Comparison of Engineering Induction Models in a Multi-Kite Optimal Control Problem

Rachel Leuthold[1], **Jochem De Schutter**[1], **Thilo Bronnenmeyer**[2], **Sébastien Gros**[3], **Moritz Diehl**[1]
[1]University of Freiburg
[2]Kiteswarms GmbH
[3]Norwegian University of Science and Technology

Rachel Leuthold

PhD Researcher
University of Freiburg
Department of Microsystems Engineering
Systems Control and Optimization Laboratory

Georges-Köhler-Allee 102
79110 Freiburg im Breisgau
Germany

rachel.colette.leuthold@imtek.uni-freiburg.de
www.syscop.de

Due to straightforward system scalability and low tether drag, the multi-kite airborne wind energy system (MAWES) appears [1] to be a promising concept. The low-order design space exploration of such a system is an ongoing challenge because design decisions and flight trajectories are highly interdependent. This challenge has been approached (as, for example, in [2] [3] and [4]) from an optimal control perspective, in order to include the influence of physical and control constraints. From [5] and [6], we know that the inclusion of an induction model will change the outcome of a MAWES optimal control problem. However, as there are many low-order ("engineering") induction models available, it is not yet certain how best to select a model for this MAWES optimal control task.

In this work, we formulate a trajectory-optimization problem for a three-kite, lift-mode MAWES using various engineering induction models – including a steady actuator disk model and the classic unsteady rotor model of [7]. We solve these problems in the awebox open-source toolbox [8]. The goal is to compare the similarity between the resulting optimization solutions, and consider any computational trade-offs. Based on this comparison, we draw conclusions about the sensitivity of the solution to the induction model and make recommendations for future model selection.

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