Topology optimization of piezoelectric structures subjected to transient dynamic loads

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Abstract

This study develops a topological design method of the piezoelectric actuator/sensor coverage attached to a thin-shell structure for reducing the structural transient dynamic response. Therein, the actuator patches and sensor patches are symmetrically attached to the host layer, and the classical negative velocity feedback control strategy is adopted for reducing the vibration level of the structure. In the mathematical formulation of the considered topology optimization model, the time integral of the displacement response over a specified time interval of interest is taken as the objective function. The relative densities of the elements in the actuator layer and the sensor layer are considered as topological design variables , and a penalization model on the structural stiffness and piezoelectric effect is employed. The adjoint-variable sensitivity analysis scheme for a general integral function within a given time interval is derived, which facilitates a gradient-based mathematical programming solution of the optimization problem. The effectiveness and efficiency of the proposed method are demonstrated by numerical examples. The proposed method can be used for providing useful guidance to the layout design of the actuator/sensor layers attached to a thin-shell structure subject to dynamic excitations, in particular impact forces.

References
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