AbstractID: 3850 Title: A Direct, Empirical Method for X-ray Scatter Correction in Digital Radiography and Cone-Beam CT

Purpose: X-ray scatter poses a severe physical limitation to image quality in cone-beam CT (CBCT), resulting in contrast reduction, image artifacts, and lack of CT number accuracy. We report and demonstrate the performance of a novel scatter correction method in which scatter fluence is estimated directly in each projection from pixel values at the edge of the detector behind the collimator leaves.

Method and Materials: The algorithm operates on the assumption that signal behind the collimator leaves is attributable to x-ray scatter. The 2D scatter fluence is estimated by interpolating between pixel values measured along the top and bottom edges of the detector behind the collimator leaves. The resulting scatter fluence is subtracted from each projection to yield primary-only images for CBCT reconstruction. Performance was investigated in phantom experiments on an experimental CBCT benchtop, and the effect on image quality was demonstrated in patient images (head, chest, and pelvis sites) obtained on a preclinical system for CBCT-guided radiation therapy.

Results: The algorithm provides significant reduction in scatter artifacts without compromise in contrast-to-noise ratio (CNR) – e.g., Head: cupping reduced from 10% to 2%, while breast-to-water CNR improved from 5.2% to 7.8%; Body: cupping reduced from 42% to 26% without change in CNR. Patient images demonstrate increased uniformity, accuracy, and contrast, with slightly increased noise (net increase in CNR) in all of the sites investigated. Qualitative evaluation illustrates that soft-tissue structures that are otherwise undetectable are clearly delineated in scatter-corrected reconstructions.

Conclusion: The algorithm provides a robust method for x-ray scatter fluence estimation and correction in CBCT. Operating from a single assumption without prior information, analytical modeling, or Monte Carlo, the technique is easily incorporated as a preprocessing step in CBCT reconstruction. Quantitative evaluation in phantoms and pre-clinical evaluation in patients demonstrates significant artifact reduction without degradation in CNR.