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A hybrid deep-learning framework based on the Wasserstein-GAN with non-subsampled contourlet transform for noise reduction in low-dose CT

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Low-dose CT (LDCT) usually reduces the dose by reducing tube current compared to the normal dose CT (NDCT), and this behavior is affected by lowering the signal-to-noise ratio (SNR), resulting in poor image quality. LDCT has negative characteristic of different noises (e.g., photon noise, electronic noise, anatomical noise, etc.). Because the image quality of low-dose CT is dominated by noise, iterative reconstruction and image processing methods have been investigated. However, these methods are still challenging. Recently, the deep-learning based noise reduction results outperform the image performance of existing methods. In this study, as an alternative approach, we propose a hybrid deep-learning framework based on the Wasserstein-GAN (WGAN) with non-subsampled contourlet transform (NSCT) for enhanced noise reduction in low-dose CT. We trained the data separately with low- and high-frequency sub-bands using the NSCT. Our results indicated that the image characteristics of the noised reduction images were nearly close to that of the NDCT images, preserving superior image features and anatomical structures. Its effectiveness was validated by comparing image performance to those from other network methods such as CNN-MSE, WGAN-VGG for LDCT noise reduction. NSCT approach is useful for the dimensionality reduction for training and its strategy was optimized by means of separation of the frequency bands for various noise components in training

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