University of Stuttgart

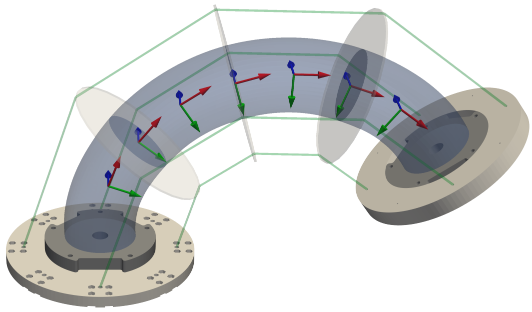
Institute for Nonlinear Mechanics

Term paper
Bachelor's thesis
Master's thesis

Design and Construction of a Tendon-Driven Continuum Robot

Topic Areas:	Technical Design, 3D Printing Parameter Identification
Advisors:	Tianxiang Dai, dai@inm.uni-stuttgart.de
Responsible Professor:	Prof. Remco Leine
Prerequisites/Prior Knowledge:	Experience or interest in CAD, 3D printing technologies, and hardware development

Continuum robots (CRs), inspired by soft-bodied organisms such as octopuses, are increasingly being applied in minimally invasive surgery, search and rescue operations, as well as in-space inspection and maintenance. Their high flexibility and dexterity enable safe interaction in complex and constrained environments. However, their compliant structure also introduces challenges in system integration, sensing, and experimental validation, especially when building reliable hardware platforms.



Tendon-driven continuum robot

To systematically investigate the behavior of continuum robots and support future research activities, a robust and modular experimental platform is required. At our institute, preliminary studies have validated individual components of a tendon-driven continuum mechanism. However, a fully integrated multi-segment robotic system with sensing, actuation, and data acquisition capabilities is still missing. Therefore, developing a dedicated test bench is a crucial step toward enabling repeatable experiments and performance evaluation.

This thesis aims to design and construct a continuum robot test bench to support future experimental studies. The specific objectives are:

- Fabrication of a continuum robot design using 3D printing [1], [2]
- Assembly and integration of the mechanical structure, actuation system, and electronics
- Integration of ArUco markers for vision-based pose estimation
- Development of a ROS 2 interface for system operation and data acquisition
- Experimental characterization of the robot behavior (e.g., stiffness properties)
- Basic model-based analysis to support parameter identification
- Iterative improvement of the structural design based on experimental results

The overall goals of this project will be adjusted based on the thesis type.

References

[1] Z. Wang et al., *Spirobs: Logarithmic spiral-shaped robots for versatile grasping across scales*, 2025.

[2] H. M. Hansen et al., *Tendon-actuated robots with a tapered, flexible polymer backbone: Design, fabrication, and modeling*, 2026.