On Accuraccy of Stabilized Finite Element Approximations of Fluid-structure Interaction Problems

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Abstract

The fluid-structure interaction problems are important in many technical applications, see e.g. [1] The mathematical simulation of such fluid and structure interaction problems is a challenging problem. It is required to consider the viscous, usually turbulent flow, changes of the flow domain in time and also the nonlinear behaviour of the elastic structure. Moreover, the coupled system for the fluid flow and for the oscillating structure needs to solved simultaneously. The changes of the fluid domain cannot be neglected and the methods with moving meshes must be employed.

In this paper the performance of the stabilized finite element method is tested on number of benchmarks in order to demonstrate its applicability and to discuss its robustness. The numerical analysis of 2D interactions of the incompressible flow with an airfoil as published e.g. in [2]. The incompressible viscous flow in the computational domain $\Omega_t \subset R^3$ is governed by the Navier-Stokes equations written in the Arbitrary Lagrangian-Eulerian form. The flow motion results in the aerodynamic forces acting on the flexibly supported airfoil, which can be vertically displaced and rotated by an angle. In this case the airfoil motion is described with the aid of (nonlinear) motion equations.

The numerical method based on the finite element method is used. The stabilization is introduced and tested. The numerical method is applied for the approximation of several benchmarks.

References

1. Earl H. Dowell and Robert N. Clark.. A modern course in aeroelasticity. Solid mechanics and its applications. Kluwer Academic Publishers, Dordrecht, Boston, 2004.
2. Miloslav Feistauer and Jaromír Horáček and Martin Růžička and and Petr Sváček.. Numerical analysis of flow-induced nonlinear vibrations of an airfoil with three degrees of freedom. Computers & Fluids, 49(1):110 – 127, 2011..