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Optimal Shape Design, theory and algorithm

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ABSTRACT

VKI lectures are attended by CFD specialists who want an entry point into shape design by computer methods. The lectures have also a written support and a book from Oxford University Press.

Objectives

- Report on the course given in VKI in June 2008
- Present a review of the theoretical results known for optimal shape design
- Present the theory of algorithm for differentiable optimization for shape design
- Introduce the problems linked with constraints and multi-objectives

Applications

Optimal shape design is the second and natural step after simulation because design improvement cannot be made by trial and errors whent here are more than a few design parameters. In aerospace there are thousand parameters because the airplane flying characteristics is very sensitive to its shape. So differentiable optimization is in principlke a better idea than black box optimization. Applications are everywhere and the latest is sonic boom reduction and also fluid-structure weight plus aerodynamic design.

Results

1. Optimization wings or wing body configuration to minimize the drag at constant lift and volume. Use of automatic differentiation to evaluate the gradients with respect to shape in a compressible Navier-Stokes flow with a k-epsilon turbulence model with wall laws.
2. Optimization of the sonic boom of a supersonic business jet. Application of the reduced gradient idea.
3. Optimization of a micro-fluid electronic device. Application of the level set method.
4. A survey of the computations made with topological gradients when the topology of the solution is not known.

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