AbstractID: 5603 Title: A novel non-rigid image registration algorithm for radiation therapy using p-element based biomechanical model (PBM)

Purpose:
Daily pre-treatment volumetric imaging can be acquired with onboard CT or MR simulator. This imaging can be used for adaptive radiotherapy (ART) provided deformations occur on time scales >15-30 min. A necessary component of ART is automatic, fast and robust deformable registration. An algorithm using p-element based biomechanical model (PMB) is presented. Its performance is compared with published algorithms.

Method and Materials:
PBM achieves successful registration using a coarse mesh by "automatic adaptivity", whereby convergence is achieved by iteratively increasing the order of the polynomial used for fitting without necessarily requiring mesh refinement (i.e. distance scaling of mesh element), resulting in linear scaling in computation time. A conventional biomechanical model (BM), which utilizes second order polynomial, requires mesh refinement at each iteration for convergence, resulting in an exponential scaling in computation time. For intra-modal deformations, the performance of PBM was compared with Demons method (DM) for T1-weighted MR and CT using simulated transformations and clinical data.

Results:
DM resulted in certain anatomical structures either missing or misplaced since it assumes that pixel intensity does not change between the target and reference images for the same structure. PBM and BM provided similar results in terms of faithful structural connectivity and accuracy, and were superior to DM. The number of p-elements in PBM was 360, much less than the 1616 elements in BM, allowing for automatic mesh generation to be more robust for PBM. Furthermore, mesh refinement was necessary in BM in order to achieve convergence. The computation time for PBM was 15% less than BM, and 100% more than DM.

Conclusion:
PBM provides a superior accuracy compared to DM. It has accuracy comparable to BM but with reduced computation time.