AbstractID: 10563 Title: Meshless deformable model based 3d registration of prostate image guided radiotherapy

Purpose: To develop a high performance registration method for mapping objects of interest in treatment images to the 3D image domain of the planning CT in IGRT for improvement of treatment accuracy and potentially adaptive online radiotherapy.

Method and Materials: A meshless deformable model has been adopted in a registration framework. The target and reference images are first registered rigidly using bony structures. Then the reference image is sampled around the volume of interest and the adjacent critical functioning organs to form a meshless point cloud, which deforms under the influence of internal structural constraints as well as intensity differences between target and reference images. The meshless model acted recursively with traditional image feature based registration to determine the optimal mapping between the reference and the target. The method was evaluated on 15 prostate datasets (each dataset includes CT and CBCT of one patient). The structures of interest in all images were delineated by a radiation oncologist (serving as the gold standard) in our new validation framework. We evaluated our method by quantitatively measuring the convergence of critical clinical objects and major image features in the reference and registered target image.

Results: For all 15 datasets, the new non-rigid registration algorithm can build the displacement map between CT and CBCT images cropped around the prostate within an average time of $38.2(\pm2.9)$ seconds. The average volumetric similarity between the registered and the reference object are over 92%. Average distance between the registered and the reference surface is approximately 1.3mm with a maximum error under 4 mm.

Conclusion: The meshless method reduces the degree of freedom in the solution space and significantly enhances the registration speed without loss of accuracy. Furthermore, the established meshless framework minimizes manual intervention during the registration thereby enhancing the potential for efficient clinical implementations.