Aerothermodynamic Design Sensitivities for a Reacting Gas Flow Solver on an Unstructured Mesh Using a Discrete Adjoint Formulation

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Abstract

An approach is described to efficiently compute design sensitivities in an inviscid, reacting gas flow solver, using a discrete adjoint formulation. In both the primal and adjoint flow solver the species continuity equations are decoupled from the mixture continuity, momentum, and total energy equations. This decoupling simplifies the implicit system, so that both solvers can be made significantly more efficient, with very little penalty on overall scheme robustness. The computational cost of the point implicit relaxation in the primal flow solver is shown to scale linearly with the number of species for the decoupled system, whereas the fully coupled approach scales quadratically. To demonstrate this capability, a hypersonic vehicle with a rcs jet configuration is proposed as a design problem in which drag and surface temperature are sought to be be optimized by a variety of design parameters related to the rcs jet conditions and geometry.

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