AbstractID: 8521 Title: Image-based modeling of tumor shrinkage or growth: towards adaptive radiation therapy of head-and-neck cancer

Purpose: Understanding the kinetics of tumor growth/shrinkage represents a critical step in quantitative assessment of therapeutics and realization of adaptive radiation therapy (ART). We establish a novel framework for image-based modeling of tumor change and demonstrate its performance**.**

Methods and materials: Due to the non-conservation of tissue, similarity-based deformable models are not suitable for describing the tumor growth/shrinkage process. Under the hypothesis that the tissue features in the tumor volume or the boundary region are partially preserved, we model the tumor kinetics by a two-step procedure: (1) auto-detection of homologous tissue features shared by the planning CT and subsequent on-treatment CBCT images using the Scale Invariance Feature Transformation (SIFT) method; (2) establishment of voxel-to-voxel correspondence between two input images for the remaining spatial points by a basis spline interpolation. The correctness of the tissue feature correspondence is doubly assured by a bi-directional association procedure, in which the SIFT features are mapped from planning CT to CBCT and reversely. Only the associations common to both mappings are used in BSpline interpolation. A number of synthetic digital phantom experiments and five clinical HN cases are used to assess the performance of the proposed technique.

Results: Image contents of the digital phantoms are modified in various ways. It is found the proposed technique can identify any of the changes faithfully. The subsequent feature-guided BSpline interpolation reproduces the “ground truth” with an accuracy better than 1.3mm. For the clinical cases, the new algorithm works reliably for a volume change less than 30%, suggesting the time span between two consequent imaging sessions should not be unreasonably far away in order for the model to function properly.

Conclusions: An image-based tumor kinetic model has been developed to better understand the tumor response to radiation therapy. The technique provides a solid foundation for future head-and-neck ART.