organized as follows. In the next two sections, a brief description of the fuzzy connected-based image segmentation method and its weaknesses can be identify. Section 5 presents Watershed method. Section 6 is devoted to comparison of

International Journal of Data Mining Techniques and Applications
Volume: 05 Issue: 02 December 2016 Page No.118-120
ISSN: 2278-2419

fuzzy connected-based method designed to cope with some of its deficiencies. Summary and future enhancement is discussed in section 7

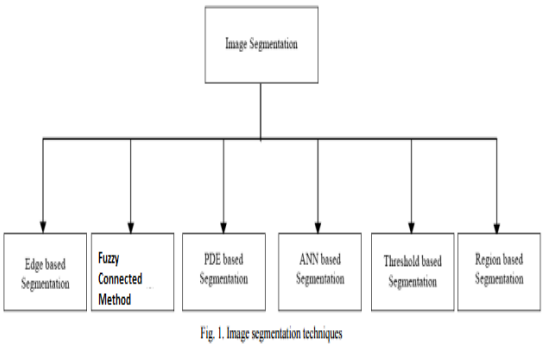

Fig.1 Various segmentation methods

IV. FUZZY CONNECTED METHOD

The idea of fuzzy connectedness goes back to the work of Rosenfeld [7]. Dellepiane et al. [3] and Udupa and Samarasekara [4] were the first authors to incorporate the fuzzy nature of images into a segmentation algorithm through the concept of fuzzy connectedness, which is supposed to capture efficiently fuzzy "hanging togetherness". In practice, the idea is to compute a map of the connectedness of every pixel in the original image, in relation with one specific (designated) pixel belonging to the OOI (Object Of Interest). Fuzzy connected algorithm implemented in MATLAB and the resultant image is shown in Fig. 2.

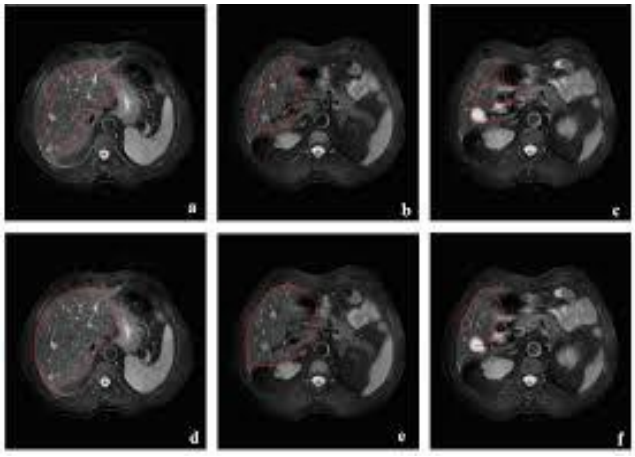

Fig.2 Liver Image Captured from MRI using Fuzzy Connected Method

(a) Original Image, (b)Gray Scale Thresholding (c and d) The Segmentation Obtained with Fuzzy Connected Method.(e) Noise (f) AfterCorrection Noiseless.

4.1 Draw Backs in Fuzzy Connected Method

Although the practical results of segmentation obtained by this method are often good, we can easily identify three types of weaknesses: (a) The segmentation results strongly depend on the choice of the functions g1 and g2 defining the pixel affinity to the reference pixel. (b) The results are also strongly dependent on the way parameters are defined in the interaction step. (c) The segmentation results also strongly depend on the threshold used for the binarization of μ. In this paper, only the last two of these deficiencies are addressed.

V. WATERSHED BASED METHOD

Several variants of an automatic segmentation method based on the watersheds have been described in the literature on mathematical morphology [8]. Local minima of the spatial gradient modulus are detected and serve as seeds for the detection of watersheds [9]. As we stated in the introduction, these methods are powerful in simple situations, but generally fail in real life complicated images. This is due to the fact that, even after regularization, the number of local minima is generally larger than the number of objects (or of regions), resulting in an over-segmentation problem which remains difficult to solve even after a posteriori aggregation of non-significant regions to significant ones.

Thus, the fuzzy connected method is modified in the following lines: First, not only one object, but the different objects or regions the user wants to differentiate, are designated and labeled. Second, in order to avoid thresholding, the affinity to any seed can be computed and the labeling of the pixel can be done according to the maximum affinity. In practice, instead of computing all the affinities for every pixel, it proves faster to label the pixels in the course of the computation. These modifications have five important consequences: a) Several labeled objects are obtained at once. b) The segmentation results are generally improved. c) There is no need to fix any threshold. d) The results obtained with the modified method can be easily compared with those from the semi-automatic watershed-based method we have developed. e) Since multiple seeds for the same OOI can be used, the evaluation of the parameters (mean and variance) is improved.

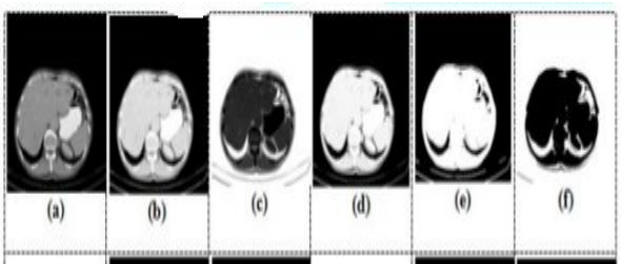

Fig.3 Liver Image Captured from MRI using Watershed Method

(a) Original Image, (b)Gray Scale Thresholding (c and d) The Segmentation Obtained with Watershed Method.(e) Noise (f) After Correction Noiseless.

International Journal of Data Mining Techniques and Applications
Volume: 05 Issue: 02 December 2016 Page No.118-120
ISSN: 2278-2419

The results from this test can be summarized as: a) The introduction of the concept of competition in the algorithm of fuzzy connected-based segmentation is really powerful and the results of segmentation are much better than the "no competition" variant. b) For this specific example, the competitive fuzzy connected-based approach outperforms the competitive watersheds method significantly, even with a small number of seeds. Figure 2 displays the original image (2a), the result of a gray scale thresholding (2b) and the segmentation obtained with the two methods (2c and 2d) as specified in the captions. Since this type of image contains many artifacts and noise, it is more difficult to perform gray level thresholding than expected (2b). The methods proposed here are well suited in this case. The segmentation results obtained with the watershed approach (2c) and the competitive fuzzy connectedness method (2d) are quite correction.

VI. COMPARISON OF FUZZY CONNECTED METHOD AND WATERSHED METHOD

In Table 1 shows the comparison two interaction methods with the following parameters. How the nature of output image is obtained, Spatial Information is rejected, Region-Continuity is average, and Computation Complexity is less in Fuzzy Connected Method and Average in Watershed method. Noise Immunity, Detection of Multiple Objects, Automaticity and Accuracy are applied the results are showed less, poor, Interactive, Average respectively.

Parameter	Fuzzy Connected Method	Watershed Method
Nature of the Output Image	Black-White	Black-White
Spatial Information	Neglected	Neglected
Region-Continuity	Moderate	Moderate
Computation Complexity	Less	Moderate
Speed	Fast	Moderate
Noise Immunity	Less	Less
Detection of Multiple objects	Poor	Poor
Automaticity	Interactive (Semi Automatic)	Interactive
Accuracy	Moderate	Moderate

Table 1: Comparison between Fuzzy Connected and Watershed Methods

VII. SUMMARY

It is agreed in this paper that the concept of fuzzy connected is very interesting in the context of semi-automatic image segmentation. However, its present implementation suffers from several drawbacks which make it very sensitive to several parameters the user has to provide. To overcome these drawbacks, we propose a new implementation of this concept, introducing the paradigm of competitive learning. This implementation attenuates some of these drawbacks, especially the need to choose a threshold. Second, we propose a method for semi-automatic segmentation, as an extension of the watershed-based method, also in presence of competition. For further research both the methods are to be extended with Noise reduction and Edge Detection Algorithms.

References

[1] E.N. Mortensen, and W.A. Barrett, Interactive segmentation with intelligent scissors, GMIP, 60, 1998, 349-384

[2] A.X. Falcão, J.K. Udupa, S. Samarasekera, S. Sharma, B.E. Hirsch, and R. de A. Lotufo, User-steered image segmentation paradigms: live wire and live lane, GMIP, 60, 1998, 233-260.

[3] S.G. Dellepiane, F. Fontana and G.L. Vernazza, Nonlinear Image Labeling for Multivalued Segmentation, IEEE Transaction on Image Processing, 5, 1996, 429- 446.

[4] J.K. Udupa, and S. Samarasekera, Fuzzy connectedness and object definition: theory, algorithms and applications in image segmentation, GMIP, 58, 1996, 246-261.

[5] B.M. Carvalho, C.J. Gau, G.T. Herman, and T. Yung Kong, Algorithms for fuzzy segmentation, Pattern Analysis & Applications, 2, 1999, 73-81.

[6] P.K. Saha, J.K. Udupa, and D. Odhner, Scale-based fuzzy connectedness image segmentation: theory, algorithms and validation, CVIU, 77, 2000, 145-174.

[7] A. Rosenfeld, Fuzzy Digital Topology, Inform. Control., 40, 1979, 76-87.

[8] J. Serra, Image analysis and mathematical morphology (London: Academic Press, 1982).

[9] S. Beucher, and F. Meyer, The morphological approach to segmentation: the watershed transformation in E.R. Doughterty (Ed.), Mathematical morphology in image processing, (New-York: Dekker, 1992), 433-481.

[10] J. Shen and S. Castan, An optimal linear operator for step edge detection, CVGIP: Graphical Models and Image Processing, 54, 1992, 112-133.

About Authors:

Currently Working as Assistant Professor in PG & Research Department of Computer Science and Applications at D.G. Vaishnav College, Arumbakkam, Chennai-600106. She is having more than 18 year's experiences. She Wrote Two Books Visual Programming for BCA, Advanced Java Programming for MCA/M.Sc.IT/BCA students of University of Madras. Her area of interest is Medical Data Mining.