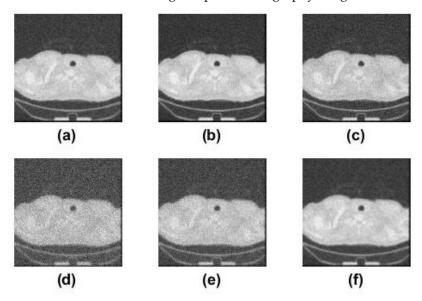# A Novel Blind Restoration and Reconstruction Approach for CT Images based on Sparse Representation and Hierarchical Bayesian-MAP

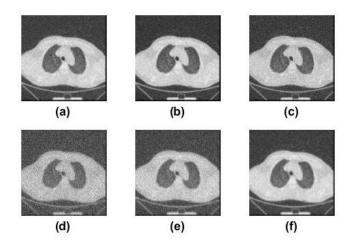**Yunshan Sun [1], Liyi Zhang [2], Yanqin Li [1,*] and Juan Meng [1]**

[1] School of Information Engineering, Tianjin University of Commerce, Tianjin 300134, China
[2] School of Electrical Automation and Information Engineering, Tianjin University, Tianjin 300072, China
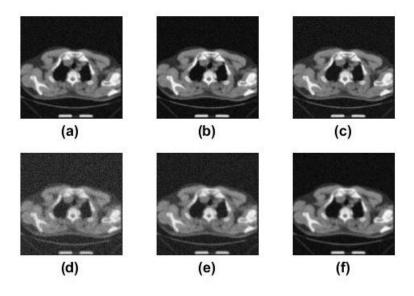* Correspondence: liyanqin-2190@126.com

This supplementary material shows additional experimental results of applying the SART, SART + TV and Wavelet methods for solving computed tomography image reconstruction problems.
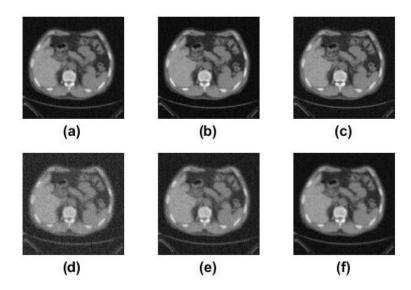

Figure S1. Experimental images and results of the first CT image. The 1st row shows the SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio=60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
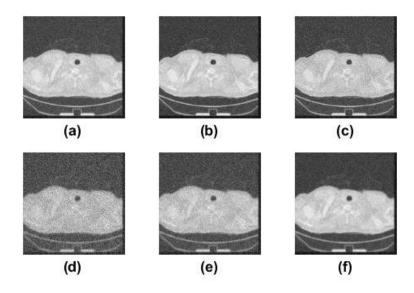
Figure S2. Experimental images and results of the second CT image. The 1st row shows the SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
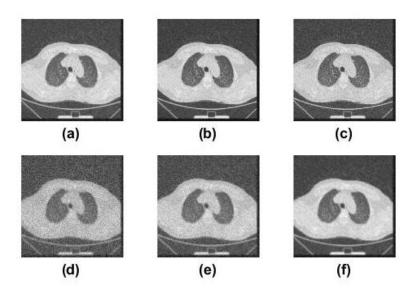

Figure S3. Experimental images and results of the third CT image. The 1st row shows the SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
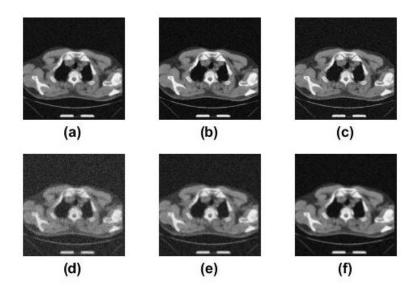
Figure S4. Experimental images and results of the fourth CT image. The 1st row shows the SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR=40dB, Sampling ratio=60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
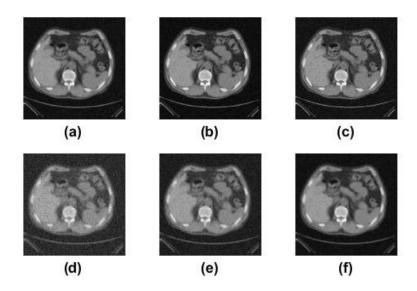

Figure S5. Experimental images and results of the first CT image. The 1st row shows the SART+TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio=60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).

Figure S6. Experimental images and results of the second CT image. The 1st row shows the SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio=60%); (**e**) the reconstruction result (SNR = 20dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
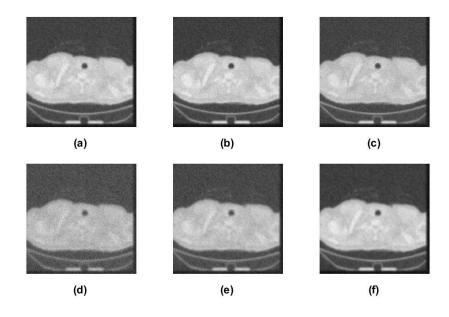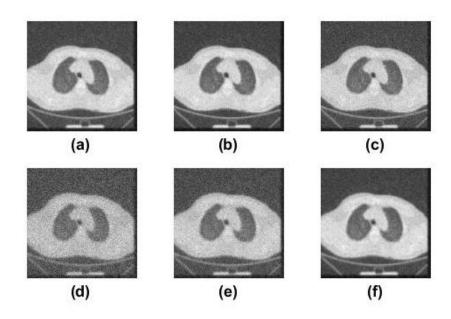

Figure S7. Experimental images and results of the third CT image. The 1st row shows the SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
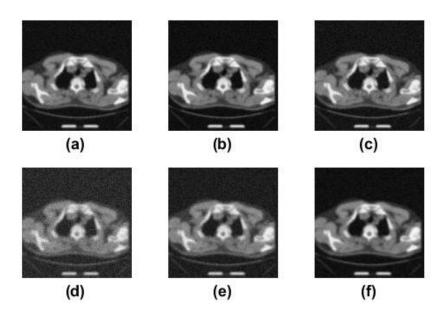
Figure S8. Experimental images and results of the fourth CT image. The 1st row shows the SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows SART + TV method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio=60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio =8 0%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).

Figure S9. Experimental images and results of the first CT image. The 1st row shows the Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).
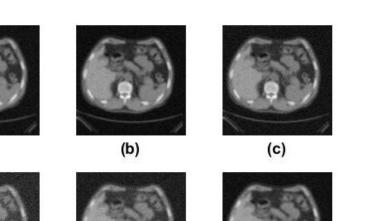
Figure S10. Experimental images and results of the second CT image. The 1st row shows the Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).

Figure S11. Experimental images and results of the third CT image. The 1st row shows the Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB) (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).

Figure S12. Experimental images and results of the fourth CT image. The 1st row shows the Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 40 dB); the 2nd row shows Wavelet method results for 60%, 80% and 100% of measurements, respectively, from left to right (SNR = 20 dB). (**a**) the reconstruction result (SNR = 40 dB, Sampling ratio = 60%); (**b**) the reconstruction result (SNR = 40 dB, Sampling ratio = 80%); (**c**) the reconstruction result (SNR = 40 dB, Sampling ratio = 100%); (**d**) the reconstruction result (SNR = 20 dB, Sampling ratio = 60%); (**e**) the reconstruction result (SNR = 20 dB, Sampling ratio = 80%); (**f**) the reconstruction result (SNR = 20 dB, Sampling ratio = 100%).