ICCES, 2023, vol.27, no.1
DOI: 10.32604/icces.2023.09472

PROCEEDINGS

A Fast Direct Boundary Element Method for 3D Acoustic Problems Based on Hierarchical Matrices

Ruoyan Li[1,2], Yijun Liu[1,*] and Wenjing Ye[2]

[1] Department of Mechanics and Aerospace Engineering, Southern University of Science and Technology, Shenzhen, China

[2] Department of Mechanical and Aerospace Engineering, The Hong Kong University of Science and Technology, Hong Kong, 999077, China

[*]Corresponding Author: Yijun Liu. Email: liuyj3@sustech.edu.cn

ABSTRACT

The boundary element method (BEM) for acoustic problems is a numerical method based on solving the discretized boundary integral equation (BIE) corresponding to the Helmholtz equation. A fast direct BEM for 3D acoustic problems is proposed in this paper, which is more suitable for broadband acoustic simulation of complex structures, such as in the design and analysis of acoustic metamaterials. The main idea of the fast direct solver is based on the hierarchical off-diagonal low-rank (HODLR) matrix, randomized interpolative decomposition and fast matrix inversion formula. Several numerical examples in solving both interior and exterior acoustic problems are presented in this paper, including radiation and scattering problems with distributed and complex structures. The numerical results show that the same level of accuracy and higher computational efficiency can be achieved by using this fast direct BEM compared with the conventional direct BEM.

KEYWORDS

Boundary element method; fast direct solver; hierarchical matrices; 3-D acoustic wave problems

Funding Statement: The authors would like to thank the financial support to this work from the National Natural Science Foundation of China (Project No. 11972179).

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.