Aerodynamic wing-shape optimization by an adaptive multi-level algorithm

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Abstract: A Full and Adaptative Multi-Level Optimum-Shape Algrithm (FAMOSA) will be proposed for the minimization of a functional constrained by a PDE state equation in a domain with shape-dependent boundaries.

The state equation is discretized over a mesh whose boundary shape is being optimized. For the optimization purposes, this boundary can be described through design parameters whose number is much less than the number of the boundary grid-points.

The shape can be thus formally represented, prior to mesh-discretization, by some parametrization. By choosing the parametrization of Bézier type, we can construct, a priori, a hierarchy of embedded nested parametric spaces, via the classical degree-elevation process, for a multi-level optimization algorithm.

Moreover, we propose an auto-adaptation algorithm of the Bézier parametrization during the optimization process, which substancially enlarge the search space for the optimal shape.

The FAMOSA algorithm will be applied to the aerodynamic optimization of a 3D wing geometry for Eulerian flows, subject to certain geometrical constraints (specified plan-form, vertical tangent at leading edge, given volume, thickness, etc.). Numerical experiments will be presented to demonstrate the efficiency of the method.

Key words: Optimum-shape design, aerodynamics, multigrid, multilevel, hierarchical smoothing, embedded Bézier shape parametrizations.