Eidgenössische Technische Hochschule Zürich
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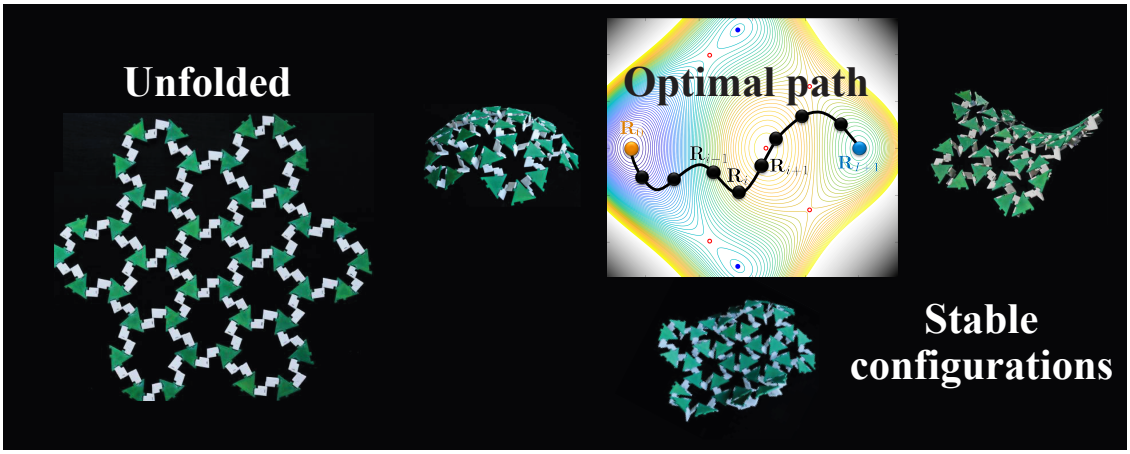
Master Thesis/Semester Project/Bachelor's Thesis

(Winter/Spring 2024):

Optimal design and actuation of multistable origami structures



Background: Origami, the ancient art of folding paper, has rapidly emerged as an engineering tool to create reconfigurable structures and materials. Origami-inspired folding offers a path to achieving shape changes that enables multi-functional structures in robotics, spacecraft, and electronics as well as metamaterials with tunable properties. A key challenge in origami engineering is actuation of a structure between desired configurations, especially for complex fold patterns with many degrees of freedom.

Reconfiguring a structure with a multitude of degrees of freedom between stable configurations requires actuation along a high dimensional path over a highly nonconvex potential energy landscape. For this purpose we have previously developed an algorithm striving to find the minimum energy actuation path, given the distribution of actuators along the structure, and assuming this actuation scheme can make the desired reconfiguration.

Project description: The ultimate goal of this project is developing methods to optimally design and actuate multistable origami structures. The initial stage will deal with structural optimization of the origami structures, such that they could be stabilized in different programmed complex configurations, while utilizing a minimum number of elastic components. Next, in order to efficiently switch between wanted equilibria, we will develop an optimization scheme, geared to minimize the number of actuators, where their optimal operation will be determined by an adaptation of the algorithm described above. Finally, if time permits, we will design an experimental rig, to validate the theory.

Pre-requisites: Strong background in mechanics, code literacy and experience with Matlab. Prior experience with nonconvex optimization techniques is preferable but not mandatory.

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