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Development of a Few-View Computed Tomographic Reconstruction Algorithm Using Multi-Directional Total Variation

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Abstract : Compressed sensing (CS) based computed tomographic (CT) reconstruction algorithm utilizes total variation (TV) to transform CT image into sparse domain and minimizes L1-norm of sparse image for reconstruction. Different from the traditional CS based reconstruction which only calculates x-coordinate and y-coordinate TV to transform CT images into sparse domain, we propose a multi-directional TV to transform tomographic image into sparse domain for low-dose reconstruction. Our method considers all possible directions of TV calculations around a pixel, so the sparse transform for CS based reconstruction is more accurate. In 2D CT reconstruction, we use eight-directional TV to transform CT image into sparse domain. Furthermore, we also use 26-directional TV for 3D reconstruction. This multi-directional sparse transform method makes CS based reconstruction algorithm more powerful to reduce noise and increase image quality. To validate and evaluate the performance of this multi-directional sparse transform method, we use both Shepp-Logan phantom and a head phantom as the targets for reconstruction with the corresponding simulated sparse projection data (angular sampling interval is 5 deg and 6 deg, respectively). From the results, the multi-directional TV method can reconstruct images with relatively less artifacts compared with traditional CS based reconstruction algorithm which only calculates x-coordinate and y-coordinate TV. We also choose RMSE, PSNR, UQI to be the parameters for quantitative analysis. From the results of quantitative analysis, no matter which parameter is calculated, the multi-directional TV method, which we proposed, is better.

Keywords : compressed sensing (CS), low-dose CT reconstruction, total variation (TV), multi-directional gradient operator
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