AbstractID: 7534 Title: Deformable registration of kV/MV projection images for quantifying patient setup offsets and anatomical deformations in head and neck IMRT

Purpose: To develop an intensity-based deformable image registration solution for detecting and quantifying both rigid and non-rigid variations typically seen in head-neck IMRT treatment, including patient position offsets, involuntary organ movements and anatomical deformations. ***Methods & Materials:*** A two-step deformable image registration solution was developed by implementing a BSpline-based non-rigid representation of head-neck anatomy and similarity metrics of mean square differences and normalized mutual information. kV and MV X-ray projection images were registered in two successive steps. First, rigid-body registrations were performed to determine patient position offsets in terms of translations and in-plane rotations. The outputs were then used to initiate deformable registrations from which non-rigid local displacements between reference and target images were extracted in the form of deformation vector fields. Validation studies were performed for patient CT simulation data, phantom images, and setup images of 12 head-neck IMRT patients. The accuracy of the registrations were examined by comparing registration results with known variations in simulation, phantom images, a set of pre-shift/post-shift confirmation images, and with a feature-based registration by subtracting coordinates of well-identified anatomical points in patient setup images of different fractions. ***Results:*** For all three data sets with known changes, the mean (SD) error in rigid-body registration was 0.3 mm (0.3 mm) for translations and 0.1° (0.1°) for in-plane rotations. The error in deformable registration of image pairs with known changes was 0.5 mm (0.9 mm). For patient images with unknown non-rigid local displacements, the agreements between deformable registration and the feature-based registration were within 2.0 mm (96.5% of registered points). ***Conclusion:*** A 2-step deformable image registration solution was developed and validated for registering kV/MV X-ray projection images. The accuracy of the registration is adequate for detecting and quantifying both rigid and non-rigid variations typically seen during patient setup and target anatomy localization for head-neck IMRT delivery.