Stabilization of a fluid-rigid body system

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Abstract. We consider the mathematical model of a rigid ball moving in a viscous incompressible fluid occupying a bounded domain Ω, with an external force acting on the ball. We investigate in particular the case when the external force is what would be produced by a spring and a damper connecting the center of the ball h to a fixed point $h_1 \in \Omega$. If the initial fluid velocity is sufficiently small, and the initial h is sufficiently close to h_1, then we prove the existence and uniqueness of global (in time) solutions for the model. Moreover, in this case, we show that h converges to h_1, and all the velocities (of the fluid and of the ball) converge to zero. Based on this result, we derive a control law that will bring the ball asymptotically to the desired position h_1 even if the initial value of h is far from h_1, and the path leading to h_1 is winding and complicated. Now, the idea is to use the force as described above, with one end of the spring and damper at h, while other end is jumping between a finite number of points in Ω, that depend on h (a switching feedback law).

Key words. fluid-structure interactions, Navier-Stokes equations, PD controller, global solutions, asymptotic stability, switching feedback.

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1. Introduction and main results

We consider a coupled system described by nonlinear partial and ordinary differential equations modelling the motion of a rigid body inside a viscous incompressible