A kernel-independent fast multipole BEM for 3-D elastodynamics

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The boundary element method (BEM) has been extensively used in elastodynamic analysis in time- and/or frequency-domain. Especially in the recent years the applications of the BEM are greatly enhanced by various acceleration techniques, of which a representative example is the fast multipole method (FMM) [1]. The implementation of the conventional FMM for elastodynamics is much involved and depends on certain expansions of the fundamental solution (integral kernel). The kernel-independent FMM (KIFMM) which is independent of the kernel functions have thus been proposed to alleviate this limitation.

In this work, the KIFMM proposed by Ying et al in [2] is adapted to accelerate 3-D BEM elastodynamic analysis in frequency domain. Time domain analysis can be realized by employing the frequency-domain approach in [3]. In the frequency domain analysis, the boundary of the elastic solid is partitioned into curved quadratic elements. By using the Nyström method the boundary integral equation is discretized into a linear system. The matrix-vector product can be efficiently computed using the KIFMM, in which all translations are performed using equivalent densities. Time domain responses are obtained by the numerical inverse Laplace transform of the frequency responses at a series of sampling frequencies. The high efficiency of the present method is demonstrated by numerical examples with around 1 million DOFs and by comparisons with existing methods.

Keywords: Boundary element method, Fast multipole method, Elastodynamics, Frequency-domain approach, Nyström method

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