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Improvement of three-material decomposition in spectral mammography using non-local means denoising

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The accurate analysis of breast imaging is important because it has been reported that an increase in breast density of only 1% results in a 2% increase in the relative risk of breast cancer. The proteins, water, and lipids that determine breast density are important biomarkers in the diagnosis of breast cancer. In mammography, photon-counting detectors (PCDs) with energy-discrimination capabilities can cause errors in the measurement of chemical composition when the attenuation coefficient is small. This is typically the case with proteins, water, and lipids because of the low photon efficiency in each bin. In this study, a dual-energy technique for PCDs was developed based on a non-local means denoising technique for accurate material decomposition and the quantification of protein, water, and lipid content. To evaluate the proposed material decomposition algorithm, spectral images were acquired with a modeled PCD using the Geant4 Application for Tomographic Emission (GATE) version 6.0. Linear, quadratic, and rational models were used for three-material decomposition based on the spectral images acquired using the PCD. The proposed algorithm yielded the best results for the estimation of breast density, composed of three materials. It was determined that the developed approach improved the accuracy of three-material decomposition using a PCD with energy-discrimination capabilities. The presented material decomposition algorithm has the potential to improve the diagnostic accuracy of breast cancer detection based on the quantitative measurement of breast density using PCDs.

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