ABSTRACT

Compliant Mechanism Design Under Uncertainties

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A compliant mechanism is the mechanism that produces its motion by the flexibility of some or all of its members when the input forces are applied. Since previous works on designing a compliant mechanism with topology optimization technique focused on maximizing its desired performance such as output displacement and mechanical or geometrical advantage, the generated motion could not be estimated and additional efforts are required to fulfill its functionality. Moreover, experimental studies show that MEMS devices may be subject to severe stochastic variations in material, and geometric properties and/or their operating environment, leading to large uncertainties in their structural behavior.

In this study structural stiffness is defined to design a compliant mechanism and the

design method satisfying desired output displacement and structural stiffness is proposed using relationship between output displacement and volume fraction. Continuous approximation of material distribution is used to be free from numerical instabilities such as checkerboards and mesh-dependency and the method of moving asymptotes is used for topology optimization with multi-constraints. Reliability analysis with analytically-derived most probable point is proposed and reliability-based designs for a specific risk or target reliability level are performed.

The results from designing displacement inverter and displacement transmitter show that the design of the compliant mechanism with specified output displacement and structural stiffness can be obtained but has a limit to its reliability against uncertainties.