

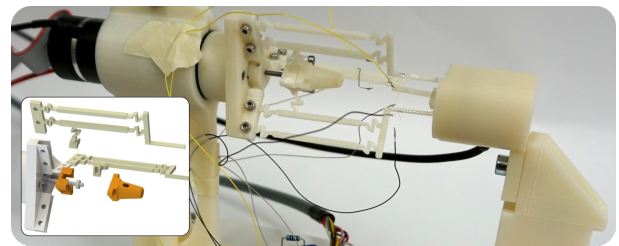
## Master Thesis: Object Slippage Detection for a Miniature Force-Sensitive Gripper

**Context:** In the scope of an ongoing research project, we are currently developing a teleoperated micro-assembly system to assemble mechatronic prototype devices (a). This system combines a robotic assembly station with a visuo-haptic user interface [1]. On the assembly side, a miniature force-sensitive gripper (b) is used to grasp and move parts following user input. Depending on material and geometry of the manipulated parts, slippage between parts and gripper fingers might occur during manipulation. This renders the assembly process much more tedious and might even damage fragile parts. Currently, the user is required to constantly be attentive to such slippages. Automating this slippage detection, for instance by means of vision-based tactile sensors [3], would hence decrease the mental load on the user and further allow for automation of certain assembly steps.

**Task description:** This thesis will be structured into two main parts. Firstly, the suitability of our current prototype gripper to perform all required assembly tasks and to implement automated slippage detection shall be investigated. To this end, the current gripper design shall be improved based on findings from past experiments. Then, a second iteration thereof shall be manufactured and validated in a small user study. Secondly, suitable methods for automated slippage detection with your improved gripper design shall be identified and evaluated. Ideally, at least one such method would be implemented in the gripper and integrated in the user study.



(a) The proposed micro-assembly system including a miniature force-sensitive gripper in the assembly side (right)



(b) FDM-printed prototype of a miniature force-sensitive gripper featuring strain gauges for interaction force measurement [2]

### Work packages:

- Review the relevant literature on concepts for slippage detection in gripping systems
- Detail the requirements for your gripper design and slippage detection method
- Redesign and manufacture the miniature force-sensitive gripper
- Analyze, compare, and ideally implement suitable slippage detection methods for the new gripper
- Evaluate the performance of your new gripper design and ideally slippage detection method in a small user study

### Benefits:

- Learn to use a state-of-the-art PLC (programmable logic controller) system (TwinCAT 3, Beckhoff Automation)
- Gain practical experience with mechanical design and additive manufacturing
- Work in an academic environment with a strong focus on application-driven, hands-on engineering

### Requirements:

- Solid background in robotics, mechanical engineering, or a closely related field
- Basic knowledge of programming (C++), kinematics, and dynamics
- Prior experience with prototyping robotic systems is a plus, but not strictly required

### References:

- [1] A. Boleyn and S. Régnier. "A Review of Haptic Feedback Teleoperation Systems for Micromanipulation and Microassembly." *IEEE Trans. Automation Sc. and Eng.*, vol. 10, no. 3, pp. 496-502, Jul. 2013. doi.org/10.1109/TASE.2013.2245122
- [2] C. Duverney et al. "Development and Evaluation of a Force-Sensitive Flexure-Based Microgripper Concept." *Proc. New Trends in Medical and Service Robotics (MESROB)*, Basel, Switzerland, Forthcoming 2021.
- [3] Y. Ito et al. "Robust Slippage Degree Estimation Based on Reference Update of Vision-Based Tactile Sensor." *IEEE Sensors J.*, vol. 11, no. 9, pp. 2037-2047, Sep. 2011. doi.org/10.1109/JSEN.2010.2104316

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Start: September 2021

Duration: 6 months

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