# ABSTRACT

## Structural Design of Piezoelectric Actuator considering Polarization Direction and Continuous Approximation of Material Distribution

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In the design of piezoelectric actuator the concept of compliant mechanism combined with piezoelectric materials has been used to magnify either geometric or mechanical advantage. The polarization of piezoelectric materials is considered to improve actuation since the piezoelectric polarization has influences on the performance of the actuator. The topology design of compliant mechanism can be formulated as an optimization problem of material distribution in a fixed design domain and continuous approximation

of material distribution (CAMD) method has demonstrated its effectiveness to prevent the numerical instabilities in topology optimization. The goal of this work is to determine the optimal topology of compliant structures and the orientation of the piezoelectric polarization using CAMD.

Coupled-filed piezoelectric analysis including poling materials is implemented and CAMD is applied to both the homogenization design method (HDM) and the simple isotropic material with penalization (SIMP) approach. The optimization problem is formulated to maximize the mean transduction ratio subject to the total volume constraints and solved using a sequential linear programming algorithm. In the numerical example different initial angles of polarization are tested to examine the local optima and structural configurations of piezoelectric actuator are compared with respect to the performance measure. It is noted that the polarization angle converges to a relative optimal value and CAMD results in the clear structural layout. The proposed topology optimization scheme considering piezoelectric polarization can provide the idea of the optimal poling direction as well as the compliant structure to improve the performance of the mechanism.