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Semi-automatic spinal cord segmentation for radiation treatment planning

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INTRODUCTION

Radiation treatment planning requires organ segmentation to optimize dose distributions. There are two kinds of segmentation methods: manual segmentation and automatic or semi-automatic segmentation. The manual segmentation is a time-consuming slice-by-slice procedure and it is difficult to reproduce results. The automatic or semi-automatic methods include statistical pattern recognition and model-based techniques, and it is generally true that tuning parameters must be changed between images. We propose a fast approach using threshold processing and linear interpolation along slice axis to segment the spinal cord in CT images. Preliminary results are shown.

METHOD

At first, the rectangular ROIs (Region Of Interest) including the spinal cord were extracted to remove uninteresting regions from whole CT image slices. Threshold processing based on CT values can extract the spinal cord; however, multiple objects including the spinal cord may come out. To remove objects other than the spinal cord, the thinness ratio (circularity) was calculated for each extracted object because the spinal cord on a slice plane is shaped like a circle. The definition of thinness ratio is shown in Fig. 1.

Noting that the thinness ratio increases when the object shape approaches a circle, the object giving the maximum thinness ratio in a slice image was considered as the spinal cord. We have found that this approach can easily extract the spinal cord from transaxial images with high contrast, while causing problems for low-contrast images. To overcome this problem, linear interpolation along the slice axis was applied for low-contrast images.

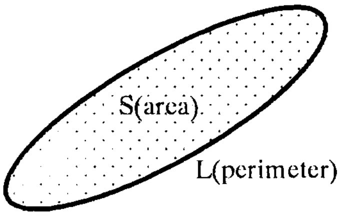
RESULT AND DISCUSSION

A preliminary result using the Visible Human Male data set (see Table I) is presented here. Figure 2 shows a sample image of the data set. Figure 3 depicts a rectangular ROI image (100x100) extracted from the sample image. Figure 4 is the segmented result overlaid with the ROI image. It took only a few seconds to complete the whole process using a Pentium II 450MHz CPU.

Recently the processing speed such as image acquisition and image display has become close to real time; and therefore, we are targetting real-time segmentation.

Table I. data set

Pixel size	512 x 512
Byte per pixel	2
Slice thickness(mm)	3
Spacing between slices(mm)	3
Number of slices	30



thinness ratio $= 4\pi S / L^2$

S : *area of object*

L : *perimeter of object*

Fig. 1 Definition of thinness ratio

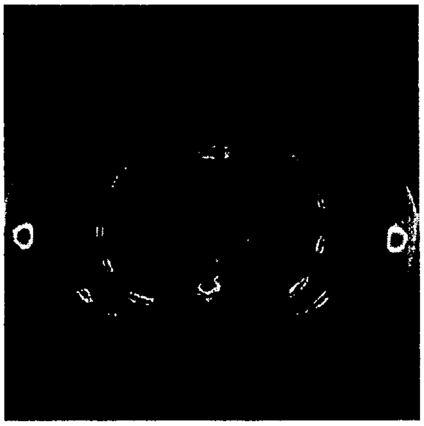


Fig. 2 Original image

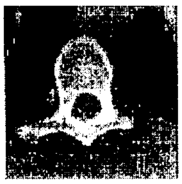


Fig. 3 Extracted ROI image

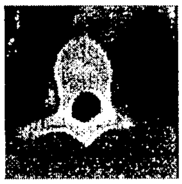


Fig. 4 Segmented result superimposed on the ROI image