Promotor: Ellen Roels

Title: Designing programmable soft matter with tunable bending behaviour

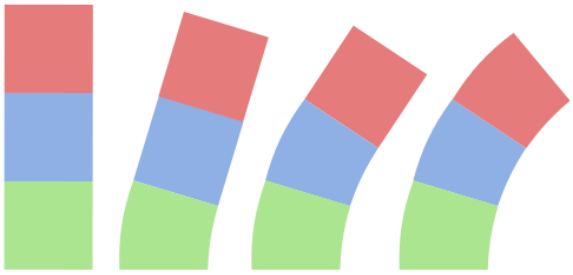
Description:

Soft robotics is a subfield of robotics that leverages the compliance of soft materials such as silicone rubber to create flexible and adaptive robotic systems. Unlike traditional rigid robots, soft robots can deform continuously, enabling new types of locomotion, manipulation and interaction with unstructured environments. One approach for controlling deformation in soft robots is tendon-driven actuation, where embedded tendons are pulled to transfer forces. By carefully designing the geometry of these structures, it is possible to tune the deformation behaviour.

This thesis focusses on the development of soft units with tunable bending behaviour, actuated using a tendon. By modifying their geometrical parameters, the bending behaviour can be tuned. These units, designed as cubic voxels are stacked on top of each other, and actuated using a single tendon routed through them. When the tendon is pulled, the units should bend sequentially in a controlled manner. Upon releasing the tendon, the unbending should follow a different, predefined sequence, introducing an asymmetric deformation-recovery cycle.

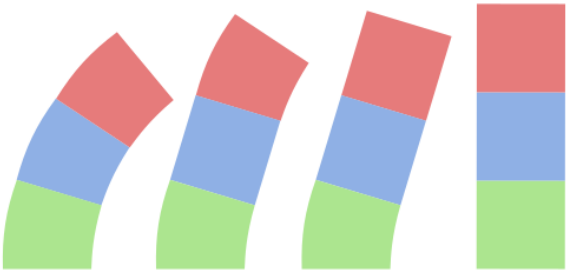
As part of this project, you will:

- Design and optimize the soft units, exploring how geometrical features influence their bending behaviour.
- Develop a computational model using finite element analysis (preferably Abaqus) to simulate their mechanical response and predict the deformation sequence.
- Manufacture the units by casting them in silicone rubber.
- Experimentally validate their behaviour, analyzing the deformation pattern and actuation force to compare with simulation results.
- Explore if this concept can be used as legs for a walking exploration robot.



Bending order: green - blue - red

Unbending order: blue - red - green



Estimated workload:

Literature study: 25%, analysis (FEM, calculations): 30%, design: 20%, manufacturing: 10%, experiments: 15%