

Smart Phantoms for Robotic Surgery

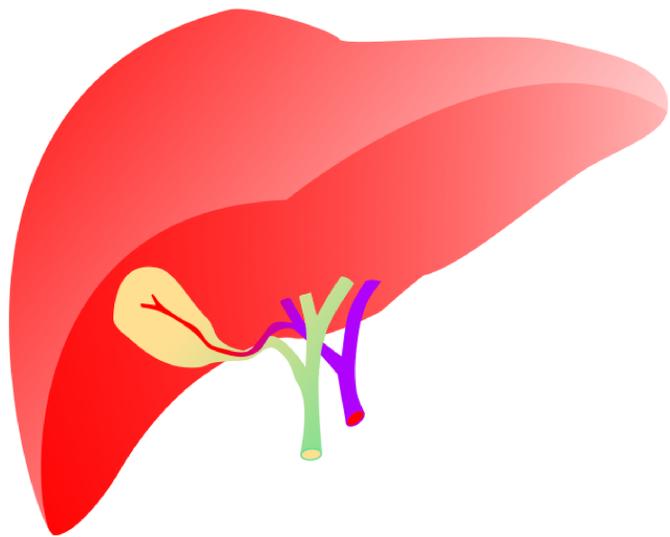
Enabling Robotic Reinforcement Learning of Surgical Skills

Bachelor's or
Master's Thesis

Context

Reinforcement learning is notoriously sample inefficient. Hundreds of thousands of interactions with an environment are required to learn simple skills. In addition, reinforcement learning assumes that we can define a reward function that supplies the agent with feedback on its behavior to guide the learning process. This reward function often requires substantial knowledge about the scene's state. Measuring the scene's state is non-trivial for scenarios outside a simulation environment.

Physical Phantoms with embedded sensors and actors will enable us to investigate robotic reinforcement learning of surgical skills outside of simulation environments. The embedded sensors are utilized to measure the scene's state while the actors reset the scene after a finished episode. The smart phantoms aim to balance setup complexity and relevance to clinical application.

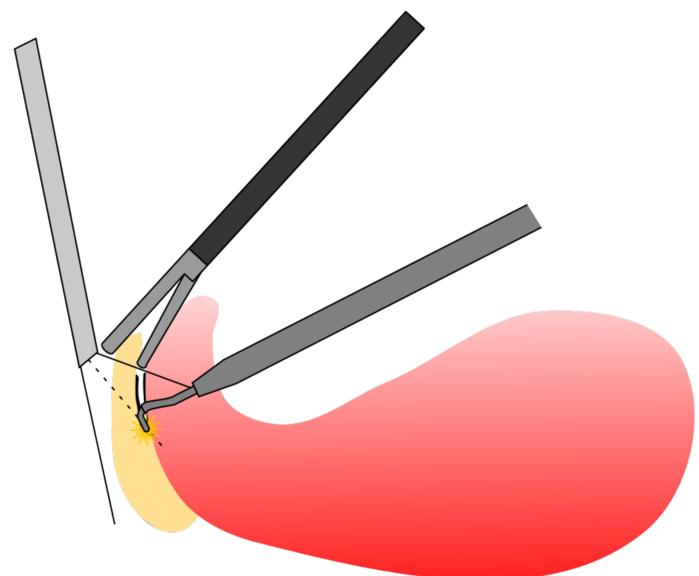
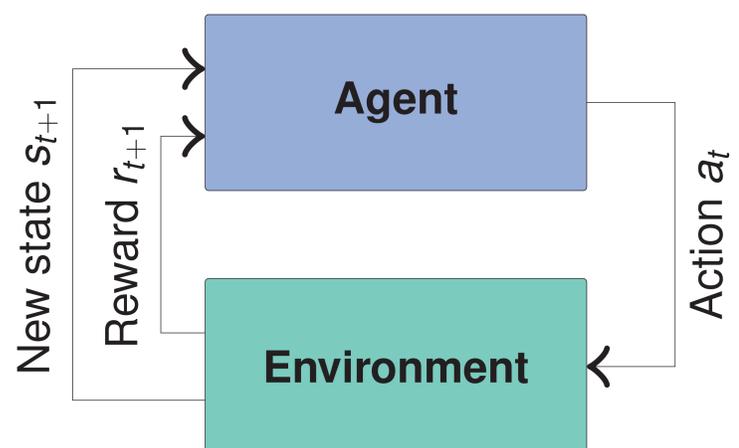


Goal

This work investigates and prototypes a smart physical phantom with embedded sensors. The phantom represents a simple surgical task from laparoscopy (e.g. exposing the gall bladder) and serves as the learning environment for robotic reinforcement learning. Embedded sensors are utilized to calculate a reward signal based on the current state of the phantom. Embedded actors reset the scene after a completed episode.

Task Summary

- Conceptualization of a smart phantom system based on a selected task from laparoscopy.
- Selection of appropriate sensors and actors to integrate into the system.
- Prototyping of the physical system.
- Development of software to interface the system.
- Design of a reward signal for use in reinforcement learning based on the phantom's state.
- Evaluation of the system in regard to durability and stability.



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