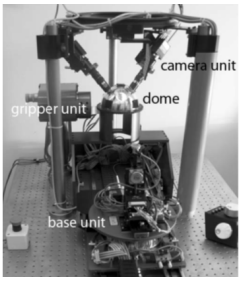
University of Basel
Department of Biomedical Engineering

BIROMED-Lab
Medical Robotics and Mechatronics

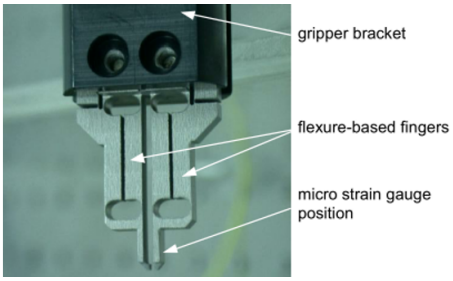
Master Thesis:
Manipulating the Micro-World - Design and Fabrication of a Small-Scale Force-Sensitive Gripping Device

Context: In the last few decades, miniaturization has been observed to be one of the main driving forces in various sectors of industry. Some examples include telecommunication, medical technology, and robotics. From an engineering point of view, working at increasingly small scales bears two key challenges: The manufacturing of micro-sized parts, and the assembly of these parts into functional devices. For series production, the assembly of such devices can usually be performed rather cost-effectively with specifically developed, dedicated assembly lines. This however is no economic solution for the assembly of single, unique prototypes, as they are often being developed in the scope of research projects. Hence, considerable effort has been put into the engineering of flexible, versatile micro-assembly systems, which can be used for the assembly of a wide range of different micro-systems [1]. Such systems typically combine one or several micro-grippers or other tools with a camera system, a moveable working platform, and an intuitive user interface; an example can be seen in **(a)**.

Task description: One of the most frequently recurring tasks in micro-assembly is the precise picking and placing of components. This is conventionally done with the use of micro-grippers or comparable devices [2]; a classic example can be seen in **(b)**. However, these devices are typically specialized on grasping only a few particular types of objects, requiring different grippers to be used during the assembly of an entire system. Furthermore, only few of these devices are force-sensitive, an indispensable feature for being able to provide the user with intuitive haptic feedback. Your task will be to develop a novel design of a small-scale force-sensitive gripping device overcoming the aforementioned limitations, to manufacture it, and to finally validate the functionality of your prototype.



(a) Example of a micro-assembly system [3]



(b) Example of a micro-gripper [4]

Work packages:

- Review the relevant body of literature and extract the key concepts and features
- Develop several designs of small-scale force-sensitive gripping devices suiting the given requirements
- Manufacture at least one of the designs
- Test and evaluate the manufactured device(s) w.r.t. the given requirements in a realistic scenario

Requirements:

- Solid background in mechanical engineering or a closely related field
- Knowledge of mechanics, basic electronics, and programming
- Ideally, practical experience with CAD (Solidworks)

References:

[1] A. Bolopion and S. Régnier. "A Review of Haptic Feedback Teleoperation Systems for Micromanipulation and Microassembly." *IEEE Trans. on Automation Sc. and Eng.*, vol. 10, no. 3, pp. 496-502, Jul. 2013.

[2] J. Cecil et al. "A Review of Gripping and Manipulation Techniques for Micro-Assembly Applications." *Int. J. of Production Research*, vol. 43, no. 4, pp. 819-828, Feb. 2005.

[3] M. Probst et al. "A Microassembly System for the Flexible Assembly of Hybrid Robotic Mems Devices." *Int. J. of Optomechatronics*, vol. 3, no. 2, pp. 69-90, May 2009.

[4] W. Chen and W. Lin. "Design of a Flexure-Based Gripper Used in Optical Fiber Handling," in *Proc. IEEE Conf. on Robotics, Automation and Mechatronics*, 2004, pp. 83-88.

Student: Mohamed Ali El Bahi
Start: April 2020
Duration: 6 months

Supervision:
Cédric Duverney

Professor: Prof. Dr. Georg Rauter

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