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Virtual monochromatic computed tomography based on compressed-sensing theory for improving image characteristics

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Since the introduction of dual-source computed tomography (CT) scanners, dual-energy CT (DECT) has been popularly used in many clinical applications for material decomposition, contrast enhancement, and artifact reduction in conventional CT images. In addition, DECT may synthesize monochromatic CT images at different x-ray energies, which can be used for routine diagnosis similar to conventional polychromatic single-energy images. These images utilize all the radiation dose in the dual-energy acquisition, and are typically reconstructed using a common filtered-backprojection-based algorithm. However, the quality of the resultant monochromatic CT images is often impaired; artifacts by scatter and noise or photon starvation still may exist in the reconstructed images. In this study, we investigated a recently popular compressed-sensing (CS)-based algorithm to produce virtual monochromatic images of less artifacts and thus to improve the image quality. CS is an innovative signal processing technique used in data acquisition and image reconstruction by finding solutions to underdetermined linear systems. A systematic simulation and experiment was performed to evaluate the effectiveness of the proposed approach. Polychromatic projections were obtained at two tube potentials of 80 kVp and 140 kVp and monochromatic CT images were reconstructed using the CS-based algorithm after applying projection-domain dual-energy processing. We compared the quality of virtual monochromatic CT images to that of polychromatic single-energy images, acquired at different tube potentials and the same radiation dose.

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