

Karlsruhe Institute of Technology

Institute for Anthropomatics and Robotics -**Health Robotics and Automation** Jun.-Prof. Dr. Franziska Mathis-Ullrich Building 40.28 http://www.hera.iar.kit.edu



# **Flexible Medical-Robotic Instruments**

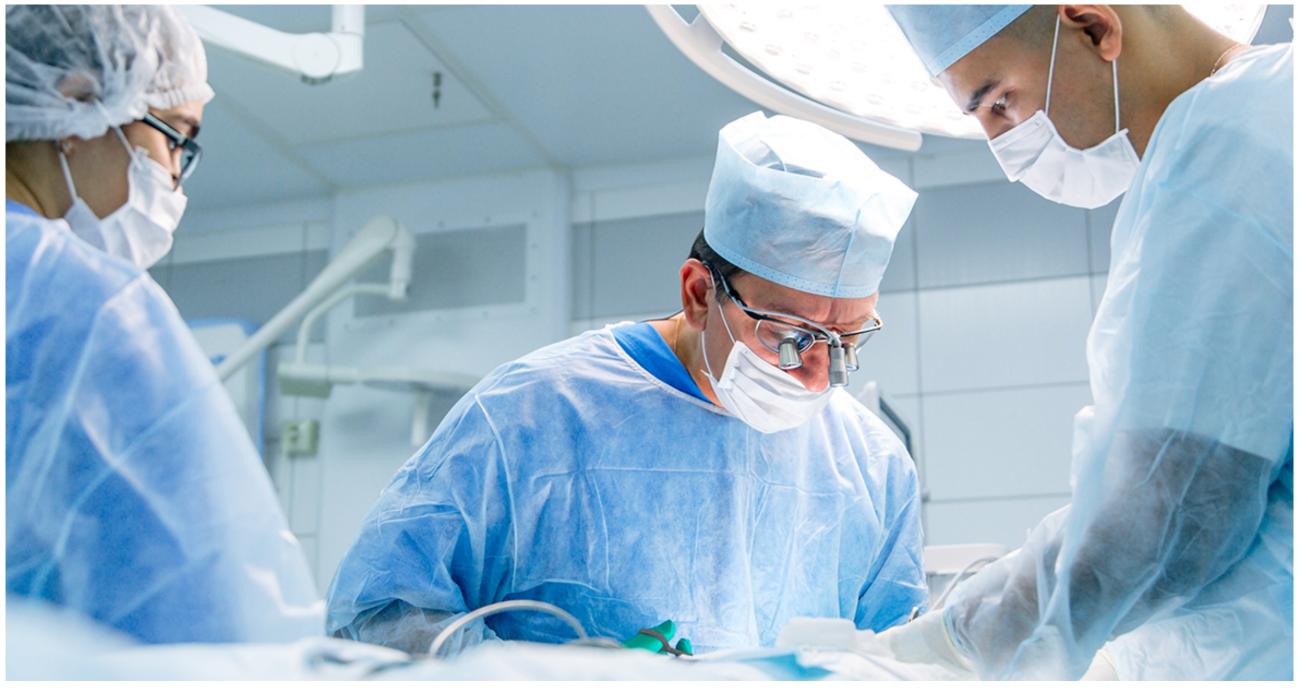
**Shape-Sensing by Self-Sensing of SMA Actuators** — 19th July 2022 —

Master's Thesis



**Task Summary** 

Flexible medical instruments in minimally invasive surgery might be of great help to surgeons while operating next to or within critical structures of the human body (e.g., crucial blood vessels). The design and control of such instruments is challenging. "Smart materials", e.g. "Shape Memory Alloys" (SMAs) could be very useful to face these challenges due to their shape memory and self-sensing ability. The latter allows to estimate the actor's shape from measuring its resistance. This approach might be able to replace visual support and additional sensors (Figure 3) by intrinsic sensing.



- **Read** about SMA actuation and self-sensing.
- **Modify** an existing experimental setup for automatic data acquisition.
- **Model** the resistance characteristic using non-linear approaches (e.g. Preisach model) and machine learning techniques (optional).
- **Evaluate** the models of different actuators for different loads.

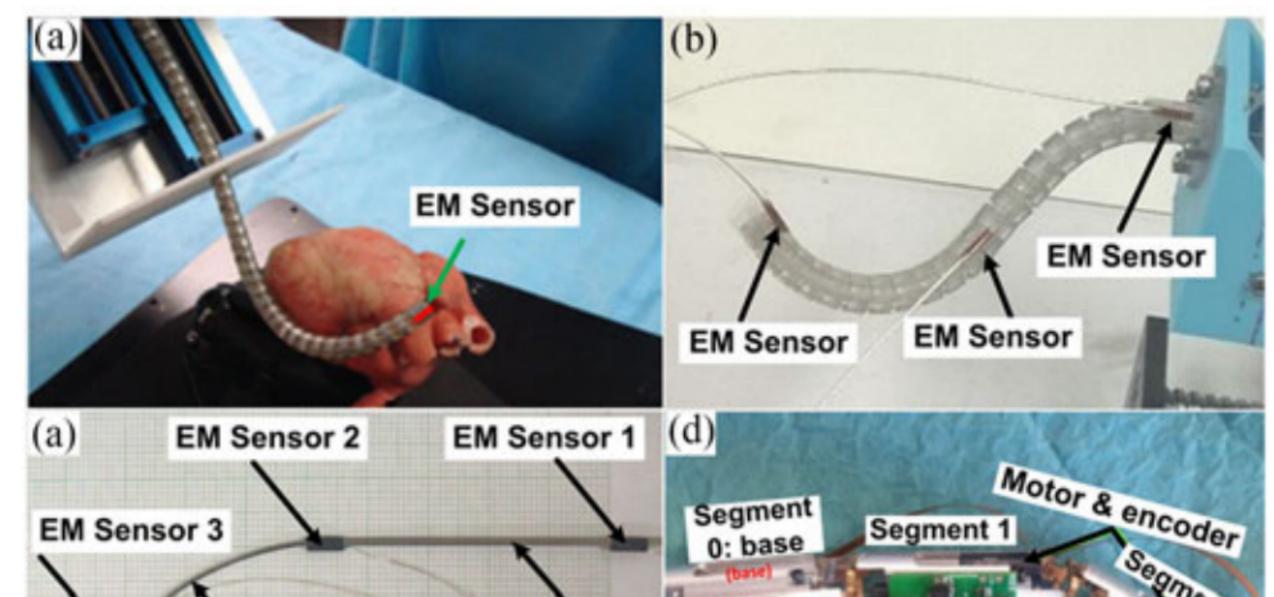


Figure 1: Team of surgeons in the operation theatre. Source: © Solvay 2020.

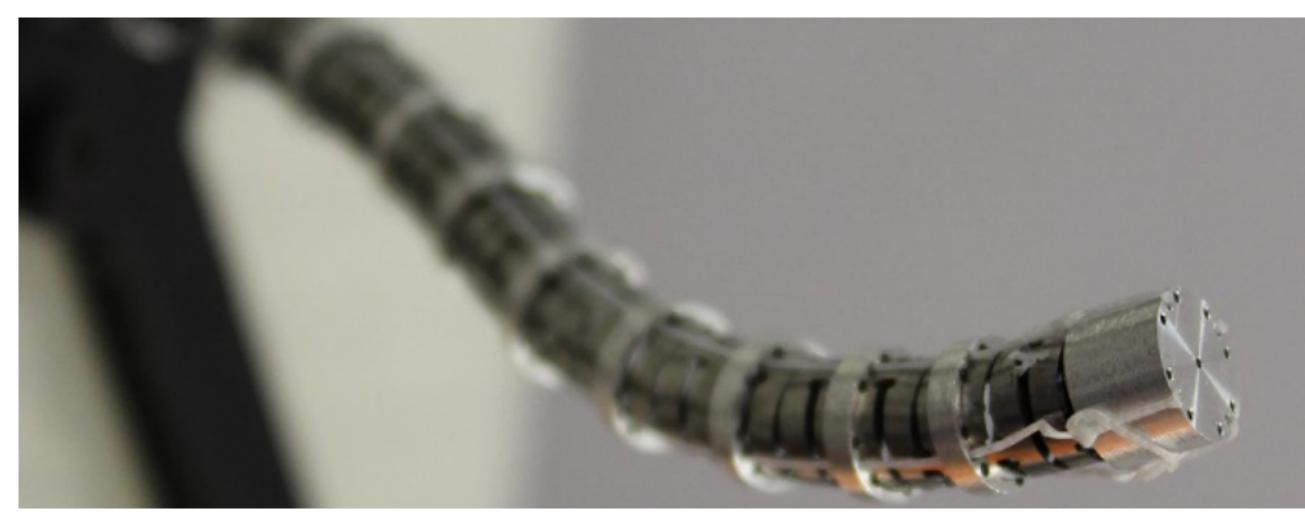


Figure 2: Hybrid continuum robot proposed by Amanov et al. (2017).

**Outer Tube** Motor & encoder Inner Tube Inertial sensor unit 4 mm (e) 6-DOF EM Sensor 5-DOF EM Sensor 125 mm 125 mm 125 mm 125 mm **Cross section EM Sensor** 

Figure 3: Shape sensing approaches (without self-sensing) as reviewed by Shi et al. (2017).

## Requirements

Qualified candidates (computer science, engineering, physics, material science) shall be interested in:

- Electronics
- Sensing

#### Objective Investigate the self-sensing ability of various SMA actuators.

#### Material science

### Contact

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