Shape and Topology Optimizations Using BEM and a Level Set Based Method

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The boundary element method (BEM) is applied for shape and topology optimization problems in three-dimensional elastostatics and acoustic problems. Although domain discretization is not needed in the BEM analyses for linear problems, and those with infinite domains, the required storage and computation costs have been very high. However, these drawbacks are now be overcome thanks to the development of the fast computation algorithm based on multipole expansions of the fundamental solutions of the governing differential equation. Hence, the shape optimization problems are now one of the competitive areas of BEM applications. The present study treats a topology optimization method for three-dimensional elastostatics and acoustic problems using the boundary element method and level set-based structural boundary expressions incorporating a fictitious interface energy model. A procedure to generate the boundary elements from the level set function at each iterative step of optimization process is also proposed. Thus, re-meshing of the body in the optimization process and specifying the boundary conditions on the boundaries under their shape modification are now possible. The approach is demonstrated through several numerical examples of optimum designs for compliance of elastic solids and sound scatters in acoustic fields using conventional and fast-multipole boundary element methods.

Keywords: Boundary elment method, topology optimization, level-set function, elastostatics, acoustic problem.