University of Basel
Department of Biomedical Engineering

BIROMED-Lab
Medical Robotics and Mechatronics

Semester Thesis: Design and simulation of series elastic joints for a prototype surgical robotic arm

Context: We are developing a robot as a part of the flagship project MIRACLE (Minimally Invasive Robot Assisted Computer–guided LaserosteotomE). The purpose of its robot is to position the endoscope, which is inserted into the human body. The robot is to be controlled by surgeons by means of an intuitive interface for physical interaction. As our prototype robot is undergoing steady development, its robotic links and geometry change with the progress of our overall project as well as the progress of our medical partners. Therefore, we are looking for a modular solution for our robotic joints including actuation, gearing, sensing, and serial elasticity. We look for series elastic joints as they are considered safer for close human-robot interaction tasks since they have compliance at a lower level of control due to their mechanical elasticity [1].

Task description: Your task will be to analyse the requirements, design and simulate the mechanical joint elements for a robot which is series elastic. To begin, with you would model a single joint with a series elastic element, and analyse its characteristics. Next, identify the design paramters which would improve the performace for a desired application. After making a design, you would incorporate it in a robot model, and study its performance through simulations.

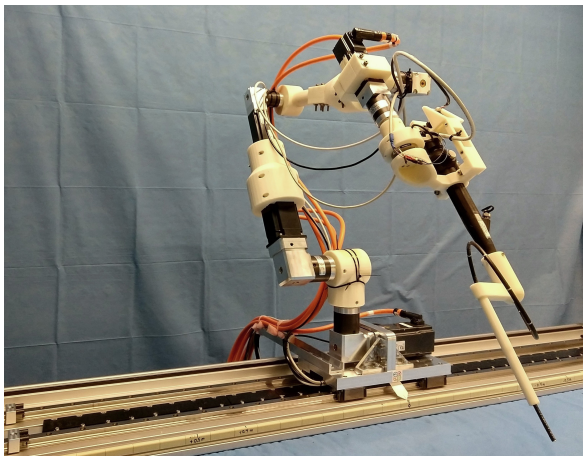

Figure 1: The current prototype of the robot holding a commercial flexible endoscope.

Workpackages:

1. Conduct a literature survey of different control architectures for series elastic joints.
2. Design and simulate the series elastic joint as a part of a robot.
3. Do a dynamic analysis and assess the performance of a joint with a mathematical model.
4. Identify the characteristic elements of such a joint and their correlation to the performance.

[1] Gill A Pratt and Matthew M Williamson. Series elastic actuators. In *Intelligent Robots and Systems 95.'Human Robot Interaction and Cooperative Robots', Proceedings. 1995 IEEE/RSJ International Conference on*, volume 1, pages 399–406. IEEE, 1995.

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