Boundary Control of strong solutions in FSI arising in coupling of elasticity with Navier-Stokes equations

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Abstract

We consider a coupled system of the linearly elastic body immersed in the flowing fluid which is modeled by means of incompressible Navier-Stokes equations. For this system we formulate an optimal control problem which amounts to a minimization of a hydro-elastic pressure on the interface between the two environments. The corresponding functional lacks convexity and radial coercivity. The approach taken is based on transforming the variable domain occupied by the fluid to the fixed one corresponding to the undeformed elastic inclusion. This leads to a free boundary elliptic problem. Mathematical challenge also results from the fact that the corresponding quasillinear elliptic model is equipped with mixed (Zaremba type) boundary conditions, which intrinsincly lead to compromised regularity of elliptic solutions. It is shown that under the assumption of small strains the controlled structure is wellposed in suitable Sobolev's spaces and the nonlinear control to state map is well defined and continuous. The obtained wellposedness result provides a foundation for proving an existence of optimal control where the latter is based on compensated compactness methods.

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