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3D Piezoelectric Structures Based Topology Optimization

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Abstract

Actuators based smart materials are of great interest at small-scales applications. Owning to their internal structure, they can change their properties in repones to external stimulus. Among them, piezoelectric actuators are of great interest thanks to their high bandwidth, high resolution, and high force density. However, most of the existing piezoelectric actuators are based on planar structure. Therefore, they have satisfactory performance for in-plane deformation and force application like 2D positioners. On the other hand, for out of plane deformation, the piezoelectric bending actuators have very low deformation range and low force amplitude. To remedy, we propose piezoelectric actuators with 3D structures that are designed by topology optimization methodology. In this regards, to improve the performance of the 3D actuator and to tackle the challenges of fabrication, the passive material is considered in the design domain to form a multi-material topology optimization. However, it should be noted that the passive and active (piezo) domains are defined a priori and will not be switched during the optimization. Although 2D multi-material approach has been presented in the literature for the passive and active piezoelectric compliant mechanisms, the 3D piezoelectric actuator has never been discussed in the literature.

Key Words: Structural optimization, topology optimization, piezoelectric actuator.