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Abstract

A simple and efficient computational framework is presented for the simulation of fluid-structure interaction problems involving rigid body and multiphase flows in the context of hydrodynamics. Unlike existing publications, this method does not solve the general motion of rigid bodies in the Lagrangian form of Newton's law. Derived from the distributed Lagrange multiplier treatment of the rigid body, a new set of governing equations is presented on the fully Eulerian one-fluid formulation. To solve the problem numerically, the complex problem is separated into three parts: balance of the momentum and mass (dynamic problem), evolving of the Heaviside function by the external velocity (geometric problem) and rigid motion projection (kinematic problem). The conservation of mass and momentum are guaranteed by the multiphase fluid solver. The water, air and structure coupling is accomplished by the smeared interface. A new way of initialisation and convection of the rigid Heaviside function is designed for an arbitrary shape. To deal with rigid velocity vector, a linear least square method is proposed. The excellent agreement between the numerical experiment and the reference data from experiments demonstrate the validity and applicability of the new methodology.

Keywords: One-fluid formulation, fluid-structure interaction, Heaviside initialisation and interpolation, linear least square projection, water impact

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