University of Basel

Project MIRACLE
Medical Robotics and Mechatronics
BIROMED-Lab

Department of Biomedical Engineering

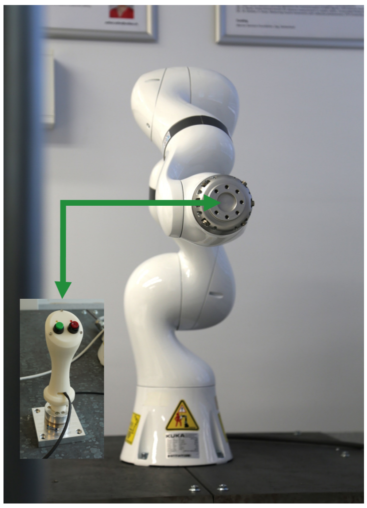
Master Thesis:
Learning desired null-space poses for inverse kinematics from the operator

Context: In the years to come, humans and robots will share space on a daily basis. This interaction is particularly acute in the medical field, where robots will perform progressively more tasks while humans remain in charge of planning and supervision. The large advantages in the coexistence of humans and robots can be found in the symbiosis between the strengths of both parties. While humans are versatile, sensitive, ethical, and creative; robots are accurate, precise, enduring, and capable of multitasking. However, functionalities that would allow a medical specialist to easily interact with the robot are still missing. Adding them will increase safety, robustness, performance, and intuitive use. Therefore, in your master thesis you will implement an interactive control interface for a KUKA lightweight robot which enables the user to train desired nullspace movements in an intuitive way.

Task description: Your task will be to add an existing 6-Dof force-torque sensor with a custommade handle including a red and green button on top of a KUKA serial robot. You will implement a control mode, where the end-effector pose of the serial robot can be controlled by the user by interacting with the handle. In addition, whenever the red button on the handle is pressed, a secondary control mode is activated. In this secondary (task-space) control mode, the current end-effector pose of the robot is fixed as a set point and the handle input can be used to make the robot move in null-space. During these null-space movements, the operator can label robot joint poses as desired for this end-effector set-point by pressing the green button. In the final step, an inverse kinematics for task-space control should be implemented that incorporates the learned desired joint poses.

Workpackages:

- Integrate the control of the robot in TwinCAT3 (target programmed in Simulink)
- Mount the handle on the robot and implement simple inverse kinematics for "task space control"
- Implement an admittance law to change the 6-DoF set point in task space based on the 6-DoF sensor input
- Implement null-space controller
- Find dissimilarity metrics for joint and task space
- Implement inverse kinematics respecting recorded poses
- Test and evaluate the functionality of your algorithm



Prerequisites: We strongly recommend participation in the block course on rapid prototyping (`https://vorlesungsverzeichnis.unibas.ch/en/semester-planning?id=235528`) which will provide you the necessary background knowledge on the TwinCAT3 software.

Start: September 2018
Duration: 6 months

BIROMED-Lab
Medical Robotics and Mechatronics

Supervision:
Manuela Eugster
Murali Karnam
Dr. Nicolas Gerig

Professor: Prof. Dr. Georg Rauter
Professor ETH: