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Abstract

**IMPLEMENTATION OF A MULTIBLOCK SENSITIVITY ANALYSIS METHOD IN NUMERICAL AERODYNAMIC SHAPE OPTIMIZATION**

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A multiblock sensitivity analysis method is applied in a numerical aerodynamic shape optimization technique. The Sensitivity Analysis Domain Decomposition (SADD) scheme which is implemented in this study was developed to reduce the computer memory requirements resulting from the aerodynamic sensitivity analysis equations. Discrete sensitivity analysis offers the ability to compute quasi-analytical derivatives in a more efficient manner than traditional finite-difference methods, which tend to be computationally expensive and prone to inaccuracies.

The direct optimization procedure couples CFD analysis based on the two-dimensional thin-layer Navier-Stokes equations with a gradient-based numerical optimization technique. The linking mechanism is the sensitivity equation derived from the CFD discretized flow equations, recast in adjoint form, and solved using direct matrix inversion techniques.

This investigation is performed to demonstrate an aerodynamic shape optimization technique on a multiblock domain and its applicability to complex geometries. The objectives are accomplished by shape optimizing two aerodynamic configurations. First, the shape optimization of a transonic airfoil is performed to investigate the behavior of the method in highly nonlinear flows and the effect of

different grid blocking strategies on the procedure. Secondly, shape optimization of a two-element configuration in subsonic flow is completed. Cases are presented for this configuration to demonstrate the effect of simultaneously reshaping interfering elements.

The aerodynamic shape optimization is shown to produce supercritical type airfoils in the transonic flow from an initially symmetric airfoil. Multiblocking effects the path of optimization while providing similar results at the conclusion. Simultaneous reshaping of elements is shown to be more effective than individual element reshaping due to the inclusion of mutual interference effects.