AbstractID: 13721 Title: Ultrafast Deformable Image Registration for Potential Adaptive Total Body Irradiation Therapy using Helical TomoTherapy

Purpose: An ultrafast deformable image registration model was developed to register planning computed tomography (CT) with the on-treatment megavoltage CT (MVCT) of the total body irradiation (TBI) patients using Helical TomoTherapy. The proposed technique constitutes a valuable platform for MVCT-based dose verification and MVCT auto-contouring for adaptive radiotherapy.

Methods and materials: MVCTs acquired prior to each treatment using Helical TomTherapy unit (HT, TomoTherapy Inc, Madison, WI) can not only be used for patient's setup, but it also contains the patient's updated anatomy, forming the basis for adaptive radiotherapy. A free form B-Spline deformable registration was carried out to derive the patient's interfraction anatomical variations by co-registering the planning CT with the individual treatment fraction MVCT. A Mattes mutual information function was used as the metric function and the limited memory Broyden-Fletcher-Goldfarb-Shanno algorithm (L-BFGS) was employed to optimize the multi-dimensional metric function. Upon successful registration, the resulting deformation field was extracted and utilized to transform the manual contours of regions of interest (ROIs) on planning CT to MVCTs. The registration accuracy was evaluated by comparing the mapped contours and manually segmented contours on MVCT. Four patients with acute myelogenous leukemia treated with TBI using HT were used to test the proposed algorithm.

Results: A free form deformable image registration model has been developed. Application of the algorithm to four leukemia patients indicates that clinically satisfactory results are achievable with a spatial accuracy better than 2mm for ROI contours mappings. As compared to the cross correlation metric function, the proposed registration model was found to be two orders of magnitude more efficient whilst a same accuracy level could be achieved.

Conclusions: A regional deformable registration model was implemented and it provides a powerful tool for auto-contouring MVCTs to maximize the potential of the adaptive TBI therapy using HT.