A sensitivity based optimization approach for aeroacoustic problems

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ABSTRACT

Human's confrontation with acoustic noise generated by fluid flow is an everyday phenomenon. Not only the sound prediction but also the sound optimization is of high interest in numerous fields in industry and current research. Optimization approaches can be divided into strategies with and without determination of the cost functional's derivatives. There are several ways to calculate the differential [2].

This contribution proposes a gradient-based optimization approach and presents the implementation and verification of a coupled sensitivity solver for aeroacoustic problems.
The governing state equations and the resulting sensitivity equations are solved with a fully conservative finite-volume approach to solve the incompressible Navier-Stokes equations. The acoustic quantities are computed with the Linearized Eulerian equations and the *Expansion about Incompressible Flow* (EIF), presented by Hardin and Pope [1] and improved by Shen and Sørensen [4], is used.
The flow sensitivities and the acoustic sensitivities are calculated with a differentiate-then-discretize approach presented by Borggaard and Burns [3]. In this approach the sensitivity equations are obtained via differentiation of the non-discretized partial differential equations with respect to the design parameters followed by discretisation.

Due to the absence of an analytical solution of aeroacoustic quantities, the verification isn't possible and the functionality of the sensitivity as a gradient has to be guaranteed by comparison with the corresponding difference quotient. The functionality is determined by aeroacoustic test cases where the acoustic sensitivities with respect to different design parameters are presented.
The main objective is to provide a basis for the optimization of aeroacoustic problems for gradient-based optimization with the computation of the aeroacoustic sensitivities.

REFERENCES

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