A meshfree method for inverse wave propagation using collocation and radial basis functions

***Lihua Wang, Zhen Wang, Zhihao Qian**

School of Aerospace Engineering and Applied Mechanics, Tongji University,
Shanghai, 200092, P.R.China.

*Presenting and corresponding author: lhwang@tongji.edu.cn

Abstract

A stable and highly accurate meshfree scheme based on strong form collocation associated with radial basis functions and explicit time integration is proposed to solve ill-posed inverse wave propagation problems. Tikhonov regularization technique and the L-curve criterion are employed to deal with the noise measurement data before solving the governing equation to get a stable solution. Appropriate weights are first derived for imposing boundary conditions and known conditions from the measurement data to yield the optimal convergence for inverse problems. Compared to the required iterative procedures in common methods, no iteration is needed in the proposed method which leads to the time-saving computation and avoids the instability resulting from the iterative methods. Dispersion analysis describes that this method has much less dispersion error than the classical finite element method (FEM) and popular weak form meshfree methods, and stability analysis is performed to predict the critical time step for the explicit time integration. Another outstanding advantage of this method is it's effortless to extend the solution scheme of one-dimensional inverse problem to high-dimensional inverse problems. Furthermore, the influences of the high noise into measurement data are evaluated, which demonstrate that even handling with very high noise in the input data the proposed algorithm can achieve stable and high-accuracy solutions.

Keywords: strong form collocation, radial basis functions, ill-posed inverse wave propagation problem, Tikhonov regularization, dispersion analysis, stability analysis