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Editorial

Editorial for Special Issue on Advanced Machine Learning Techniques for Remote Sensing: Algorithms and Applications

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The ongoing development of Earth observation techniques has led to a dramatic increase in the availability and utilization of remote sensing (RS) data over the past few decades. This growth has been fueled by advancements in satellite technology, aerial imaging, and ground-based sensing systems, resulting in a wealth of data with diverse spatial, spectral, and temporal resolutions. Remote sensing data plays a crucial role in a wide array of applications, including land cover mapping, urban planning, environmental monitoring, agriculture investigation, and disaster assessment. In parallel with the expansion of RS data, there has been a notable surge in the development and application of machine learning (ML) models and algorithms tailored for RS data processing and information extraction. ML techniques offer powerful tools for handling the complexity and volume of RS data, enabling automated analysis, pattern recognition, and decision-making. These ML-based approaches have demonstrated significant potential in enhancing the efficiency and accuracy of various remote sensing tasks, from image classification to change detection. Despite the considerable progress made in RS data processing and ML algorithms, there remains a continuous demand for further research and innovation in this field. The complexity of RS data, characterized by its high dimensionality, spatial heterogeneity, and temporal dynamics, presents ongoing challenges and opportunities for methodological advancements. Additionally, emerging

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technologies and scientific inquiries continually push the boundaries of what is achievable with RS data, necessitating the development of new methods and techniques. This special issue focuses on recent advances and novel approaches RS data analysis and ML applications. Specifically, the series seeks to promote research in image processing, including restoration, enhancement, and denoising techniques, to improve the quality and usability of RS imagery. Furthermore, the series highlights the importance of classification algorithms for accurately identifying and categorizing land cover types, objects, and phenomena in RS data. This special issue has accepted four articles, highly recommended by the editors and reviewers.

The 1st paper is titled "Geo-DefakeHop: High-Performance Geographic Fake Image Detection", authorized by Hong-Shuo Chen, Kaitai Zhang, Shuowen Hu, Suya You and C.-C. Jay Kuo. This paper proposed a robust fake satellite image detection method, called Geo-DefakeHop. Geo-DefakeHop is developed based on the parallel subspace learning (PSL) methodology. PSL maps the input image space into several feature subspaces using multiple filter banks. By exploring response differences of different channels between real and fake images for filter banks, Geo-DefakeHop learns the most discriminant channels based on the validation dataset, uses their soft decision scores as features, and ensemble them to get the final binary decision. Geo-DefakeHop offers a light-weight high-performance solution to fake satellite images detection.

The 2nd paper is titled "Oriented Ship Detection Based on Coordinate System Projection in SAR Images", authored by Jiangtao Wang and Mingyang Wang. This paper provides an oriented object detection method based on coordinate system projection (CSProjection). In this work, the key point of the ship, namely, the center point was detected and a coordinate system was established with the object center point as the base point. Then, a bounding box of the oriented object can be obtained through the projection information of the object. This method can effectively reduce the number of parameters applied to determine the oriented bounding box during training and decrease the network complexity.

The 3rd paper is titled "AMBNet: Adaptive Multi-feature Balanced Network for Multimodal Remote Sensing Semantic Segmentation", authored by Xiaochen Xiu, Xianping Ma, Man-On Pun and Ming Liu. This work proposes an Adaptive Multi-feature Balanced network (AMBNet) for semantic segmentation in complex urban remote sensing scenarios. To fully exploit optical images and Digital Surface Models (DSM) data obtained from remote sensing sensors, a Depth Feature Extraction and Balancer (DFEB) module is devised to estimate and balance the depth information of all pixels by capturing detailed structural compositions of the ground surface. After that, a Parallel Multi-Stage Segmentator (PMSS) comprised of a dual-branch Encoder and Decoder with skip connections is constructed to perform effective segmentation by exploiting the balanced DSM (BDSM) and optical information. As a result,

the proposed AMBNet can make effective use of optical images to complete depth information, so as to achieve multimodal information assisted semantic segmentation for complex remote sensing scenes.

The 4th paper is titled "ESAFormer: Multi-resolution Fusion Network for Pansharpening", authored by Xiangzeng Liu, Rutao Li, Ziyao Wang, Ronghan Li, Qi Cheng and Qiguang Miao. This paper proposes a novel fusion network (ESAFormer) that effectively enhances the spatial and spectral information representation. In the proposed model, a hybrid multiresolution structure of CNN and Transformer is deployed to allow the features of LRMS images and PAN images to fuse progressively. Subsequently, the enhanced spatial attention module is adopted to preserve spatial details and long-range information.

This special issue on the advancements in remote sensing (RS) data and machine learning (ML) algorithms underscores the profound impact of technology on Earth observation and environmental monitoring. As highlighted throughout the series, the proliferation of RS data, coupled with the sophistication of ML models, has unlocked unprecedented opportunities for diverse applications ranging from land cover mapping to disaster assessment. The series has showcased a plethora of research endeavors aimed at pushing the boundaries of image processing, classification, object detection, multi-temporal analysis, and information fusion within the realm of RS data. By embracing emerging topics, advanced ML algorithms, and novel applications, this thematic collection serves as a catalyst for further innovation and exploration in the field.

Guest Editors

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