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Application of the fast multipole method for solving very large acoustic radiation problems

Raphael Hallez[a], Koen De Langhe[a], Michel Tournour[a] and Toufic Abboud[b]

[a]LMS International, Researchpark Z1, Interleuvenlaan 68, 3001 Leuven, Belgium

[b]IMACS, Ecole Polytechnique, 91128 Palaiseau Cedex, France

Boundary element method is well known and extensively used to solve acoustic radiation problems. It is especially appropriated for exterior radiation since the fluid domain does not need to be meshed, as opposed to the finite element method. However, the mathematical formulation leads to a dense matrix system of equations. Therefore, the size of the model increases drastically as the frequency of analysis increases and huge computer resources are required to solve complex models in the mid-frequency range. The fast multipole method can be used to extend the boundary element model and solve such problems. For a model with N nodes, this technique brings the number of operations down to O(N*LogN) instead of O(N**3) for conventional boundary elements. This new methodology has been applied here to study the acoustic radiation of a complete car in the mid-frequency range. The accuracy of the results as well as the computation time demonstrate the great potential of this new method to solve very large acoustic radiation problems.