

Purpose: With advancement in computed tomography (CT) reconstruction and dose reduction technologies, e.g., Model-Based-Iterative-Reconstruction (MBIR) and Adaptive-Statistical-Iterative-Reconstruction (ASiR), there is potential for significant dose reduction in clinical practice; therefore, it is immensely desirable to have a benchmarking of dose reduction steps to ensure un-compromised diagnostic image-quality at optimally reduced dose levels. Purpose of this work was to develop and evaluate a new projection domain noise insertion tool that can emulate lower dose scans using routine dose scans, and can provide a benchmarking guide for clinicians and physicists to achieve optimal dose levels without multiple scans of the patient.

Methods: In order to emulate lower dose CT projections at reduced signal-to-noise-ratio (SNR), a normally distributed random noise (quantum and electronic) was added to the transmission data obtained from initial scan. The estimate of variance was obtained using initial projections with appropriate scaling to represent true x-ray photon-flux for desired dose reduction factor. For validation of the method, a GE multi-slice CT system was used to acquire a set of multi-dose data for cylindrical and anthropomorphic phantoms. A comparison of emulated vs. acquired scans was made at different dose levels (upto 1/56th) relative to a baseline higher dose. Image noise, Modulation Transfer Function (MTF), Noise-Power-Spectrum (NPS), and artifacts were compared between the emulated low dose scans and the corresponding acquired scans. In addition, few clinical case studies were also used to compare the imaging performance in clinical data.

Results: Initial results for the presented noise emulation method showed very good agreement with noise, MTF and NPS from actual acquired scans at significantly reduced dose levels, demonstrating immense potential in dose reduction studies and clinical protocol optimizations.

Conclusions: The noise emulation tool has potential to provide a benchmarking guide to explore optimal dose levels without having multiple scans of the patient.