AbstractID: 11323 Title: Simultaneous Delineation of Bladder and Prostate from 3D CT: An Optimal Graph-Theoretic Approach

Introduction Precise target delineation is critical for a successful 3-D radiotherapy treatment planning for prostate cancer treatment. Automatic segmentation techniques are urgently needed due to large amounts of 3-D image data that require increased time for manually contouring. We report a novel segmentation method for simultaneous 3-D surface detection of bladder and prostate, incorporating both edge and shape information. Our method is the first attempt to employ an arc-weighted graph-based representation for simultaneous surface detection, which delivers a globally optimal solution in low-order polynomial time.

Method and Material The core of our approach is to represent segmentation problem using an arc-weighted graph, which permits a wider spectrum of constraints into 3-D graph-theoretic approach. Hard surface interacting constraints are enforced in interacting regions to preserve geometric relationships between partially interacting boundary surfaces of prostate and bladder. Soft smoothness shape compliance is further employed to incorporate shape information. Two globally mutually interacting optimal surfaces are then computed by solving a maximum flow problem.

Testing the approach was accomplished on 13 CT data sets from different patients. Computed results were compared with expert-traced standard.

Results Our method yielded high-quality segmentation, despite of the low saliency of CT images. The average probability of correct detection was 0.958 ± 0.024 for bladder and 0.852 ± 0.046 for prostate. The average probability of false detection was 0.115 ± 0.062 for bladder and 0.136 ± 0.045 for prostate. The unsigned surface distance error was 1.04 ± 1.00mm for bladder and 1.38 ± 1.08mm for prostate. The percentage of expert-defined surface points with less than 5mm from our computed surface was 99% for bladder and 98.6% for prostate.

Conclusion We develop a novel segmentation method for simultaneous detection of bladder and prostate. A sub-voxel accuracy was achieved, which demonstrates the promise of our algorithm.