Universität Stuttgart

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NRG

Type-of-PDE-Preserving Turbulence Models for the Incompressible RANS Equations

Bachelor/ Master Thesis/ HiWi Position (m/w/d)

Background

The ability to accurately predict turbulent flows is crucial for the design of energy-efficient systems like an aircraft or a gas turbine. The Reynolds-averaged Navier-Stokes (RANS) equations paired with a simple eddy viscosity-based turbulence model enjoy great popularity as their numerical solution is computationally efficient and usually stable. Due to severe accuracy limitations, machine learning methods are used to tune the coefficients of the turbulence model for particular applications. Unfortunately, many of these potentially highly accurate models fail to converge. This may be a consequence of the data-driven coefficients expressions locally changing the type of the (incompressible) RANS equations from elliptic to hyperbolic.

Project Description

This thesis is supposed to reveal the constraints on the coefficients of the turbulence model that would guarantee that the RANS equations remain elliptic, whether these constraints are actually hurt by unstable models, and how these constraints can be efficiently enforced in the flow solver. To this end, the work is structured as follows:

- Literature review
- Derivation of the type-preservation constraints on the closure coefficients
- Monitoring whether these constraints are hurt during simulations with stable and unstable turbulence models
- Development and implementation of an efficient enforcement strategy to guarantee type-preservation into OpenFOAM
- Documentation of the results

Your Profile

- Solid understanding of the classification of second order PDEs
- Basic C++ programming skills
- Basic understanding of turbulence modeling

Application

If you are interested, even if you don't fulfill all the listed requirements, please send your application (incl. CV and latest transcript) via e-mail.

Start: as soon as possible

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