An adaptive wavelet method for fluid-structure interaction

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One of the most practically important problems in aerodynamics is calculating moderate to high Reynolds number flow around solid obstacles of arbitrary shape. This problem arises in aerodynamics (e.g. turbulent flow over the wings and fuselage of airplanes), in off-shore drilling (e.g. water flow around riser tubes transporting oil from the sea bed to the surface), and in the wind engineering of buildings. In each case the primary difficulty arises from the need to calculate turbulent or transitional flow with boundary conditions on complicated domains. In addition, it may be important to allow for the obstacle to move or deform in response to the applied fluid forces (this motion in turn affects the flow).

In this paper we propose combining two mathematical approaches to calculate fluid-structure interaction numerically. The first technique, the adaptive wavelet method, tackles the problem of efficiently resolving a high Reynolds number flow in complicated geometries (where grid resolution should depend both on time and location). The second technique, Brinkman penalization, addresses the problem of efficiently implementing solid boundaries of arbitrary complexity.

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