AbstractID: 5847 Title: A surface based method for adaptive treatment planning in real-time - application to prostate IMRT

Purpose: To develop a method for adaptive treatment planning in real-time based on fast structure segmentation using deformable surface model and surface based dose optimization.

Methods and Materials: A parametric surface model is used for target segmentation with in-room acquired CT images, starting from a superimposed template structure on the image dataset. The 3D surface of the target is obtained as tensor product of B-spline curves, and the 2D contours are generated using B-spline interpolations for direct manipulations. The interpolating points and cross-sectional contours are displayed in multiple views of reformatted CT slices. The target surface is updated in real-time following the shifts of interpolating points. The algebraic representation of the target uses polar angle and height in cylindrical coordinates as parameters. The surface normals are calculated, particularly on the portion interfaced with a critical structure, such as the rectum. The dose and the dose gradients on the target surface are calculated. Adaptive dose optimization is performed without the outline of critical structures. The optimization conditions are that the surface dose is uniform; the surface dose gradients are normal to the surface for dose conformity; and the gradients on the portion interfaced with critical structures are maximized for the best critical structure sparing.

Results: The modeled prostate surface agreed with axial contours within 2 mm. Optimized intensity maps based on surface-based conditions intensity optimization were similar to that of an optimized template plan, thus small adaptive changes of the plan could be made.

Conclusion: The feasibility of real-time treatment planning relies on fast structure segmentation and characterization of the target volume changes from the simulated dataset. B-spline surface model gives an accurate and smooth representation of the target and simple surface-based optimization conditions can be applied for efficient for real-time planning.