No. 24
A FAST ITERATIVE RECONSTRUCTION METHOD BASED ON FUNCTIONAL REGIONS. Y. Zhang, N. H. Clithorne, J. A. Fessler, W. L. Rogers, Division of Nuclear Medicine, University of Michigan, Ann Arbor, MI.

Iterative reconstruction methods offer the potential for improved quantitative accuracy over filtered backprojection because they accurately model the tomograph response and Poisson counting noise as well as allowing the use of spatially-varying side-information derived from MRI or CT images. However, because of their heavy computational burden and sometimes slow convergence rate, they are not yet practical in a clinical setting—especially in 3D where the number of voxels can easily exceed a quarter million.

To decrease the computational overhead we have developed a dual-grid iterative reconstruction method where the first pixel-grid is based on segmenting the reconstruction volume into regions over which the activity is potentially smoothly varying. These “functional-pixels” can be determined by mapping organ and region boundary data obtained from MRI or CT data into the ECT data. Reconstruction is performed first using an un-regularized solution objective on the coarse grid. When coarse-grid convergence is attained the reconstruction is mapped, without smoothing, onto a conventional fine grid of square pixels and further reconstruction is performed using a regularized solution criteria. If the boundaries of these functional regions have been determined accurately, the convergence rate will be greatly enhanced. Inaccuracies in region boundaries can be accounted for with some loss in convergence rate.

Evaluation of the method in 1D and 2D simulations with noiseless data have demonstrated that, for approaches optimized, the results of the dual-grid method are up to a factor of eight lower than those using the conventional, fine-grid only method at 50 iterations. These performance advantages are likely to further increase in 3D based on the functional-pixel to fine-grid pixel ratio will generally be much smaller than in 1D or 2D.

The dual-grid method has the potential for greatly reducing the amount of computation. 3D iterative reconstruction is easy to implement and can be applied to both least-squares and maximum-likelihood solution objectives.

No. 25
A RECONSTRUCTION ALGORITHM USING SINGULAR VALUE DECOMPOSITION TO COMPENSATE FOR CONSTANT ATTENUATION IN SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY. G.T. Gullberg and G.L. Zeng. The University of Utah, Salt Lake City, UT.

The development of reconstruction algorithms to correct for constant attenuation has important application in SPECT imaging of the brain. Previously, a convolution reconstruction algorithm was developed which mathematically can be shown to be an accurate reconstruction of projections of emission sources within a constant attenuating media. The major problem with the algorithm is the severe noise amplification. The algorithm was based upon being able to represent the projection data as projections of the exponential Radon transform and uses an exponential backprojector after applying a reconstruction filter to the modified projection data. Due to the exponential backprojector, the point spread function of the backprojection has a hyperbolic cosine factor, which makes the point spread function non-local and noise amplifying. Even if window functions are applied to the filters to try to remedy the noise amplification, the window functions do not help very much to improve the image quality in a noisy reconstruction. A new algorithm is derived from the singular value decomposition (SVD) of the exponential Radon transform. Using SVD to reconstruct an image, the projection data is first backprojected using the standard tomographic backprojection without the exponential term. The point spread function of the backprojection is local and easy to regularize. Using the SVD approach, regularization is accomplished by truncating the terms with small singular values. Computer simulations show an improvement in the SVD method over the convolution backprojection method when the projection data is corrupted with noise.