AbstractID: 13342 Title: A First-Order Method for Low-Dose 4D CBCT Image Reconstruction by Compressed Sensing

Purpose/Objective: In four-dimensional cone-beam computed tomography (4DCBCT), there is a trade-off between the image quality and radiation dose depending on the gantry speed. A higher gantry speed is desirable for short scanning time and low radiation dose, but the image quality is degraded because it leads to reduced number of projections in each individual respiratory phase. The aim of this study is to develop a novel compressed sensing based formalism for high quality 4DCBCT image reconstruction with sparse and potentially low dose projections.

Methods/Materials: To maximally utilize the information from the under-sampled projection data acquired with low mAs protocol, a compressed sensing method with total-variation is employed. We first solve an unconstrained LASSO (least absolute shrinkage and selection operator) problem based on least-square criterion regularized by total-variation. The least-square criterion reflects the fidelity of the measured line integrals, and the image total-variation suppresses the noise while preserving the edge information. Then, the LASSO problem is updated and solved repeatedly by Bregman iterations. The performance of the proposed algorithm is demonstrated through a series of phantom experiments, and the results are compared to those of conventional filtered back-projection (FBP).

Results/Discussion: The phantom studies have shown artifacts free images can be obtained with as small as 35 noisy or low current projections per phase, which is adequate for clinical 4DCBCT (7~10 phases) reconstruction without slowing down the gantry rotation. Additionally, the algorithm converges an order of magnitude faster to the optimal solution than steepest-decent methods (e.g. POCS) with the same requirement on computer memory. With such small number of projections, the conventional FBP failed to yield meaningful 4DCBCT images.

Conclusions: 4DCBCT images are attainable using sparse and low tube current projection data. The method significantly reduces the radiation dose and scanning time as required by conventional 4DCBCT imaging based on FDK technique.