State-of-the-Art in Energy Optimization for Quadcopter UAVs: Trends, Techniques, and Future Directions

Mohammed Edawdi[1], Sara Waśniewska[1], Marcin Żugaj[1]
[1)]Warsaw University of Technology

Abstract:

As quadcopter Unmanned Aerial Vehicles (UAVs) become increasingly prevalent in applications such as delivery services, environmental monitoring, and aerial photography, optimizing their energy consumption remains a paramount challenge. This paper provides a comprehensive review of the latest trends and state-of-the-art techniques in energy optimization for quadcopter UAVs, addressing this critical aspect to enhance operational efficiency and extend mission durations.

We systematically examine various strategies, including flight path optimization algorithms that account for wind conditions and terrain features, adaptive control systems that dynamically adjust flight parameters in real-time, and models and simulations for accurate energy consumption estimation. By analyzing recent advancements and comparing their effectiveness, we highlight both the achievements and gaps in the field.

Key findings indicate significant progress in the development of sophisticated algorithms and control systems that contribute to energy savings. Integrating environmental factors, such as wind patterns and turbulence, into flight planning and control can lead to substantial improvements in energy efficiency. Emerging trends, such as the use of machine learning techniques for predictive modeling and real-time optimization, hold great potential for future research and application.

Keywords:

Energy Optimization, Quadcopter UAVs, Flight Path Optimization, Adaptive Control Systems, Environmental Condition Management.