remote sensing

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Editorial

Editorial for Special Issue "Hyperspectral Imaging and Applications"

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Abstract: Due to advent of sensor technology, hyperspectral imaging has become an emerging technology in remote sensing. Many problems, which cannot be resolved by multispectral imaging, can now be solved by hyperspectral imaging. The aim of this Special Issue "Hyperspectral Imaging and Applications" is to publish new ideas and technologies to facilitate the utility of hyperspectral imaging in data exploitation and to further explore its potential in different applications. This Special Issue has accepted and published 25 papers in various areas, which can be organized into 7 categories, Data Unmixing, Spectral variability, Target Detection, Hyperspectral Image Classification, Band Selection, Data Fusion, Applications.

Keywords: band selection; data fusion; data unmixing; hyperspectral image classification; hyperspectral imaging; spectral variability; target detection

1. Introduction

Over the past years hyperspectral imaging has received considerable interests [1] such as parallel processing [2], real-time processing [3,4]. It deviates from traditional spatial domain-based image processing and multispectral imaging in many different ways. It has attracted many people from different disciplinary areas to explore new ideas and new applications [5]. In recent years, a significant increase in publications in hyperspectral imaging has provided evidence that hyperspectral image processing has broken away from traditional spatial domain analysis-based remote sensing and successfully branched out to stand alone as a potential and promising research area. Most importantly, hyperspectral imaging have also changed many ways in which algorithms are designed and developed. As a consequence, many problems such as subpixels and mixed pixels that are generally encountered in hyperspectral imaging have become major issues for traditional spatial domain-based techniques [6]. Also, the traditional concept of "*seeing-is-believing*" by visual inspection may no longer true in hyperspectral imaging since targets of interest may be completely embedded in a single pixel or partially but not fully occupy a single pixel in which case only spectral properties that can be used to characterize such targets for data analysis. Therefore, this Special Issue "Hyperspectral Imaging and Applications" is devoted to topics which can demonstrate the utility of hyperspectral imaging in data exploitation and to further explore its potential in different applications. This Special Issue has accepted and published 25 papers in various areas, which can be organized into 7 categories with the number of papers published in every category included in its open parenthesis.

1. Data Unmixing (2 papers)
2. Spectral variability (2 papers)
3. Target Detection (3 papers)
4. Hyperspectral Image Classification (6 papers)
5. Band Selection (2 papers)
6. Data Fusion (2 papers)
7. Applications (8 papers)

Under every category each paper is briefly summarized by a short description in the following section so that readers can quickly grab its content to find what they are interested in.

2. Overview of Published Papers

Part I: Data Unmixing (2 papers)

09-001074

Nonnegative Matrix Factorization with Data-Guided Constraints For Hyperspectral Unmixing

Risheng Huang, Xiaorun Li and Liaoying Zhao

This paper proposes a nonnegative matrix factorization with data-guided constraints (DGC-NMF) for hyperspectral unmixing where DGC-NMF imposes on the unknown abundance vector of each pixel with either an L1/2 constraint or an L2 constraint to enforce sparseness and evenness, respectively.

09-01224

Joint Local Abundance Sparse Unmixing for Hyperspectral Images

Mia Rizkinia and Masahiro Okuda

This paper proposes propose an algorithm that exploits the low-rank local abundance by applying the nuclear norm to the abundance matrix for local regions of spatial and abundance domains where the local abundance regularizer is collaborated with the L2,1 norm and the total variation for sparsity and spatial information, respectively.

Part II: Spectral Variability (2 papers)

09-00748

Criteria Comparison for Classifying Peatland Vegetation Types Using In Situ Hyperspectral Measurements

Thierry Erudel, Sophie Fabre, Thomas Houet, Florence Mazier and Xavier Briottet

This paper develops various criteria to inventory and evaluating the performance of discrimination techniques for peatland habitats based on in situ spectra. Two main methods are applied for vegetation discrimination: the similarity measurement techniques and the supervised classification methods with sometimes application of a preliminary spectral band reduction technique.

09-00884

Reducing the Effect of the Endmembers' Spectral Variability by Selecting the Optimal Spectral Bands

Omid Ghaffari, Mohammad Javad Valadan Zoej and Mehdi Mokhtarzade

This paper proposes an approach, called Prototype Space (PS) to simultaneously mitigate spectral variability and reduce correlation among different endmembers in hyperspectral datasets. The idea is to utilize the angular discrepancy of bands where each band is treated as a space point and the proposed method is to identify independent bands according to their angles.

Part III: Target Detection (3 papers)

10-00103

Recursive Local Summation of RX Detection for Hyperspectral Image Using SlidingWindows

Liaoying Zhao, Weijun Lin, Yulei Wang and Xiaorun Li

This paper develops a recursive local summation RX anomaly detection approach using sliding windows which can avoid the calculation of historical information and thus speed up the processing. In addition, a background suppression algorithm is also proposed to remove the current under test pixel from the recursively update processing.

10-00434

A Sliding Window-Based Joint Sparse Representation (SWJSR) Method for Hyperspectral Anomaly Detection

Seyyed Reza Soofbaf, Mahmod Reza Sahebi and Barat Mojaradi

This paper develops a new sliding window-based joint sparse representation (SWJSR) anomaly detector for hyperspectral data which can improve the detection probability of anomaly presence in signals using the integration of information gathered during transition of sliding window for each pixel.

00-516

A Deep Pipelined Implementation of Hyperspectral Target Detection Algorithm on FPGA Using HLS

Jie Lei, Yunsong Li, Dongsheng Zhao, Jing Xie, Chein-I Chang, Lingyun Wu, Xuepeng Li, Jintao Zhang and Wenguang Li

This paper uses a deep pipelined background statistics (DPBS) approach to optimizing and implementing a well-known subpixel target detection algorithm, called constrained energy minimization (CEM) on FPGA by using high-level synthesis (HLS) and offers significant benefits in terms of increasing data throughput and improving design efficiency.

Part IV: Hyperspectral Image Classification (6 papers)

09-00872

Multiscale Union Regions Adaptive Sparse Representation for Hyperspectral Image Classification

Fei Tong, Hengjian Tong, Junjun Jiang and Yun Zhang

This paper proposes an approach, called Multiscale Union Regions Adaptive Sparse Representation (MURASR) for hyperspectral image classification to make full use of the advantages of two recentky developed classifiers Multiscale Adaptive Sparse Representation (MASR) classifier and Multiscale Superpixel-Based Sparse Representation (MSSR) classifier and overcome their weakness.

09-00924

Hyperspectral Image Classification Based on Semi-Supervised Rotation Forest

Xiaochen Lu, Junping Zhang, Tong Li and Ye Zhang

This paper develops a semi-supervised rotation forest (SSRoF) algorithm as an improved Rotation forest (RoF) algorithm to take advantage of both the discriminative information and local structural information provided by the limited labeled and massive unlabeled samples, thus providing better class separability for subsequent classifications.

10-00515

Semi-Supervised Classification of Hyperspectral Images Based on Extended Label Propagation and Rolling Guidance Filtering

Binge Cui, Xiaoyun Xie, Siyuan Hao, Jiandi Cui and Yan Lu

This paper proposes a semi-supervised classification method based on extended label propagation (ELP) and a rolling guidance filter (RGF) called ELP-RGF, in which ELP is designed to take advantage of unlabeled samples to improve classification performance.

09-001094

Hashing Based Hierarchical Feature Representation for Hyperspectral Imagery Classification

Bin Pan, Zhenwei Shi, Xia Xu and Yi Yang

This paper combines the advantages of a multiple feature fusion (MFF) and spectral-spatial feature extraction (FE), and further proposes an ensemble based feature representation method for

hyperspectral imagery classification, which aims at generating a hierarchical feature representation for the original hyperspectral data.

10-00441
Classification of Hyperspectral Images by SVM Using a Composite Kernel by Employing Spectral, Spatial and Hierarchical Structure Information
Yi Wang and Hexiang Duan

This paper introduce a classification framework for hyperspectral images (HSIs) by jointly employing spectral, spatial, and hierarchical structure information where the three types of information are integrated into the SVM classifier in conjunction with multiple kernels.

10-00396
Hyperspectral Classification Based on Texture Feature Enhancement and Deep Belief Networks
Jiaojiao Li, Bobo Xi, Yunsong Li, Qian Du and Keyan Wang

This paper proposes a hyperspectral classification framework based on an optimal Deep Belief Networks (DBN) and a novel texture feature enhancement (TFE) to enhance classification accuracy.

Part V: Band Selection (2 papers)

10-00113
Band Subset Selection for Hyperspectral Image Classification
Chunyan Yu, Meiping Song and Chein-I Chang

This paper develops a new approach to band subset selection (BSS) for hyperspectral image classification (HSIC) which selects multiple bands simultaneously as a band subset, referred to as simultaneous multiple band selection (SMMBS), rather than one band at a time sequentially, referred to as sequential multiple band selection (SQMBS), as most traditional band selection methods do.

10-00367
Progressive Sample Processing of Band Selection for Hyperspectral Image Transmission
Keng-Hao Liu, Shih-Yu Chen, Hung-Chang Chien and Meng-Han Lu

This paper proposes an online BS method, called progressive sample processing of band selection (PSP-BS) that allows us obtain instant BS results in a progressive manner during HSI data transmission, which is carried out under band-interleaved-by-sample/pixel (BIS/BIP) format.

Part VI: Data Fusion (2 papers)

10-00373
Structure Tensor-Based Algorithm for Hyperspectral and Panchromatic Images Fusion
Jiahui Qu, Jie Lei, Yunsong Li, Wenqian Dong, Zhiyong Zeng and Dunyu Chen

This paper develops a new hyperspectral image fusion algorithm using structure tensor to fuse hyperspectral and panchromatic (PAN) images by merging spectral information of the former and spatial information of the latter.

09-001006
Integration of Absorption Feature Information from Visible to Longwave Infrared Spectral Ranges for Mineral Mapping
Veronika Kopa˘cková and Lucie Koucká

This paper proposes a fusion method to integrate two different airborne image datasets, HyMap (VIS/NIR/SWIR image data) and Airborne Hyperspectral Scanner (AHS, LWIR image data) for data analysis. It demonstrated that when the absorption feature information derived from multispectral LWIR data is integrated with the absorption feature information derived from hyperspectral VIS/NIR/SWIR data, an important improvement in terms of more complex mineral mapping is achieved.

Part VII: Applications (8 papers)

Applications (Forestry: Classification of tree species)
09-00875
Classification of Tree Species in a Diverse African Agroforestry Landscape Using Imaging Spectroscopy and Laser Scanning
Rami Piiroinen, Janne Heiskanen, Eduardo Maeda, Arto Viinikka and Petri Pellikka

This paper studies tree species classification of tree species in a diverse african agroforestry landscape using data collected by imaging spectroscopy and laser scanning at the tree crown level, with primary interest in the exotic tree species for tree species classification.

Applications (Forestry: Detection of newly grown tree leaves)
10-00096
Adaptive Window-Based Constrained Energy Minimization for Detection of Newly Grown Tree Leaves
Shih-Yu Chen, Chinsu Lin, Chia-Hui Tai and Shang-Ju Chuang

This paper applies a hyperspectral subpixel target detection technique, called Constrained Energy Minimization (CEM) along with several its variations, which is to detect of newly grown leaves via a UAV multispectral imager.

Applications (Satellite Calibration)
10-00120
Vicarious Radiometric Calibration of the Hyperspectral Imaging Microsatellites SPARK-01 and -02 over Dunhuang, China
Hao Zhang, Bing Zhang, Zhengchao Chen and Zhihua Huang

This paper develops a procedure to use dark current computation process average multiple lines of long strip imagery acquired over open oceans during nighttime and non-uniform correction process by using images acquired after the adjustment of the satellite yaw angle to 90. This technique was shown to be suitable for large-swath satellite image relative calibration.

Applications (Brain tumor detection in magnetic resonance imaging)
09-01174
A Hyperspectral Imaging Approach to White Matter Hyperintensities Detection in Brain Magnetic Resonance Images
Hsian-Min Chen, Hsin Che Wang, Jyh-Wen Chai, Chi-Chang Clayton Chen, Bai Xue, Lin Wang, Chunyan Yu, Yulei Wang, Meiping Song and Chein-I Chang

This paper applies a nonlinear band expansion (NBE) process is proposed to expand MR images to a hyperspectral image so that the well-known hyperspectral subpixel target detection, called constrained energy minimization (CEM) along with its iterative version of CEM (ICEM) for white matter hyperintensities (WMHs).

Applications (Detection of water stress in vineyards)
10-00202
Modelling Water Stress in a Shiraz Vineyard Using Hyperspectral Imaging and Machine Learning
Kyle Loggenberg, Albert Strever, Berno Greyling and Nitesh Poona

This paper applies two ensemble learners, i.e., random forest (RF) and extreme gradient boosting (XGBoost), for detection of water stress in vineyards and discriminating stressed and non-stressed Shiraz vines using terrestrial hyperspectral imaging.

Applications (Post-fire severity)
10-00389
Evaluating Endmember and Band Selection Techniques for Multiple Endmember Spectral Mixture Analysis using Post-Fire Imaging Spectroscopy
Zachary Tane, Dar Roberts, Sander Veraverbeke, Ángeles Casas, Carlos Ramirez and Susan Ustin

This paper uses imaging spectroscopy data combined with Multiple Endmember Spectral Mixture Analysis (MESMA), a form of spectral mixture analysis that accounts for endmember variability, to map fire severity of the 2013 Rim Fire. To reduce the dimensionality of the imaging spectroscopy data we used uncorrelated Stable Zone Unmixing (uSZU) for band selection.

Applications (On-Board Compression)

10-00428

A New Algorithm for the On-Board Compression of Hyperspectral Images

Raúl Guerra, Yubal Barrios, María Díaz, Lucana Santos, Sebastián López and Roberto Sarmiento

This paper develops a new transform-based lossy compression algorithm, namely Lossy Compression Algorithm for Hyperspectral Image Systems (HyperLCA), which has been shown to achieve high compression ratios with a good compression performance at a reasonable computational burden.

Applications (Hyperspectral Pansharpening)

10-00445

Hyperspectral Pansharpening Based on Intrinsic Image Decomposition and Weighted Least Squares Filter

Wenqian Dong, Song Xiao, Yunsong Li and Jiahui Qu

This paper develops a Component substitution (CS) and multiresolution analysis (MRA)-based hybrid framework based on intrinsic image decomposition and weighted least squares filter for hyperspectral pansharpening.

3. Conclusions

The Guest Editors of this Special Issue would like to thank all authors who have contributed to this volume for publishing their research findings. Our special thanks also go to anonymous reviewers for their hard working and providing their valuable and insightful comments to help the authors improve their paper presentations and quality. Last but not least, we also would like to thank the Remote Sensing editorial team for its support during the tedious process. This volume would not have completed without their help.

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