

AbstractID: 4791 Title: 4D cone-beam CT (CBCT) using an on-board imager

Purpose: To develop an artifact-free four-dimensional (4D) cone-beam CT (CBCT) imaging technique for image-guided radiotherapy, and to optimize the image quality, scanning time, and patient radiation dose with respect to acquisition parameters such as the number of gantry rotations, gantry-rotation speed, and x-ray tube current.

Method and Materials: A Varian Trilogy™ system was employed for this study. To sort CBCT projections in terms of patient breathing phase, a CT-opaque fiducial was adhered to the patient skin and tracked automatically in the projection space, and the phases of the fiducial trajectory were used to tag the projections. Projections after phase-binning were subsequently reconstructed to yield 4D-CBCT images. To reduce/eliminate view-aliasing artifacts due to limited number of projections in each phase, both “multiple-rotation” and “slow-gantry-rotation” strategies were investigated. Quantitative evaluation and comparison were performed with a motion phantom for the following acquisition settings: (i) varying number of gantry rotations (1~8) with all other scanning parameters kept the same; (ii) varying x-ray tube current together with the number of rotations while keeping the radiation dose constant, namely, 1-rotation-80mA, 2-rotation-40mA, 4-rotation-20mA, and 8-rotation-10mA; (iii) varying gantry-rotation speed (1deg/sec~8deg/sec). Three patient cases were used in the study.

Results: The image quality, represented by relative error (RE), varied nonlinearly with the number of rotations: RE reduction became less pronounced as the number of rotations increased. After 3~5 rotations, the benefit resulting from more rotations started saturating. When the dose level was kept the same, the images of 1-rotation-80mA and 8-rotation-10mA acquisitions had the largest and smallest REs, respectively. Similar RE reduction behaviors were found when slowing down the gantry-rotation speed. For the patient cases, 4D images were obtained with negligible motion or view-aliasing artifacts.

Conclusion: We have successfully demonstrated that the commercially available OBI system can be utilized to acquire artifacts-free 4D-CBCT images without increasing the patient radiation dose.