AbstractID: 6989 Title: Denoising of Monte Carlo Dose Distributions via Wavelet Threshold Denoising

Monte Carlo (MC) dose distributions may be post-processed via statistical estimation techniques to make an improved estimate of the true underlying smooth dose distribution (Deasy (2000) *Phys. Med. Biol.* **45**: 1765-1779). We demonstrate wavelet threshold denoising of MC dose distributions.

Wavelet transforms are fast linear transforms similar to Fourier transforms. A key property of the wavelet transform is that a sampled rough function (such as MC noise) gives wavelet transform coefficients which are more nearly equal in amplitude than those of a sampled smooth function. Wavelet hard-threshold denoising sets to zero wavelet coefficients which fall below a threshold; the signal is then reconstructed. We applied wavelet threshold denoising to two cases: a dose distribution generated by 10-MeV electrons incident on a water phantom with a step-heterogeneity, and secondly, a 2 cm x 2 cm pencil beam dose distribution generated using the ITS MC code, the ICCR lung-like test geometry, and the associated 6 MV photon spectrum. In both cases, with a suitable value of the threshold parameter, voxel-to-voxel noise is suppressed without significant introduction of bias, even where sharp interface effects occur in the ICCR example. We implemented the computationally efficient 9,7-biorthogonal filters in C. Two dimensional dose slices (120 x 120) can be denoising in a few milliseconds on a personal computer. We conclude that wavelet shrinkage denoising is a promising method for effectively accelerating MC dose calculations at least several-fold. Supported by NCI grant CA85181.