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# Harnessing the Power of Model-Based Control to Further the Performance and Robustness of Airborne Wind Energy Systems


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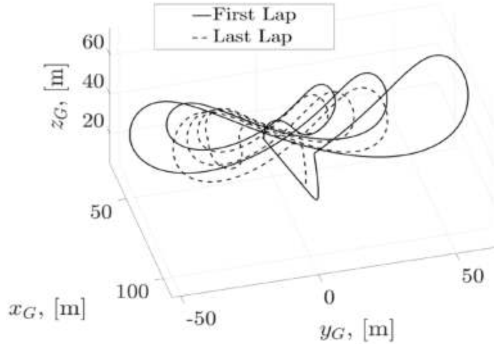
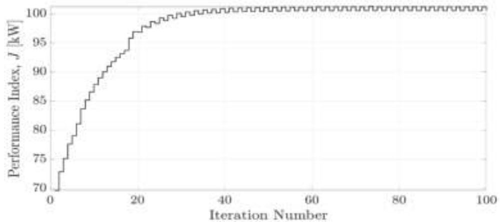
The past two decades have been pivotal for the field of airborne wind energy (AWE) systems, with concepts moving from paper to practice, and experimental demonstrations moving from short-duration demonstrations of basic crosswind flight to long-duration demonstrations and pilot projects. Embedded within this success story of airborne wind energy is the story of how model-based control tools, often glossed over in other application domains in favor of “black box” techniques, have played a pivotal role in realizing the levels of performance and robustness seen in AWE systems today. Underlying the development of these model-based control strategies has been a suite of experimentally validated dynamic models, ranging in complexity from point mass models to six degree-of-freedom kite models with multi-element tethers. These models have been used to develop an arsenal of control tools for AWE systems, including nonlinear model predictive control (NMPC), Smith predictors for delay compensation, and iterative learning control (ILC) for flight path adaptation. Even when data-driven modeling has been leveraged for control, the underlying controllers have been consistently verified against physics-based models that allow for the certification of system performance and robustness. This talk will highlight a number of model-based control success stories within the AWE field, focusing on the modeling approaches employed and the mechanisms used to ensure that the underlying control approaches could in fact be realized in the field. In presenting these case examples, the talk will showcase how our community can indeed serve as a guide for the successful application of model-based control to a complex, high-order system.




*Example illustrating the use of ILC for figure-8 flight path adaptation.*




*Example performance improvement resulting from the use of ILC for figure-8 flight path adaptation.*