Topology optmimzation of multi-stable elastic structures

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ABSTRACT

In this talk we discuss computational methods which is intended to be used to design structures that are expected to snap. One example of such structures are multi-stable micro-flexures that buckle to perform digital computations. Since such structures inevitably function under finite strains we model the material by general finite strain hyper-elasticity. The balance equations are solved using the finite element method in a total Lagrangian setting along with Newton-Raphson iterations. To trace the load paths and to be able to pass singular points we make use of path following technique.

To find the optimal material layout we associate one design variable with each element such that material and void can be represented. The optimization problem is then to find a material distribution such that the objective is minimized while fulfilling the constraints. In our application the objective is to find a layout that gives a stable state in terms of energy level while having distinct states, i.e. the difference in deformation between the stable states should exceed a given threshold. We also impose a constrains on the availibe mass of the device.

To solve the optimization problem we use mathemetical programming and in particular we use the Method of Moving Asymptotes (MMA). The gradients required to form the convex approximations are established via the adjoint sensitivity approach. To form a well-posed problem we reguralize the optimization problem via the use of a PDE filter.