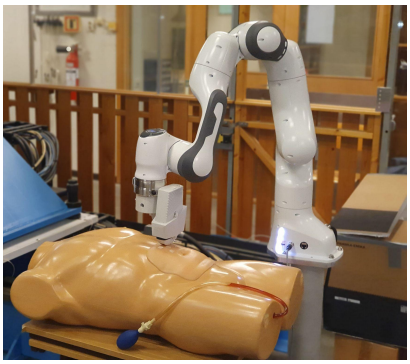
Learning for Robot Control from a Handful of Trials

Background

Robots capable of learning dexterous manipulation skills possess great potential for revolutionizing the use of robotic solutions across industrial and healthcare sectors. However, achieving human level manipulation skills with robots demands learning based control. Reinforcement Learning (RL) framework promises to solve such complex robot control problems through trial and error by posing this as a learnable problem. But, RL methods in general are extremely sample hungry. For example, model-free RL algorithms require millions of interactions with the system to learn an optimal controller, which is infeasible on a robotic system. Inorder to solve this drawback of RL, we focus on a highly sample efficient approach for robot learning by leveraging on human demonstrations, learning a probabilistic model of the system and utilizing low level robot controllers.

In this project/thesis work, we will focus on model-based RL approaches to learn complex robot control policies from a handful of trials. The research work includes both theoretical guarantees and practical validation on a lab set-up using a Franka Emika Panda robot. Check out video1, video2, demonstrating a cartesian impedance controller and a hybrid force motion controller implemented on a Panda robot

This thesis call is associated with the project Robotics for Moving Objects (ROMO), which is a collaboration between NTNU and SINTEF. If you are motivated to develop robotic systems capable of learning and adapting for complex real-world application, here is an ideal opportunity for you. You will be working with simulations and lab set-up with the Franka Emika Panda robot. You will have the opportunity to work in collaboration with the multidisciplinary team composed of researchers from NTNU and SINTEF Digital and other students involved in the project. It is encouraged to write a conference paper as one of the outcomes of the thesis.



Tasks

- Reviewing sample efficient model-based RL algorithms.
- Theoretical formulation and implementation of a sample efficient model based RL algorithm for robotic manipulation.
- Setting up a simulation environment with already available low level robot controllers.
- Evaluation and validation of the approach in simulation and in lab set-up for ultrasound examination using Franka Emika Panda robot.

Qualifications

- Necessary to have basic knowledge in robotics, control engineering and machine learning.
- Programming knowledge in Python / C++.
- Experience with reinforcement learning, gaussian processes, robotic manipulators, ROS are advantageous.

---

*The tasks defined are based on the general approach, but not final, exact tasks could depend on the progress and results during the thesis. Contact for further details: akhil.s.anand@ntnu.no