AbstractID: 13193 Title: Localizing intracavitary brachytherapy applicators from conebeam CT x-ray projections via a novel iterative forward projection matching (IFPM) algorithm

Purpose: To present a novel method for reconstructing the 3D pose (positions & orientations) of radio-opaque objects of known but arbitrary shape from a small set of 2D x-ray projections, in support of intra-operative brachytherapy planning.

Methods and materials: IFPM finds the object pose by minimizing the sum-of-squared-intensity-differences (SSD) between the computed and experimentally-acquired auto-segmented object projections. Starting with an initial estimate of the applicator pose, IFPM iteratively refines the pose parameters (positions and 3 Euler angles) until the SSD converges. The applicator model is a mesh of discrete points derived from a complex combinatorial geometric model of the actual applicator. Three pairs of computed and measured projection images, with known imaging geometry, are used. Projection images of an intrauterine tandem were acquired from Acuity digital-simulator. Image pre-processing step was performed to create blurred binary applicator-only images. To quantify IFPM accuracy, the reconstructed 3D pose of the applicator model was forward projected and overlaid with the measured images and the dice similarity coefficient (DSC) was computed for each image-pair.

Results: In the numerical simulations, the tandem and colpostats positions (x, y, z) and orientations (α, β, γ) were estimated with (0.28, 0.3, 0.37) mm and (0.9, 0.8, 1.0)^{o} accuracies, respectively. For the measured tandem images, the DSC was better than 0.88 for each image-pair.

Discussion: We have developed a new, accurate, and completely automatic method to localize radio-opaque applicators of arbitrary shape from x-ray projections. Also, no lateral film is required. By localizing the applicator internal structure and the sources, the effect of intra/inter-applicator attenuation can be included in the resultant dose distribution. Further development and validation tests with tandem and colpostats will be performed for the accurate and robust applicator/sources localization in ICB patients.

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