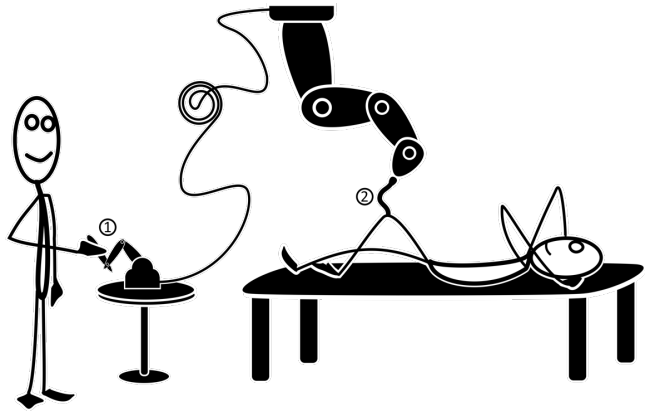
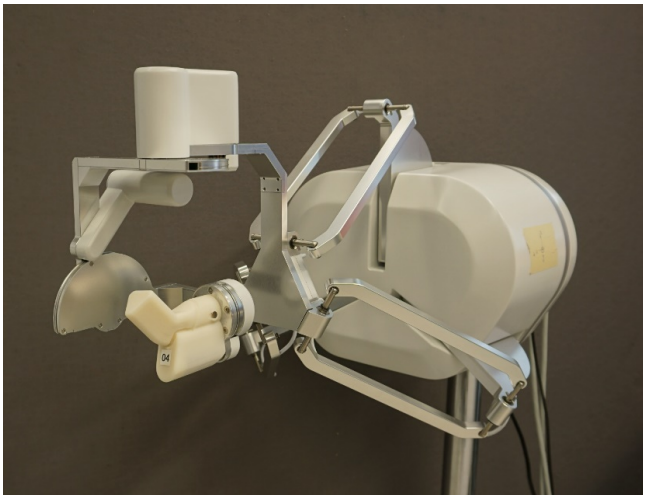
University of Basel

Department of Biomedical Engineering

Enhancement of Telmanipulation – A Survey on Haptic Guidance for a 6-DoF Robotic Endoscope



Teleoperation setting for robot-assisted surgery: The motion of the surgeon is recorded by the master device ① and transferred to the operating robot ②. (Image: Esther Zoller)



6-DoF haptic input device that can be used as a teleoperation master device. (Picture: Esther Zoller)

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When manipulating an object, we are naturally capable of controlling its position and orientation using haptic information. However, in robot-assisted minimal invasive surgery, haptic feedback is lost. As a consequence, researchers have to find new ways to assist surgeons so that they can regain control when operating. Set up as software-generated constraints, virtual fixtures either encourage the surgeon to move the robot along a pre-defined path or prevent the robot from entering so-called forbidden regions. In robot-assisted minimal invasive laser osteotomy, virtual fixtures have been considered to assist surgeons when moving an endoscopic end-effector to a specific orientation. It is, however, unclear how to implement virtual fixtures in a feasible and safe way.

To provide an overview on current orientational control strategies, a systematic literature research was carried out. The metrics chosen to evaluate the investigated orientational constraint methods are task completion time and task precision.

All encountered orientational control strategies showed an increase in task precision when compared to unconstrained test runs. Also, most orientational constraints led to a reduced operation time.

Wide-ranging control methods which guide the user along the entire manipulation show best results in operator performance. However, when only alignment of the end-effector is desired, it is up to debate if local orientational control already meets the demands of telemanipulated surgery. Dissipative control strategies that act in a passive way and redirect the surgeon's energy may offer the best answer yet on how to implement orientational virtual fixtures.

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