AbstractID: 6965 Title: Improving noise-resolution tradeoffs in x-ray CT imaging by statistical image reconstruction

Purpose: To assess the potential of a statistical image reconstruction (SIR) algorithm, penalized alternating minimization (AM) [IEEE TMI 26: 283] for improving image quality, relative to filtered back projection (FBP), for a given imaging dose. Minimizing the x-ray CT imaging dose is an important goal both for CT-guided radiotherapy and for imaging of pediatric patients and screening healthy populations.

Method and Materials: Synthetic datasets with Poisson noise were formed from cylindrical phantoms with a variety of simulated high and low contrast features. A penalized AM algorithm based on separable surrogate penalty functions was implemented and investigated for Good's roughness penalty, an edge-preserving log-cosh penalty, and a novel penalty on local transmission fluctuations, all of which were applied only to adjacent pixels. Simulations were performed for a Somatom Plus 4 third generation geometry. Image blur (resolution) was specified in terms of the FWHM (σ) of the Gaussian, which when convolved with the truth image, best matched the estimated image. Resolution was varied by adjusting the filter cutoff frequency for FBP and the Lagrange multiplier for AM. Noise was quantified by image intensity variance in a uniform region.

Results: For a fixed photon fluence, penalized AM images had smaller variances than FBP at all image blur levels, although the differences were not significant for low spatial resolution and low contrast features. However, for clinically relevant $\sigma < 2$ mm, the advantage of AM increased with increasing spatial resolution and contrast. For example, at $\sigma = 1$ mm, FBP had 48% and 24% larger variances for 75% contrast inserts with 0.5 mm pixels and 10% contrast with 1 mm pixels. The three penalty functions had comparable performance.

Conclusion: Regularized AM SIR has the potential to realize signal-to-noise ratio gains equivalent to 30% imaging dose increases.

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