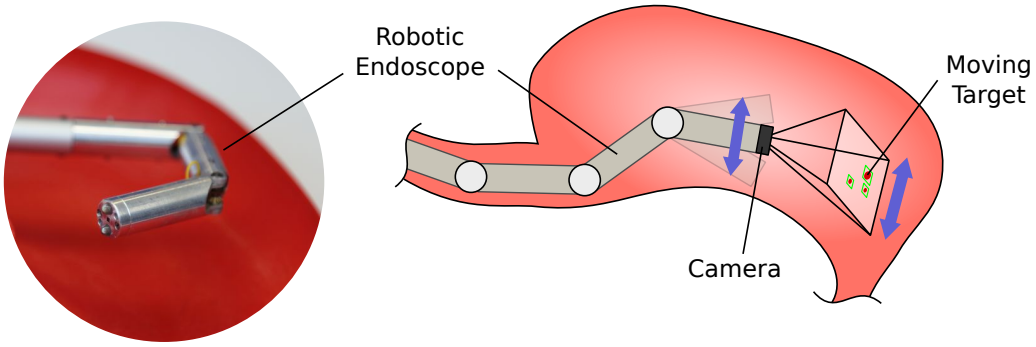
University of Basel

Project MIRACLE
Medical Robotics and Mechatronics
BIROMED-Lab

Department of Biomedical Engineering

# Master Thesis:
# Visual Servoing Test Bench for an Articulated Robotic Endoscope

**Context:** In recent years, more and more robots have found their way into operating rooms. Some of them enabled or improved minimally invasive procedures, i.e. procedures with a minimal number and size of skin incisions. Advantages of minimally invasive surgeries include the reduction of postoperative pain and a faster healing process. For the surgeon, manual handling of instruments through a small incision is difficult and robots can help to perform these interventions faster and with greater precision. We are working on equipping a surgical robot with a dexterous, snake-like tool called a flexible endoscope which allows to automate certain surgical tasks inside the body. In order to close the control loop of the endoscope, accurate position feedback is required, which remains a major challenge. One option towards improved position feedback is to install a camera on the endoscope, estimate the pose of the endoscope tip relative to the target by processing the acquired images, and use this information to control the robot – a technique commonly known as *visual servoing*.




**Task description:** In this project you will implement visual servoing for an articulated robotic endoscope and develop a test bench where different approaches of visual servoing for endoscopes can be assessed. This includes the following work packages:

- Basic research: Literature research is conducted on existing concepts for visual servoing, including available hardware, image-processing techniques, and control strategies.
- Visual servoing implementation: Based on the literature research and own ideas, different concepts are developed to implement visual servoing for the endoscope. The goal is that the endoscope can follow a moving target (e.g. a surgical instrument, reference markers, ...) in at least two degrees of freedom. These concepts are then evaluated with respect to criteria such as precision, safety, and real-time capabilities. The most promising concept is chosen and implemented in the existing control architecture, which is based on TwinCAT3 and Simulink.
- Test bench development: A test bench is developed which allows to simulate use cases of the endoscope and assess different visual servoing concepts. For example, the test bench should feature a movable stage, variable lighting, etc.
  Your visual servoing implementation is evaluated using the test bench.

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Start: October 2018, Duration: 6 months

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