Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Mechanics & Materials Laboratory
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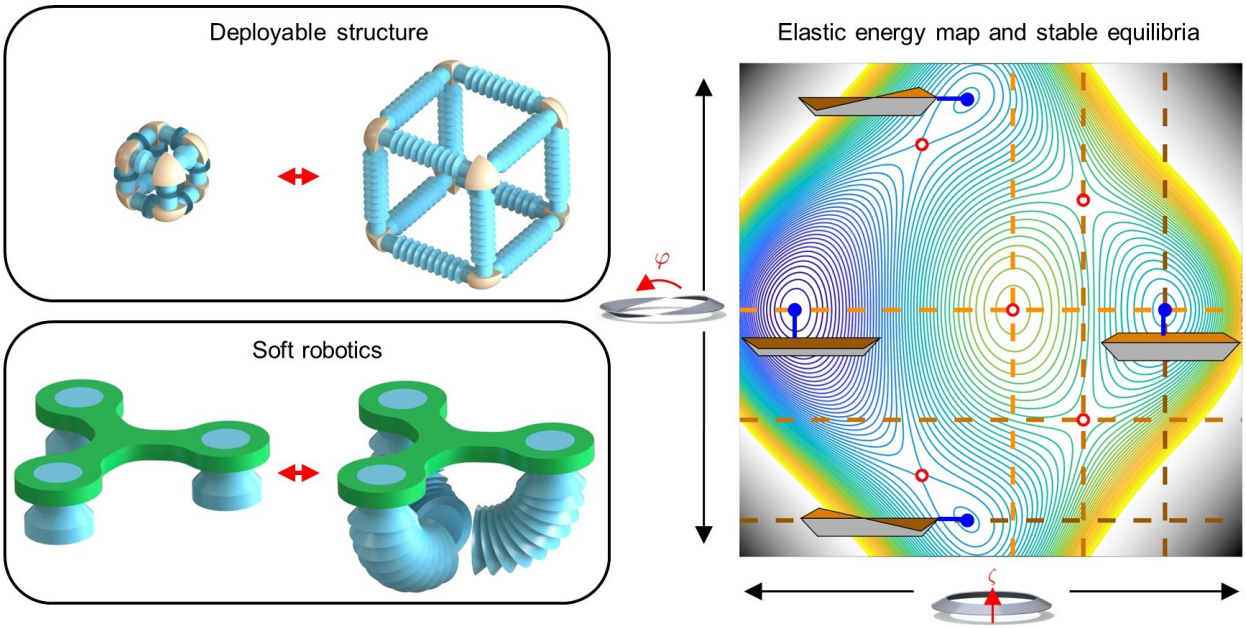
www.mm.ethz.ch

Master Thesis/Semester Project

Experimental study for deployable structures and soft robotics with straw-based metamaterials



Description: Reconfigurable metamaterials whose shapes and properties can be tailored thanks to the multistability of their constituent unit cells, have attracted significant attention due to their unique characteristics. For example, large elastic deformations, wide range of Poisson's ratio, as well as multiaxial complex stable states. Such properties have cross-disciplinary importance and they can be vital for a large variety of applications spanning from deployable structures to soft robots.

Deployable structures are flexible structures that can transform from a compact state to a predetermined operational configuration upon actuation. The ability of the deployable structure to reconfigure its shape makes it useful in many fields, including aerospace, construction and machines.

Soft robots, on the other hand, have bodies made out of intrinsically soft and extensible materials or structures. These robots have a continuously deformable structure with muscle-like actuation that emulates biological systems, resulting in a relatively large number of degrees of freedom. This allows them to achieve complex motion, adaptable shape, impact absorbtion, multi-functionality and safely interact with human.

Our ongoing research deals with truss metamaterials, whose members are modelled as "bendy-straws" which are characterized by local multistability. Namely, under suitable design parameters each constituent segment of every straw has four stable equilibria in 2D and infinite stable equilibria in 3D, which provide a straw-based truss metamaterial, a myriad of stable configurations. Thus, a careful design of such metamaterials can lead to a structures with different operative stable configurations, having distinct static and dynamic properties.

The goal of this project is to apply the straw-based metamaterial in deployable structures and soft robotics. Based on current airtight design for compressible fluids actuation, the project will involve designing, fabricating and testing different straw-based structures, such as, soft robotic gripper, soft mobile robot, miniaturized prototypes for deployable constructions and so on. The displacement and force of the structure will be measured by our established computer vision algorithm and force sensor. The results will be compared with current computational models for quantitative validation. As an outcome of this project, we aim to gain better understanding on the real-world applications of straw-based truss metamaterials.

Pre-requisites:

- A background in solid and fluid mechanics
- Literacy in computer aided mechanical design
- Strong technical skills and willingness to take part in developing a physical experimental setup
- Code literacy, experience with Matlab

For more information, please contact:

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