Foreword to the Special Issue on Quality Improvements of Remote Sensing Data

REMOTE sensing data are often degraded by many issues that may include the failure of onboard hardware, signal downlink, atmospheric conditions, and overall quality/age of the sensors (for example, in terms of signal-noise ratio or sharpness). These factors reduces the quality of the acquired data, making it often difficult or impossible to extract relevant information.

In the past two decades, we have seen an increased interest by the research community in the development of restoration and enhancement techniques. Specifically, the theoretical, conceptual, and algorithmic advancements in the areas of data modeling, optimization, and statistical inference have opened new opportunities to improve the quality of remote sensing data. This special issue (SI) provides a venue to the most recently developed methods and techniques.

In early 2017, a Call for Papers for this SI was distributed to the community, seeking contributions to serve as references for the state of the art in quality improvement of remote sensing data. A total of 26 papers were submitted in response to the call, and, after a peer-review process, 11 were recommended for publication and are included in this issue. The 11 articles are organized into the following groups:

1) denoising of very high resolution (VHR) optical remote sensing images (one paper);
2) restoration of hyperspectral images (three papers);
3) quality improvement and/or evaluation of SAR images (four papers);
4) reconstruction of time-series remote sensing data (one paper);
5) resolution enhancement by fusing multisource data (paper papers).

The first paper of this SI elaborates on the problem of denoising optical VHR images [item 1) in the Appendix]. Masse *et al.* present several optimizations to mitigate the high-computational complexity of nonlocal Bayes based denoising methods, aiming at improving their efficiency while keeping good denoising performance.

The next three papers mainly focus on the restoration problem of hyperspectral images. Bai *et al.* transform the task of image denoising into a high-order tensor approximation problem, and propose a hierarchical least square based non-negative Tucker decomposition method to improve both efficiency and efficacy [item 2) in the Appendix]. He *et al.* model stripes, dead lines, and impulse noise as sparse noise, and formulate a model by combining local low-rank matrix recovery and spatial-spectral total variation [item 3) in the Appendix]. Zhuang and Bioucas-Dias also make full use of the sparse and low-rank properties of hyperspectral images, and propose two fast and competitive algorithms for image denoising and inpainting, respectively [item 4) in the Appendix].

This SI also includes four papers that illustrate different approaches for improving the quality of synthetic aperture radar (SAR) data. Ma *et al.* make a broad review on recent developments of polarimetric SAR despeckling and give comparisons of several state-of-the-art methods [item 5) in the Appendix]. Abergel *et al.* present subpixellic methods for sidelobes suppression of single look complex SAR images, which can produce images with improved quality suitable both for visual inspection and further processing [item 6) in the Appendix]. Ali *et al.* evaluated three techniques for removing the Sentinel-1 “border noise” and concluded that the bidirectional all-samples are the best, which is very significant for real-time or near real-time services of Sentinel-1 data [item 7) in the Appendix]. Bueso-Bello *et al.* provide a performance evaluation of TanDEM-X quad-polarization products with the goal of validating the improvements obtained by the optimized parameters [item 8) in the Appendix].

Wang *et al.* illustrate a novel method for the processing of normalized difference vegetation index (NDVI) time-series [item 9) in the Appendix]. The approach reduces the noise caused by snow in the third-generation NDVI dataset from Global Inventory Modeling and Mapping Studies.

The last two papers aim at improving the spatial resolution of remote sensing images by data fusion. Liu *et al.* propose a trapezoid interpolation based thermal disaggregation model to generate fine resolution land surface temperature (LST) products from coarse resolution LST ones. The proposed model takes advantage of auxiliary data based on the fractional vegetation cover, the index-based built-up/bare land index, and other data [item 10) in the Appendix]. Song *et al.* present a spatio-temporal fusion method for Landsat and MODIS images aimed at high spatial and temporal superresolution. In this paper, deep learning is employed to improve the robustness of the inference [item 11) in the Appendix].

The papers in this SI represent a comprehensive review on the state of the art relative to quality improvements of remote sensing data. We believe that the new insights uncovered in these papers will open new perspectives and set a reference for future research in the field.

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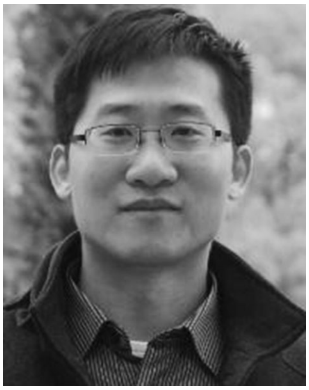
APPENDIX
RELATED WORK

1) A. Masse, S. Lefèvre, R. Binet, S. Artigues, G. Blanchet, and S. Baillarin, "Denoising very high resolution optical remote sensing images: Application and optimization of nonlocal bayes method," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 691–700, Mar. 2018.
2) X. Bai, F. Xu, L. Zhou, Y. Xing, L. Bai, and J. Zhou, "Nonlocal similarity based nonnegative tucker decomposition for hyperspectral image denoising," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 701–712, Mar. 2018.
3) W. He, H. Zhang, H. Shen, and L. Zhang, "Hyperspectral image denoising using local low-rank matrix recovery and global spatial-spectral total variation," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 713–729, Mar. 2018.
4) L. Zhuang and J. M. Bioucas-Dias, "Fast hyperspectral image denoising and inpainting based on low-rank and sparse representations," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 730–742, Mar. 2018.
5) X. Ma, P. Wu, Y. Wu, and H. Shen, "A review on recent developments in fully polarimetric sar image despeckling," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 743–758, Mar. 2018.
6) R. Abergel, L. Denis, S. Ladjal, and F. Tupin, "Subpixellic methods for sidelobes suppression and strong targets extraction in single look complex sar images," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 759–776, Mar. 2018.
7) I. Ali, S. Cao, V. Naeimi, C. Paulik, and W. Wagner, "Methods to remove the border noise from Sentinel-1 synthetic aperture radar data: Implications and importance for time-series analysis," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 777–786, Mar. 2018.
8) J.-L. Bueso-Bello, P. Prats-Iraola, M. Martone, J. Reimann, U. Steinbrecher, and P. Rizzoli, "Performance evaluation of TanDEM-X quad-polarization products in bistatic mode," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 787–799, Mar. 2018.
9) C. Wang, J. Chen, Y. Tang, T. A. Black, and K. Zhu, "A novel method for removing snow melting-induced fluctuation in GIMMS NDVI3g data for vegetation phenology monitoringa case study in deciduous forests of north america," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 800–807, Mar. 2018.
10) K. Liu *et al.*, "A thermal disaggregation model based on trapezoid interpolation," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 808–820, Mar. 2018.
11) H. Song, Q. Liu, G. Wang, R. Hang, and B. Huang, "Spatiotemporal satellite image fusion using deep convolutional neural networks," *IEEE J. Sel. Topics Appl. Earth Observ. Remote Sens.*, vol. 11, no. 3, pp. 821–829, Mar. 2018.



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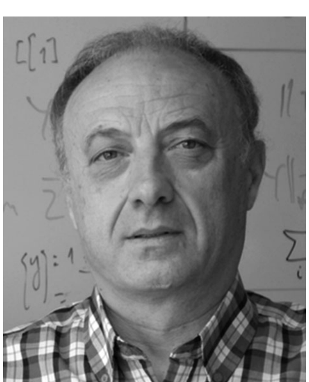

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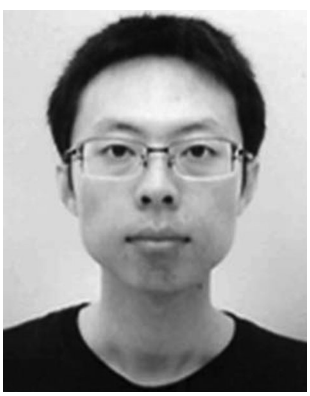

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