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Nota di contenuto	Contents; 1 Introduction; 2 Optimal shape design; 2.1 Introduction; 2.2 Examples; 2.2.1 Minimum weight of structures; 2.2.2 Wing drag optimization; 2.2.3 Synthetic jets and riblets; 2.2.4 Stealth wings; 2.2.5 Optimal breakwater; 2.2.6 Two academic test cases: nozzle optimization; 2.3 Existence of solutions; 2.3.1 Topological optimization; 2.3.2 Sufficient conditions for existence; 2.4 Solution by optimization methods; 2.4.1 Gradient methods; 2.4.2 Newton methods; 2.4.3 Constraints; 2.4.4 A constrained optimization algorithm; 2.5 Sensitivity analysis 2.5.1 Sensitivity analysis for the nozzle problem2.5.2 Numerical tests with freefem++; 2.6 Discretization with triangular elements; 2.6.1 Sensitivity of the discrete problem; 2.7 Implementation and numerical issues; 2.7.1 Independence from the cost function; 2.7.2 Addition of geometrical constraints; 2.7.3 Automatic differentiation; 2.8 Optimal design for Navier-Stokes flows; 2.8.1 Optimal shape design for Stokes flows; 2.8.2 Optimal shape design for Navier-Stokes flows; References; 3 Partial differential equations for fluids; 3.1 Introduction; 3.2 The Navier-Stokes equations

3.2.1 Conservation of mass; 3.2.2 Conservation of momentum; 3.2.3 Conservation of energy and the law of state; 3.3 Inviscid flows; 3.4 Incompressible flows; 3.5 Potential flows; 3.6 Turbulence modeling; 3.6.1 The Reynolds number; 3.6.2 Reynolds equations; 3.6.3 The k - model; 3.7 Equations for compressible flows in conservation form; 3.7.1 Boundary and initial conditions; 3.8 Wall laws; 3.8.1 Generalized wall functions for u; 3.8.2 Wall function for the temperature; 3.8.3 k and ; 3.9 Generalization of wall functions; 3.9.1 Pressure correction 3.9.2 Corrections on adiabatic walls for compressible flows; 3.9.3 Prescribing μ_w ; 3.9.4 Correction for the Reichardt law; 3.10 Wall functions for isothermal walls; References; 4 Some numerical methods for fluids; 4.1 Introduction; 4.2 Numerical methods for compressible flows; 4.2.1 Flux schemes and upwinded schemes; 4.2.2 A FEM-FVM discretization; 4.2.3 Approximation of the convection fluxes; 4.2.4 Accuracy improvement; 4.2.5 Positivity; 4.2.6 Time integration; 4.2.7 Local time stepping procedure; 4.2.8 Implementation of the boundary conditions; 4.2.9 Solid walls: transpiration boundary condition; 4.2.10 Solid walls: implementation of wall laws; 4.3 Incompressible flows; 4.3.1 Solution by a projection scheme; 4.3.2 Spatial discretization; 4.3.3 Local time stepping; 4.3.4 Numerical approximations for the k - equations; 4.4 Mesh adaptation; 4.4.1 Delaunay mesh generator; 4.4.2 Metric definition; 4.4.3 Mesh adaptation for unsteady flows; 4.5 An example of adaptive unsteady flow calculation; References; 5 Sensitivity evaluation and automatic differentiation; 5.1 Introduction; 5.2 Computations of derivatives; 5.2.1 Finite differences; 5.2.2 Complex variables method

Sommario/riassunto

Examining shape optimization problems for fluids, with the equations needed for their understanding and the simulation of these problems, this text introduces automatic differentiation approximate gradients, and automatic mesh refinement.
