



Project Type _____

- Master Thesis
- Bachelor Thesis
- Research Project

Supervisors _____

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Difficulty _____

Algorithmic



Math



Application



Human-Robot Collaboration using Behavioral Cloning and Teleoperation

Description

Human-robot collaboration is becoming one of the key fields in robotic. Here, the robot must be able to perform complex movements in coordination with a human partner. Several challenges are present in this scenario. For once, the prediction and the modelling of human actions is a very hard task in general. Furthermore, a simulated environment of the human-robot collaboration is usually impossible since a real human is involved. Finally, the resulting policy of the robot must be safe and controlled since the robot interacts directly with its human partner.

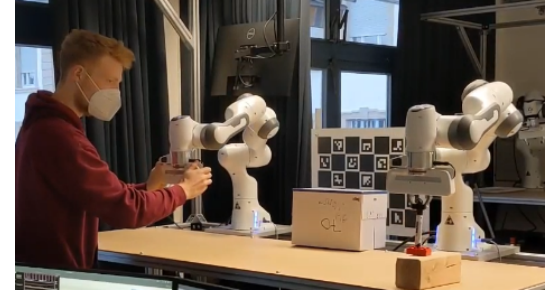


Figure 1: Execution of the teleoperation system at the ALR.

One way of teaching a robot a given task is to use a behavioral cloning algorithm [2] to learn from an expert. During demonstrations the expert robot movements are given by another human which teleoperates [1] the robot as shown in Figure 1. In order to learn complex and smooth trajectories, we incorporate movement primitives [3] which model the robot trajectory as a weighted sum of basis functions. Thus, during training the robot has to generalize the actions from the expert in a given situation and learn the weights for the movement primitive basis functions which correspond to the desired trajectory. We additionally aim to apply new variants of movement primitives which got recently developed here at the ALR.

Tasks

- Expand the current teleoperation setup to record robot trajectories and task-related data.
- Create a dataset of a human-robot collaboration task where the robotic movement is controlled via teleoperation.
- Apply a behavioral cloning algorithm to learn a robot policy that imitates the human expert which can solve the task.
- Compare different motion primitive variants for the planning of the robot trajectories.

References

- [1] S. Lichiardopol. A survey on teleoperation. 2007. DCT 2007.155.
- [2] Takayuki Osa, Joni Pajarinen, Gerhard Neumann, J. Andrew Bagnell, Pieter Abbeel, and Jan Peters. An algorithmic perspective on imitation learning. *Found. Trends Robotics*, 7(1-2):1–179, 2018.
- [3] Matteo Saveriano, Fares J. Abu-Dakka, Aljaz Kramberger, and Luka Peternel. Dynamic movement primitives in robotics: A tutorial survey. *CoRR*, abs/2102.03861, 2021.