Medical Instruments with SMAs
Thermodynamic Control of Flexible Instruments.
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Context
Flexible medical instruments in minimally invasive surgery might be of great help to surgeons while operating next to or within critical compartments of the human body (e.g., crucial blood vessels). The design and control of such instruments is challenging. “Smart materials”, such as so called "Shape Memory Alloys" (SMAs) could be very useful to face these challenges due to their ability to memorise an arbitrary shape when heated. While the handling of SMAs regarding their fabrication and application (e.g., heat transfer, shape restoration) is quite demanding, their potential for creative new approaches in steering and actuation are of great interest for ongoing research in the field of medical robotics. Usually, SMA actuators use Joule-Heating and active or passive cooling to conduct a fully actuation cycle. However, for medical applications, the acceptable heat transfer from the instrument to the patient’s body must not be harmful and is thus limited. Therefore, fail-safe strategies and mechanisms are needed.

Objective
Investigate SMA actuators for in-vivo applications. Hypothesis: A human’s body temperature can create enough heat to induce motion in a suitable SMA actuator. Its cooling could be actively controlled externally by different means.

Task Summary
- Review thermodynamic control strategies for SMA actuator.
- Compare (and modify) suitable cooling techniques regarding a medical in-vivo deployment.
- Design and fabricate a demonstrator.
- Test the demonstrator in an experimental setup, that mimics the thermodynamical conditions of an in-vivo procedure.

Requirements
Qualified candidates (computer science, engineering, physics, material science) shall be interested in:
- Thermodynamic challenges
- Experimentation

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