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Using High Resolution Design Spaces for Aerodynamic Shape Optimization Under Uncertainty
Application of Jetstream to a Suite of Aerodynamic Shape Optimization Problems

Using High Resolution Design Spaces for Aerodynamic Shape Optimization Under Uncertainty
Aerodynamic Shape Optimization of Wings Including Planform Variables
Aerodynamic Shape Optimization of Wing and Wing-body Configurations Using Control Theory
Aerodynamic Shape Optimization of Rotor Airfoils Via a Genetic Algorithm
New Design Concepts for High Speed Air Transport
Massively Parallel Aerodynamic Shape Optimization
Advances in Aerodynamic Shape Optimization Using Control Theory
Improving the Efficiency of Aerodynamic Shape Optimization on Unstructured Meshes
Aerodynamic Shape Optimization Using Control Theory
Numerical Methods for Aerodynamic Shape Optimization
Aerodynamic Shape Optimization Using Analytical Asymptotic Flow Solution and Genetic Algorithm

RIVERA BRAIDEN

Aerodynamic Shape Optimization Techniques Based on Control Theory

Aerodynamic Shape OptimizationAerodynamic Shape OptimizationNew Design Concepts for High Speed Air Transport
This book presents the challenges, the tools and the concepts for developing economically viable high speed civil transport aircraft under environmental constraints. Computational tools for aircraft design and optimization are outlined and application in an industrial environment is shown for new and innovative case studies.
The Discrete Adjoint Approach to Aerodynamic Shape Optimization LAP Lambert Academic Publishing
This paper describes the implementation of optimization techniques based on control theory for wing and wing-body design. In previous studies it was shown that control theory could be used to devise an effective optimization procedure for airfoils and wings in which the shape and the surrounding body-fitted mesh are both generated analytically, and the control is the mapping function. Recently, the method has been implemented for both potential flows and flows governed by the Euler equations using an alternative formulation which employs numerically generated grids, so that it can more easily be extended to treat general configurations. Here results are presented both for the optimization of a swept wing using an analytic mapping, and for the optimization of wing and wing-body configurations using a general mesh. Reuther, James and Jameson, Antony Ames Research Center

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Aerodynamic Shape Optimization of a Subsonic Inlet Using 3-D Euler Computation Springer Science & Business Media

This paper explains why high resolution design spaces encourage traditional airfoil optimization algorithms to generate noisy shape modifications, which lead to inaccurate linear predictions of aerodynamic coefficients and potential failure of descent methods. By using auxiliary drag constraints for a simultaneous drag reduction at all design points and the least shape distortion to achieve the targeted drag reduction, an improved algorithm generates relatively smooth optimal airfoils with no severe off-design performance degradation over a range of flight conditions, in high resolution design spaces parameterized by cubic B-spline functions. Simulation results using FUN2D in Euler flows are included to show the capability of the robust aerodynamic shape optimization method over a range of flight conditions.

BiblioGov

Practical aerodynamic shape design problems must balance performance optimization over a range of on-design operating conditions with constraint satisfaction at off-design operating conditions. A multipoint optimization formulation can be used to represent on-design and off-design conditions with corresponding objective or constraint functions. Two methods are presented for obtaining optimal airfoil designs that satisfy all design objectives and

constraints. The first method uses an unconstrained optimization algorithm where optimal design is achieved by minimizing a weighted sum of objective functions at each of the conditions. To address competing design objectives between on-design and off-design conditions, an automated procedure is used to weight off-design objective functions to limit their influence on the overall optimization. The second method uses the constrained optimization algorithm SNOPT, allowing aerodynamic constraints imposed at off-design conditions to be treated explicitly. Both methods are applied to the design of an airfoil for a hypothetical aircraft, which is formulated as an 18-point multipoint optimization.
An Efficient Method for Aerodynamic Shape Optimization Createspace Independent Publishing Platform
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Aerodynamic Shape Optimization
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Optimization consists on finding the best possible solution to a problem, which usually means finding the minima of

functions in a feasible region. The need of solving optimization problems is present in many diverse areas of science and engineering. Shape optimization is critical for the design of wind turbines and slender structures. By using highly efficient Computational Fluid Dynamics (CFD) based on the Vortex Particle Method (VPM), a wind simulation can be generated and structural behavior obtained. Automatization of the optimization process is created by parametrization of the CFD model and defining optimization objectives, thus generating an optimization model. Simulation-based optimization is performed by running simulations nested in the optimization algorithms.
Aerodynamic Shape Optimization of Unsteady, Chaotic Flows BiblioGov

Abstract: "This paper describes the implementation of optimization techniques based on control theory for wing and wing-body design. In previous studies [18, 19, 22] it was shown that control theory could be used to devise an effective optimization procedure for airfoils and wings in which the shape and the surrounding body-fitted mesh are both generated analytically, and the control is the mapping function. Recently, the method has been implemented for both potential flows and flows governed by the Euler equations using an alternative formulation which employs numerically generated grids, so that it can more easily be extended to treat general configurations [34, 23]. Here results are presented both for the optimization of a swept wing using an analytic mapping, and for the optimization of wing and wing-body configurations using a general mesh."

Aerodynamic Shape Optimization of Two-dimensional Airfoils Under Uncertain Conditions

Abstract: "This work describes the implementation of optimization techniques based on control theory for complex aircraft configurations. Here control theory is employed to derive the adjoint differential equations, the solution of which allows for a drastic reduction in computational costs over previous design methods [13, 12, 43, 38]. In our earlier studies [19, 20, 22, 23, 39, 25, 40, 41, 42] it was shown that this method could be used to devise effective optimization procedures for airfoils, wings and wing-bodies subject to either analytic or arbitrary meshes. Design formulations for both potential flows and flows governed by the Euler equations have been demonstrated, showing that such methods can be devised for various governing equations [39, 25]. In our most recent works [40, 42] the method was extended to treat wing-body configurations with a large number of mesh points, verifying that significant computational savings can be gained for practical design problems. In this paper the method is extended for the Euler equations to treat complete aircraft configurations via a new multiblock implementation. New elements include a multiblock-multigrid flow solver, a multiblock-multigrid adjoint solver, and a multiblock mesh perturbation scheme.

Two design examples are presented in which the new method is used for the wing redesign of a transonic business jet."

Numerical Shape Optimization of Airfoils with Practical Aerodynamic Design Requirements

This paper explains why high resolution design spaces encourage traditional airfoil optimization algorithms to generate noisy shape modifications, which lead to inaccurate linear predictions of aerodynamic coefficients and potential failure of descent methods. By using auxiliary drag constraints for a simultaneous drag reduction at all design points and the least shape distortion to achieve the targeted drag reduction, an improved algorithm generates relatively smooth optimal airfoils with no severe off-design performance degradation over a range of flight conditions, in high resolution design spaces parameterized by cubic B-spline functions. Simulation results using FUN2D in Euler flows are included to show the capability of the robust aerodynamic shape optimization method over a range of flight conditions.Li, Wu and Padula, SharonLangley Research CenterHIGH RESOLUTION; SHAPE OPTIMIZATION; VARIATIONAL PRINCIPLES; PARAMETER IDENTIFICATION; ROBUSTNESS (MATHEMATICS); COMPUTATIONAL FLUID DYNAMICS; AIRFOILS; AERODYNAMIC COEFFICIENTS; DRAG REDUCTION; FLIGHT CONDITIONS; EULER EQUATIONS OF MOTION; LIFT; MULTIDISCIPLINARY DESIGN OPTIMIZATION; ALGORITHMS

Adjoint Methods for Aerodynamic Shape Optimization

Abstract: "We consider the problem of finding the shape of an airfoil which produces a pressure distribution closest to a desired one. The flow is modeled by the nonlinear potential equations of compressible flow. The problem is formulated as an optimization problem constrained by a discrete approximation to a nonlinear boundary value problem. We present a new parallel infeasible path method for this class of optimization problem. The method is based on a null space representation tailored to the structure of the constraint Jacobian matrix. The resulting null space projections formally involve inverses of the stiffness matrix. The algorithm requires only two stiffness matrix solves per optimization iteration, in contrast to a conventional path-following method, which resolves the full physics at each iteration. The algorithm has been implemented on a CM-2, and requires no new data structures or communication patterns beyond those needed for numerical solution of the boundary value problem. We discuss numerical evidence for the superiority of the new method relative to a conventional path-following approach."

Missile Aerodynamic Shape Optimization Using Genetic Algorithms

Two distinct parametrization procedures of generating free-form surfaces to represent aerospace vehicles are presented. The first procedure is the representation using spline functions such as nonuniform rational b-splines (NURBS) and the second is a novel (geometrical) parametrization using solutions to a suitably chosen partial differential equation. The main idea is to develop a surface which is more versatile and can be used in an optimization process. Unstructured volume grid is generated by an advancing front algorithm and solutions obtained using an Euler solver. Grid sensitivity with respect to surface design parameters and aerodynamic sensitivity coefficients based on potential flow is obtained using an automatic differentiator precompiler software tool. Aerodynamic shape optimization of a complete aircraft with twenty four design variables is performed. High speed civil transport aircraft (HSCT) configurations are targeted to demonstrate the process. Thomas, Almuttil M. and Tiwari, Surendra N. Unspecified Center NCC1-68...

Aerodynamic Shape Optimization

This master thesis investigated the applicability of the Hicks-Henne bump functions and Free-Form Deformation as shape deformation methods used for aerodynamic shape optimization by the adjoint method. In order to alleviate user effort in the setup of simulations and post-processing of results, a MatLab framework has been developed. This framework integrated shape definition, meshing, file management, flow solver and post-processing tools. The external tools were open-source software. to allow the use of arbitrary cell and processor core numbers. The computational fluid dynamics solver, SU2 was used to obtain direct flow and adjoint solutions and to perform shape deformations using the built in nonlinear constrained optimization function. Automatic mesh generation was done using GMSH. The thesis focused on inviscid and viscous 2D problems in the transonic and supersonic flow regimes. The definition of the initial aerodynamic shapes was done using the Class-Shape Transformation method. The test cases optimization problems with the NACA0012 airfoil as the initial airfoil for deformation, with drag reduction as the objective function. The test cases involved different constraints e.g. airfoil thickness, lift coefficient and pitching moment coefficient. Comparisons were made between the two methods in terms of performance in the minimization of the objective function. The results of the optimization problems were compared to reference airfoils from literature. Both deformation methods proved to be effective, clear superiority of one method over the other could not be shown.*****This master thesis investigated the applicability of the Hicks-Henne bump functions and Free-Form Deformation as shape deformation methods used for aerodynamic shape optimization by the adjoint method. In order to alleviate user effort in the setup of simulations and post-processing of results, a MatLab framework has been developed. This framework integrated shape definition, meshing, file manage

Aerodynamic Shape Optimization Using Simultaneous Pseudo-timestepping

Practical experience with airfoil optimization techniques has revealed unexpected difficulties. Traditionally the performance of an airfoil is optimized for given, or assumed, model parameters. Experience has indicated that a deterministic optimization for discrete operating conditions may result in dramatically inferior performance when the actual conditions are difficulties different from these, somewhat arbitrarily chosen, design values. Extensions to multi-point optimization have proven unable to adequately remedy the problem of "localized optimization". This paper presents an intrinsically statistical approach and demonstrates how the shortcomings of multi-point optimization with respect to "localized optimization" can be overcome.

NURBS Based Aerodynamic Shape Optimization

Practical experience with airfoil optimization techniques has revealed unexpected difficulties. Traditionally the performance of an airfoil is optimized for given, or assumed, model parameters. Experience has indicated that a deterministic optimization for discrete operating conditions may result in dramatically inferior performance when the actual conditions are difficulties different from these, somewhat arbitrarily chosen, design values. Extensions to multi-point optimization have proven unable to adequately remedy the problem of "localized optimization". This paper presents an intrinsically statistical approach and

demonstrates how the shortcomings of multi-point optimization with respect to "localized optimization" can be overcome.

Aerodynamic Shape Optimization of Internal Fluid Flow Systems

The main objective of this has been the development awl maturation of a adjoint-based, viscous design techniques for Aerodynamic Shape Optimization (ASO) of complete aircraft configurations. We have followed a systematic approach in the development, validation and testing of our methods. In addition, we have carried out some preliminary work in the development of a mathematical environment for high-fidelity aero-structural optimization as a first step towards the realization of a high-fidelity multidisciplinary optimization disability. A number of significant milestones achieved in this process are detailed in the final report.

Aerodynamic Shape Optimization of Wing and Wing-Body Configurations Using Control Theory

Abstract: "Aerodynamic shape design has long persisted as a difficult scientific challenge due [sic] its highly nonlinear flow physics and daunting geometric complexity. However, with the emergence of Computational Fluid Dynamics (CFD) it has become possible to make accurate predictions of flows which are not dominated by viscous effects. It is thus worthwhile to explore the extension of CFD methods for flow analysis to the treatment of aerodynamic shape design. Two new aerodynamic shape design methods are developed which combine existing CFD technology, optimal control theory, and numerical optimization techniques. Flow analysis methods for the potential flow equation and the Euler equations form the basis of the two respective design methods. In each case, optimal control theory is used to derive the adjoint differential equations, the solution of which provides the necessary gradient information to a numerical optimization method much more efficiently then [sic] by conventional finite differencing. Each technique uses a quasi-Newton numerical optimization algorithm to drive an aerodynamic objective function toward a minimum. An analytic grid perturbation method is developed to modify body fitted meshes to accommodate shape changes during the design process. Both Hicks-Henne perturbation functions and B-spline control points are explored as suitable design variables. The new methods prove to be computationally efficient and robust, and can be used for practical airfoil design including geometric and aerodynamic constraints. Objective functions are chosen to allow both inverse design to a target pressure distribution and wave drag minimization. Several design cases are presented for each method illustrating its practicality and efficiency. These include non-lifting and lifting airfoils operating at both subsonic and transonic conditions."

Aerodynamic Shape Optimization of Two-dimensional Airfoils Under Uncertain Conditions

Aerodynamic Shape OptimizationAerodynamic Shape OptimizationNew Design Concepts for High Speed Air TransportSpringer Science & Business Media

One-shot Methods for Aerodynamic Shape Optimization

Aerodynamic Shape Optimization of a Hsct Type Configuration with Improved Surface Definition

Aerodynamic Shape Optimization Using Vortex Particle Simulations