On numerical solution of fluid-structure interaction problems: application on flow in a channel with moving walls

Petr Sváček[1]

In this paper the numerical solution of two dimensional fluid-structure interaction problems is addressed. We consider the fully coupled formulation of incompressible viscous fluid flow over a structure, which is described by a limited number of generalized coordinates.

The mathematical formulation of a relevant fluid-structure interaction problem is given. For the flow model we use the incompressible system of Navier-Stokes equations with large values of the Reynolds number $10^4 - 10^6$. The Navier-Stokes equations are spatially discretized by the FE method and stabilized with a modification of the Galerkin Least Squares (GLS) method; cf. [2].

The motion of the computational domain is treated with the aid of Arbitrary Lagrangian Eulerian(ALE) method. The GLS stabilizing terms are modified in a consistent way with the weak formulation of the ALE method.

The structure model is considered as a solid body with several degrees of freedom and described by a system of nonlinear ordinary differential equations. The construction of the ALE mapping is based on the solution of an elastic problem.

The method is applied onto a problem of interaction of channel flow with moving walls (a model of flow through a vocal fold).

References:

[1] Dowel E. H.: A Modern Course in Aeroelasticity, Kluwer Academic Publishers, Dodrecht, 1995.
[2] Gelhard T., Lube G. and Olshanskii M.A.: Stabilized finite element schemes with LBB-stable elements for incompressible flows, Journal of Computational and Applied Mathematics, 177:243-267, 2005.

[1]Czech Technical University in Prague, Fac. Mechan. Eng., Dep. of Technical Mathematics, Karlovo nam. 13, 12135 Prague, Czech Republic,
Petr.Svacek@fs.cvut.cz