AbstractID: 5694 Title: Enhanced 4D CBCT imaging for slow-rotating on-board imager

Purpose: Four-dimensional (4D) cone-beam CT (CBCT) is currently obtained by respiratory phase binning of the acquired projections followed by independent CBCT reconstruction of the rebinned projections for each phase. Due to the significantly reduced number of projections in a single phase bin, the quality of 4D-CBCT images is severely degraded. In this work, we develop a technique to combine the data from all phases for greatly enhanced 4D CBCT.

Method and Materials: 4D-CBCT data were acquired with "extremely-slow-gantry-rotation" protocol (1 deg/sec) on a Varian Acuity system. The respiratory phase binning was achieved by automatic texture matching of the CBCT projections, and 4D-CBCT images were subsequently obtained by Feldkamp reconstruction of the phase-binned data. Finally, to enhance the quality, the 4D-CBCT images were superimposed via deformable registration based on maximum mutual information and BSpline model. The method was quantitatively evaluated with numerical and physical phantom experiments. Three clinical cases are also being investigated.

Results: The numerical and physical phantom studies showed that 4D CBCT resulted in less motion artifacts than 3D CBCT, however, the view-aliasing artifacts are visible in 4D CBCT images due to limited number of projections being used for reconstructing each phase, this led to large fluctuation of the CT numbers in any uniform region and generally reduced contrast-to-noise ratio (CNR). In comparison, the proposed 4D CBCT technique scientifically improved the CT number accuracy, the image uniformity, and the CNRs.

Conclusion: A novel technique for 4D CBCT imaging with a slow-rotating onboard imager has been developed. It integrates information of different respiratory phases to achieve an enhanced image quality. The improvement on the CT number accuracy is extremely important to image-guide radiation therapy for on-line treatment planning and off-line dose verification.