University of Basel
Department of Biomedical Engineering

BIROMED-Lab

Semester Project:
Testing Usability of Surgeon Input Mappings With an Externally Tracked VR-Headset to Display an Endoscopic Camera Image

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: Input mapping based on the HMD's internal tracking is to be compared to mapping using an external optical tracking system in terms of user performance and comfort. To this end, firstly, data streaming from the external tracking system to the control system needs to be implemented. Secondly, a framework for controlling the camera pose based on the internal and external tracking data needs to be developed. Finally, a small pilot study will provide comparative insights between the two methods. The controlled camera will either be a physical, robot-mounted device, or a virtual camera in the VR scene, depending on the defined requirements of the pilot study.
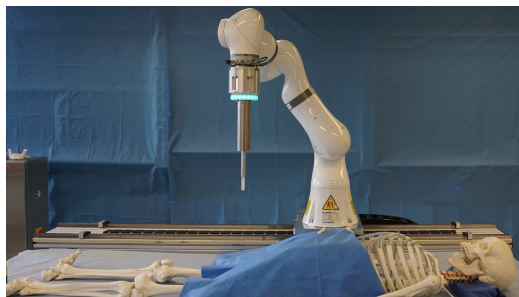
(a) Surgical robot setup with a mock-up endoscope (without a working camera) at BIROMED-Lab.
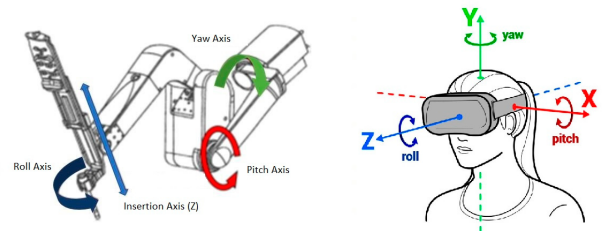
(b) Pose control of the endoscopic camera in the da Vinci surgical system (left) based on the tracked HMD pose (right) [1].

Work packages:

- Review the relevant literature on tracking-based input mapping methods for moving robot-mounted cameras
- Detail the requirements for your experimental setup and input mapping methods
- Implement a pipeline for streaming pose data from the given optical tracking system to the control system
- Create a framework to realise camera motion control from the external optical tracking system and the internal HMD tracking
- Conduct a small pilot study to evaluate and compare camera control with the external and internal tracking systems for user comfort and performance

Benefits:

- Learn to work with an optical tracking system and VR equipment
- Gain experience with conducting pilot studies for comparative analyses
- 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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