SemiGLS stabilization of FEM for solving Navier-Stokes equations

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ABSTRACT

Reliable modelling of flows for high Reynolds numbers, which appear in engineering practice, is still quite challenging. A way that allows using established FEM solvers for higher Reynolds numbers is employing stabilization to the method. The technique introduced by Hughes and Franca as the Galerkin Least Squares (GLS) method provides the basis for presented research.

We consider the *incompressible Navier-Stokes system*

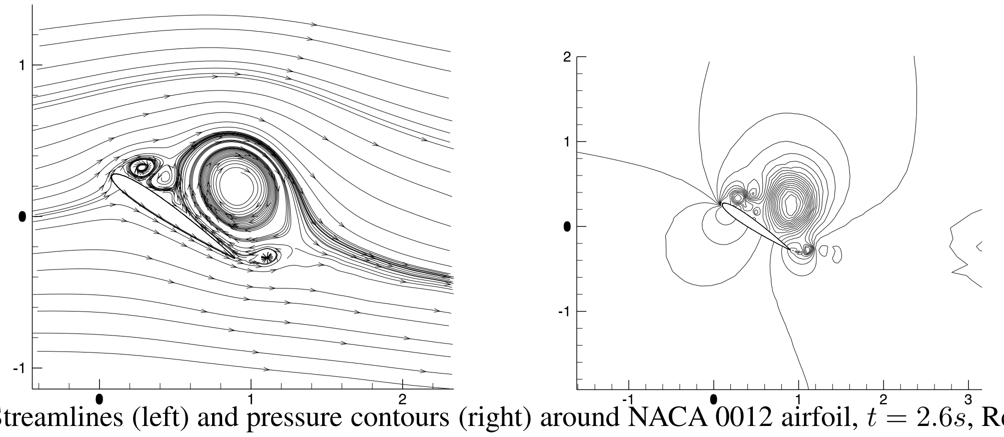
$$\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u} \cdot \nabla)\mathbf{u} - \nu \Delta \mathbf{u} + \nabla p = \mathbf{f} \quad \text{in } \Omega \times [0, T] \tag{1}$$

$$\nabla \cdot \mathbf{u} = 0 \quad \text{in } \Omega \times [0, T] \tag{2}$$

By the scheme presented by Hughes and Franca, we stabilize the momentum equation (1), while the continuity equation (2) is left without stabilization. Such approach we call *SemiGLS*.

We developed and implemented an algorithm for solving the problem. Hood-Taylor finite elements are used. These satisfy Babuška-Brezzi stability condition. Two versions were prepared – for steady and for unsteady problems. For careful derivations of the algorithm and for determining parameter τ, see [2]. Many numerical results are included in [1].

The algorithm has proved the ability to solve flows with high Reynolds numbers. We have also introduced two approaches to investigation of the error of the stabilized method.



Streamlines (left) and pressure contours (right) around NACA 0012 airfoil, $t = 2.6s$, Re = 100,000

Acknowledgement: This work has been supported by the grant GACR No. 106/05/2731/1.

REFERENCES

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[2] P. Burda, J. Novotný, J. Šístek, "On a modification of GLS stabilized FEM for solving incompressible viscous flows", accepted in Int. J. Numer. Meth. Fluids.