AbstractID: 10731 Title: Permanent brachytherapy seed localization via iterative forward projection matching (IFPM) algorithm using intraoperative cone-beam-CT sinogram projections

Purpose: To experimentally validate a new algorithm for reconstructing the 3D positions of implanted brachytherapy seeds from intraoperatively acquired 2D cone-beam CT sinogram projections.

Methods and materials: The iterative forward projection matching (IFPM) algorithm consists of finding the 3D-seed geometry that minimizes the sum-of-squared-intensity differences between computed projections of the candidate seed array positions and experimentally acquired auto-segmented projections of the implanted seeds. Starting with clinically reasonable initial-estimate of the seed configuration, e.g., the ultrasound pre-plan, IFPM iteratively refines the 3D-seed coordinates and the imaging view-points until the computed and measured projections match. Four Pd^{103} post-implant patients were scanned using an Acuity digital-simulator with a full 660 projections conebeam-CT(CBCT) for post-implant dosimetry. 3-10 x-ray images were selected from the CBCT sinogram and were preprocessed to create the binary seed-only images. 2D Gaussian functions centered at each binary image centroid were used to create gray scale images. The Gaussian width was reduced when IFPM converged. To quantify IFPM accuracy, the reconstructed seed positions were forward projected and overlaid with the measured seed images and found the nearest-neighbor-distance between computed and measured seed positions for each image-pair.

Results: For all example cases, the mean registration error was found to be about 1.2mm; the IFPM converged in 16-21 iterations and in 4-7 iterations following reduction of Gaussian blurring function width with computation time of about 1.9-2.3 minutes/iteration on a 2 GHz processor.

Discussion: The IFPM algorithm avoids the need for matching corresponding seeds images on each projection as required by standard back-projection methods. Also it has a potential to accommodate incomplete data by iteratively recreating the overlap seeds on the matching computed projections. Our preliminary results of the patient's studies demonstrated that ~1mm accuracy in reconstructing the 3D-positions of brachytherapy seeds from the measured 2D projections.

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