

AbstractID: 13887 Title: 4DCT Reconstruction from Undersampled Projections using Edge-preserving Total Variation and Non Local Means

Purpose: Four-dimensional computed tomography (4DCT) is widely used in radiotherapy planning for thorax and upper abdomen to take respiratory motion into consideration. However, its high radiation dose becomes a major concern and impedes its wide application. In this work, we proposed an iterative 4DCT reconstruction algorithm with both an Edge-Preserving Total Variation (EPTV) regularization and a Non-Local Means (NLM) regularization to accurately reconstruct 4DCT images from highly undersampled projections to reduce imaging dose. **Methods and Materials:** In 4DCT, images of neighboring phases usually share similar structures, though these structures are apart from each other spatially in neighboring phases due to breathing motion. To take this temporal correlation into the reconstruction process, we propose to use NLM as a temporal regularization in 4DCT reconstruction. For this purpose, each phase of the 4DCT is iteratively reconstructed by a modified total variation method, namely EPTV method. NLM regularization is imposed in each iteration step to enhance image quality. Specifically, we consider every possible small patch in all phases. Patches spatially close to each other in successive phases are weighted averaged, with high weights assigned to similar patches. We tested our reconstruction algorithm on a NCAT phantom at thorax region and a real patient 4DCT thorax data. 4DCT images obtained from our EPTV+NLM approach are compared with those obtained from the EPTV method. Relative errors are computed and are used to evaluate the reconstruction quality. **Results:** About 40 x-ray projections for each breathing phase are enough to accurately reconstruct the 4DCT image in both test cases. The images reconstructed with NLM regularization are found to have lower relative error and hence better image quality than those reconstructed otherwise. **Conclusions:** Our proposed EPTV+NLM method is a robust approach for the 4DCT reconstruction, where NLM as a temporal regularization can considerably enhance the reconstructed image quality.