AbstractID: 3483 Title: An Efficient Algorithm for Image-based Dose Deformation and Accumulation

Purpose: Construction of the accumulated dose distribution for fractionated radiation delivery in deforming organs based on automated image segmentation and deformable registration of primary and secondary CT datasets.

Method and Materials: Femur heads, bladder, rectum and prostate were automatically segmented in CT image pairs with 3D deformable triangular surface models. A displacement vector was estimated for each voxel using deformable point-based registration. The vertices of corresponding adapted surface meshes provided corresponding anatomical landmarks, and the deformation between the surfaces was interpolated to every voxel according to a physics-based deformation model. The deformation vector field was applied to warp the primary to the secondary CT, and to warp the dose distributions of the simulated treatments to the original treatment plan. The performance of the registration algorithm to match surfaces was evaluated by warping the bladder and the rectum from one patient to a second patient and measuring surface distances between the warped and target structures. The performance for dose warping was assessed by visually comparing the planned dose in the secondary image to the dose warped from the primary to the secondary image.

Results: The surface difference between the warped and target bladder (rectum) was 0.65±0.12 mm (1.80±0.97 mm) in 26 patients. The quality of the dose distribution and the variation of dose volume histograms between warped and un-warped plans appeared reasonable on visual inspection. Efficient image resampling techniques enable visual evaluation of the warping result at interactive speed on standard hardware. The surface warp took 2 seconds, plus 5 seconds for warping the 79x60x35 dose grid.

Conclusion: The work indicates the potential for efficient dose re-planning based on secondary CT imaging during treatment and automated image-processing. Validation work is necessary to assess the effect of different volumetric deformation models on the resulting dose distribution.