AbstractID: 11686 Title: Respiratory Motion Correction of Cone-Beam CT in Abdomen Using a Patient-Specific Motion Model

Purpose: Respiratory motion reduction methods to improve cone-beam CT quality (CBCT) have focused on the thorax, but reduced tissue contrast in abdomen poses additional challenges. We report a method to correct CBCT in abdomen, using a motion model adapted to the patient from a prior respiration-correlated CT (RCCT) image set.
Method and Materials: Model adaptation consists of nonrigid image registration that maps each RCCT image to a reference image in the set, followed by principal component analysis (PCA) to reduce noise in the resultant deformation fields and relate them to diaphragm position and motion (inhalation or exhalation). CBCT projection images are sorted into subsets according to diaphragm position in the images and reconstructed, yielding a set of low-quality 3-D images. Model application deforms the CBCT images to a reference CBCT in the set; combining all images yields a high-quality CBCT image with reduced motion artifacts. We also investigate a simpler correction method, which does not use PCA and correlates motion state with respiration phase. Comparison of contrast-to-noise ratios of pixel intensities within kidneys relative to surrounding background tissue provides a quantitative assessment of relative organ visibility.
Results: Evaluation of CBCT examples in upper abdomen shows that streaking artifacts and blurring of liver, kidneys, spleen, bowel and implanted fiducial markers are visibly reduced with PCA-model-based correction. Phase-based motion correction without PCA reduces blurring less effectively; in addition, implanted markers appear broken up, indicating inconsistencies in the correction. Model-based motion correction shows the highest contrast-to-noise ratios in the cases examined.
Conclusion: Motion correction of CBCT in abdomen is feasible and yields observable improvement. The PCA-based model is an important component: first, by removing noise; second, by relating deformation to diaphragm position rather than phase, thus accommodating breathing pattern changes between imaging sessions.