Solving time-dependent acoustic problems with a Lagrangian meshfree finite difference particle method

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Abstract

The development of computational acoustics allows simulation of sound generation and propagation in complex environment. In particular, meshfree particle method, which is always regarded as a pure Lagrangian approach, is easily represented complicated domain topologies, moving boundaries, and multiphase media. This work presents a Lagrangian meshfree method in solving time-dependent acoustic problems. The Lagrangian acoustic wave equations, Lagrangian acoustic perturbation equations, and Lagrangian fluid dynamic equations are solved for transient problems. The finite difference particle method (FDPM) based on the generalized finite difference scheme is used as a computational acoustic method. A hybrid meshfree and finite-difference time-domain boundary treatment technique is utilized to represent different acoustic boundaries including rigid, soft, and absorbing boundaries. One- and two-dimensional problems are considered with linear and nonlinear governing equations. The method is compared with smoothed particle hydrodynamics (SPH) method and corrective smoothed particle method (CSPM). Accuracy, convergence, and efficiency of the finite difference particle method are evaluated with different numerical examples.

Keywords: computational acoustics; meshfree method; Lagrangian approach; finite difference particle method; smoothed particle hydrodynamics; acoustic perturbation equation