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Boundary control of a 3-D fluid - structure interaction with moving frame.

Abstract

Boundary control problem corresponding to a minimization of hydrodynamic resistance on an interface between a 3-D solid and a 3-D fluid is considered. The problem is motivated by a multitude applications arising in bio-mechanics, aeroelasticity and industrial processes. Specific examples include: controlling blood flow in cardiovascular systems, flutter control in aeroelasticity, controlling pressure in heart valve dynamics etc.

The PDE system is modeled by system of partial differential equations describing motion of an elastic body inside an incompressible fluid. The fluid is governed by the incompressible Navier-Stokes equations while the structure is represented by the system of dynamic elasticity. The interface between the two environments undergoes oscillations which leads to moving frame configuration giving rise to quasilinear system. The control applied is a boundary control exerted on a part of the surface of the fluid via Dirichlet boundary conditions and the functional cost represents hydrodynamic pressure on the wall of the body. As a consequence, the optimization problem under consideration is neither convex, nor smooth.

We prove that under small disturbance hypothesis, control-to-state map is well posed and the optimal control problem admits a solution. We will distinguish between local and global theory, where local refers to solutions obtained for finite time with the size of the data depending on time horizon. In the presence of frictional damping affecting the solid the results obtained are global-so that the size of the data can be chosen uniformly in time. This allows consideration of infinite time horizon boundary control problem.The latter along with a corresponding stabilization problems will be considered as well.

REF: Small data global existence for a fluid-structure model model. M. Ignatova, I. Kukavica. I. Lasiecka and A. Tuffaha)- *Nonlinearity* to appear 2017