An Adjoint Solver For An Industrial Cfd Code Via Automatic

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ANSYS Fluent: Using the Adjoint Solver to Optimize the Shape of a Duct in a Bounded Space - Part I **Enabling Optimization Using Adjoint Solvers I Hong Zhang, Argonne** Fluids Shape Optimisation - Adjoint

Solver Fluent 2020R2 (60fps) Getting started: Ansys Fluent adjoint solver Airfoil optimization using ANSYS adjoint solver ~~Load Adjoint Solver in Ansys Fluent~~ ~~Chapter IV - Part II - Inverse Design using Adjoint Flow Solver~~ **Meet The Expert: Adjoint Solver** Optimizing airfoil using FLUENT Adjoint solver (3) Smart Shape Optimization with ANSYS Adjoint Solver How to: SMART Shape Optimization with ANSYS Adjoint Solver *Optimizing airfoil using FLUENT Adjoint solver (2) Applied Optimization - Sequential Quadratic Approximation* ~~MIT Numerical Methods for PDEs Lecture 18: Adjoint Sensitivity Analysis of Linear Algebraic Systems~~ ~~MIT Numerical Methods for PDEs Lecture 18: Adjoint Sensitivity Analysis of Poisson's equation~~ ~~0. Topology optimization: Introduction~~

FLUENT 3.2: Flow Solver Methods*How to do Optimization in ANSYS* ~~Wing Shape Optimization for Drones and Light Aircraft~~ Adjoints *Optimization with Ansys Workbench* **Optimization with Ansys CFD (Fluent 19.2)** *adjoint-based optimization* ANSYS for Structures: Smart Shape Optimization with ANSYS Adjoint Solver ANSYS Fluent: Using the Adjoint Solver to Optimize the Shape of a Duct in a Bounded Space - Part II ~~Ansys Fluent Adjoint Solver for gas flow design optimization~~ Optimizing airfoil using FLUENT Adjoint solver (1)

Surface Optimization with Continuous AdjointShape optimisation using adjoint methods

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CFD-CAA analysis and optimization methods with industrial application

An Adjoint Solver For An

Free Matrix Adjoint calculator - find Matrix Adjoint step-by-step This website uses cookies to ensure you get the best experience. By using this website, you agree to our Cookie Policy.

Matrix Adjoint Calculator - Symbolab Math Solver

Math Problem Solver (all calculators) Adjoint Matrix Calculator. The calculator will find the adjoint (adjugate, adjunct) matrix of the given square matrix, with steps shown. Show Instructions. In general, you can skip the multiplication sign, so `5x` is equivalent to `5*x`.

Adjoint Matrix Calculator - eMathHelp

Adjoint Solver Meep contains a density-based adjoint solver for efficiently computing the gradient of an objective function with respect to the permittivity on a discrete spatial grid in a subregion of the cell. Regardless of the number of degrees of freedom for the grid points, just two separate timestepping runs are required.

Tutorial/Adjoint Solver - MEEP Documentation

This video demonstrates how to use ANSYS Fluent's adjoint solver to optimize the shape of an air duct within a space defined by imported bounding surfaces, i...

ANSYS Fluent: Using the Adjoint Solver to Optimize the ...

What is the Adjoint Solver? The Adjoint Solver is a specialized CFD tool that allows the users to obtain detailed sensitivity data for the performance of a fluid dynamic system. Designers can use this sensitivity data to automatically generate get an answer to the question “How and where should I modify my geometry to achieve my design objectives – ie. to reduce drag by 10% and/or increase lift by 10%?”.

Shape Optimisation without constraints - How to use the ...

Shape optimization can help you find the optimal solution. ANSYS Fluent adjoint solver takes your stated goals and uses them to automatically morph and optimize the geometry. The adjoint solver can optimize the shape of your component and reduce simulation time in many ways, including: Finding the best-performing shape; Automatically morphing the shape

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Shape Optimization: Adjoint Methods & Parametric Design ...
HELYX-Adjoint is a continuous adjoint CFD solver for topology and shape optimisation developed by ENGYS based on the extensive theoretical work of Dr. Carsten Othmer of Volkswagen AG, Corporate Research. The technology has been extensively proven and validated through productive use in real-life design applications, including: vehicle external aerodynamics, in-cylinder flows, HVAC ducts, turbomachinery components, battery cooling channels, among others.

HELYX Adjoint CFD Optimisation | ENGYS
Methods based on solution of adjoint equations are used in wing shape optimization, fluid flow control and uncertainty quantification. For example. d X t = a (X t) d t + b (X t) d W. {\displaystyle dX_ {t}=a (X_ {t})dt+b (X_ {t})dW} this is an Itō stochastic differential equation.

Adjoint equation - Wikipedia

An industrial application is presented to show that the Adjoint solver can be used for optimization of a Formula 1 front wing, taking into account the geometrical uncertainties associated with the...

Optimization under Uncertainty using Adjoint Solver and ...
Ansys Fluent Adjoint Solver-based Optimization. Companies around the world continuously seek to optimize their products and improve on existing performance. The shape optimization process can often be time-consuming, requiring substantial manual inputs and multiple design iterations. Adjoint Solver — a free add-on module available with Ansys Fluent — enables shape optimization in a smart and automatic way with minimal turnaround time.

Ansys Fluent Adjoint Solver-based Optimization | Resource ...
Adjoint-solver module for MEEP. Contribute to HomerReid/meep_adjoint development by creating an account on GitHub.

GitHub - HomerReid/meep_adjoint: Adjoint-solver module for ...
Stanford University, Stanford, California 94305. DOI: 10.2514/1.29123

An automatic differentiation tool is used to develop the adjoint code for a three-dimensional computational fluid dynamics solver. Rather than using automatic differentiation to differentiate the entire source code of the computationalfluiddynamicssolver,wehaveappliedeitselectivelytoproducecodethatcomputesthefluxJacobian matrixandtheotherpartialderivativesthatarenecessarytocomputetotalderivativesusinganadjointmethod.The ...

ADjoint: An Approach for the Rapid Development of Discrete ...
www.rbf-morph.com RBF Morph, an ANSYS Inc. Partner 2014 ANSYS USERS MEETING May 2014 - Milano, Italy Adjoint Key Ideas •An adjoint solver allows to compute the derivatives of an engineering quantity with respect to the positions of all the nodes of the mesh.

How to Boost ANSYS Fluent Adjoint Using RBF Morph Software
Adjoint equations produce shape derivative values of a given objective function in a single solve of the adjoint equations. Therefore, the adjoint approach to design and sensitivity analysis represents a significant advantage to other alternative techniques when the number of objective functions is significantly smaller than the number of

independent shape parameters.

Adjoint Solver - Application in External Car Aerodynamics ...
The nonlinear eigenvalue problem and its adjoint are solved by an in-house adjoint Helmholtz solver, based on an axisymmetric finite volume approach. In addition to first-order correction terms of the adjoint formulation, which are often used in literature, second-order terms are also taken into account.

Uncertainty Quantification of Growth Rates of ...
covers meep.adjoint,a submodule of the meeppython module that implements an adjoint-based sensitivity solverto facilitate automated design optimization via derivative-based numerical optimizers. The meep.adjointdocumentation is divided into a number of subsections: This overviewpage reviews some basic facts about adjoints and optimizers,

Standard methods for unsteady optimization carry heavy computational costs and large storage requirements, mostly due to the lengthy time integration involved in the unsteady flow simulations. Such difficulties limit its practical application to cases where the time integration is performed over only a smaller segment of the entire period. The result is a loss of accuracy in the representation of the physical model. For certain unsteady flows with periodicity, a dramatic reduction in both compu- tational cost and required storage is realized through implementing the Time Spectral method. Furthermore, by introducing an adjoint-based method as an alternative way of obtaining gradient information, computational cost is further reduced. This combi- nation of Time-Spectral and adjoint-based methodology therefore allows for unsteady optimization within a reasonable time frame while maintaining accuracy. In this dissertation, the Discrete Adjoint method is implemented and applied to unsteady flows with periodicity, in the context of the Time Spectral Method. The acquired adjoint gradient information is fed into an optimizer and truly unsteady optimization work is carried out for the first time on a realistic test case. The devel- opment and implementation of necessary boundary conditions prove crucial for the successful implementation of the Discrete Adjoint method. As a simple test case, the NACA 0012 airfoil is selected for simulation in steady inviscid, unsteady inviscid, steady viscous, and unsteady viscous flows. In each case, the resulting gradient information obtained from both the adjoint and finite difference method is compared. Upon completion of the airfoil test case, the adjoint-based method is applied to a helicopter blades, UH60, for both steady and unstaedy inviscid flows. The gradient information obtained by the adjoint-based method shows good agreement with the conventional, Finite Difference gradient information. The design methodology was developed for a single processor, however, multi- processor capability is also implemented. In order to accommodate realistic meshes, multi-block capability is added as well. With all of the necessary components im- plemented, optimization is carried out on the UH60 helicopter blade. The objective function is time-averaged torque over all time instances and the optimized result shows an improvement of 5 % over the current configuration. Stanford University Multi-block (SUmb), while implementing the unsteady Reynolds-Averaged Navier Stokes equations with multi-block and multi-processor algorithms, is the chosen flow solver. PETSc is employed as the adjoint solver. Successful implementation of the Discrete Adjoint method to unsteady fluids with periodicity provides the gradient information more easilty than the traditional finite difference method which is hindered by its heavy computational cost and large stor- age requirements. This research establishes a new optimization methodology which utilizes Discrete

Adjoint gradient information derived from flow solutions, obtained using the Time Spectral method.

An aerodynamic shape optimisation capability based on a discrete adjoint solver for Navier- Stokes flows is developed and applied to a Blended Wing-Body future transport aircraft. The optimisation is gradient-based and employs either directly a Sequential Quadratic Programming optimiser or a variable-fidelity optimisation method that combines low- and high-fidelity models. The shape deformations are parameterised using a Bþezier-Bernstein formulation and the structured grid is automatically deformed to represent the design changes. The flow solver at the heart of this optimisation chain is a Reynolds averaged Navier- Stokes code for multiblock structured grids. It uses Osher approximate Riemann solver for accurate shock and boundary layer capturing, an implicit temporal discretisation and the algebraic turbulence model of Baldwin-Lomax. The discrete Navier-Stokes adjoint solver based on this CFD code shares the same implicit formulation but has to calculate accurately the flow Jacobian. This implies a linearisation of the Baldwin-Lomax model. The accuracy of the resulting adjoint solver is verified through comparison with finitedifference. The aerodynamic shape optimisation chain is applied to an aerofoil drag minimisation problem. This serves as a test case to try and reduce computing time by simplifying the fidelity of the model. The simplifications investigated include changing the convergence level of the adjoint solver, reducing the grid size and modifying the physical model of the adjoint solver independently or in the entire optimisation process. A feasible optimiser and the use of a penalty function are also tested. The variable-fidelity method proves to be the most ef- ficient formulation so it is employed for the three-dimensional optimisations in addition to parallelisation of the flow and adjoint solvers with OpenMP. A three-dimensional Navier- Stokes optimisation of the ONERA M6 wing is presented. After describing the concept of Blended Wing-Body and.

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."

We formulate a generalized optimization problem for a non-linear dynamical system governed by a set of differential equations. The plant under focus is the 2-D Kolmogorov flow, as this flow has inherent turbulence which would give rise to chaos and intermittent bursts in a selected observable. As a first step, an observable with potential extreme events in its time series is selected. In our case, we choose the kinetic energy of the flow field as the observable under study. The next step is to derive the adjoint equations for the kinetic energy that is the quantity of interest with the velocity field as the optimizing variable. This obtained velocity field forms the precursor for extreme events in the kinetic energy. The prediction capabilities for this precursor are then explored in more detail. The goal is to select the precursor such that it predicts the extreme events in a given time horizon which can generate warning signals effectively. We also present a coupled flow solver in Nek5000 and adjoint solver in MATLAB, the latter can be applied to any dynamical system to study the extreme events and obtain the relevant precursor. In a consecutive section, the results for extreme events in the kinetic energy and the lift coefficient for the flow over a 2-D airfoil are presented. As part of future work, the implementation and application of the solver for the flow past the airfoil and over a 3-D Ahmed body are proposed.

In this thesis, mesh adaptation using continuous adjoint is tested on two-dimensional Euler equations. Both the flow solver and the adjoint solver are implemented with the high order spectral difference (SD) method. Both h and p adaptation are studied. The test cases include a half-cylinder in subsonic flow and a NACA 0012 airfoil in subsonic and transonic flows. It is found that h-refinement is more suitable for flow discontinuities while p-refinement offers a better performance in smooth flows. Both adaptation methods lead to a faster functional convergence than uniformly h or p refined meshes. In addition, the adapted meshes show similar patterns as those arrived at using the discrete adjoint method. Comparisons between different adjoint target output functionals are also made.

"This work proposes a framework for fully-automatic gradient-based constrained aerodynamic shape optimization in a multistage turbomachinery environment. A turbomachinery solver which solves the Reynolds-averaged Navier-Stokes (RANS) equations to a steady-state in both rotating and stationary domains is developed. Characteristic-based inlet and outlet boundary conditions are imposed, while adjacent rotor and stator rows are coupled by mixing-plane interfaces. To allow for an efficient but accurate gradient calculation, the turbomachinery RANS solver is adjointed at a discrete level. The systematic approach for the development of the discrete adjoint solver is discussed. Special emphasis is put on the development of the turbomachinery specific features of the adjoint solver, i.e. on the derivation of flow-consistent adjoint inlet and outlet boundary conditions and, to allow for a concurrent rotor-stator optimization and stage coupling, on the development of an exact adjoint counterpart to the non-reflective, conservative mixing-plane formulation used in the flow solver. The adjoint solver is validated by comparing its sensitivities with finite-difference gradients obtained from the flow solver. A parallelized, automatic grid perturbation scheme utilizing radial basis functions, which is accurate and robust as well as able to handle complex multi-block grid configurations, is employed to calculate the gradient from the adjoint solution. A sequential quadratic programming algorithm is utilized to determine an improved blade shape based on the gradient information. The functionality of the proposed optimization method is demonstrated by the redesign of two different transonic compressor configurations. The design objective is to maximize the isentropic efficiency while constraining the mass flow rate and the total pressure ratio. The influence of the constraints on the design problem is investigated by comparing the results with those of an unconstrained optimization." --

The Second-Order Adjoint Sensitivity Analysis Methodology generalizes the First-Order Theory presented in the author's previous books published by CRC Press. This breakthrough has many applications in sensitivity and uncertainty analysis, optimization, data assimilation, model calibration, and reducing uncertainties in model predictions.

The book has many illustrative examples that will help readers understand the complexity of the subject and will enable them to apply this methodology to problems in their own fields. Highlights: • Covers a wide range of needs, from graduate students to advanced researchers • Provides a text positioned to be the primary reference for high-order sensitivity and uncertainty analysis • Applies to all fields involving numerical modeling, optimization, quantification of sensitivities in direct and inverse problems in the presence of uncertainties. About the Author: Dan Gabriel Cacuci is a South Carolina SmartState Endowed Chair Professor and the Director of the Center for Nuclear Science and Energy, Department of Mechanical Engineering at the University of South Carolina. He has a Ph.D. in Applied Physics, Mechanical and Nuclear Engineering from Columbia University. He is also the recipient of many awards including four honorary doctorates, the Ernest Orlando Lawrence Memorial award from the U.S. Dept. of Energy and the Arthur Holly Compton, Eugene P. Wigner and the Glenn Seaborg Awards from the American Nuclear Society.

With the rapid growth of aircraft traffic and the new modes of transport such as Urban Air Mobility systems crowding the air space, aircraft noise is no longer a mere design constraint but an important factor to design and optimize for. Reducing aircraft noise however requires efficient coupling of simulation tools with design methods to be able to meet the stringent future aircraft noise requirements that allow for sustainable growth. Gradient-based design optimization based on adjoint method for sensitivity analysis offers a feasible design approach. Adjoint methods based on steady state physics have been widely in practice in industrial applications mainly for aerodynamic optimization so far. However, extending this approach to aeroacoustic optimization is not straightforward and not a common practice in industrial settings due the requirement of unsteady adjoint solutions that is prohibitively expensive. This dissertation presents temporal and spatial coarsening techniques for the computation of low-cost unsteady adjoints to obtain sensitivities for aeroacoustic shape optimization. The effects of the coarsening techniques on the accuracy of the gradients are analyzed by using different levels of temporal and spatial coarsening using multiple two dimensional and three dimensional test cases. Computational cost savings as well as reduction of memory storage requirements up to 10% of the base adjoint solutions are presented while maintaining reasonable accuracy in the gradients driving the optimization for these test cases. Finally, an extension to the temporal coarsening technique is proposed with non-uniform time stepping of adjoint solver based on the local flow truncation error estimates of the flow solver. The proposed extension is demonstrated to further improve the accuracy of the low-cost gradients providing motivations for the future directions of the work done in this thesis.