APCOM & ISCM
11-14th December, 2013, Singapore

Shape Optimization of A Body Located in Adiabatic Viscous Flows Using Adjoint Equation Method

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The purpose of this study is to find out an optimal shape of a body located in compressible viscous fluids assuming adiabatic state. In the computational fluid dynamics, an incompressible viscous flow is mostly assumed, which is mostly used for the practical analysis. In this research, we use compressible viscous flow assuming adiabatic state which resembles normal compressible flow, however, thermal exchange is excluded. We analyze the two equation systems which are conservation of mass and momentum. The Poisson's low, which expresses the relation pressure and density, is applied as the state equation. We use the two dimensional analysis domain, however, three dimensional extension is straight forward. The linear interpolation function is applied. SUPG (Streamline-Upwind / Petrov-Galerkin) method and SLG (Semi-Lagragian Galerkin) method and two-step explicit method are techniques for removing numerical instability. In this research, SUPG method is applied to the analytical technique. In the temporal discretization and the special discretization, the implicit scheme and the finite element method is adopted. The optimal shape is obtained by minimizing fluid forces acting on the body. The performance function which consists of fluid forces are minimized in this control theory. The adjoint equation is applied to inverse analysis.

Keywords: Shape optimization, Adiabatic state, Adjoint equation method, Conservation of mass, Conservation of momentum, Poisson's low, SUPG method, implicit scheme, performance function