University of Basel

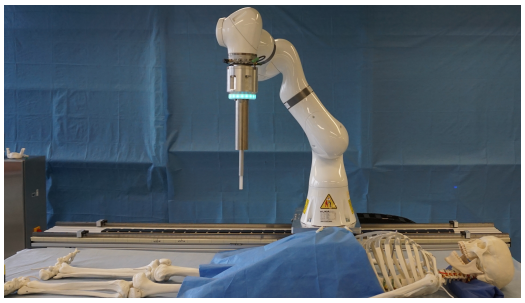
Department of Biomedical Engineering

BIROMED-Lab

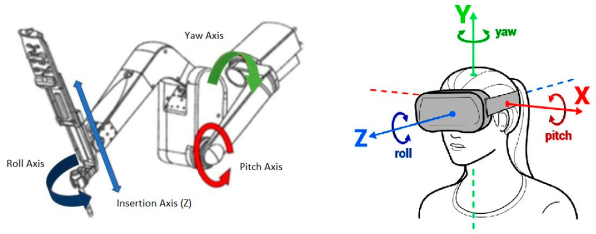
Master Thesis: Testing Usability for Different Surgeon Input Mappings in VR to Move a Robot-Mounted Neuroendoscope

Context: In the scope of an ongoing research project, we are currently developing a robot for surgical applications (such as neuroendoscopy) based on a KUKA LBR iiwa (**a**) mounted with an endoscopic camera to view the surgical site. The endoscope camera video is provided to the surgeon through a monitor or a head-mounted display (HMD). For moving the endoscope, promising input mapping methods need to be identified, evaluated, and compared.

Task description: A mock-up endoscope with a working camera that can be mounted on the existing robot needs to be built. A framework for acquiring surgeon's input, mapping it to desired endoscope motion, and visualizing the endoscope video stream needs to be developed. Different input and mapping methods for controlling the endoscope pose need to be implemented, for instance based on a simple joystick or on the tracked HMD position (**b**). In the latter case, an approach to deal with potential motion sickness will need to be developed as well [2]. Finally, these methods shall be evaluated in a small user study in terms of user performance and comfort.



(a) Surgical robot setup with a mock-up endoscope (without a working camera) at BIROMED-Lab.



(b) Pose control of the endoscopic camera in the da Vinci surgical system (left) based on the tracked HMD pose (right) [1].

Work packages:

- Review the relevant literature on input mapping methods for moving robot-mounted endoscopes
- Detail the requirements for your experimental setup and input mapping methods
- Design an endoscope mock-up with a working camera to mount on the surgical robot
- Create a framework to realise endoscope motion from different user input (based on joystick or HMD tracking) and streaming image data
- Design and conduct a usability study to evaluate and compare your methods for user comfort and performance

Benefits:

- Gain experience with designing and conducting user studies
- Learn to work with a medical robot (KUKA LBR iiwa), and VR equipment
- Work in an academic environment with a strong focus on application-driven, hands-on engineering

Requirements:

- Background in health science, user-centric design, mechanical engineering, or a closely related field
- Comfortable with programming (C++, ideally C#)
- Prior experience with programming of VR-based applications and basic kinematics are a plus, but not strictly required

References:

[1] T. Dardona et al. "Remote Presence: Development and Usability Evaluation of a Head-Mounted Display for Camera Control on the da Vinci Surgical System." *Robotics*, vol. 8, no. 2, pp. 31-44, Apr. 2019. doi.org/10.3390/robotics8020031

[2] B. Patrão et al. "How to Deal with Motion Sickness in Virtual Reality." *Proc. Portuguese Meeting on Computer Graphics and Interaction*, Coimbra, Portugal, pp. 40-46, Nov. 2015. doi.org/10.2312/pt.20151201

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