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LEVEL SET-BASED TOPOLOGY OPTIMIZATION METHOD FOR MECHANICAL STRUCTURES CONSIDERING STRUCTURAL FLEXIBILITY

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Topology optimization methods [1] such as the homogenization design method and density approaches have been widely applied to industrial product design problems. In these methods, the optimal configurations are represented as a material distribution that includes intermediate material and the obtained configurations therefore lack clear boundaries. To overcome this issue, level set-based shape optimization methods [2] and topology optimization methods [3] have been proposed during the last decade. In level set-based methods the structural boundaries are represented using the iso-surface of a scalar function, the so-called level set function. To represent changes in the configurations during the optimization process, the level set function is updated. In addition, the geometrical complexity of the obtained optimal configuration can be controlled when a fictitious interface energy model [3] is used.

On the other hand, mechanical resonators are designed to be flexible to achieve a specified motion as a sensor. Such sensors are widely applied in micro-electromechanical systems (MEMSs). This research presents an optimum design method for mechanical resonators using a level set-based topology optimization method and the Finite Element Method (FEM) that considers structural flexibility. First, the design requirements for the mechanical resonators are discussed and an optimum design problem is then formulated that addresses the desired design of the mechanical resonators. Next, the level set-based topology optimization method is formulated using a fictitious interface energy model. Based on this formulation, a new topology optimization algorithm is constructed that employs the FEM when solving the governing and adjoint equations and updating the level set function. Finally, three-dimensional numerical examples are provided in order to confirm the usefulness of the proposed optimum design method.

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