

Foreword to the Special Issue on Pattern Recognition in Remote Sensing

THE constant increase in the amount of remotely sensed images as well as the urgent need for the extraction of useful information from such data sets have made the development of new pattern recognition techniques a popular research topic for several decades. This data volume, together with the complexity of the content acquired by a diverse set of sensors, require new interdisciplinary work involving the application of novel pattern recognition techniques to unsolved problems in remote sensing image analysis that cannot be handled by using traditional remote sensing methods. Therefore, a wide range of pattern recognition techniques have been proposed for both traditional application areas such as land cover and land use classification, road network extraction, and agricultural mapping and monitoring, as well as more recent topics such as monitoring of human settlements, management of natural resources, response planning for natural and human-induced disasters, assessment of the impact of climate change, and conservation of biodiversity.

One of the important challenges in the combined fields of pattern recognition and remote sensing is the increasing resolution of the data that has led to an expansion in the data volume and an increase in the complexity of the analysis algorithms. Higher resolution often applies to the spatial characteristics of the images where additional patterns are visible in large scenes and, therefore, more elaborate yet faster techniques need to be developed to detect and recognize them. Furthermore, a characteristic peculiar to remote sensing is that “high” resolution may mean not only “high spatial”, but also “high spectral” resolution, leading to a wealth of problems related to high dimensionality of feature spaces, and “high temporal” resolution, requiring new methods for time series analysis. Researchers also need to take into account the nature of different sensors used for collecting data with different modalities such as multi-spectral and hyper-spectral data, as well as synthetic aperture radar (SAR) data, so that proper techniques that are capable of modeling the peculiar statistical properties of each type of data are used. Finally, performance evaluation of the developed supervised, semi-supervised, unsupervised, batch and active learning algorithms is also an interesting problem given the limited availability of detailed ground truth data sets.

This special issue is associated with the 6th IAPR Workshop on Pattern Recognition in Remote Sensing (PRRS 2010) [1] that was held in Istanbul, Turkey, on August 22, 2010 in conjunction with the IAPR International Conference on Pattern Recognition (ICPR 2010) with co-sponsorship by IAPR and IEEE Geoscience and Remote Sensing Society. The PRRS Workshop, that is implemented by the IAPR Technical Committee 7 on Remote Sensing, offers an opportunity for researchers to gain a better understanding of the many diverse research topics in remote

sensing that require contributions from the pattern recognition community, and has established itself as an important event for scientists involved in the combined fields of pattern recognition and remote sensing.

The special issue follows the tradition of three earlier issues [2]–[4] for promoting the state-of-the-art pattern recognition research on the analysis of remote sensing data sets. Papers were solicited from the pattern recognition, geoscience, and remote sensing communities at large through an open call for papers. The issue is composed of the following nine papers, selected among the 30 received submissions according to the standard review process of the IEEE JOURNAL OF SELECTED TOPICS IN APPLIED EARTH OBSERVATIONS AND REMOTE SENSING (JSTARS), covering different aspects of remote sensing image analysis.

- 1) In [5], a procedure to adapt a classifier trained on a source image to a target image with similar spectral properties based on SVM is presented. This approach is designed to boost the performance of active learning methods when applied in the context of domain adaptation. The adaptation is carried out in two steps: Step 1—an active selection of the pixels to be labeled is performed on a set of candidates of the target image in order to select the most informative pixels, and Step 2—the weights associated with these samples are iteratively updated using different criteria, depending on their origin (source or target image). In order to validate the proposed methodology, experiments on two VHR QuickBird images and on a hyperspectral AVIRIS image are conducted and the results are compared with existing techniques that do not involve any adjustments to the target domain. It is concluded that the best performance is obtained with the new approach.
- 2) In [6], a comparative study on the effects of the quantity of training examples on the classification accuracy of support vector machine (SVM), relevance vector machine (RVM), and sparse multinomial logistic regression (SMLR) classifiers is presented. The experiments using both airborne and spaceborne multispectral data sets show that the RVM and SMLR are able to achieve similar classification accuracies as the SVM but require considerably fewer training examples. The results also show that the training cases that are found to be useful by SVM and RVM have distinct and potentially predictable characteristics, and suggest a potential to design classifier-specific intelligent data acquisition activities using small training sets.
- 3) In [7], a link-based cluster ensemble technique is used to improve cloud classification and satellite precipitation estimation. The method consists of segmentation of infrared cloud images into patches, cloud patch feature extraction, combination of multiple data partitions from different clustering methods using a pairwise similarity cluster

ensemble, and precipitation estimation. The experiments show that using the cluster ensemble increases the performance of rainfall estimates compared to other methods.

- 4) In [8], a methodology to automatically extract river structures in high resolution SAR imagery is presented. This method is based on mathematical morphology and supervised image classification, using automatically selected training samples. When applied to TerraSAR-X imagery, the proposed method achieves accurate results and performs almost similar in terms of accuracy, when compared to the other techniques that require manual user interaction. Moreover, the proposed method can be easily applied to multitemporal and multipolarized image data, thus providing flexibility to extend to larger scale applications.
- 5) In [9], an algorithm to extract road network for SAR images based on multiscale geometric analysis (MGA) with beamlet is proposed. The main idea is to acquire pairs of connection points between road candidates according to the guidance segments which are obtained with MGA. This process allows the capture of linear features at multiple scales based on statistical and geometrical properties. Experiment results show that the proposed method has higher completeness and quality indexes than traditional methods.
- 6) In [10], a new approach for sea ice segmentation in SAR images is described. The approach combines an edge-preserving region-based representation with a region-level Markov random field (MRF) model. The watershed algorithm is used to partition the image into primitive regions, and the MRF is used to model the contextual dependencies among these regions. The region-based representation largely reduces the search space during optimization, improves parameter estimation of the feature model, and leads to considerable computational savings and reduced probability of false segmentation.
- 7) In [11], a novel method for oil spill regions segmentation from SAR imagery is presented. This approach is based on an adaptive level set evolution process based on the IR components of the imagery. This can be achieved by combining a new signed pressure function, derived from the illumination and reflectance values present in the image with homomorphic decomposition to extract the IR components in an image. The corresponding results obtained are found to be superior when compared with traditional techniques; thus leading to more accurate identification of the oil spill regions.
- 8) In [12], an enhanced super-resolution mapping method that combines the positive attributes of contouring and the Hopfield neural network is presented. This enhanced method is based on fitting a contour of equal class membership to a pre-final output of a standard Hopfield neural network. The application of the proposed method to both simulated and real image data sets show that this method is more accurate than the standard contouring and Hopfield neural network based methods individually, with error typically reduced by a factor of two or more.
- 9) In [13], a series of analyses using both simulated and real satellite image data with the goal of assessing how land-

scape patch size and parameter weighting for super resolution mapping through Hopfield Neural Network (HNN) affects land cover classification is described. An integrated approach based on the fusion of classification results derived from different HNN parameters setting is proposed in order to enhance the performance of the methodology for areas with a mix of large and small patches and results presented over real case high and low resolution digital and multiband images (derived from Google Earth satellite images small subsets and MODIS data over a lake region in Canada). It is shown that the method's suitability varies between landscapes, being most suited to situations in which landscape patches are large.

We are pleased to offer this special issue to the scientific community, and hope that it accomplishes our goal of highlighting recent advances in a wide range of challenges within the combined fields of pattern recognition and remote sensing. We would like to take this opportunity to thank the Editor-in-Chief of JSTARS, Prof. Jocelyn Chanussot, for his constant support to this special issue, as well as all the authors and reviewers for their outstanding contributions.

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