5th World Conference on Sustainability, Energy and Environment

Prague, Czech Republic 18 – 20 September 2025

Prediction Of Energy Consumption in Unmanned Aerial Vehicles (UAVs)

dr hab. inż. Agnieszka Jastrzębska, Mateusz Lerke, Wojciech Kwiatkowski

Warsaw University of Technology, Poland

ABSTRACT

This study addresses the problem of predicting energy consumption in Unmanned Aerial Vehicles (UAVs), with a particular focus on identifying the parameters that exert the greatest influence on battery performance. Accurate estimation of energy demand is crucial for reliable mission planning, safe operation, and extended flight endurance. The primary objectives of this work were fourfold: (i) to provide users with clear and interpretable post-mission feedback, most notably the remaining battery state of charge (SOC); (ii) to ensure model explainability and transparency; (iii) to develop a universally applicable framework capable of generalization across different UAV platforms; and (iv) to achieve the highest possible predictive accuracy while maintaining these requirements. To this end, a hybrid modeling strategy was employed, combining data-driven machine learning techniques with a physics-based theoretical foundation. The resulting framework not only quantifies the impact of weather conditions on UAV energy consumption and battery dynamics but also highlights the importance of trajectory design and velocity control in optimizing flight range. Furthermore, the proposed approach is lightweight, adaptable, and transferable to other quadrotor systems, thereby offering both practical usability and scalability. Overall, the findings provide valuable insights into energy-aware UAV mission planning and pave the way toward more efficient aerial operations.

Keywords: battery state of charge; explainability; linear regression; time series; weather conditions impact; machine learning