AbstractID: 3541 Title: Towards Intra-operative Dosimetry in Prostate Brachytherapy

Purpose: Intra-operative dosimetric optimization of TRUS-guided prostate brachytherapy implants requires localization of seeds relative to prostate [1]. Analytical tools are available to intra-operatively tailor an implant-plan, thereby accounting for inevitable deviations [2].

Method and Materials: The majority of the practitioners have C-arm fluoroscopes in the treatment room, making intra-operative dosimetry feasible with little additional cost. The obstacles towards intra-operative dosimetry are: (a) discerning the 3D poses of fluoro images, (b) registering fluoroscopy to TRUS, and (c) establish seed correspondences in multiple fluoro images. We address the first two issues by single-image-based fluoroscope tracking (FTRAC) fiducial with salient attributes: small dimensions (*3x3x5cm*); need not be close to the anatomy of interest; auto-segmentable; and mathematically robust to segmentation, calibration, and image distortion errors. The 3D coordinates of the segmented seeds are calculated upon resolving the correspondence of seeds in the multiple X-ray images, achieved by an algorithm called MARSHAL. We formalize seed-matching as a network flow problem, which has salient features: (a) extensively studied exact solutions, (b) performance claims on the space-time complexity, (c) optimality bounds on the final solution.

Results: The FTRAC fiducial tracks a C-arm to an accuracy of *0.56mm* in translation and 0.33^{o} in orientation, comparable to commercial tracking systems. On pre-segmented images, MARSHAL achieved 100% correct matching in simulation experiments. In experiments on a precision-machined phantom, the FTRAC and MARSHAL correctly matched and reconstructed 98.5% of the seeds with a mean 3D accuracy of 0.63*mm*, while the mean error for the mismatched 1.5% of seeds was only 0.91*mm*.

Conclusion: Performance of FTRAC and MARSHAL appear to be adequate for intra-operative dosimetry in brachytherapy.

[1] Nag et al. Int J Radiat Oncol Biol Phys 51(5):1422-30
[2] Todor et al. Phys Med Biol 48(9):1153-71

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