

AbstractID: 1052 Title: X-ray CT Signal Statistics

X-ray CT Signal Statistics

The statistics of X-ray computed tomography (CT) signals, such as noise variance and probability distribution functions (pdf), are important components for noise simulations or the development of statistical reconstruction algorithms. The model usually adopted for CT signal acquisition is that of a uniform quantum-counting detector, obeying Poisson statistics. In reality, CT scanners employ spatially varying polyenergetic x-ray sources with discrete detectors that integrate absorbed energy in the presence of electronic system noise and digital quantization. We present an experimental method to measure signal statistics, a model that accurately represents polyenergetic energy-integrating detectors, and analyze measurements derived from clinical CT scanners to characterize their performance. Projection data (sinograms) were obtained for phantoms fabricated as simple geometric objects (cylinders, slabs) and isolated in the scanner field of view. Attenuation profiles were accurately estimated for these objects and distributions of measurements about this mean were accumulated. Histograms of these measurements represent signal pdf's. The quantum mottle component of the noise is shown to be a compound Poisson process, with a form dependent on x-ray source spectra. Other factors found to contribute to signal statistics include electronic system noise and non-uniform flux due to bowtie filters for beam-hardening equalization. Experimental results for several scanner models over a range of scan protocols are reported.