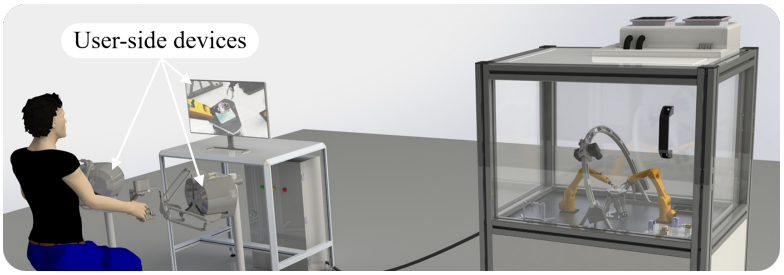
University of Basel
Department of Biomedical Engineering

BIROMED-Lab
Medical Robotics and Mechatronics

Master Thesis:
Ergonomically Optimal and Adaptable Placement of User-Side Devices for a Visuo-Haptic Teleoperation Console

Context: In the scope of an ongoing research project, we are 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, providing haptic feedback to the user for a more intuitive interaction [1]. This interface consists of a number of different devices, such as several off-the-shelf and custom haptic input devices (**b**), pedals, a monitor, and a head-mounted display (HMD) with optical tracking stations. Currently, all of these devices have been placed solely based on prior experiences and common best practices and have been fixed provisionally to fit the developers' needs. Thus, it is cumbersome to quickly adapt the user console to other users' anatomies to ensure better ergonomics. Quick adaptation would be of great benefit when conducting studies involving a larger number of different users, as the placement of user-side devices has been shown to influence teleoperation performance [3].

Task description: Based on the given micro-assembly application and further potential applications for the user console, it shall be investigated which user-side devices are required for which specific tasks. Then, it shall be analyzed which parts of the user's anatomy will influence the optimal device placement and which device positions and orientations need to be adaptable. Typical ranges for the relevant anatomical dimensions of potential users shall be identified from literature. A functional prototype of a modular framework housing all required user-side devices needs to be designed and manufactured. A procedure shall be defined for fast and easy adaptation of the device placement to a new user and/or application, without the need for time-consuming trial-and-error placements. Finally, your proposed framework and adaptation procedure shall be evaluated in a small proof-of-concept study.



(a) The proposed micro-assembly system - the user side (left) consists of a range of human interface devices

(b) Example of a commercial haptic input device [2]

Work packages:

- Identify required user-side devices and review the literature on their ergonomically optimal placement
- Detail the requirements for console framework and adaptation procedure, including typical anatomical ranges
- Design and manufacture the modular console framework, integrate all user-side devices
- Develop a procedure to quickly adapt the device placement to a new user and/or application
- Evaluate your console framework and adaptation procedure in a small proof-of-concept study

Benefits:

- Gain practical experience with user-oriented design and implementation of user studies
- Work in an academic environment with a strong focus on application-driven, hands-on engineering

Requirements:

- Solid background in industrial design, mechanical engineering, or a closely related field
- Basic knowledge of anatomy and ergonomics is a plus, but not strictly required
- Prior experience with designing user interfaces is a plus, but not strictly required

References:

[1] A. Bolopion 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] Force Dimension. *lambda.7.* (2020). Accessed: Aug. 12, 2021. [Online]. Available: forcedimension.com/products/lambda
[3] D. Zhang et al. "An Ergonomic Shared Workspace Analysis Framework for the Optimal Placement of a Compact Master Control Console." *IEEE Robotics and Automation Letters*, vol. 5, no. 2, pp. 2995-3002, Apr. 2020. doi.org/10.1109/LRA.2020.2974428

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