

Purpose: To develop and test a novel reconstruction method that incorporates the varying attenuation properties of the full spectrum of x-ray energies generated by the x-ray tube and used to acquire the tomosynthesis projections.

Methods: The spectral reconstruction (SR) method utilizes a polyenergetic x-ray source model and reconstructs the breast volume where each voxel represents a glandular fraction. The glandularity of each voxel is approximated by a maximum likelihood (ML) estimate that takes into account the attenuation of x-rays of all energies in the spectrum and the subsequent beam hardening that occurs as they travel through the volume. A gradient descent optimization algorithm is used to compute the ML estimates of the entire volume. The SR method was used to reconstruct images of a heterogeneous breast tomosynthesis phantom and patient images. These images were compared to reconstructions obtained from a standard monoenergetic maximum likelihood expectation maximization (MLEM) iterative reconstruction method. The contrast-to-noise ratio (CNR) of masses and the Full Width at Half Maximum (FWHM) of the signal profiles in two directions of microcalcifications were assessed.

Results: The image quality of the SR phantom and patient images was higher than that demonstrated by the MLEM reconstructions. The swirl patterns of the heterogeneous tomosynthesis phantom are more clearly defined and beam hardening artifacts are greatly reduced. The images reconstructed with the SR method also demonstrated an increase in CNR of up to 81% of masses embedded in the breast tomosynthesis phantom. In the signal profile measured perpendicular to x-ray tube movement, the FWHM of microcalcifications of the SR images differed by less than 5% from that of the MLEM images.

Conclusions: SR method has the potential to greatly enhance the image quality of breast tomosynthesis images, reduce reconstruction artifacts, and provide quantitative reconstructions.