AbstractID: 1172 Title: 4D CT imaging via breath-hold and pyramid-based non-linear image registration

We propose a novel approach to reconstructing a 4D CT data set using 2-3 3D breath-hold CT scans at different fixed phases (end-inspiration, end-expiration and a middle-phase) from a single-slice spiral CT scanner and pyramid-based non-linear image registration. The pyramid algorithm divides image space into varying resolutions from coarsest to finest and measures the similarity between corresponding blocks from the source and target image sets thus avoiding local extreme traps. Parameters such as the iteration number and the factor balancing similarity and energy constraints within the algorithm can be tuned to obtain images at different phases. The registered volume is used as the new source image and the procedure is repeated until the most-recently generated image closely matches the target image. The algorithm was tested by acquiring ten known-phase image sets simulating breath-holds of a modified first-aid thorax phantom fitted with an inflatable balloon. The balloon was inflated and deflated using a mechanical oscillator with a phase indicator and breath-holds were simulated by turning the oscillator off at desired phases. Full inflation and deflation balloon images were used to reconstruct intermediate phases; an additional phase was added to test the improvement in the reconstruction accuracy. The maximum deviation in the reconstructed and measured balloon volumes were 5% and 3% with the 2 and 3 simulated breath-hold data sets, respectively; the maximum contour deviation was 2 mm and 1 mm respectively. With this approach, we can implement breath-holds during CT simulation but not during treatment delivery still, enabling 4D treatment planning.