The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Genuinely nonlinear stabilization techniques for fluid flow problems

Bohumír Bastl, Marek Brandner, Kristýna Slabá 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

Keywords: *isogeometric analysis, convection dominated, spurious oscillations, stabilization techniques*

The basic difficulties of the continuous Galerkin-based discretization methods as the isogeometric analysis (IgA) are interior and boundary layers in solution of the convection dominated problems, where solution gradients are very large and which cannot usually be resolved properly. It leads to unwanted spurious (nonphysical) oscillations in the numerical solution, which cause loss of accuracy and stability.

In order to overcome these deficiencies, many stabilization techniques have been proposed with the aim to remove (or to diminish) spurious oscillations without leading to excessive smearing of discontinuities or layers. The approaches originally intended for the finite element method are employed for isogeometric discretization including the streamline upwind/Petrov-Galerkin (SUPG) method and the spurious oscillations at layers diminishing (SOLD) method. Another stabilization technique proposed by Nazarov for a scalar conservation law and a turbulent compressible flow in [1] is isotropic, based on a residual norm and it is genuinely nonlinear (i.e., it is nonlinear even for the linear 1D case).

In this contribution, we focus on new stabilization scheme, which is a modification of the mentioned residual based artificial viscosity procedure (cf. [1]) and the classical streamline diffusion method. It means that it is a purely nonlinear approach and it has the character of a viscous term, which acts in the streamline direction. The stabilization term contains an artificial viscosity which is used as a switch that activates the classical streamline stabilization and at the same time ensures consistency in the sense of the Galerkin method.

REFERENCES

[1] M. Nazarov and J. Hoffman, Residual-based artificial viscosity for simulation of turbulent compressible flow using adaptive finite element methods. *International Journal for Numerical Methods in Fluids*, Vol. **71(3)**, pp. 339–357, 2013.

[2] E. Burman and A. Ern, Nonlinear diffusion and discrete maximum principle for stabilized Galerkin approximations of the convection–diffusion-reaction equation. *Computer Methods in Applied Mechanics and Engineering*, Vol. **191(35)**, pp. 3833–3855, 2002.