Topological Design Methods for MEMS

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MEMS is an acronym for Micro-Electro-Mechanical Systems, which are essentially very small electronically-activated mechanical devices. They have an enormous range of possible applications as micro-scale sensors and micro-scale tools. Conceivably, they could be applied in medicine, automotive engineering, aerospace engineering and a host of other fields.

One of the obvious differences between MEMS and more traditional large-scale mechanical systems is their size. Because MEMS are so small, they cannot be designed as a sequence of different parts which are then joined together with bolts, hinges, or welds. Instead, available manufacturing techniques for MEMS (laser-assisted vapor deposition, and lithographic techniques) typically require that they be monolithic continuum structures without joints. Most MEMS therefore function as compliant mechanisms, or structures that gain desired output motions in response to input loadings primarily by means of the deformation of the different elastic structural components. In this sense, such MEMS differ quite markedly from large scale mechanical systems which gain output motions primarily by rigid body translations and rotations. Thus, in an ideal sense MEMS are based on compliant mechanisms, and function as hingeless, continuum structures.

While the technologies for manufacturing MEMS have undergone great advances and development over the past decade, the technologies by which they are analyzed and designed have not. In this program research is being performed on applying structural topology optimization and other CAD tools that were originally developed for large-scale mechanical systems to the design of MEMS.