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Tumor Segmentation on CT Images Using Globally Optimal Single Surface Detection

Introduction The problem of accurate and reproducible tumor definition is essential for radiation therapy in treatment planning as well as for volumetric assessment of tumor response to therapy. To improve the quality and reproducibility of the tumor definition as well as to accelerate the workflow of the oncologist and radiologist , novel automated segmentation tools are needed. Nodule and lesion segmentation remain challenging and are not yet solved satisfactorily.

Method and Material Our tumor segmentation algorithm is based on a single surface detection algorithm using regional properties. To use this method for tumor segmentation, we created a framework which requires a small amount of user input that is then followed by an ellipsoidal transform on the data. The framework then uses the single surface detection method optimizing the intra-class variance. The surface detection method utilizes the techniques of shape probing, graph search and parametric maximum-flow.

Our algorithm was tested for the segmentation of liver tumors from 15 CT image data sets and lung tumors from 18 CT image data sets. Surface positioning error and volume measures compared with expert-traced results were computed.

Results Our segmentation method demonstrated low surface positioning errors and robust performance compared with the expert-traced results. The average signed and unsigned positioning errors for liver lesions were -0.07 ± 0.31 and 0.77 ± 0.16 voxels. For lung tumors, the average signed and unsigned positioning errors were -0.03 ± 0.10 and 0.78 ± 0.13 voxels. Volume measures also showed accurate and robust correlation with expert-traced results with 90% of acceptable percentage in terms of volume overlap.

Conclusion We have implemented a novel single surface detection method that minimizes the intra-class variance and provided a framework for tumor segmentation. Experiments on liver lesions and lung tumors show good applicability with sub-voxel accuracy achieved for both cases.