Adjoint-Based PDE-Constrained Robust Optimization of Aircraft Systems Using Reduced-Order Models

D. Amsallem[1], C. Bou-Mosleh[2], P. Avery[1], Y. Choi[1], and C. Farhat[1]

[1]Department of Aeronautics & Astronautics, Stanford University, Stanford, CA, US
[2]Notre Dame University, Beirut, Lebanon

Design optimization under PDE constraints is usually a computationally intensive task due to the repeated computations associated with solving the PDE. Projection-based model reduction aims at alleviating that cost by reducing the dimensionality of the system of equations to be solved by considering solutions confined to a subspace of much smaller dimension.

In this work, a comprehensive approach is developed for the robust optimization of full aircraft systems with a large number of design variables. In addition, the operating conditions for the system of interest are also parameterized. The proposed approach relies on the definition of two reduced-order models: the first one for the forward system and the second one for the adjoint system. Both reduced-order models are constructed by a greedy approach in the space of operating conditions parameters. As the design of the aircraft evolves, the reduced-order models are also updated using a Trust-Region Model Management framework.

An application to the robust design of an aircraft system will highlight the capability of the proposed approach to accelerate the design process.