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## Loss-Minimizing Model Predictive Control for the Power Conversion System of an Airborne Wind Energy System

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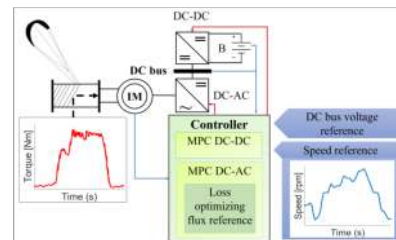
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The mechanical-electrical power conversion system in AWE Systems (AWES) is crucial for efficiently generating and storing electricity [1]. When selecting the machine for power conversion, Permanent Magnet Synchronous Generators (PMSG) are often favored for their high efficiency [2]. However, Induction Machines (IM) can be competitive due to lower manufacturing costs if their control optimizes electrical performance.

This work introduces a loss-minimizing model predictive control (MPC) strategy tailored to IMs in AWES applications. It is specifically suited for this application since it employs a power converter switching strategy to minimize electromagnetic torque noise and enhance dynamic response. Unlike conventional methods, where the reference stator flux for the IM is kept constant, this MPC dynamically adjusts the stator flux reference to reduce total electric loss across varying speed and torque ranges relevant to the AWES application. This is achieved without added computational overhead of offline optimization.

The developed simulation framework is schematically shown in the figure. Its main building blocks are the mechanical model of the kite, the IM, the DC-AC converter which controls it and a bi-directional DC-DC converter which connects a battery with the constant DC bus feeding the aforementioned DC-AC converter. The proposed control was tested and compared to a MPC without the torque noise minimization strategy and stator flux reference optimization for the optimum mechanical cycle of an AWES. The proposed electric topology and control is suited for two AWE prototypes with 3 lines and onground

control [3] and 1-line and onboard control [4]. The enhancement features proposed for the control improve the total electrical cycle energy efficiency of the AWES up to 35% in this case study. Matching the electrical efficiencies reached when using a PMSG instead of a IM.



Topology and proposed MPC for an AWES power conversion system

References:

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