AbstractID: 12726 Title: Noise reduction with detail preservation for low-dose kilovoltage CBCT using nonlocal means algorithm

Purpose: kV-CBCT has shown enormous benefits for patient setup and treatment verification in radiotherapy. With the frequent uses of CBCT, the cumulative imaging dose to normal tissues may not be insignificant. A lower mAs protocol in CBCT acquisition reduces the dose, but dramatically degrades image quality due to excessive noise. This work studies the effectiveness of a denoising algorithm, namely nonlocal means (NL-means), in reducing noise while preserving details in low-dose CBCT images.

Method and Materials: NL-means algorithm estimates the true value of a pixel as a weighted average of all pixels in the image, where the weights depend on the similarity between the pixels. Unlike the local smoothing or filtering methods, NL-means can reduce noise while preserve details. The parameters of NL-means were optimized for the low-dose CBCT. A non-stationary correction for avoiding blurring out nonrepeated structures was examined. A CatPhan and an anthropomorphic head phantom were used to evaluate its performance.

Results: In all images tested, the noise was clearly reduced by the NL-means algorithm. In the five contrast objects, the contrast-to-noise ratios were increased significantly (mean 1.1 to 5.5), and even higher than those in high-dose CBCT (mean 3.0). Line pairs with spatial resolutions 1 to 5 lp/cm were more distinguishable. Finer lines (6 -7 lp/cm) were blurred out compared to the high-dose CBCT. For the anthropomorphic head phantom, the suppressed noise resembled the desired white noise. The noise in all structures was reduced while the details and fine structures were well preserved. The image appears to be of similar or even higher quality than high-dose CBCT.

Conclusion: Results on a CatPhan and an anthropomorphic phantom demonstrated that NL-means effectively reduced the noise while preserved most fine structures in low-dose CBCT.