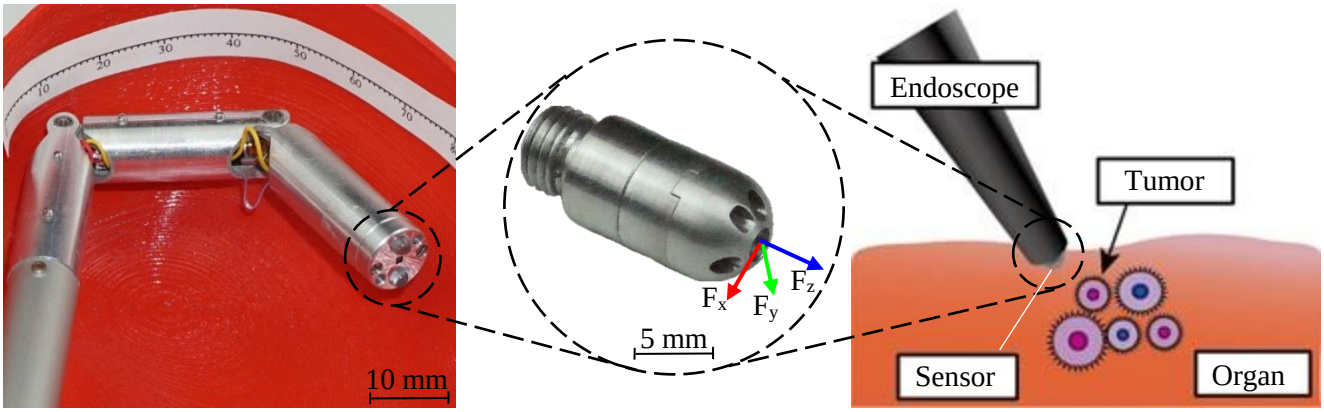
University of Basel

Project MIRACLE
Medical Robotics and Mechatronics
BIROMED-Lab

Department of Biomedical Engineering

Master Thesis:
Design and Implementation of an Encapsulated Force Sensing Device for Minimally Invasive Endoscopic Palpation

Context: In recent years, the development of endoscopes and endoscopic tools enabled or improved Minimally Invasive Endoscopy (MIE) procedures, where the natural orifices or small skin incisions are used as pathways for endoscopic examination of internal tissue's structures (i.e. color, shape, etc.). However, in MIE procedures, surgeons have to rely on visual information. So the image quality is important (resolution, data rate, focus, etc.), while the sense of touch is partially or completely lost. In other words, the surgeon cannot use his fingers to palpate the organs during the MIE procedure compared to open surgery. Thus, an artificial sensing mechanism is required. Within the MIRACLE project, we are working on equipping a tip of an endoscope with a tri-axial force sensor for palpation of internal tissue. In this way, the force sensor will provide haptic information to the surgeon, quantifying interaction forces between the endoscope's tip and tissue. Having more knowledge on the changes of interaction forces between the tip of an endoscope and tissue, it will be possible to quantify tissue elastic properties. Furthermore, following the changes in tissue elastic properties, it will be possible to detect borders of cancerous tissue below the organ surface in an early stage of the development.



Task description: In this project, you will refine the design of existing tri-axial force sensors and implement them to the tip of an endoscope. This includes the following work packages:

- Basic research: Literature research is conducted on existing principles of force sensing and available hardware with special regard to accuracy, sensitivity, force range, and miniaturization.
- Concept development: Based on the literature research and own ideas, different concepts are developed to implement a tri-axial force sensor in the endoscope's tip. These concepts are evaluated with respect to criteria such as miniaturization potential, accuracy, reliability, repeatability, and autoclavability.
- Implementation: The most promising concept is designed and manufactured. The sensor is then included in the existing prototype and its control architecture, which is based on TwinCAT3 and MATLAB Simulink.
- Testing, evaluation and characterization of the system with respect to its requirements.

Desirable background: Bachelor in Mechatonics or Electrical/Mechanical Engineering with programming skills in SolidWorks, C++, MATLAB, and programs for designing PBCs (i.e. Altium Designer, Eagle).

Start: January 2019, Duration: 6 months

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