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GUEST EDITORIAL

Special Section Guest Editorial: Advanced Infrared Technology and Remote Sensing Applications II

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IR technology and its applications have been growing exponentially in the past decade due to the deployment of novel materials in previously unexplored IR bands, including visible-near IR [0.7 μm – 1.1 μm], near IR [1 μm – 3 μm], and very-far IR [15 μm – 100 μm] in addition to the traditional mid-IR [3 μm – 5 μm] and far IR [8 μm – 14 μm] spectral bands. This technological expansion has fueled novel IR applications as related to remote sensing of the Earth, atmosphere, and the skies, either from a mobile platform or from the ground. Neural networks, machine learning, and artificial intelligence have stepped in to deduce information with increasingly higher accuracy to obtain surface feature and water levels in remote and difficult-to-access regions. With the weather patterns that have in recent years been increasingly chaotic, changes to Earth surface shape and water levels need to be monitored continuously.

Dave et al. used data from the experimental Indian Nano-Satellite (INS)-2TD in a long-wave infrared (7 to 16 μm) region with spatial resolution of 175 m to study the retrieval of land surface temperature (LST) using a physics-based generalized single-channel (GSC) algorithm. The algorithm shows consistent performance with root-mean-square error of 2.87 K and 0.97 R2. The results reveal that the retrieved INS-2TD LST products perform very well, except having a hot bias of around 4.78 K over the Himalayan mountains due to the topographic effect. These results show the overall reasonable accuracy of the retrieved LST over heterogeneous surfaces and highly dynamic atmospheric conditions.

Xu et al. propose an innovative infrared and visible image fusion model, developing an End-2-End approach to share and combine multi-scale features wisely. Features are obtained by a symmetric multi-scale decomposition encoder that are later split into shared and individual features. A self-augmented decoder uses the individual fusion feature maps as the main input and the shared fusion feature maps as the residual input to reconstruct the fused image, which exhibit outstanding subjective and qualitative results.

Lee et al. studied water depth retrieval across various environments, deemed essential for habitat modeling, hydraulic structure design, and watershed management. The critical impact of the gradient descent algorithm often was not evaluated. This study adopted an artificial neural network (ANN) with seven gradient descent methods, including step, momentum, quick propagation, delta-bar-delta, conjugate gradient, Levenberg–Marquardt, and resilient backpropagation, for shallow water depth modeling. The selection of gradient descent algorithm was identified as pivotal; an inappropriate selection might even result in performance inferior to a traditional linear regression model. In the sensitivity analysis, near-infrared and normalized difference water index were classified as highly sensitive. By leveraging multispectral data and vegetation indices with ANN, the optimal gradient descent algorithm and the critical model input for shallow water modeling were identified.

Machuca, Meza, and Vera presented a single-shot super-resolution technique that leverages computational imaging to mitigate non-uniformity noise in infrared imaging systems. It is well recognized that conventional infrared imaging systems have sensor and optical limitations that result in degraded imagery. The proposed approach integrates phase modulation and reconstruction methods that rely on the variability and redundancy of information present in the scene to recover high-spatial frequency details and reduce non-uniformity noise effectively.

While this special section took advantage of the algorithms and their improvements in data mining using existing remote sensing instruments, we hope it further enhances multi-disciplinary collaboration in building remote sensing instruments, data science, and artificial intelligence. The editors wish to express their gratitude for the dedication of authors contributing to this special section. We also acknowledge the important participation that the referees bring to the section.