6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11 – 15 June 2018, Glasgow, UK

Shape optimization using a continuous adjoint solver with an adjoint two-equation turbulence model and vertex morphing

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Key Words: *Vehicle Aerodynamics, Adjoint Optimization, Adjoint Turbulence, Vertex Morphing*

The lack of sophisticated continuous adjoint turbulence models are still of ongoing interest in both research and industry. This paper aims to present a validation and application to an industrial case of the fully differentiated Low-Re Launder-Sharma-k-epsilon model as first presented by Papoutsis et al. [1].

The derivation and implementation of the adjoint turbulence model and the implementation in the open-source OpenFOAM-toolbox will be discussed, as well as the dependency of the obtained sensitivities of the used computational grid and the turbulent intensity of the case. The validity of the implemented model will be demonstrated by comparing the adjoint sensitivities to reference finite difference sensitivities.

Subsequently the application of the method including the adjoint turbulence model to an industrial case will be presented. A discussion of the distinction of the frozen and adjoint turbulence sensitivities will follow. Finally the vertex morphing method [2] will be applied to optimize the geometry. The differences in the resulting designs resulting from the frozen and the adjoint turbulence approach will be compared and discussed.

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