

AbstractID: 11593 Title: Prostate localization using daily cone-beam computed tomography imaging: assessment of accuracy using similarity metrics and observation-based measures

Purpose: To estimate the accuracy of daily CBCT/CT prostate rigid-body registrations using different similarity metrics (SM) and observation-based measures, and to determine the tradeoffs of these methods.

Methods and Materials: Daily CBCT images of 29 prostate cancer patients were retrospectively analyzed; 14 patients with calcifications in the prostate (*calcification* dataset) and 15 patients without calcifications (*no-calcification* dataset). Three groups of test registrations were performed. *Test1:* 70 CT/CBCT pairs in the *calcification* dataset were registered using 17 SMs and their various parameters (6580 registrations), and compared using the calcification mismatch vector length as an end-point. *Test2:* Using the 4 best SMs based on *Test1*, 75 CBCT/CT pairs from the *no-calcification* dataset were registered using visual comparison as the endpoint (300 registrations), i.e. the accuracy of prostate contour overlays on CBCT images were visually ranked. *Test3:* For the top ranked SM based on the above 2 tests, the registration accuracy was estimated from 356 CBCT/CT registrations from 11 patients in the *calcification* dataset with and without calcification filtering from registrations.

Results: *Test1:* Incremental-sign-correlation (ISC), gradient-correlation (GC), gradient-difference (GD), and normalized-cross-correlation (NCC) were the SMs with the least vector length errors ($\mu \pm \sigma$: $1.6 \pm 0.9 \sim 2.9 \pm 2.1$ mm). *Test2:* Using visual criteria, 2 of the 3 reviewers ranked GC slightly higher than the other SMs. *Test3:* Using GC, 96% of registrations (341/356 registrations) showed less than 3 mm error when calcifications were filtered. Corresponding errors were L/R: 0.1 ± 0.5 mm, A/P: 0.8 ± 1.0 mm, and S/I: 0.5 ± 1.1 mm. Existence of prostate calcifications increased the number of successful registrations to 97%.

Conclusion: The estimated <3 mm error was approximately 96% (1.1 mm SD) using GC, ISC and GD similarity measures. These measures offer a relatively quick and accurate means of assessing CBCT/CT registrations in the routine clinical setting. User observation is a necessary requirement in the overall QA of the process.