Adjoint Assisted Surrogate Modeling for Robust Design with Multiple Objectives

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Realistic engineering design often involves the consideration of uncertainties affecting the system. When optimizing the design these uncertainties have to be taken into account to find robust solutions. Furthermore, the optimization may involve multiple competing objectives. Here, the aim is to find a set of solutions that fulfill the concept of Pareto optimality. In a previous work, multi-objective optimization and robust design were combined using the epsilon-constraint approach together with the non-intrusive polynomial chaos approach in the context of aerodynamic shape optimization[1]. We consider uncertainties in the flight conditions and in the geometry.

The use of various robustness measures, that are suitable in a multi-objective context, makes the gradient-based optimization approach more difficult. We make use of a signed distance function as an additional constraint to account for average losses in multi-objective space. Additional constraints may slow down the optimization progress and the chances for getting stuck in a local optimum increase significantly. Therefore, we propose to extend the gradient-based optimization approach by making use of an adjoint assisted surrogate model. As a result, a global search is conducted on a surrogate model that is built using a Gaussian process model. The model is refined for optimization using an expected improvement method[2] and sampling assisted by the gradient information obtained from a discrete adjoint solver based on algorithmic differentiation[3].

References

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