3D Spinal Cord and Nerves Segmentation from STIR-MRI*

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Abstract. In this paper, we present a system for spinal cord and nerves segmentation from STIR-MRI. We propose an user interactive segmentation method for 3D images, which is extended from the 2D random walker algorithm and implemented with a slice-section strategy. After obtaining the 3D segmentation result, we build the 3D spinal cord and nerves model for each view using VTK, which is an open-source, freely available software. Then we obtain the point cloud of the spinal cord and nerves surface by registering the three surface models constructed from three STIR-MRI images of different directions. In the experimental results, we show the 3D segmentation results of spinal cord and nerves from the STIR-MRI (Short Tau Inversion Recovery - Magnetic Resonance Imaging) images in three different views, and also display the reconstructed 3D surface model.

Keywords: STIR-MRI, spinal cord segmentation, random walker algorithm, 3D point set registration, 3D affine Fourier transform, surface reconstruction.

1 Introduction

Nowadays, due to the higher medical treatment level, in the human life expectancy has increased steadily in the past few decades. The rapid rise in the elderly population leads to the increase of the cases of spinal cord diseases, such as the degenerative and osteoporosis diseases. To treat these diseases, surgery is usually needed. Recently, Minimally Invasive Surgery (MIS) becomes more popular, because it does only make small injuries and cause less pain to the patient, thus taking shorter time for recovery. When doing MIS of spinal cord, an accurate Computer Aided Diagnosis (CAD) is very important, such as the patients 3D organ model, which can help the physician avoid hurting the spinal cord and nerves. Computer Tomography (CT), Magnetic resonance imaging (MRI) and STIR-MRI provide vital information separately, and these images can be used for 3D model reconstruction of organs or regions of interest. In this paper, we

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especially focus on the STIR-MR images, which contains more spinal cord and nerves information, and try to build a 3D surface model from the segmented region.

This paper is organized as follows. We review some related works in Section 2. The 3D segmentation method based on Random Walker Algorithm [1] and 3D registration method are given in Section 3. We present the segmentation results and display the 3D surface model reconstruction in Section 4. In the end, we conclude this paper in Section 5.

2 Related Works

Since medical image segmentation has been developed for a long time, there are three main approaches; i.e. threshold-based, recognition-based, and contour-based approaches. But most of these method are concentrated on some specialized regions; for example, brain, heart, and other internal organs. The research on spinal cord and nerves segmentation is not common. Spinal cord and nerves has complicated shape and structure. It divides into branches outside the vertebral column, and the branches are really tiny. Besides, the intensity, shape, and position of spinal cord and nerves may be so different from one slice to the next. Because of the above reasons, accurate spinal cord and nerves segmentation is still a challenging problem.


3 3D Segmentation and Surface Model Reconstruction

3.1 3D Random Walker Segmentation Algorithm

For medical image segmentation, it is hard to use an automatic method to obtain precise results. Even using learning-based methods, due to the variations between patients, it is still a difficult job without human labeling. Therefore, we use a semi-automatic segmentation method, Random Walker Segmentation proposed by Grady [1], in this work. In this method, an user has to initially give some labels as input seed points for background and foreground. The probabilities of all unlabeled points reaching the labeled points, are computed by this algorithm.