Assessment of Different Grasp Type Handles to Improve the Usability of Surgical Teleoperation

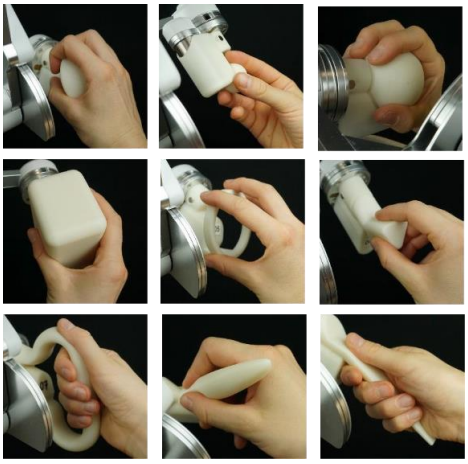

Figure 1: Nine different grasp type handles that can be mounted on the lambda.6 haptic device (Picture: E. Zoller).

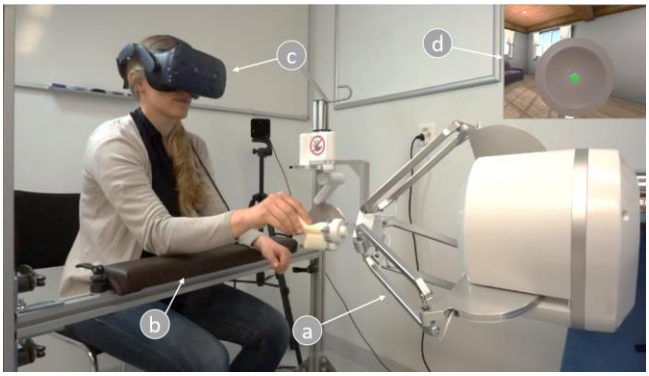

Figure 2: Experimental setup for the peg-in-hole task: a) lambda.6 haptic device (Force Dimension, Nyon, Switzerland), b) armrest, c) head-mounted display (HMD, HTC, New Taipei City, Taiwan), and d) the virtual environment that is displayed on the HMD to the participant (Picture: S. von Ballmoos).

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Using surgical teleoperation systems offers benefits like fine manipulation capabilities, repeatability, and high accuracy [1]. Literature indicates that an ideal teleoperation setup allows the user to reach all necessary orientational motions and includes a handle with an ergonomic and task specific design [2,3].

To understand the features of an efficient and ergonomic handle design for teleoperation, a user study has been conducted comparing the performance of different grasp type handles (Fig. 1) in a placement task. Four performance metrics, namely the task completion time, movement smoothness, collision forces, and perceived cognitive workload, have been investigated for a peg-in-hole task. 27 participants have conducted the task by controlling a virtual object with a 6 degrees-of-freedom haptic device (Fig. 2). Linear mixed-effects models were used to statistically investigate if the performance metrics differed among the investigated grasp type handles.

Very high evidence was found that the grasp type influences all of the metrics of interest. Further pairwise comparisons were performed for all metrics. With the reported results, suggestions for handle designs were made to improve the design process for teleoperation interfaces.

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