HIGH-FIDELITY AERO-STRUCTURAL DESIGN OF SUPERSONIC CONFIGURATIONS

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Abstract. High-fidelity multidisciplinary techniques are essential for the design of revolutionary aircraft and spacecraft for which a large experience database has not been yet developed. Unfortunately, high-fidelity design involving even a single discipline is so computationally demanding that few efforts have been made to account for the interactions with additional disciplines. This talk describes a new coupled-adjoint method for aero-structural optimization that allows for the simultaneous optimization of both the shape of the aircraft, and its underlying structure with computational cost that is independent of the number of design variables in the problem. The flow is governed by the Euler or Navier-Stokes equations, while the structure is described using a detailed finite element model. A large number of design variables (> 1,000) are used to parameterize the detailed shape of the aircraft. The shape and thicknesses of all elements in the structural model are also allowed to vary. Optimum designs are achieved using a nonlinearly constrained sequential quadratic programming optimization method with gradients provided by the solution of the aero-structural coupled adjoint method. In addition, we describe our efforts to construct a high-fidelity design framework where the geometry (aerodynamic shape and structural layout) is central to the exchange of information between disciplines and is handled via a direct interface to a CAD solid representation. Applications to the aero-structural design of efficient low-boom, supersonic transport aircraft are also presented.