University of Basel
Department of Biomedical Engineering

BIROMED-Lab
Medical Robotics and Mechatronics

Master Thesis: Development of a modular series elastic joint for a prototype robotic arm for surgeries

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 design and develop the mechanical joint element for the robot which is series elastic. To begin, with you would need to design a single joint in a modular and scalable way, wherein the same design can be easily extended to replace all the joints in the robot. It needs to incorporate the elements for series elasticity, mechanical features for sensing, link attachment, and cable routing. The final design would be manufactured, tested, and evaluated for its performance. Based on the outcome of the testing phase, the design would be improved or extended to the other joints of the robot.

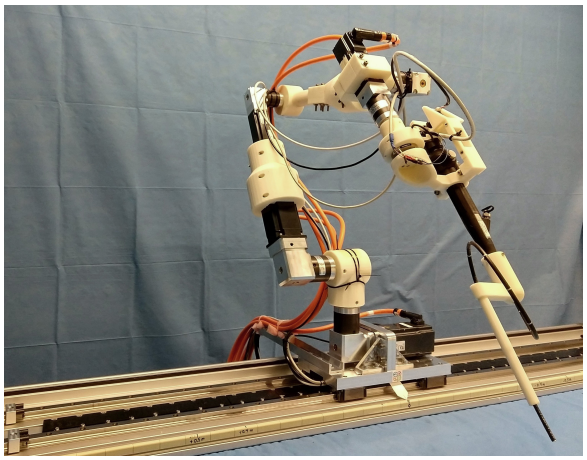

Figure 1: The current prototype of the robot holding a commercial flexible endoscope.

Workpackages:

1. Conduct a literature survey of different architectures, and designs of series elastic joints.
2. Identify the characteristic elements of such a joint and their correlation to the performance.
3. Identify the requirements of the joint for the application at hand, for surgeries.
4. Optimise and design a modular series elastic joint for desired characteristics.
5. Manufacture a prototype, test and evaluate it.

[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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