AbstractID: 9430 Title: Comparison of multiple 3D-3D anatomy-based rigid image registration methods for prostate patient setup before external-beam radiotherapy

Purpose: To assess the variability in translational setup corrections computed via several different 3D to 3D rigid registration methods and conditions using only the image intensity information.
Method: Fifteen pairs of male pelvic CTs were rigidly registered using multiple registration metrics, methods, and image content. Similarity was measured using mutual information and mean-squared-difference. The registrations were iterated using two different search algorithms. The effect of image resolution was observed by downsampling in each slice by factors of 2 and 4. The effects of image content were observed by using the entire image and then using only bony landmarks in the similarity measures. The uncertainty associated with the choice of source and target images was revealed by switching the roles of the two registered images. For each image pair the translational shifts for all the registration methods and conditions were compiled and the standard deviation around the mean shifts was computed.
Results: Reversibility errors ranged from 0 to 1.8 mm for the various algorithms and conditions. The radial standard deviation of the various methods and conditions was 0.8 mm when the entire image was registered and 0.3 mm when only bony landmarks were used. Down-sampling by a factor of 2 improved robustness with only a small loss in precision. Mutual information failed in nearly all cases when the images were thresholded to isolate bony features.
Conclusions: Rigid image registrations have an intrinsic uncertainty that depends on the algorithm, the resolution of the images, and the features used to establish rigid congruence. Registration uncertainty should be accounted for in planning margins and patient setup procedures. In the absence of an absolute ground truth test of registration accuracy, the standard deviation in the shifts calculated by several different methods provides a useful estimate of that uncertainty.

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