Safe and sample efficient robot learning with robotic manipulators

Background

Acquiring human level manipulation skills on robots is a challenging task as even the seemingly mundane task of picking up and opening a water bottle demands an enormous level motor activity and coordination. Robots capable of dexterous manipulation skills possess the potential to revolutionize the level of automation in Industrial and healthcare sectors. The robot learning approach leveraging on human demonstrations promise to teach the robots efficiently to solve complex manipulation tasks without having a well-defined model of the task and environment (e.g Dynamic movement primitives). An example of learning from human demonstration on ping-pong game, follow this link video.

This thesis call is associated with the project, **Robotics for Moving Objects (ROMO)** between NTNU and SINTEF. Here, we focus on developing methods enabling robots to perform dynamic interaction and manipulation tasks on moving objects. Particularly, we are trying to combine **reinforcement learning** with traditional robot control methods such as impedance control. One of the challenging aspects of the project is to develop methods for the real-world robots to learn safely and sample efficiently. Unlike simulated environments, the real robots can't perform millions of trials nor run into unsafe states.

If you are motivated to develop robotic systems capable of learning and adapting for real-world application (e.g healthcare robots) ensuring safety and robustness, here is an ideal opportunity for you. You will be working with either of the robots (**Frank Emika - Panda robot, UR-10)** or both. You will have the opportunity to work in collaboration with the multidisciplinary team comprising 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 for master project and thesis:

- Setting up the robot with ROS2 and integrating frameworks for data collection from human demonstration and robot learning /control in python.
- Defining safety constraints for robot learning in the moving object scenario and integrating it in the learning framework.
- Identifying and developing methods for safe and sample efficient robot learning.
- Testing and evaluating the methods on a real-world application such as, robot hanging an object on a moving overhead conveyor, robot performing an ultrasound scan on a human dummy.

Qualifications:

- Necessary to have basic knowledge in robotics, control engineering and machine learning.
- Programing knowledge in Python / C++, MATLAB.
- Experience with reinforcement learning, 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