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Shape Derivative Formula of Domain Integral Type

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Abstract

Determining the optimum shape of the domain in which a boundary value problem of a partial differential equation is defined is called a shape-optimization problem. One way to formulate this problem is to choose the domain mapping as the design variable. Cost functions are defined as functionals of the design variable and the solution to the boundary value problem. The shape derivatives, which are defined as the Fréchet derivatives with respect to domain variation, of the cost functions have been evaluated assuming appropriate regularity in the boundary value problem using the formulae of boundary integral type.

In the present paper, instead of the well-known equation of boundary integral type to evaluate the shape derivatives, an equation of domain integral type is proposed. Several propositions are introduced and used to obtain the equation of domain integral type. The superiority of the equation is to be applicable to the boundary value problems including singular points, that is, less smoothness for the solution of the boundary value problem is required to evaluate the shape derivatives. This method is applied to the mean compliance minimization problem of linear elastic body. Numerical example shows the validity of the method.