Karlsruhe Institute of Technology

Autonome Lernende Roboter (ALR)

Prof. Gerhard Neumann

Project Type

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

Supervisors

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Difficulty

Algorithmic

Math

Application

Reinforcement Learning for Multiple-Embodiment Grasping

Description

Reinforcement Learning (RL) and Imitation Learning have achieved remarkable results in various domains of robotics, including grasping and object manipulation [2]. Recently, diffusion models have emerged as a promising avenue for modeling multimodal data, making them well-suited for robotics grasping applications [3]. Although numerous algorithms exist in the current literature, there is not yet a clear consensus on the best way to integrate diffusion into RL. In this thesis, you will explore the application of diffusion-based RL specifically for robotic grasping.

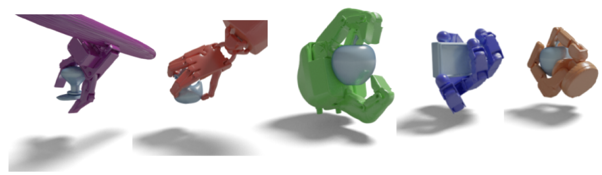

Figure 1: Illustration taken from [1] to illustrate grasping for multi-embodiment.

Furthermore, a potential continuation of the thesis could explore the transfer of your method to multiple-embodiment grasping. Modern generalist approaches rely on vast data from heterogeneous sources to train models capable of controlling diverse robot kinematics. Although effective, most generalist actors do not primarily target grasping but solve it as a downstream task, with performance inferior to current specialist methods. To close this gap, you will apply your methods to handle multiple embodiments of grippers.

Tasks

- You will design architectures and pipelines to transfer current methods to an online RL algorithm
- Create RL environments for single- and multi-embodiment grasping using our grasp-dataset generation pipeline
- Benchmark current state-of-the-art approaches in robotics grasping
- You will work under remote and on-site supervision of the research staff, who will provide guidance throughout the thesis. Most systems and frameworks are already in place, offering you an excellent opportunity to hone your skills

Qualifications

- *Education*: Studies in computer science or mathematics
- *Experience*: Proficient in Python, including best practices in code structure and packaging. Experience with Machine Learning like PyTorch, JAX and TensorFlow. Knowledge in physical simulators like MuJoCo, Bullet or Isaac Sim. Familiarity with high-level graphics libraries like Open3D is a plus.
- Languages: Fluent in German or English (written and spoken)

References

[1] Maria Attarian, Muhammad Adil Asif, Jingzhou Liu, Ruthrash Hari, Animesh Garg, Igor Gilitschenski, and Jonathan Tompson. Geometry matching for multi-embodiment grasping. In *Proceedings of the 7th Conference on Robot Learning (CoRL)*, 2023.

[2] Cheng Chi, Siyuan Feng, Yilun Du, Zhenjia Xu, Eric Cousineau, Benjamin Burchfiel, and Shuran Song. Diffusion policy: Visuomotor policy learning via action diffusion. In *Proceedings of Robotics: Science and Systems (RSS)*, 2023.

[3] Hyunwoo Ryu, Jiwoo Kim, Junwoo Chang, Hyun Seok Ahn, Joohwan Seo, Taehan Kim, Jongeun Choi, and Roberto Horowitz. Diffusion-edfs: Bi-equivariant denoising generative modeling on se (3) for visual robotic manipulation. *arXiv preprint arXiv:2309.02685*, 2023.