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Efficient Simulation of Fully Coupled Wave-Body Interactions on a Cartesian Grid[1] JIANMING YANG, FREDERICK STERN, University of Iowa
— The sharp interface Cartesian grid method by Yang and Stern (Sharp interface immersed-boundary/level-set method for wave-body interactions, J. Comput. Phys. 228 (2009) 6590-6616) is extended for the efficient simulation of fully coupled wave-body interactions of a single body with a two-phase incompressible flow. The overall approach is based on a fractional-step method using finite differencing on a staggered Cartesian grid and the governing equations are solved in a non-inertial reference frame following the motion of the body. A level set method is adopted for the fluid-fluid interface tracking and a direct forcing immersed boundary method is used for the fluid-solid boundary treatment. The relationship between the body velocity and the explicit momentum forcing given by Kim and Choi (Immersed boundary method for flow around an arbitrarily moving body, J. Comput. Phys. 212 (2006) 662-680) is utilized for the non-iterative solution of fluid-structure interactions. The forces and moments calculation in the framework of solid-liquid-gas system is emphasized. Several cases ranging from water entry problems to ship moving in waves are demonstrated to showcase the accuracy and efficiency of the method.

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