An adaptive numerical scheme for solving incompressible free-surface flows

Dena Kazerani *

This work concerns the numerical treatment of the free surface incompressible Navier–Stokes equation with surface tension. We use the level set formulation to represent the fluid free-surface. Thanks to this formulation, the kinematic boundary condition is treated by solving an advection equation satisfied by the level set function. This equation is solved on a computational domain containing the fluid domain, over small time subintervals. Each iteration of the algorithm corresponds to the adevction of the fluid domain on a small time subinterval and to solve the time-discretized Navier–Stokes equations only on the fluid domain. The time discretization of the Navier–Stokes equation is done by the characteristic method. Then, the key tool which lets us solve this equation on the fluid domain, is an anisotropic mesh adaptation. Indeed, the mesh is adapted at each iteration such that we get convenient approximation errors in the vicinity of the fluid domain. The resolution of the discretized Navier–Stokes equation is done using the Uzawa algorithm for a convenient finite element method. The slip boundary conditions are considered by adding a penalization term to the variational formulation associated to the problem.

Keywords : Incompressible fluid, Navier–Stokes equation, level set method, anisotropic mesh adaptation, characteristic method

Références

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*INRIA-Paris, EPC REO, 2 rue Simone Iff, CS 42112, 75589 Paris Cedex 12