AbstractID: 8197 Title: Dose Reduction in Kilovotage Cone-Beam Computed Tomography for Radiation Therapy

Purpose: To develop an effective method of improving low-dose kV CBCT image quality using statistics-based sinogram smoothing so that the patient's imaging dose can be greatly reduced through the use of low-mAs protocol.

Method and Materials: Based on the sinogram noise properties, a penalized weighted least-squares (PWLS) objective function was constructed, and the ideal sinogram was then estimated by minimizing the PWLS objection function. The variance of sinogram data was chosen as the weight the PWLS objective function and it determined the contribution of each measurement. To preserve edge information during noise reduction, we proposed an anisotropic quadratic form penalty. The quadratic form penalty encourages equivalence between neighbors and the anisotropic penalty provides the mechanism to control the influence of different neighbors according to its corresponding gradient. The proposed anisotropic penalty tends to discourage equivalence between neighbors if the gradient is large, thus edge information will be preserved in the smoothed sinogram. Two experimental phantom studies were performed to demonstrate the effectiveness of the presented algorithm. CBCT projection images were acquired by the ExactArms (kV source/detector arms) of a Varian Trilogy™ treatment system.

Results: Noise in the reconstructed CBCT image acquired with the low-mAs protocol was greatly suppressed after the proposed sinogram image processing, without noticeable sacrifice of the spatial resolution. For both phantoms, image quality of the low-dose (100 mAs/projection) CBCT reconstructed from the sinogram processed by the PWLS criterion is comparable to its corresponding normal-dose (800 mAs/projection) images in terms of contrast-to-noise ratio and fine structures preservation.

Conclusion: The presented PWLS sinogram smoothing algorithm reduces CBCT radiation dose by a factor of 1/8 without compromising the quality of reconstructed images.