AbstractID: 5363 Title: Stochastic Noise in CT Images

Purpose: Because diagnostic Computed Tomography (CT) imaging involves a tradeoff between image quality and radiation risk, there is great interest in determining the effects of stochastic noise on the utility of clinical tasks. The reconstruction processes used in CT result in noise properties that are non-local and anisotropic in the image domain. A commonly used approximation for computing image noise from raw measurement data was empirically tested for validity. A noise variance mapping scheme was used to estimate stochastic noise in complex anatomical scenes and was compared to variance measurements of image simulations generated with controlled amounts of synthetic noise.

Methods: The commonly assumed transformation between linear and log variance ($\sigma^2=1/Q$) was tested for Poisson random numbers with means ranging from less than one to larger than 30. Noise variance maps were generated by filtered back projection using the square of the reconstruction kernel operating on sinogram variance estimates. A series of images was reconstructed by adding Poisson noise to sinogram data, and the variance of regions of interest in the image sequence was calculated.

Results: The approximation that log variance is proportional to the inverse number of quanta fails badly for $N<10$. Estimated variance maps were found to agree with empirical measurements of image variance. The noise variance in a CT image is a slowly varying spatial function. Image simulations demonstrated that noise has a texture that is highly anisotropic and can mimic anatomic structures.

Conclusions: CT noise is a complex phenomenon. Variance maps are a useful tool for estimating noise in structured image regions where direct variance measurements fail. Fortunately most clinical scans operate at higher flux levels where the commonly used variance approximation is valid. Low-dose protocols must be carefully evaluated to determine the effects of stochastic noise on diagnostic performance.