

AbstractID: 8580 Title: Volumetric Analysis of Moving Structures in Radiation Treatment Planning

Purpose: The purpose of this study is to design and validate a set of metrics for volumetric analysis of moving structures in radiation treatment planning.

Method and Materials: 4D CT based treatment planning in thoracic radiation oncology requires a specific set of metrics for quantitative comparison of moving treatment planning volumes. For each pair of reference and test volumes axial overestimation and underestimation areas as functions of z coordinate are defined as the areas bounded by the set of contours in each axial slice. The axial underestimation and overestimation volumes are defined as integrals of corresponding areas along the z-coordinate. The sagittal and coronal under/overestimation areas and volumes are defined analogously. An efficient and robust implementation for polygonal contours was obtained by using the Delaunay triangulation. The above metrics were used to compare different methods for determination of demonstrable respiratory motion of the GTV (iGTV) in 4-D CT datasets. 27 patients with non-small-cell lung cancer (stage I: 17, stage III: 10) who underwent 4-D CT simulation were studied. The iGTV was determined manually by (a) combining the GTV contours from 10 phases ($GTV_{AllPhases}$) (b) combining the GTV contours from two extreme respiratory phases (0 and 50%) ($GTV_{2Phases}$) (c) contouring using the MIP (GTV_{MIP}) and (d) contouring using the MIP followed by modification with visual verification in individual respiratory phases ($GTV_{MIP_Modified}$). For comparison of different approaches, $GTV_{AllPhases}$ was used as the reference.

Results: The proposed metrics were successfully applied to 27 patients to show that iGTV as determined from GTV_{MIP} and $GTV_{2Phases}$ underestimated iGTV as determined from the reference $GTV_{AllPhases}$. Modification of iGTV determined from GTV_{MIP} based on visual verification of contours through each individual phase reduced the degree of underestimation.

Conclusion: The constructed metrics provide very good tools for volumetric analysis of moving structures.