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Efficient scheme of low-dose CT reconstruction using TV minimization with an adaptive stopping strategy and sparse dictionary learning for post-processing

Key words: Low dose CT; CT imaging; Total variation; Sparse dictionary learning

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Motivation

- low-dose CT has become highly desirable because of growing concern for the potential risks of excessive radiation. However, it is challenging to maintain image quality while reducing radiation dose.
- Compressed sensing based iterative reconstruction achieves excellent imaging performance, but requires a large number of iterations. To promote clinical application of the CS-based method for low-dose CT, the reconstruction speed must be increased.

Main idea

- Inspired by compressed sensing and sparse representation, we present a complementary method for low-dose CT reconstruction.
- Our goal is to reconstruct fine enough images from low dose projections, with reduced time overhead compared with CS-based iterative reconstruction.

Method

1. TV minimization is employed to reconstruct an intermediate image, and then sparse coding is used for post processing to remove the remaining noise and yields a clinically acceptable CT image.
2. The computational cost is reduced by properly scheduling these two algorithms using an adaptive stopping strategy.

Major results

- We test our method on Shepp-Logan digital phantom in both low-current case and few-view case.

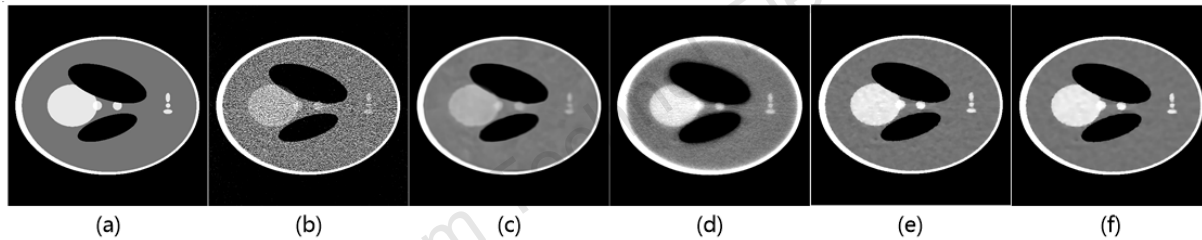


Fig. 2 Imaging results of different methods for low-current case on Shepp-logan

(a) ground truth image; (b) FBP; (c) FBP-BM3D; (d) SART; (e) ABOCS; (f) proposed method. Display window is $[-250\ 300]$ HU.

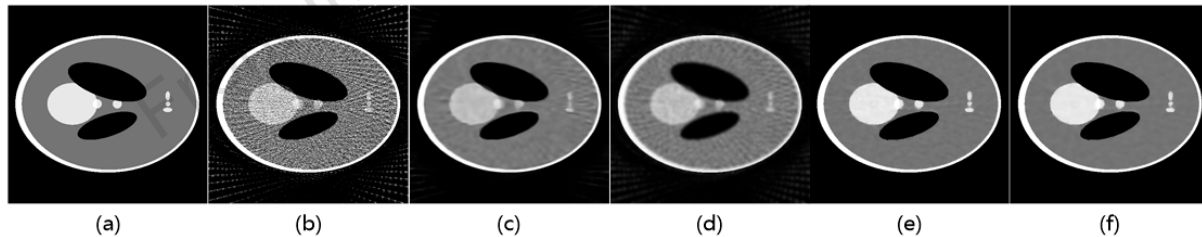


Fig. 3 Imaging results of different methods for few-view case on Shepp-logan

(a) ground truth image; (b) FBP; (c) FBP-BM3D; (d) SART; (e) ABOCS; (f) proposed method. Display window is $[-250\ 300]$ HU.

Major results (Cont'd)

- The proposed method achieves better visual and numeric results than other methods.
- Compared with ABOCS, the proposed method realizes an almost fourfold speed up because of the significant reduction of iterations.

Conclusions

- We present a novel solution for low-dose CT reconstruction by combining TV minimization and sparse dictionary learning.
- Experiments revealed that the proposed method achieves better imaging results than analytical algorithm, conventional iterative reconstruction, and a CS-based reconstruction method ABOCS.
- Specially, compared with ABOCS, the proposed method maintains better image quality with reduced time overhead.
- The performance of our method demonstrates its power and potential for low dose CT reconstruction.