MITI Research Group

Universitäts Klinikum

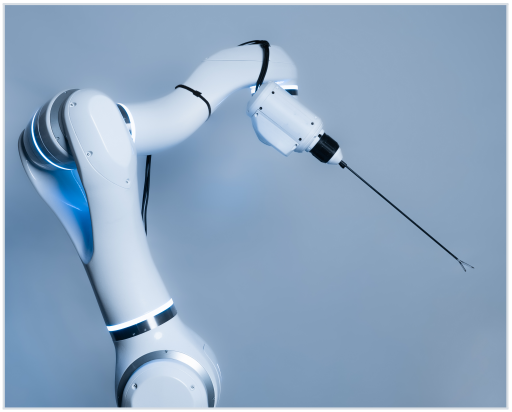
MASTER'S / SEMESTER THESIS • MITI RESEARCH GROUP • TUM KLINIKUM

Force and Kinematic Characterization of Instruments for Robotic Laparoscopic Surgery

Design and Prototyping of a Modular Test Bench

The idea

Robotic laparoscopic surgery needs robots to trust their tools. We're building a (semi-)autonomous robotic surgery platform. Before it can safely handle soft tissue, we must first know how each tool actually behaves — how it delivers force at the tip and how the tip precisely moves.
The challenge: instruments like the Karl Storz Clickline and da Vinci EndoWrist transmit force and motion through complex, tool-specific mechanisms that remain inadequately characterized. We're looking for a student to design and build a modular device that measures this behavior, giving us a reliable way to characterize and calibrate different surgical instruments.



Surgical robotic platform developed for our ASSIST project, utilizing Karl Storz Clickline Instruments.

What you'll do

- Survey the state of the art and frame the problem
- Shape the requirements together with our engineers and clinicians
- Design, prototype, and build a modular measurement device for single- to multi-DOF instruments
- Characterize both the forces and the actuation-to-motion behavior, and distill it into a per-instrument mapping
- Bring it to life with embedded electronics, firmware, and a ROS2 interface that connects to our robot stack

In short, we're picturing a modular rig that works across different instruments and grasper types and captures both force and motion, statically and/or dynamically. It should be repeatable, reliable, and cost-effective — a working proof-of-concept device. Beyond that, the approach is open: how we mount, sense, and record is up to us, as long as the measurements are accurate.

Your profile — the essentials

- A background in Mechatronics, Robotics, Mechanical, or Medical Engineering — or equivalent, demonstrated project experience
- Confident with CAD and mechanical design
- Comfortable with electronics and (embedded) programming
- A structured, independent way of working

What you'll get out of it

- Full ownership of a real hardware–software project, from concept to working prototype
- A clinical R&D environment, working on a system that feeds an actual robotic platform
- Access to our workshop, FDM/SLA printers, waterjet, and robotics lab
- Lots of hands-on prototyping

Nice-to-have experience

- ROS2 or a similar robotics middleware
- Electronic circuit & PCB design
- Integrating force, load-cell, or force/torque sensors
- Motion or position measurement (encoders, optical, or vision-based tracking)
- Design for manufacturing and tolerancing (CNC)
- Data analysis in Python or MATLAB

Apply

Apply with your CV and at least one of: an engineering portfolio, a motivation letter, a GitHub repo, or similar.

Note: While academic records are important, I am especially interested in what you've developed or built — such as projects, theses, or student team work.

Starting date: *ASAP*

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Application deadline: *01.07.2026*