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IDENTIFICATION OF IMMERSED OBSTACLES VIA EXTENDED BOUNDARY MEASUREMENTS USING A GAME STRATEGY APPROACH

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Abstract: In this work, we consider the identification of one or more obstacles immersed in a viscous and incompressible fluid flow governed by the Stokes equations, from incomplete over-specified measurements at the boundary of the flow. Our purpose is to extend the method introduced in [1], based on a game theory approach, to develop a new algorithm for simultaneous identification of the objects and missing boundary data, of Dirichlet and Neumann type conditions. Consider a bounded open domain, which is filled with a fluid. Its boundary is sufficiently smooth and composed of two connected components. We consider an unknown obstacle immersed in this domain. The inverse problem considered here consists, then, from the given velocity and stress forces on an accessible part of the outer boundary, to determine the unknown obstacle such that the fluid velocity u and the pressure p verified the Stokes system with homogeneous Neumann boundary conditions on the obstacle using the Neumann and Dirichlet data on an accessible part of the outer boundary. This problem is formulated as a Three-player Nash game. The first player takes the known Dirichlet data and uses the Neumann condition on the inaccessible part of the outer boundary as a strategic variable. The second player is given the known Neumann data, and plays with the Dirichlet condition prescribed over the inaccessible boundary. Both of the two players consider a response fixed by the third player, which controls the obstacle shape. We have adopted the level-set method for an implicit representation of the contour of this object. Then, we introduce three objective functions, where each player tries to optimize his own cost by seeking to converge towards an equilibrium that represents a compromise between them. This equilibrium is defined as a solution of the multi-objective optimization problem (Nash equilibrium) and which is expected to approximate the coupled problem solution. In order to test the efficiency and robustness of the proposed approach and to compare with the existing methods, a numerical study is carried out for different forms of the obstacle.

References

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