Foreword to the Special Issue on Pattern Recognition in Remote Sensing

SPACEBORNE and airborne remote sensors have important applications in environmental monitoring, resource management, disaster response, and homeland security. Remote sensors with different modalities (e.g., multispectral, hyperspectral, optical, infrared, and radar sensors) are now often used together to achieve the optimal outcomes in information mining and scene understanding. Pattern recognition is very useful in the analysis of remote sensing data. The large amount of data available makes remote sensing technology uniquely suitable for statistical pattern recognition [1].

To address the challenges and advances in pattern recognition in remote sensing, the Remote Sensing and Mapping Technical Committee (TC7) of International Association for Pattern Recognition (IAPR) organized a biennial workshop on Pattern Recognition in Remote Sensing (PRRS). This workshop series has been a popular forum for peers to exchange ideas and timely follow the trends in both fields of pattern recognition and remote sensing.

On November 11, 2012, PRRS was successfully held in Tsukuba Science City, Japan. Following the tradition of previous journal special issues [2]–[5], we are glad to present a new special issue associated with PRRS in 2012. Twenty-five papers are included, which are briefly introduced as below.

A. Traditional Classification

Classification itself remains as an important topic in remote sensing applications. In traditional classification, it is assumed that the number of classes is known, and each pixel (or object) is assigned to one of these classes. In [6], the bag-of-visual words (BOVWs) model is applied to high spatial-resolution (HSR) image classification and categorization; specifically, a concentric circle-structured multiscale BOVW method using multiple features is proposed, which is superior to many existing BOVW methods in solving land-use scene classification problem. In [7], feature extraction from a hierarchy of segmented regions is studied for multispectral image classification; the *bag-of-visual-word-Propagation* approach propagates features along multiple scales, which are very efficient and can yield comparable results to low-level extraction approaches. In [8], morphological profiles (MPs) are considered for classification of HSR hyperspectral images, where multiple structuring elements (SEs) with different shapes are proposed to use because they together can produce higher classification accuracy with spatial-spectral information. In [9], different base images, from which MPs are constructed, are studied; it is found that the multilinear PCA (MPCA) is a powerful approach for base image extraction due to its tensor-based nature in exploiting the spectral–spatial correlation between neighboring pixels. In [10], the classification of ground penetrating radar (GPR) signals is addressed, where a time–frequency or a time-scale transform is first applied to the one-dimensional radar trace, sparse kernel feature selection is then employed to extract an optimum set of features for classification, and finally, the combination of sparse kernel feature selection and support vector machine (SVM) classification yields very high accuracy with only a small number of features.

B. Class-of-Interest Classification

In practice, it may be impossible to have an accurate information on the number of classes. This is particularly true for high resolution images, where many classes may become distinct in the background. It would be more useful if a technique can classify the classes of interest while ignoring the interference from others. In [11], extraction of impervious surfaces from HSR satellite images (i.e., GeoEye-1 and WorldView-2) with different feature sets (i.e., basic multispectral information, relative spectral indices, and texture indices based on local variance) for SVM classification is studied, and the influence of data source and training size on impervious surface extraction is discussed. In [12], unmanned aerial vehicles (UAVs) and associated sensing systems for automatic detection of palm trees are presented, where various algorithms (e.g., scale-invariant feature transform (SIFT), extreme learning machine (ELM), level sets (LSs), and local binary patterns (LBPs)) are synergized to distinguish palm trees from other vegetation species. In [13], an efficient regions of interest (ROI) detection algorithm based on multiscale feature fusion is developed, wherein an input image is processed along two extracted feature channels of intensity and orientation, followed by a weighted across-scale fusion method to combine conspicuity maps at different scales into one map retaining salient regions at different scales. In [14], the all-sky cameras (ASCs) in the MIRACLE network are considered, which take images of the night sky at regular intervals of 10–20 s. For efficient auroral activity detection, this paper describes a method for automated classification of ASC images into three mutually exclusive classes: aurora, no aurora, and cloudy, which not only reduces the amount of data to be processed, but also facilitates in building statistical models to link the magnetic fluctuations and auroral activity for auroral activity forecasting.

C. Fine Structure Extraction

Accurate extraction of fine structures, such as river networks, road networks, and railways, become possible when HSR data are more available. In [15], an automated multiscale procedure is presented for delineating complete river networks by utilizing a modified normalized difference water index and OTSU segmentation. This method classifies the large and small rivers

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separately and combines the two classified results to generate the final delineated river networks, outperforming the other three alternative approaches (large river classification, maximum likelihood classifier, and SVM). In [16], a semiautomatic airport runway extraction method is developed by integrating a long straight line finder and a region-based level set evolution (LSE). Compared to other existing methods, it has much fewer parameters and is computationally more efficient. In [17], mobile laser scanning (MLS) is applied to rapid 3-D mapping of railways, with details being captured along the corridors, including tracks, clearance of overhanging wires, natural obstructions (e.g., trees and rock faces), and tunnel/bridge clearances by using both the geometry and intensity information in the MLS point cloud. In [18], an accurate road centerline extraction method from HSR multispectral images is presented, which integrates tensor voting, principal curves, and the geodesic method to cope with complicated road shapes. In [19], road network extraction is investigated by using synthetic aperture radar (SAR) images, and a new method is developed based on the region growing to quickly extract the road network, which is suitable for different resolution SAR images.

D. Super-Resolution

Although image spatial resolution has been increased with the advance of sensor technology, it would be helpful if image spatial resolution can be further improved by using a software. In [20], a nonlocal pairwise dictionary learning (NPDL) model that learns an estimated dictionary and a residual dictionary from low-resolution (LR) image is applied to remote sensing image super-resolution (SR); nonlocal self-similarity and local spatial-similarity constraint regularization terms are introduced to the image optimization process to consider photometric, geometric, and feature information of the given LR image, thereby enhancing the quality of reconstruction. In [21], the low-rank and sparse (LRS) decomposition is explored to solve the problem of pansharpening, where a pansharpening method called ImPCA is designed based on the component substitution (CS) concept, and then the local dissimilarity between multispectral and panchromatic images is taken into account by exploiting the context-based decision (CBD) model to reduce spectral distortion.

E. Natural and Manmade Disaster Related Applications

It is the applications in disaster monitoring and assessment that makes remote sensing technology more valuable. Six papers in this special issue are relevant to such applications. In [22], a semiautomated object-based image analysis (OBIA) methodology is proposed to locate landslides by using normalized difference vegetation index (NDVI), brightness, textural features derived from satellite imagery (IRS-ID and SPOT-5), slope and flow direction derivatives from a digital elevation model (DEM), and topographically oriented gray-level cooccurrence matrices (GLCMs). In [23], distribution of debris flows is mapped with a geographical information system (GIS), an artificial neural network (ANN) model, and a logistic regression (LR) model. Such study is important to assess the factors controlling the development of debris flows and to identify the areas susceptible to their occurrences. In [24], methods are presented to automatically classify GPR images of crevasses on ice sheets using a combination of SVMs and hidden Markov models (HMMs). The combined HMM–SVM method retains all of the correct classifications by the SVM, reduces the false positive rate, and also reduces the computational burden in classifying GPR traces. In [25], a sequential detection algorithm using simulated annealing (SA) to detect patterns in seismic data is proposed, and the proposed sequential detection is better than that of synchronous detection in detecting a large number of patterns. In [26], GPR is used for quality assessment of bridge decks due to its high speed and fine resolution. In this paper, potential autofocusing metrics are nominated and evaluated by both simulation and experimental data, and the results demonstrate that the higher-order metrics are the most robust and sensitive autofocusing metrics for the migration of GPR data from RC bridge decks. In [27], the performance of three reconstruction techniques frequently applied to process GPR data (i.e., Stolt migration, back projection, and microwave tomographic inversion (MWT)) are compared in the detection of landmines with different sizes.

F. Others

In [28], based on the differences in physical and optical properties between aerosols and clouds, a new approach is proposed to distinguish aerosol-laden areas from cloudy regions using MODIS level 2 cloud properties (e.g., cloud fraction, cloud phase, and cloud top pressure products). In [29], subpixel mapping is addressed, which has been proven efficient for allocating subpixels within a mixed pixel. To obtain more accurate mapping at the subpixel scale, an improved method combining spatial dependence with directivity and connectivity of linear land covers is proposed, and simulated annealing arithmetic (SAA) is applied to optimize subpixel allocation. In [30], accuracy and adaptability of the SIFT matching method for SAR images are studied under strong multiplicative speckle noise, where SIFT point matching can be optimized based on the edge point feature in SAR images.

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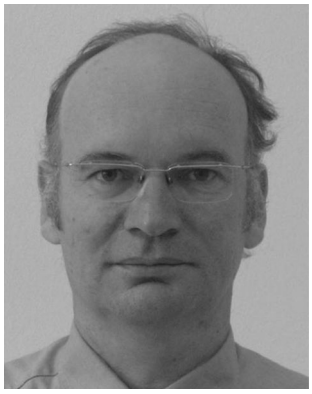

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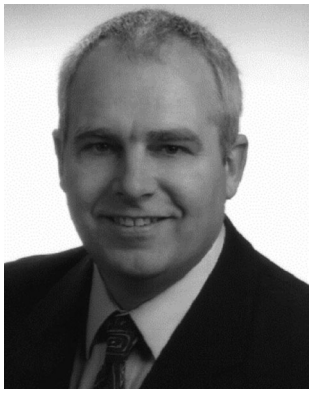

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