

Wave propagation in a 3D fully nonlinear NWT based on MTF coupled with DZ method for the downstream boundary

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Abstract. Wave propagation in a three-dimensional (3D) fully nonlinear numerical wave tank (NWT) is studied based on velocity potential theory. The governing Laplace equation with fully nonlinear boundary conditions on the moving free surface is solved using the indirect desingularized boundary integral equation method (DBIEM). The fourth-order predictor-corrector Adams-Bashforth-Moulton scheme (ABM4) and mixed Eulerian-Lagrangian (MEL) method are used for the time-stepping integration of the free surface boundary conditions. A smoothing algorithm, B-spline, is applied to eliminate the possible saw-tooth instabilities. The artificial wave speed employed in MTF (multi-transmitting formula) approach is investigated for fully nonlinear wave problem. The numerical results from incorporating the damping zone (DZ), MTF and MTF coupled DZ (MTF+DZ) methods as radiation condition are compared with analytical solution. An effective MTF+DZ method is finally adopted to simulate the 3D linear wave, second-order wave and irregular wave propagation. It is shown that the MTF+DZ method can be used for simulating fully nonlinear wave propagation very efficiently.

Keywords: NWT; DBIEM; multi-transmitting formula; damping zone; MTF+DZ

1. Introduction

When simulating the nonlinear wave propagation through an unbounded domain in the time domain, it is necessary to truncate the computational domain into a finite domain in order to reduce computational cost. Thus, non-reflecting radiation condition is required for the truncated surface, however, there is no exact non-reflecting condition in existence. The Sommerfeld-Orlanski's condition (Orlanski 1976) has been widely used for linear simulation; this condition is local in both time and space and dependent on the phase velocity of out-going wave but cannot ensure good results for irregular wave problem. The global matching or shell function method (Dai and Duan 2008, Newman 2010) can be very accurate for linear irregular wave radiation but with relatively large computational effort on comparing with the local method and still can not fully satisfy the nonlinear condition. Another common used method is Damping Zone

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