Purpose: To provide a flexible environment for experimenting with various combinations of input images, arc length and resolution, projection geometries, search methods, and cost functions for projection-to-volume ("2D-3D") image registration

Methods: A MATLAB graphical user interface was developed to align a series of orthogonal pairs of radiographs acquired during arc therapy to projections through a region of interest of a reference CT image volume. The projection and volume geometries are based on a distributable image registration toolbox. Experiments can use single or orthogonal radiograph series, simulations from second input volumes, modified volumes of the reference CT such as additive noise, and variable regions of interest. Two forward projection algorithms (Siddon and separable footprint) are incorporated, both mutual information and SSD metrics can be used, and search engines include conjugate gradient (for SSD), simplex, as well as direct mapping of the cost function in a user-defined local search region.

Results: A number of initial experiments have been performed with this interface. The tradeoffs of local contrast and detail versus angular range, image noise, and angular resolution for identifying local transformations have been explored. The impact of removing, maintaining, or reducing CT signals outside the region of interest for alignment to radiographs has been tested. Modifications including temporal regularization to monitor movement during arc rotation are easily implemented within this open framework.

Conclusions: This environment is continuously expanding, and should support collaborative investigations across institutions on common problems and solutions for projection-based image registration.

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