3279 Atlas-Based Segmentation in Head and Neck IMRT

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Purpose/Objective(s): IMRT is driven by volumetric segmentation, which necessitates greater care and accuracy when contouring structures. The anatomical contouring process requires both clinical knowledge and ample workload. This project evaluated the performance of atlas-based anatomical segmentation algorithms for head and neck (H&N) cancer patients.

Materials/Methods: Twenty IMRT head and neck cases were randomly and retrospectively chosen. These cases included their planning CT scans and physician-drawn structures. The twenty cases were divided into two sets: Set 1) atlas creation database (ten) and Set 2) patient test cases (ten). Two methods were investigated in this project using Velocity Medical Solutions' VelocityAI software: Method-1) atlas was created using all ten cases to create an average patient atlas; and Method-2) all atlases were applied to test cases for each patient case with an additional new methodology that performs automated comparison and organ refinement.

Results: Ten OARs were compared to physician-drawn structures using the Dice similarity coefficient (DSC). Both methods performed quite well on the brain, brainstem, spinal cord, eyes and mandible with mean DSCs ranging between 0.607-0.947 and 0.671-0.933 for method-1 and method-2, respectively. However, the two methods did not perform as well on the oral cavity, parotids and sphincter muscle with mean DSCs ranging between 0.408-0.690 and 0.474-0.706 for method-1 and method-2, respectively. Method-2 yielded slightly better structures than the other method with little clinical modification needed for successful structures.

Conclusions: Both methods have great potential and can be used to quickly provide a starting point for H&N OAR delineation. The use of multiple atlases exhibited in method-2 shows the most promise for reducing the uncertainty with expert-drawn structures.

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3280 Dosimetric Evaluation and Optimization of a Novel CBCT Estimation Method for Adaptive Radiation Therapy (ART)

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Purpose/Objective(s): Cone beam CT (CBCT) has become a powerful tool for ART, which is potentially useful for lung cancer treatments. However, the accumulated dose from CBCT over a 33 Fxn lung cancer treatment course is not negligible and may be of clinical significance. Previously we developed a novel CBCT estimation method using patient prior information to reduce imaging dose significantly. The accuracy of the method was evaluated using only anatomical criteria. Here we provide a comprehensive dosimetric evaluation of this unique method to optimize its performance for dose calculation in ART.

Materials/Methods: Patients' prior CBCT or simCT datasets are used as the prior information, and the new patient CBCT volume to be estimated is considered as a deformation of the prior patient volume. The displacement vector field (DVF) is solved by minimizing deformation energy and maintaining new projection data fidelity using a nonlinear conjugate gradient method. The new CBCT volume is then obtained by deforming the prior image volume according to the solution of the DVF. The 4D CT images of 10 lung cancer patients at inhale and exhale phases were used to simulate prior and new CBCT images. CBCT images were estimated from projections simulated within different scan angles (30, 60, 90 and 360deg) along different directions (AP, Lateral, Oblique, and Dual-angle: AP+Lat) with different projection numbers (30, 60 and 120). IMRT treatment plans were created in the iplan (BrainLab) TPS using the Monte-Carlo dose calculation algorithm to deliver a dose of 2Gyx33 Fxn to the PTV contoured in the prior CBCT images. The plan was then mapped to the estimated CBCT and new CBCT images and dose was recalculated. The dosimetric error was evaluated by comparing the percentage difference between the PTV coverage, PTV min, mean, and max dose in estimated images and new CBCT images.

Results: The estimation errors for PTV coverage, PTV min, mean and max doses were all within 1% for CBCT estimated from 60proj in 360deg scan angle. The errors for PTV coverage and min dose incrementally increased to 8% and 13% as scan angle was reduced to 30deg. Increasing projection number to 120 did not lead to significant improvement, while reducing proj num to 30 for 360deg scan only increased the PTV min dose error to 13%. Changing scan directions had minimum effects on estimation accuracy. PTV mean and max doses were not sensitive to the change of scan parameters, and errors were within 2% for all the estimated images.

Conclusions: The method is able to achieve accurate dosimetric estimation using 60proj acquired over 360deg, which represents a tenfold reduction of the current CBCT imaging dose. PTV min dose is most sensitive to the reduction of scan angle and proj num while PTV mean and max doses are least sensitive to change of scan parameters.

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3281 Dosimetric Evaluation of MRI-based Treatment Planning for Lung Volumetric Modulated Arc Therapy VMAT Plans

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Purpose/Objective(s): The objective of this study is to evaluate the dosimetric accuracy of VMAT dose calculation using only a T1 MR image of the lung. MRI based radiotherapy dose calculation techniques have shown promising results for disease sites with complex heterogenous anatomy such as pelvis, head and neck, and brain. For lung, tissue heterogeneity is more pronounced due to the large density difference between the lung, its surrounding tissues and bones. This study aims to evaluate the dosimetric effect of MRI-based dose calculation for lung VMAT cases. Using an automated segmentation algorithm with thresholding, a T1 MRI lung volume is segmented into 4 distinct types - air, lung, tissue, and bone. Each voxel is then assigned a fixed CT number.