Integrating Hybrid Models and Remotely Piloted Aircraft Systems for Enhancing Last-Mile Delivery Logistics

Abstract:

This presentation introduces a comprehensive hybrid delivery framework that integrates Remotely Piloted Aircraft Systems (RPAS) with conventional trucks to advance last-mile logistics performance. The proposed model is designed to address multiple, often conflicting, objectives, including minimizing operational costs, reducing delivery times, improving energy efficiency, and mitigating operational risks. To achieve these goals, the framework employs a combination of mixed-integer programming and advanced metaheuristic algorithms, enabling effective optimization in complex and dynamic delivery environments. A central feature of the framework is its capacity to support the design of hybrid delivery networks by incorporating risk assessment procedures based on the Specific Operations Risk Assessment (SORA) methodology, a detailed battery consumption model accounting for payload and flight conditions, and scenario-based coordination strategies between trucks and RPAS. These scenarios range from fully independent RPAS operations to closely synchronized Truck–RPAS collaboration, enabling adaptability across urban, suburban, and rural contexts. The methodology further allows for robust performance under variations in traffic, weather, and infrastructure conditions, ensuring practicality for real-world deployment. Simulation-based evaluation of the framework demonstrates significant potential for improving operational efficiency, achieving substantial reductions in CO_2 emissions, and enhancing the overall resilience and sustainability of delivery networks. The findings highlight the promise of hybrid RPAS–truck systems as a transformative solution for the evolving logistics sector, capable of meeting growing demands for speed, flexibility, and environmental responsibility while addressing regulatory and safety considerations through integrated risk management.

Bio:

I am Armin Mahmoodi, a dedicated Ph.D. candidate and research associate in aerospace engineering at Carleton University, Ottawa, Canada, with a strong background in Industrial Engineering. My research focuses on advancing RPAS delivery networks, supply chain management, and risk assessment, combining technical depth with strategic insight. I specialize in integrating machine learning techniques and metaheuristic optimization to develop innovative hybrid models for unmanned aircraft systems (UAS) and air-to-ground collaborative operations. My work has been widely recognized in the academic community, with over 650 citations and more than 30 published articles in high-impact journals, including Annals of Operations Research, Expert Systems with Applications, and Science of The Total Environment. In addition to serving as a peer reviewer for leading publishers such as Elsevier, SAGE, and Springer Nature, I also contribute as an editor for respected journals including SAE International and Taylor & Francis. I have received recognition for my commitment to teaching and mentorship, including a nomination for the Outstanding TA Award at Carleton University. My teaching portfolio spans courses such as Dynamics and Fluid Mechanics I, reflecting both versatility and dedication to student success. Beyond academia, I hold advanced drone piloting certifications from Transport Canada, supporting both my research and field operations. Driven by a collaborative spirit and a passion for innovation, my mission is to enhance the safety, efficiency, and sustainability of next-generation aerospace systems, bridging theoretical research with practical, real-world applications.