Special Issue on Spatial Information and Digital Twins for Built Environment Development: Part 5

Preface

The integration of spatial information into digital twin frameworks is fundamentally restructuring the paradigms through which we perceive, monitor, and manage the built environment. Expanding upon the discourse established in our previous series, this fourth installment investigates the evolution of digital twins from static representations into dynamic, intelligent ecosystems capable of addressing multifaceted challenges in urban planning, environmental stewardship, and public safety. This paradigm shift is propelled by the synergistic convergence of advanced remote sensing, artificial intelligence (AI), and high-precision spatial modeling. The coalescence of these technologies facilitates the seamless synchronization of physical and virtual realms, enabling real-time data assimilation and predictive analytics—capabilities that were previously beyond reach.

This special issue curates eight peer-reviewed contributions that underscore cutting-edge advancements and practical applications within this domain. The articles span a diverse spectrum of topics, ranging from environmental monitoring via satellite and aerial sensing to AI-driven safety management and sustainable construction methodologies. First, several studies demonstrate the efficacy of remote sensing and spatial analysis in environmental and facility management. Li *et al.* characterized the spatiotemporal dynamics of Urban Land Surface Temperature (LST) in Chuncheon utilizing multitemporal remote sensing data and spatial regression models, offering critical implications for urban heat mitigation strategies. Kim *et al.* introduced an optimized Composite Vegetation Index (CVI) leveraging drone-based multisensor data to precisely diagnose forest health and monitor pine wilt disease. Hwang *et al.* employed Sentinel-1 and TanDEM-X SAR satellite imagery alongside PSInSAR techniques to monitor long-term ground displacement at waste landfill sites, providing a comparative analysis of varying analytical tools. Huh and Lee presented a robust methodology for assessing coastal erosion vulnerability by constructing a high-resolution 3D digital twin derived from aerial imagery and LiDAR data.

Subsequently, the issue addresses advancements in digital twin standardization and sustainable construction materials. Lee and Ahn proposed a methodology for the automated generation of Level of Detail (LOD) 0–3 building models using Industry Foundation Classes (IFC) data, thereby enhancing the interoperability of the National Digital Twin. Son *et al.* investigated the environmental and economic implications of utilizing waste glass-based permeable blocks through a modular Life Cycle Assessment (LCA), contributing to carbon neutrality initiatives within the construction sector. Finally, the application of AI for safety and risk management is explored. Hong *et al.* validated a real-time risk detection framework for swimming pool safety, benchmarking the performance of state-of-the-art object detection models, including YOLOv12

and RT-DETR. Park *et al.* proposed an AI-based pedestrian obstruction analysis framework for passenger terminals utilizing wearable sensors and Mask R-CNN, introducing a novel metric for the quantification of pedestrian safety risks.

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