

Telemanipulation in Robotic Surgery

Control of a Redundant Robot under Motion Restrictions

Bachelor's or
Master's Thesis

Context

Telemanipulation is a technique to remotely control the movement of a robotic arm. In robotic surgery, telemanipulation is used to tirelessly control the movement of surgical robots with high precision. Motion scaling can help surgeons to maneuver surgical instruments with sub-millimeter accuracy, and motion filtering can suppress jitters in movements of the surgeons.

Laparoscopy is the minimally invasive surgery of the abdomen. Rod-shaped surgical instruments are inserted through small incisions in the abdominal wall, reducing the amount of damaged tissue, but also greatly reducing the degrees of freedom. The motion of laparoscopic instruments is restricted by the incision to four rotational and one translational degrees of freedom.

Telemanipulation of a redundant robotic arm in laparoscopic surgery thus deals with **calculating the required movements of the robotic joints**, such that the robotic end-effector follows the desired change in the four degrees of freedom of the laparoscopic instrument.

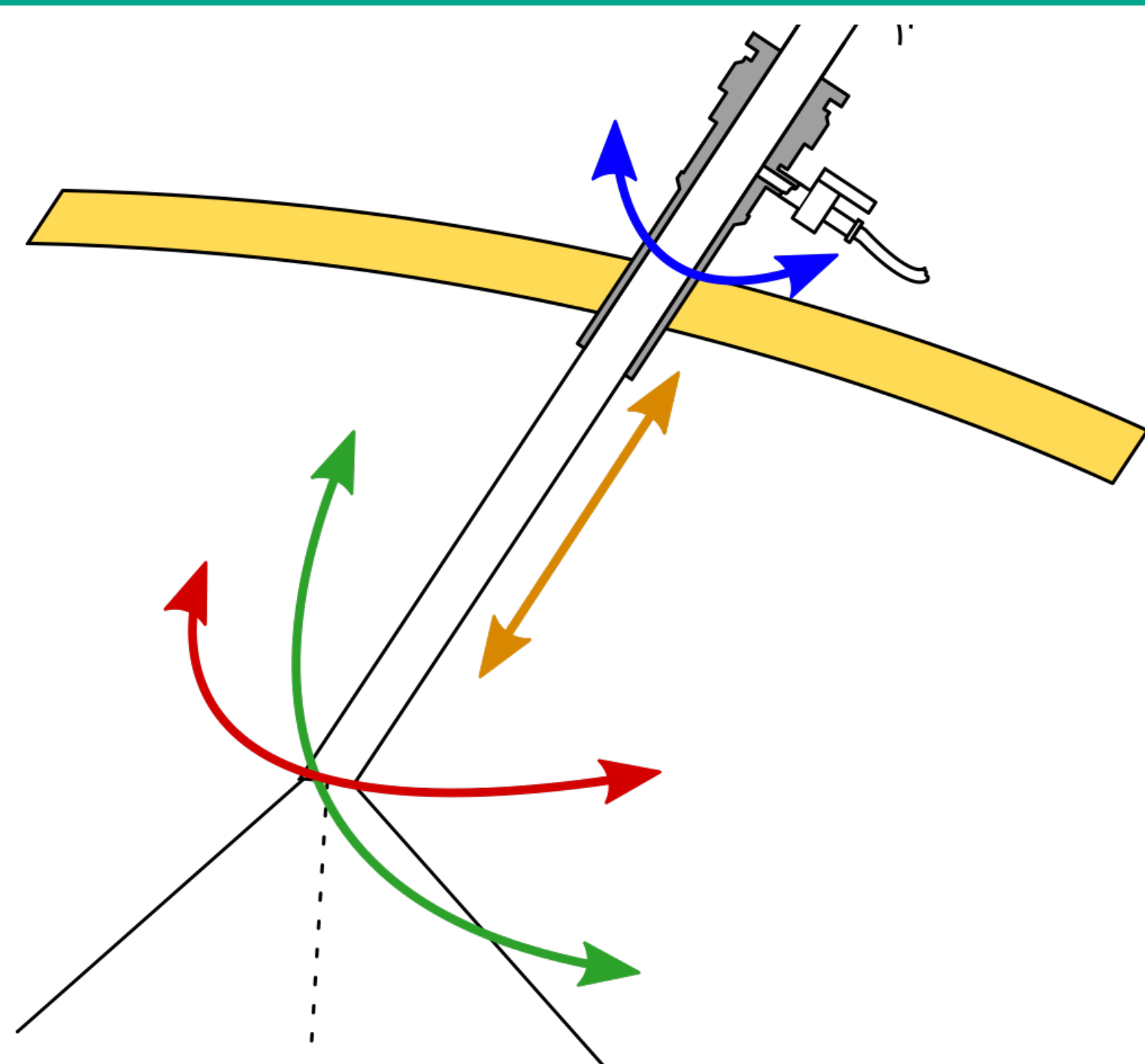


Figure 1: Degrees of freedom in laparoscopy

Goal

Create a telemanipulation setup for laparoscopic surgery with a Franka Emika Panda robot. The teleoperator will control the four degrees of freedom of the laparoscopic instrument, clamped to the end of the robotic arm. The motion of the robotic arm will respect the motion constraints introduced by the incision at all time.

Task Summary

- Survey the state of the art in telemanipulation for robotic surgery.
- Design a control concept that maps the motion of the laparoscopic instrument to the movements of the robotic joints.
- Implement and evaluate the concept on a real robotic arm.

Concrete plans will be worked out together with your individual knowledge and preferences.

Your Profile

Motivated student of computer science, electrical engineering, physics, mathematics, or mechanical engineering with an interest in **robotic surgery**. Prior knowledge in robotics and control is not necessary, but advantageous. Solid programming skills and very good English or German language skills are required. Interested in research between theory and practice in an interdisciplinary team.

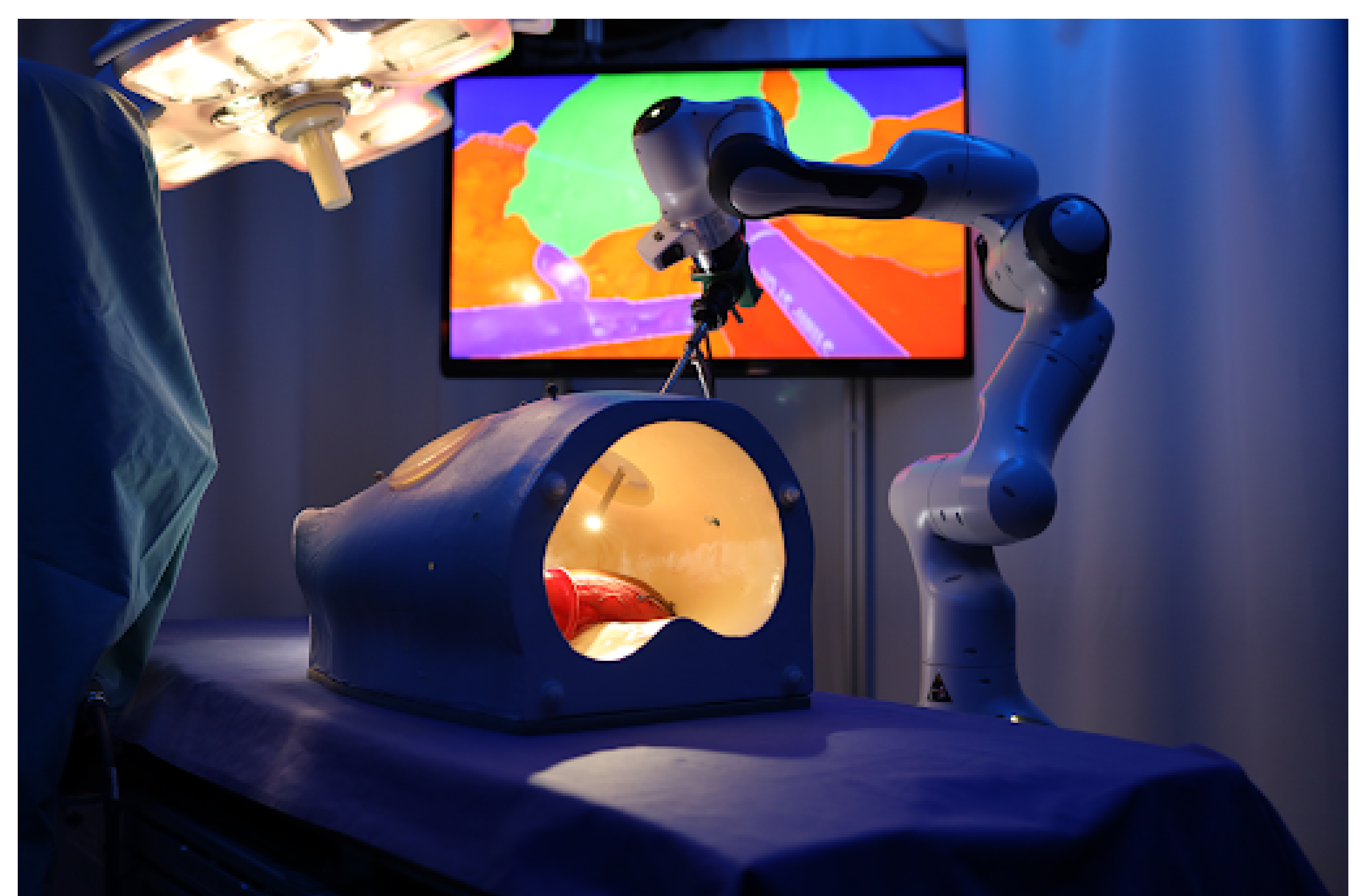


Figure 2: Panda robot in a laparoscopic phantom

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