MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-513 (project 665) | July 2024

Remote Sensing of Multimodal Transportation Assets Using Drones

the ISSUE

Drone technologies offer a paradigm shift in railroad inspection and monitoring, enhancing operational efficacy, reducing carbon footprint, and mitigating safety hazards. Similarly, drones, especially when integrated with real-time kinematic global positioning systems and artificial intelligence, offer a compelling solution for efficient roadway condition monitoring. Despite the burgeoning applications of drones in various infrastructure sectors, there remains a research gap in quantifying their specific utility and evaluating the cost-effectiveness of drone use for railroad inspection and monitoring. There is a critical need for objective performance metrics and cost-benefit analyses to guide future adoption and optimization.

the RESEARCH

This multidisciplinary research provides a comprehensive analysis of emerging technologies in railway inspection and monitoring (RIM) and drone-based road condition monitoring (RCM), and also characterizes the landscape of drone technology development. Utilizing systematic literature review methods, the study scrutinizes 107 articles mined from more than 7,500 publications from 2014 to 2022. The research identifies key drivers, such as cost-effectiveness, safety enhancements, and operational efficiency, which motivate the adoption of drones in RIM and RCM. It categorizes applications, discusses challenges, and offers a cost-benefit framework. In the realm of drone technology development, the study introduces a novel propulsion efficiency index (PEX) to objectively compare heavy-lift drone designs. The study employs statistical analyses, including ANOVA and multilinear regression, to validate the PEX as a reliable metric. Bibliometric analyses further elucidate dominant research themes and collaborative networks

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Project Title

Remote Sensing of Transportation Assets Using Drones and Artificial Intelligence

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the FINDINGS

The research reveals that drones offer substantial benefits in RIM and RCM, including cost and time savings, enhanced safety, and operational efficiency. It identifies key applications and challenges, offering a framework for cost-benefit analysis. In assessing drone technology development, the study introduces a PEX as a reliable metric for comparing heavy-lift drone designs. Statistical validation confirms that the PEX accounts for more than 90% of the variance in design performance. The study also highlights the significant role of U.S. academic institutions in drone-based RIM and RCM research, with a robust collaborative network involving China.

the IMPACT

The implementation of the findings promises to revolutionize both road and rail infrastructure monitoring. Drone technologies will make defect identification faster, safer, and more cost-effective, thereby enhancing operational efficiency and safety. The introduction of a PEX to evaluate drone technologies offers a standardized metric for performance comparison, facilitating informed decision-making for potential adopters. Collectively, these advancements stand to significantly improve maintenance practices, reduce accident rates, and bolster the resilience and efficiency of multimodal transportation systems.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1175