AbstractID: 12825 Title: Accuracy limits for projection-to-volume targeting during arc therapy

Purpose: To investigate the fundamental accuracy limit of estimating local configuration of tumors using projection-to-volume alignment between a small spread of radiographs and a reference CT volume.

Method and Materials: We used a real thorax CT volume at the inhale state as the reference and synthesized two target volumes at another inhale and exhale state based on two corresponding real volumes of the same patient. The projection radiographs of limited-angle scans with six arc lengths (12^o, 18^o, 24^o, 36^o, 60^o and 90^o) centered at three angles (0^o, 45^o and 90^o) were generated from these two target volumes. The tested projection-to-volume registration method used a nonrigid B-spline motion model, a cost function composed of a sum of squared difference (SSD) measure and a regularizer to encourage local invertibility, and the conjugate gradient optimization method implemented in a 4-level multi-resolution scheme. Registration was also performed on radiographs corrupted by Poisson noise with two different incident intensities simulating 10^5 and 10^4 counts per ray.

Results: The experiments demonstrated the potential accuracy of limited-angle projection-to-volume registration. Registration accuracy can be sensitive to angular center, tends to be larger along the projection direction, and tends to decrease away from the rotation center, whereas registration accuracy tends to be maintained at different noise levels and extents of deformation.

Conclusion: This investigation indicates the potential of position monitoring of high contrast tumors during treatment using a small spread of projections without implanted markers. This investigation may also help optimally design various parameters for position monitoring, such as projection arrangement (hardware configuration), noise/dose tradeoffs, and temporal/spatial accuracy limits.

This work was supported in part by NIH grant P01 CA59827.