Autonome Lernende Roboter (ALR)
Prof. Gerhard Neumann

Project Type

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

Supervisors

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Difficulty

Algorithmic

Math

Application

Long-Term Prediction for Pushing and Grasping with Deep Reinforcement Learning

Description

In this project, we aim to optimize a policy that allows a robot to achieve a long-term goal in visual grasping and manipulation.

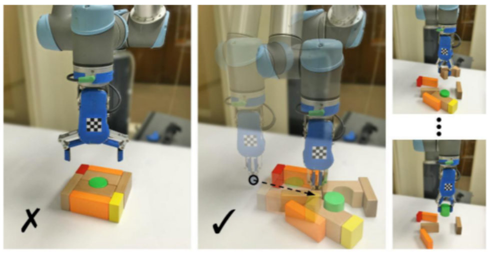

Figure 1: Example of pushing and grasping synergies [2].

In this project, we will reimplement one of the state-of-art approaches [2] that proposes learning synergies for grasping and pushing with self-supervised Deep Reinforcement Learning. This approach basically uses RL (Q-learning) to train a robot how to synergize between non-prehensile (e.g. pushing) and prehensile (e.g. grasping) actions with an objective to simply remove a heap of objects. Extending this algorithm to allow continuous actions, and other tailored long-term tasks (e.g. searching for objects) or incorporate reshaped rewards (e.g. actions to reduce uncertainty) might be non-trivial. Based on this insight, we will propose improvements to enable those extensions.

Tasks

- Re-implementation: Extending the formulation in [2] to model continuous actions, e.g. continuous pushing and grasping angles. The original implementation of the push-and-grasp algorithm [2] has existed Simulation Framework in the lab. (related work: Chease Finn about Visual Foresight)
- Improvements: We will propose three improvements: i) embed a recurrent network (e.g. using action conditioning for Recurrent Kalman Network (RKN) [1]) to estimate a forward model that can predict the pixel-wise change given an action and a current scene; ii) use planning (e.g. model predictive control (MPC) with random shooting or cross entropy method (CEM)) for action selection, and iii) propose simple entropy rewards for pushing actions (e.g. as by-product of using RKN and planning).
- Benchmarking: The approach will be evaluated against the existing method on a simulated robot system.

References

[1] Philipp Becker, Harit Pandya, Gregor H. W. Gebhardt, Cheng Zhao, C. James Taylor, and Gerhard Neumann. Recurrent kalman networks: Factorized inference in high-dimensional deep feature spaces. In Kamalika Chaudhuri and Ruslan Salakhutdinov, editors, *Proceedings of the 36th International Conference on Machine Learning, ICML 2019, 9-15 June 2019, Long Beach, California, USA*, volume 97 of *Proceedings of Machine Learning Research*, pages 544–552. PMLR, 2019.

[2] Andy Zeng, Shuran Song, Stefan Welker, Johnny Lee, Alberto Rodriguez, and Thomas A. Funkhouser. Learning synergies between pushing and grasping with self-supervised deep reinforcement learning. In *IEEE International Conference on Intelligent Robots and Systems (IROS) 2018*, pages 4238–4245.