Zurich University of Applied Sciences

Specialisation Project 1

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# Extension of the SA turbulence model for rough walls in ADflow

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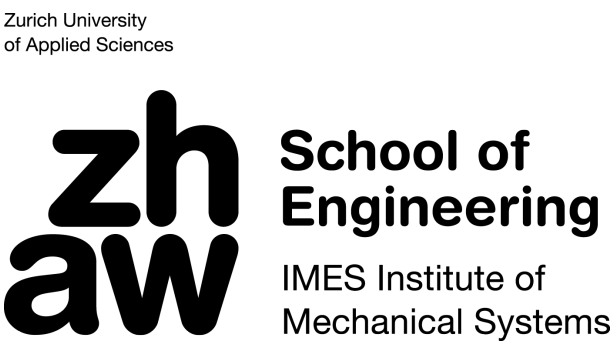

**Abstract**

As the available computer power increases, Reynolds Averaged Navier Stokes (RANS) based optimizations come more and more in reach. When performing such high fidelity optimization, it is necessary to properly represent all flow conditions. If one fails to do so, the optimizer might exploit effects that do not exist in reality.

This work extends the Spalart Allmaras (SA) turbulence model in the open source CFD solver ADflow for rough walls with a modification originally proposed by Boeing. ADflow is specialized in optimizations and thus uses the *adjoint method* to compute the gradients needed in an efficient manner. To make the rough modification available for optimizations, the changes have been differentiated using Automatic Differentiation (AD).

For verification, the implementation is compared against theory, the open source CFD solver SU2 and experimental data of a *flat plate a zero incidence* for various surface roughnesses. The modified gradients are verified using the complex step method.

The results show that the implementation under-predicts the effect of roughness. But the predicted shape of the effect seems correct. The computed gradients only match to a relative tolerance of 1e−7 compared to complex step. A relative tolerance of less than 1e−8 would be desirable with the methods employed.

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