AbstractID: 13648 Title: Optimize the smoothing parameter in penalized weighted least-squares algorithm for noise reduction of low-dose CBCT

Purpose: A statistical projection restoration algorithm based on the PWLS can substantially improve the image quality of low-dose CBCT images. The performance of PWLS is largely determined by the choice of smoothing parameters. In this work, we developed a technique to obtain the optimal parameter in PWLS algorithm for the noise suppression in low-dose CBCT.

Methods and Materials: In radiotherapy, daily CBCT is acquired for the same patient during a treatment course. In this work, we acquired the CBCT with a high mAs protocol for the first session and then lower mAs protocol for the subsequent sessions. The high-mAs projections served as the goal (ideal) toward which the low-mAs projections need be smoothed by minimizing the PWLS objective function. The optimal smoothing parameter was inversely calculated by plugging both the high and low mAs projections into the derivative of the objective function. Then the obtained smoothing parameter can be used for PWLS to eliminate the noise in low-dose projections. An anthropomorphic head phantom was used to investigate the effectiveness of the proposed strategy.

Results: The optimal smoothing parameter in PWLS was obtained for each projection in a CBCT set. The noise in the low-dose CBCT images reconstructed by the FDK algorithm using the PWLS smoothed projections was greatly suppressed. Image quality in PWLS-processed low-dose CBCT is comparable to its corresponding high-dose CBCT.

Conclusion: A novel strategy was proposed to estimate the optimal smoothing parameter for the PWLS algorithm. The proposed strategy can be extended to any Bayesian-based image restoration algorithms that require pre-defined smoothing parameters.