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Sensitivity Assessment of Optimal Solution in Aerodynamic Design Optimisation using SU2

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Abstract

Computational fluid dynamics has become the method of choice for aerodynamic shape optimisation of complex engineering problems. However, the sensitivity of the final aerodynamic shape to numerical parameters has been largely underestimated to date. The purpose of this work is to investigate the influence that numerical parameters have on the optimisation results for two aerofoil problems (NACA 0012 and RAE 2822) in transonic flow, and to provide compact guidelines for best practice. Numerical parameters include: a) two parameterisation methods, Hicks–Henne bump functions and free–form deformation; b) numerical settings related to the tuning of each parameterisation method; and c) closure coefficients of Spalart–Allmaras (SA) turbulence model. All optimisations were performed using the open–source software tool SU2, and gradients were computed using the continuous adjoint method. It was found that: a) the optimisation result of NACA 0012 aerofoil exhibits strong dependence on all numerical parameters investigated, whereas the optimal design of RAE 2822 aerofoil is insensitive to those numerical settings; b) the degree of sensitivity reflects the difference in the design space, particularly of the local curvature on the optimised shape; c) the closure coefficients of SA model affect the final optimisation performance, raising the need for a good calibration of the turbulence model.

Keywords: aerodynamic shape optimisation, SU2, uncertainty,

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