AbstractID: 13543 Title: Low dose and edge-preserving CBCT reconstruction by compressed sensing with anisotropic diffusion filter utilizing prior images in IGRT

Purpose: Radiation dose incurred to patients during repeated CBCT scans has caused great concerns. Decreasing the number of projections reduces the radiation dose, but this leads to significantly degraded image quality. In this work, we propose a method to solve the sparse data CBCT reconstruction problem by compressed sensing (CS) technique with anisotropic diffusion filter (ADF) utilizing prior images.

Method and Materials: The reconstructed images from full projections taken in the first day of the patient¡¯s treatment were used as prior knowledge. In a subsequent scan of the same patient on a different day, the prior images were utilized as an initial guess in the iterative reconstruction process with limited projections. Our CS method minimized ADF of image subject to the data fidelity by using a constrained optimization strategy. The data fidelity constraint is enforced by the simultaneous algebraic reconstruction technique and the image constraint is minimized by the standard steepest gradient descent method. A series of phantom and patient studies were carried out.

Results and discussion: A CS-based CBCT reconstruction technique with ADF has been established. The technique allows us to effectively take advantage previously obtained CBCT images and provides high quality CBCT images with undersampled projections. With the prior knowledge assisted CS-ADT method, we were able to use as little as 36 projections to obtain high contrast-to-noise images with spatial resolution comparable to images reconstructed with fully sampled data. With such sparse projection data, the traditional FDK-only reconstruction failed to yield meaningful images. View aliasing artifacts seen in FDK images were greatly suppressed in images reconstructed by the prior knowledge assisted CS-ADT method.

Conclusions: Use of prior knowledge and CS method provides an effective way for sparse data CBCT reconstruction. It reduces radiation dose in the repeated CBCT scans and greatly enhances image quality.