Special Issue: Intelligent Systems for Railway Infrastructure

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Railway infrastructure plays a crucial role in the efficient operation of transportation systems across the globe. To meet the increasing demand for sustainable and safe transportation, whilst maintaining competitiveness, modernizing and optimizing railways is essential. According to a report by the International Union of Railways (UIC), railways are highly energy-efficient and environmentally friendly, emitting far fewer greenhouse gases per passenger-kilometer than other modes of transport such as road or air travel [1]. Given the pressing challenges of climate change and urban congestion, the significance of railways as eco-friendly and efficient transportation solutions is increasingly apparent.

Addressing these demands necessitates the development of intelligent systems that enhance railway operations and management. These systems utilize cutting-edge technologies and methodologies to create a comprehensive and efficient railway ecosystem, with increased safety, reliability, and sustainability, as well as a better overall passenger experience [2]. Advanced sensor technologies, such as high-speed cameras and LiDAR, enable the real-time monitoring of track conditions and rolling stock, facilitating the early detection of defects and anomalies to prevent accidents. Data analytics, driven by machine learning and artificial intelligence, enable the predictive maintenance and optimization of train schedules, thereby reducing downtime and operational costs. Automation and control systems, including train control, enhance safety by averting collisions and derailments. Sustainability practices, such as electrification and the adoption of renewable energy sources, contribute to reducing the carbon footprint of railways [3].

As technology continues to advance, the future of railway transportation holds the promise of even more intelligent and interconnected systems. Research and development in this field are pivotal to unlocking the full potential of railways as a sustainable and efficient mode of transportation [4].

This Special Issue comprises a collection of papers that explore pioneering research efforts in the field of intelligent systems for railway infrastructure. It serves as a platform to showcase the latest breakthroughs and innovations in sensor technologies, data analytics, automation, safety measures, and sustainability practices within the railway industry. The research contributions collated in this Special Issue provide valuable insights into the development of intelligent railway systems, emphasizing their pivotal role in advancing the efficiency, safety, and environmental sustainability of modern railway operations.

This Special Issue features five papers that each represent a range of topics within the field of intelligent systems for railway infrastructure. These papers explore topics ranging from predictive maintenance algorithms and real-time data analytics to advanced safety measures and passenger-centric technologies. Each paper contributes to our broader understanding of how intelligent systems are shaping the future of railway operations by enhancing efficiency, safety, and passenger experience.

Soares et al. [4] conducted a comprehensive analysis of the greenhouse gas emissions associated with urban rail transit systems, with a specific focus on the Pernambuco Metro. This study is crucial in the context of environmental sustainability and provides insights into reducing emissions, making urban rail transit more eco-friendly. Wang et al. [5] addressed...
the critical issue of safety in railway transportation, particularly regarding the transport of dangerous goods. The study focused on identifying optimal locations for emergency facilities to effectively respond to uncertain conditions, significantly contributing to the mitigation of potential risks. Sharma et al. [6] explored aspects of comfort and safety regarding rail travel. Through experimentation and mathematical modeling, the authors investigated the dynamics of flexible–rigid rail vehicles, which have potential implications for improved passenger comfort and safety. Szczeponik and Grzechca [7] presented an innovative approach to railway signal systems. The creation of a signal database for speed estimation in an axle counter system represented a significant step forward in enhancing the accuracy and reliability of railway operations. Silva et al. [8] showcased collaborative efforts in the context of the In2Track EU projects. The study focused on a damping assessment for filler-beam railway bridges, contributing valuable insights to bridge design and safety.

Although submissions for this Special Issue have been closed, as we look ahead, it is evident that the development and application of intelligent systems will continue to play a pivotal role in addressing challenges and opportunities within the railway sector. With the ever-growing need for sustainable and efficient transportation, researchers and practitioners in this field are working at the forefront of innovation, shaping the future of railway infrastructure. We anticipate further breakthroughs in the years to come, contributing to the development of safer, greener, and more efficient railway systems worldwide.

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References

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