Comparing goal-oriented RANS error estimates applied to high-lift configuration computations

Frédéric Alauzet, Loic Frazza

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

Comparing goal-oriented RANS error estimates applied to high-lift configuration computations

Frédéric Alauzet[1] and Loïc Frazza[2]

[1] Researcher, GAMMA3 Team, INRIA Saclay Ile-de-France, France
frederic.alauzet@inria.fr
[2] PhD Student, Gamma3 Team, INRIA Saclay Ile-de-France, France
loic.frazza@inria.fr

Keywords: *Error estimates, RANS, adaptive methods, goal-oriented, anisotropic-mesh adaptation, high-lift configuration*

This presentation discusses an anisotropic adaptive strategy in the context of the 3rd AIAA high-lift prediction workshop. If anisotropic mesh adaptation has proven its reliability for inviscid flows [1, 2], additional challenges remain to be solved to have the full gain of adaptivity, including early asymptotic (spatial second) order convergence, early capturing of the scales of then physical phenomena, . . . Several (fundamental) modifications are needed in the classical adaptive loop to address complex viscous effects. This includes the way error estimates are evaluated, how viscous solutions are interpolated between (anisotropic) meshes, and finally the generation of the boundary layer mesh to comply with the metric size prescription. Addressing fully each of this component remains a challenge on itself.

In this presentation, we propose two error estimates to address the RANS equations, this implies in particular to treat appropriately the considered turbulence model. Here, we only consider the one equation Spalart-Allmaras turbulence model.

The first approach relies on an *a priori* analysis leading to an adjoint-based weighted interpolation error for the convective terms: $\int |\nabla W_h^*||F(W) - \Pi_h F(W)|$ and a specific error estimate for the Laplacian based equation to derived again an adjoint-based weighted interpolation error for the viscous terms: $\int |\rho(H(W^*))||W - \Pi_h W|$, where W is the equation state, W^* the adjoint state and F the convective operator.

The second approach relies on a linearization of the conservative form of the equations leading to the following estimate for the inviscid terms: $\int |\frac{\partial F}{\partial W}(W_h) \cdot \nabla W_h^*||W - \Pi_h W|$, and for the viscous terms: $\int |K(W_h) : H(W_h^*)||W - \Pi_h W|$ where $K(W)\nabla W$ are the viscous fluxes.

For the source term in both cases, we consider the interpolation error of the source term weighted by the adjoint state.

REFERENCES

[1] F. Alauzet and A. Loseille, *High-order sonic boom modeling based on adaptive methods*, J. Comp. Phys., Vol. **229**, pp. 561-593, 2010.

[2] A. Loseille, A. Dervieux and F. Alauzet, *Fully anisotropic goal-oriented mesh adaptation for 3D steady Euler equations*, J. Comp. Phys., Vol. **229**, pp. 2866-2897, 2010.