Stabilization techniques in IgA discretization of convection dominated flow problems

Marek Brandner* **and Eva Turnerová***

* New Technologies for the Information Society (NTIS)
Faculty of Applied Sciences, University of West Bohemia
Univerzitní 8, 201 00 Plzeň, Czech Republic
e-mail: turnerov@kma.zcu.cz

ABSTRACT

The Navier-Stokes equations are the basis for computational modeling of the flow of an incompressible Newtonian fluid. The fluid flow behaviour is very complex and depends on viscosity ν, geometry and fluid velocity. Despite the development of the numerical methods for direct numerical simulation and especially simulation of the large eddies, Reynolds–Averaged Navier–Stokes (RANS) approach based on the averaging of the Navier–Stokes equations is the most common method to describe turbulent flow so far. The reason is the lower memory requirements since the whole range of the scales is modeled and only the effect of the turbulence on the mean flow behaviour is considered. The fundamental problem of the solution of the RANS equations is to close the problem by a model of turbulence.

In this contribution, we focus on incompressible fluid flow simulated by RANS equations closed with two-equation k-omega turbulence model. Isogeometric Analysis (IgA) based on Galerkin method is applied for approximation of the initial-boundary value problem such that the behaviour of the numerical solution on the computational domain composed of several B-spline/NURBS objects (patches) is considered.

Similarly to other approaches, numerical solution based on IgA to convection dominated problems or problems including steep gradients in the domain suffer from spurious oscillations. Therefore, we investigate the stabilization techniques which increase the stability, however, without degrading accuracy. We compare different linear and nonlinear stabilization techniques (SUPG method, crosswind stabilization, isotropic stabilization, etc.).

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