AbstractID: 14056 Title: Tumor motion assessment with 4D Cone Beam CT using Prior Image Constrained Compressed Sensing (PICCS)

Purpose: 4D-CBCT provides capability of in-room measurement of breathing induced tumor motion before the treatment. However, to ensure sufficient image quality for motion assessment, investigators have proposed to prolong the data acquisition from 1 minute to 4 minutes or more. In this paper, we present a method which could generate high quality 4D-CBCT images and support tumor motion extraction using the standard 1-minute protocol with an on-board imager.
Method and Materials: The enabling technique is Prior Image Constrained Compressing Sensing (PICCS) reconstruction method. PICCS maintains high temporal resolution for each phase-bin image after resorting the projection data. Within each phase bin, although the number of projections is vastly undersampled, PICCS reconstruction ensures high SNR characteristics since the SNR is primarily determined by the prior image reconstructed from all cone-beam projection data without gating. Patient studies were conducted for validation. The first case was a 1-minute CBCT scan; the second case, although originally a 4-minute scan, was used to simulate a 1-minute scan by down-sampling the projection data by 4 times. For both cases, both FBP and PICCS algorithms were performed to reconstruct 4DCBCT images; a deformable registration method was also applied to extract the tumor motion. For the second case, a comparison was also made between 4-minute FBP images and 1-min PICCS images.
Results: For 1-minutes scans from both studies, PICCS images showed superior image quality to FBP ones; as a result, PICCS images generated physically acceptable tumor motion profiles which agree well with direct observation. Compared with FBP images from the 4-minute scan, PICCS images from the simulated 1-minute scan showed higher SNR and more physically accurate motion profile.
Conclusion: Clinical feasibility of 1-minute PICCS-4DCBCT was demonstrated. The proposed method is able to reconstruct high SNR 4D images for tumor motion assessment, without slowing down the data acquisition.