Foreword to the Special Issue on Information Extraction From High-Spatial-Resolution Optical Remotely Sensed Imagery

AS AN accurate and low-cost data source high resolution optical remotely sensed imagery has been increasingly used in many applications such as classification [1], [2], object detection and identification [3], and change/multitemporal analysis [4], [5]. Despite the abundant information in addition to the spectral signatures brought by high spatial resolution, traditional spectral-based and pixel-based methods usually fail to accomplish these tasks because of the large spectral diversity of same objects, complex spatial relationships between objects, and the huge data volume. Many efforts have been made by the remote sensing community to address the problems including the fusion of multiple data sources [6], object-based image processing [7], [8], various textural and semantic features [9], the use of machine learning algorithms [10], scene understanding, etc. Meanwhile, new techniques are developed for the emerging demands as environmental assessment and population estimation.

This Special Issue intends to introduce recent advances in the information extraction and application of high spatial resolution optical remotely sensed imagery, which contains 26 papers covering main topics in this field.

I. Pre-processing

For remotely sensed data, pre-processing methods such as radiometric calibration usually need to be considered due to sensor noises and various environmental interference before they are used for other applications, especially those involving multi-temporal/sensor imagery. In this issue, a radiometric calibration method for small unmanned aircraft systems (sUAS), a popular platform to acquire VHR imagery recently, is established in [11]. In [12], authors investigated how different atmospheric correction methods affect the discriminative ability of spectral features for urban tree species. Based on the time-space-spectrum continuum constructed from historical time series, [13] reconstructed missing pixels contaminated by clouds with machine learning tools. Besides optical imagery, other data sources are often helpful in the applications because of their complementary properties, but sometimes different sources do not cooperate well. For instance, elevation data such as DSM cannot match off-nadir VHR optical imagery. To coregister off-nadir images and elevation data, a line-of-sight DSM is developed and used for building detection in [14].

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II. Segmentation

A traditional view of remotely sensed imagery is that each pixel is associated with its spectral signature which can be assigned to a certain land cover/use. Although the view still holds for VHR imagery, high-spatial-resolution provides us with another convenient view that each pixel is associated with an object that consists of spatially connected pixels and represents a certain land cover/use. Recently, object-based image processing has become popular in classification, object detection, etc., but high-quality image segmentation is still challenging. This issue contains three papers concerning segmentation. In [15], an object-based Markov random field model is proposed for semantic segmentation of VHR images. Region size and edge information are employed in the model. In [16], an unsupervised local metric to quantify under- and over-segmentation is presented. Based on mean shift method, a hierarchical segmentation tree is constructed for context-based feature extraction [17].

III. Feature Extraction

Spectral features are not sufficient to characterize different land covers/uses in VHR images, and many effective spatial, textural, and semantic features have been proposed, e.g., morphological profiles, etc. In this issue, two papers focus on developing new features. [18] presents a local texture based on graph model in a pointwise approach, and [19] introduces a spatial feature based on mean shift vector and extends the feature for object-based classification. Another paper [20] evaluates the sensitivity of spatial features (PANTEX and MBI [21]) against contrast adjustment for built-up detection.

IV. Classification

Classification of remotely sensed imagery, also referred to as land cover/use mapping, is an important task. As mentioned earlier, much work has been conducted from the perspective of feature extraction [18], [19], object-based image processing [17], etc. This section introduces five papers involving other important problems in high-resolution image classification.

Accurate training samples are essential for classification, but they are often difficult and time-consuming to collect in many applications. Recently, active learning, semi-supervised learning, and transfer learning have been used to reduce the number of required samples. In this issue, an approximate spectral clustering ensemble for unsupervised classification is presented [22], which requires no labeled samples.

Scene classification is a challenging research problem due to the so-called semantic gap between low-level features (e.g., shape, texture, and spectra) and high-level semantics (e.g., residential, commercial, industrial areas, or more deep descriptions, such as a beautiful city garden). To address this issue, in [23], a two-step classification approach is proposed, where intra-scene feature similarity and inter-scene semantic dependency are employed to classify heterogeneous urban scenes. In [24], an improved unsupervised feature learning algorithm based on spectral clustering is proposed for producing a better representation of remote sensing scenes.

In addition, to solve the mixed pixel problem in classification, two super-resolution mapping methods are presented in this issue. A regularization method that integrates multiscale spatial information and a class-allocation algorithm using multiple shifted images are developed in [25] and [26], respectively.

V. Object Detection and Identification

Object detection is a major focus in VHR image processing. Although object detection can be regarded as an ordinary two-class classification, sometimes it is more common that people develop a specific detection method based on the prior knowledge and object-specific features directly. There are five papers concerning object detection in this issue. Class-specific sparse representation as well as Hough voting is used in [27] for detecting an object class. In [28], rooftops are extracted with only visible bands according to the spatial relationship between shadows and rooftops. The segmentation of rooftops is based on Grabcut method. In [29], a built-up area detection method is developed, which segments corner density map with Cauchy graph embedding optimization. An identification method of water-body types over urban areas is proposed in [30], which combines pixel- and object-based classification. Based on saliency analysis of co-occurrence histogram, [31] segments region of interests from the saliency map.

VI. Change and Multitemporal Analysis

Recently, more and more researchers focus their research to change and multitemporal analysis due to the environmental and urban changes worldwide, e.g., urbanization in the developing countries. In [32], an object-based 3-D building change detection method is presented. It produces DSM from stereo images and makes full use of the height information. In [33], an expert knowledge-based multitemporal imagery analysis is established for the monitoring of user-defined region of interest. [34] presents an unsupervised change detection based on parallel particle swarm optimization.

VII. Applications

A web-based thematic mapping of VHR imagery is presented in [35]. It integrates supervised classification in a complete web architecture, and enables interactively navigation and selection of samples.

In [36], optical and LiDAR data are used to identify tree species in Japanese complex mixed forest, where LiDAR data are used to delineate tree crowns first, and the spectral features and the size and shape of trees are combined for classification.

In [37], a four-step method for estimating house vacancy rate (HVR) using nighttime light data is presented. Fifteen metropolitan areas in the United States are selected, and the spatial pattern of HVR is analyzed in both the national level and the metropolitan level.

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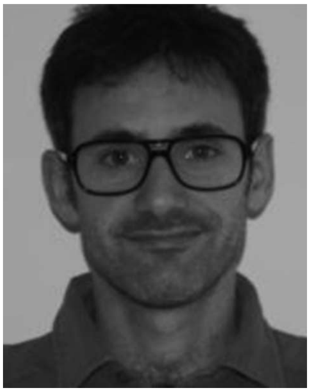

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