AbstractID: 7260 Title: High-quality four-dimensional CBCT reconstruction with virtual projections

Purpose: Due to significantly reduced number of projections per phase, the quality of 4DCBCT images is often degraded by view-aliasing artifacts. Acquisitions using slow-gantry-rotation or multiple-gantry-rotations can improve the 4D images, but at the cost of extra scan time, which may render them clinically impractical. Here we report a new progress in developing high-quality 4DCBCT without prolonging the acquisition time.

Method and Materials: The technique developed here is to reduce the view-aliasing artifacts resulted from insufficient sampling by properly "borrowing" projections from other phases. To do so, a motion model linking the data of different phases is derived from deformable registrations of coarse (conventional) 4DCBCT phases with consideration of patient's simulation 4DCT. This 4D patient model allows us to properly transform projections from other phases onto the phase under reconstruction, leading to increased sampling in 4DCBCT. The proposed approach is quantitatively evaluated with motion phantoms and two clinical lung cases for a number of metrics, including RMSE of CT numbers, image uniformity, and contrast-to-noise-ratio (CNR).

Results: An important finding of this work is that, by the aid of "virtual projection" derived from coarse 4DCBCT and 4D (or breath-hold 3D) simulation CT images, the 4DCBCT view-aliasing artifacts can be dramatically reduced, resulting in greatly improved CT-number accuracy, image uniformity and CNR in all testing cases. Compared with the conventional 4DCBCT, the overall reduction in CT number fluctuation is ~38% and the CNR increase is ~65%.

Conclusion: Improving the trade-off between image quality and scan time is the key to making 4D onboard imaging practical and clinically useful. A novel strategy for enhancing 4DCBCT images without increasing scan time and radiation dose has been developed for onboard CBCT imaging system. The method should find valuable applications in patient setup, dose verification in 4D, as well as adaptive radiation therapy in the future.