Master Thesis: Design and Evaluation of a Measurement Probe for Contact-Forces in Minimally Invasive Knee Surgery

Context: We are developing a robotic endoscope with an integrated laser osteotome to combine the advantages of laser osteotomies with those of minimally invasive surgery. One of the main challenges when developing robotic tools for minimally invasive surgery are unknown mechanical requirements and uncertainties. It is difficult to find literature documenting anatomical manipulation requirements such as the forces required to manipulate a robotic tool inside a human joint. We already conducted experiments for estimating expected contact forces between the endoscope end-effector and the surrounding tissue inside the human knee joint capsule [Eugster et al., CRAS, 2018].

Task description: Your task will be to develop an improved measurement probe which can measure the contact forces in the knee. The probe-tip should have the same dimensions as our robotic end-effector and should enable the measurement of normal forces that are acting on its surface. You will start by designing and evaluating possible measurement principles. After selecting the most promising principle you will manufacture a prototype of the measurement-tip and evaluate its performance. Additionally, you will develop a probe handle which enables to move the probe-tip inside the human knee joint. After you evaluated and improved the functionality of your measurement probe it will be ready to be tested inside a human knee joint.

Workpackages:

- Conduct a broad literature research on possible force sensing principles and devices. Concentrate on those which are miniaturizable to the needed dimensions.
- For proof of concept you develop simple prototypes of the selected measurement principles and evaluate their performance.
- Manufacture a prototype of the entire probe.
- Test and evaluate the performance of the probe and apply improvements if necessary.
- If the performance of the probe is sufficient, we can conduct experiments in the anatomy to measure contact forces inside the knee joint.

Student:
Start: 6 months
Duration: 6 months
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