A face-oriented stabilized fictitious domain approach for 3D incompressible Navier-Stokes equations applied to fluid-structure interaction

Abstract:
A new stabilized XFEM based fixed-grid approach for the transient incompressible Navier-Stokes equations using cut elements is proposed. Boundary conditions on embedded boundaries are imposed weakly using a Nitsche type approach. Ghost-penalty terms for velocity and pressure are added for stability reasons and to improve the conditioning of the system matrix. The idea of ghost-penalties, previously developed for Stokes problems, is extended to the incompressible Navier-Stokes equations by the usage of face-oriented fluid stabilizations also in the interface zone. We obtain optimal error convergence and a good system conditioning in the viscous and the convective dominated cases. Further, the results are much more accurate and less sensitive to the location of the interface. Numerical results of a convergence analysis and results for fluid-structure interaction problems are shown.

Stichworte:
Navier-Stokes equations, face-oriented stabilization, ghost-penalty, Nitsche's