平成 28 年度修士論文

題目　Vertebral Region Segmentation in CT Image Based on Morphology and Graph Cuts Algorithm

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Bone metastasis, one kind of complications, which are easily caused by advanced cancers, could be manually detected by radiologists using medical imaging techniques in the past years. However, it takes up much labor force, and has low detection rate of early bone metastasis because radiologists cannot become aware of imperceptible changes on vertebrae of patients. Computer Aided Diagnosis (CAD) systems, that are based on highly complex pattern recognition, can assist doctors to make relative efficient and accurate diagnosis. As one of several important steps in CAD system, the performance of segmentation of Region of Interest (ROI) has direct influence on following image processing even on diagnosis precision of bone metastasis. There are some algorithms having been proposed until now to realize objective segmentation which is required to have higher accuracy. Mathematical morphology is an automatic segmentation method which can guarantee that the segmentation result has clear boundary. However, there is a limitation for it to segment multiple regions from medical image. Graph Cuts algorithm has interactive platform, and can extract all ROIs in case that some seed points in foreground (object) and background are chosen by radiologists manually. However, the similar gray level between vertebrae and other regions in Computed Tomography (CT) images causes the failure of segmenting border with Graph Cuts.

In order to obtain vertebral segmentation with higher efficiency and accuracy, a method combining mathematical morphology based on labeling algorithms and Graph Cuts, is proposed in this thesis. It inherits high precision edge extraction with mathematical morphology and labeling algorithm, and also applies the interactive interface of Graph Cuts algorithm. The segmentation processes for vertebrae are initiated performing format conversion, initial segmentation of ROI and binary with appropriate threshold. Mathematical morphology is applied to denoising after the region of vertebra being filled with connected component labeling algorithm. Final segmentation of vertebrae can be acquired with Graph Cuts in which some seed points should be chosen from foreground (object) and background, respectively.

The method was tested on 100 CT slices chosen from 10 patients, and the results of vertebral segmentation were assessed quantitatively by comparing with segmentation performed independently by radiologists. About evaluation of vertebral segmentation with the proposed method, *True Positive Rate* (*TPR*) is 96.72[%], and *False Positive Rate* (*FPR*) is 1.84[%], that both have better performance than conventional Graph Cuts algorithm, 90.07[%] of *TPR* and 2.32[%] of *FPR*. Besides, the efficiency of Graph Cuts in the proposed method, 379.58 [ms/slice] based on the similar seed points and 338.50 [ms/slice] based on the adaptive seed points, is also better than conventional Graph Cuts algorithm, 408.98[ms/slice].

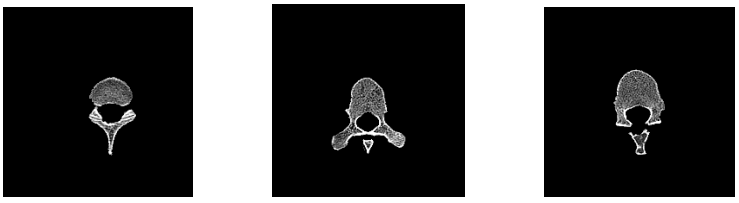

Fig. Vertebral segmentation with Graph Cuts algorithm