An application of fast multipole method to isogeometric boundary element method in two-dimensional acoustic problems

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Abstract

According to the concept of isogeometric analysis (IGA), the B-spline basis functions are used to describe the geometry and approximate the physical fields. The method circumvents the requirement to generate a mesh, which is a significant progress in reducing the gap between engineering design and analysis. As Non-Uniform Rational B-splines (NURBS) can represent the structural geometric exactly, some researchers have applied the IGA to the boundary element method (BEM), forming the IGA BEM. We have applied IGA BEM in the two-dimensional acoustic problems to improve the computational accuracy. The Burton-Miller method is adopted to conquer the fictitious eigenfrequency problem in solving exterior acoustic problems. Furthermore, we introduce the fast multipole method (FMM) to the IGA BEM to reduce the computational complexity from $O(n^2)$ to $O(n)$, where n is the computational DOF. Finally, we compare the IGA FMBEM with IGA BEM to demonstrate the acceleration of FMM and the potential of solving large-scale engineering problems. In addition, we also compare the IGA BEM with the conventional BEM using constant elements to test the promotion of accuracy.

Keywords: Isogeometric analysis, NURBS, Boundary element method, Burton-Miller, Fast multipole method, Acoustic problems