Aerospace Seminar

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Reduced Order Modelling for 2D Cross-Section with Varying Angle of Attach using Divergence-Conforming Isogeometric Navier-Stokes Solver

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Abstract: Repetitive solutions of parametrized flow problems can be quite demanding, each solution involving a million or more degrees of freedom, that takes hours or days of computational time. A promising methodology to reduce the (on-line) computational effort is the use of Reduced Order Modelling (ROM). ROM offers the possibility to balance loss of accuracy with gain in efficiency, see [1].

We have tied ROM with a divergence-conforming isogeometric high-fidelity method for incompressible flow simulations and achieved (significant) additional speedup compared to non-conforming methods [2]. The additional speedup is related to less computations related to the supremizers needed for avoiding that the ROM model get a rank-deficient velocity-pressure block.

Our aim is that all the forms in the ROM-system may be expressed as linear combinations of forms, precomputed in the offline stage, that are parameter-independent. However, for the case of moving fluid boundaries, e.g. rotating 2D cross-section due to fluid-structure interaction, this is not straight forward due to the changes to the fluid domain. We have solved this for a problem with varying angle of attack by mapping the fluid problem for every angle of attach back to the initial configuration (i.e. zero angle of attach) and developed a Taylor series for the Jacobian mapping (we use Jacobian mapping in order to preserve the divergence-conforming property of our formulation) to achieve affinity.

We will illustrate the performance of the development method by doing high fidelity simulations of stationary Navier-Stokes were performed of flow around a NACA0015 airfoil cross-section where we vary the inflow velocity and the angle of attack.