AbstractID: 13207 Title: Quantitative evaluation and optimization of an algorithm for non-rigidly registering serial CT images to the planning CT during prostate-cancer radiation therapy

Purpose: To identify the optimal parameters for a non-rigid registration algorithm and to assess its accuracy for deformably registering serial prostate cancer CT images acquired during radiation therapy. Such registrations are needed to map organ segmentations from the planning CT onto daily replanning CTs and for cumulative dose reconstruction.

Method and Material: Data sets were provided by the Netherlands Cancer Institute and consisted of multislice CT images of 17 prostate cancer patients each scanned 10-12 times during radiation therapy. One physician contoured bladder, rectum, and prostate on all images. The small-deformation, inverse-consistent linear-elastic (SICLE) registration algorithm (TMI 20: 568, 2001) was used to estimate the deformation vector field (DVF) that simultaneously matched CT intensity (intensity matching, IM) and the three segmented regions (contour matching, or CM). IM was used to find DVFs mapping the first image (source) to each of the other subsequent images (target images) for all patients. IM + CM and CM was assessed for a pair of images for each of 10 patients. Endpoints included comparing deformed source contours to manually drawn target contours via the Dice similarity Index (DSI) and Pearson Correlation Coefficient (CC). CC and difference images (deformed source-target) were used to quantify IM accuracy.

Results: IM+CM vs. IM increased mean DSI from 0.78 to 0.95, 0.84 to 0.92, and 0.77 to 0.90 for rectum, prostate, and bladder, respectively, with CC improvements of 14%, 9%, 12%. Compared to CM, IM+CM produced better soft-tissue registration outside contoured regions, with minimal IM loss relative to IM alone.

Conclusion: IM registrations failed to produce acceptable registrations in about 1/3 of the cases, with accurate rectal deformation proving to be especially challenging. Simultaneously contour and intensity matching gave the best overall registration accuracy.

Supported by Grant P01 CA 116602.