Karlsruhe Institute of Technology

Autonome Lernende Roboter (ALR)

Prof. Gerhard Neumann

Project Type

- ☑ Master Thesis
- ☑ Bachelor Thesis
- ☑ Research Project

Supervisors

☞ Ge Li

@ ge.li@kit.edu

Difficulty

Algorithmic

Math

Application

Contextual Policy Search for simulated Robot Table Tennis

Description

Table tennis is a popular sport containing various levels of skills. Due to its high complexities in motion and strategy, table tennis is a good platform for testing different algorithms of control theory, robotics, and machine learning. In this project, we want to learn a versatile set of table tennis strikes, such as forehand, backhand, loop or smash. We will consider a contextual policy search scenario [1] where the robot has to adapt its motion to the incoming ball trajectory (the context).

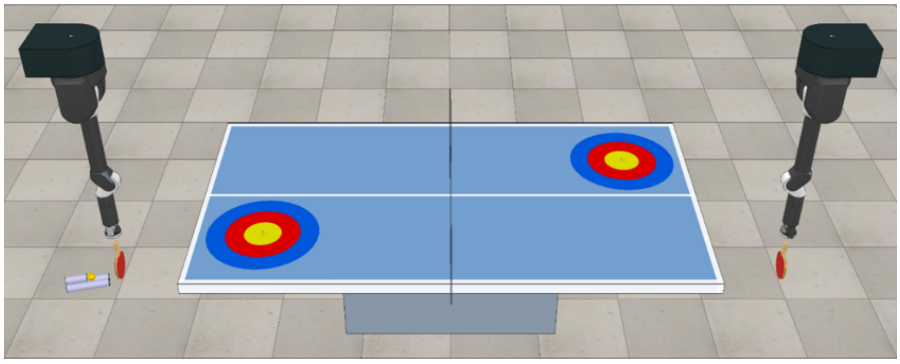

Figure 1: Robot table tennis simulation setup in CoppeliaSim® with two Barrett® WAM manipulators, whose original hardware setup is in the Max Planck Institute for Intelligent Systems in Tübingen.

So far, a robot table tennis simulation environment (See Figure 1) has been defined and should be improved to support contextual learning. We want to apply latest insights from information theory [2] in combination with reinforcement learning methods [3] to learn a versatile, contextual skill library.

Tasks

- Literature Research & Benchmarks: Review different approaches in contextual learning and their benchmarks for evaluation.
- Setup Contextual Cases for Testing: Design and implement different robot table tennis learning tasks in simulation environment.
- Extend Latest algorithms: Cooperate with other members at ALR to test and improve information-theoretic contextual algorithms in development.
- Experiment of High Level Robot Skills (Optional): For example, design and implement policies to switch between forehand and backhand strikes.

References

[1] Abbas Abdolmaleki, Bob Price, Nuno Lau, Luis Paulo Reis, and Gerhard Neumann. Contextual Covariance Matrix Adaptation Evolutionary Strategies. pages 1378–1385, Melbourne, Australia, August 2017. International Joint Conferences on Artificial Intelligence Organization.

[2] Oleg Arenz, Mingjun Zhong, and Gerhard Neumann. Trust-Region Variational Inference with Gaussian Mixture Models. *arXiv:1907.04710 [cs, stat]*, July 2019. 00001 arXiv: 1907.04710.

[3] Christian Daniel, Gerhard Neumann, Oliver Kroemer, and Jan Peters. Hierarchical Relative Entropy Policy Search. page 50. 00113.