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GUEST EDITORIAL

Special Section Guest Editorial: Advanced Spectral Analysis Techniques and Remote Sensing Applications

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Spectral analysis technology represents a fundamental tool for the extraction of valuable information from spectral detection and imaging data. It can be utilized in various remote sensing applications. With the development of optical sensors, traditional spectral analysis methods may face challenges that arise due to the higher spectral resolution of multispectral to hyperspectral data, wider spectral range including ultraviolet, visible, and infrared wavelengths. Therefore, more sophisticated spectral analysis technology is urgently required. In recent decades, machine learning, especially deep learning techniques, have brought spectral analysis into the era of artificial intelligence (AI), enabling both qualitative and quantitative analysis in a more precise and robust way.

This special section aims to collect the latest developments on spectral analysis techniques and remote sensing applications. Nine excellent papers have been included in this special section, covering the following topics including: (1) spectral analysis for soil organic matter estimation; (2) spectral analysis for vegetation parameter inversion; (3) hyperspectral image super-resolution; (4) hyperspectral image classification; (5) spectral change detection.

Zhou et al. proposed an improved standard-sample calibration transfer method, in order to study the transferability of machine learning prediction models between different soil types. The results obtained by the improved model demonstrated higher accuracy of SOM prediction compared with the sample mixing method. Guo et al. used partial least squares regression (PLSR) and support vector machine regression (SVR) to establish a SOM estimation model for monitoring of soil nutrients in tensile fissures, which can provide reference for the rapid and accurate estimation of SOM in coal mining fissure zones.

Magalhães et al. compared the performance of various regression models based on Sentinel satellite images, with the aim of indirectly estimating the value of canopy water content (CWC) and equivalent water thickness (EWT) in maize more accurately. The superior performance of the AdaBoost regression (AR) model was validated in this analysis. Yasir et al. proposed a new index for estimating leaf water content based on multi-angular reflection. The effectiveness and superiority of this index were validated by 683 samples of different plant species. Jia et al. used machine learning to integrate in-situ hyperspectral data with Sentinel-2 MSI images to combine their complementary advantages, which effectively improves the accuracy of large-scale Chlorophyll-a (Chl-a) concentration estimation.

Xu et al. proposed a two-stream self-attention network (TSSA-Net) to capture global features from both multispectral and hyperspectral images. The network comprises two streams, each of which is designed to extract spatial and spectral abundance maps. The proposed method enables the generation of more effective hyperspectral image super-resolution results can be obtained.

Fang et al. proposed a novel approach, the regularized spatial-spectral transformer for domain adaptation (RSTDA), with the aim of effectively extracting spatial-spectral features from HSI data and enhancing the accuracy of cross-scene HSI classification. To this end, they adopted a smooth adversarial training strategy within the model. Atik and Atik applied explainable artificial intelligence (XAI) technology to optimal band selection in hyperspectral image classification. Their findings indicate that XAI-based methods were capable of identifying informative bands and demonstrated superior performance in subsequent tasks, as compared to other methods.

Bhattacharjee, Chakravortty, and Ghosh used the Bayesian change point detection method to identify nonlinear responses and abrupt changes in mangrove health, indicating that small environmental stresses lead to large eco-system changes over time. Results confirms that the Hurst *t*-statistics method identifies the same change points as the Bayesian approach.