Karlsruhe Institute of Technology

FZI

Autonomous Learning Robots (ALR) & IDS @ FZI Forschungzentrum Informatik

Prof. Gerhard Neumann

Project Type

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

Supervisors

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Difficulty

Algorithmic

Math

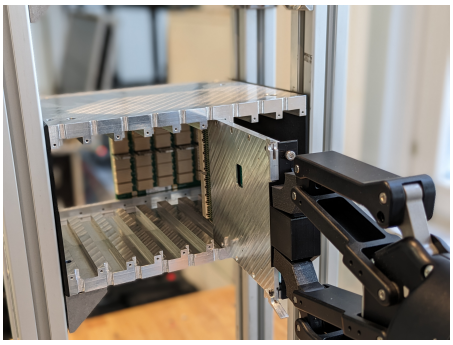
Application

Diffusion-based Imitation Learning for Contact Rich Manipulation

Description

Diffusion models underlay some of the most impressive recent generative AI models such as DALL-E or Midjourney. Furthermore, they have recently been successfully applied to *imitation learning*[1, 2]. This paradigm aims at teaching robots new skills using demonstrations from human experts which are to be imitated by the robot.

In this thesis, we want to evaluate how we can use diffusion-based imitation learning for realistic industrial applications such as the one shown in Figure 1. In contrast to commonly used benchmarks, such tasks are usually rich in contacts between different objects and require very high precision and force-aware manipulation to ensure successful execution without damage to components of the task or the robot itself.



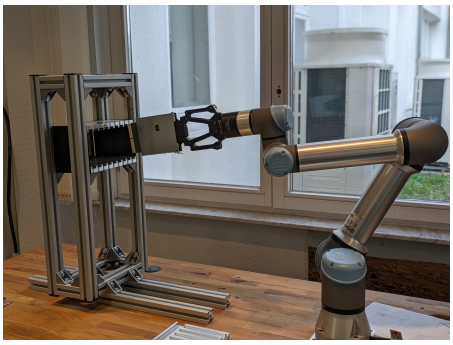


Figure 1: In our task, the robot has to insert a hard drive into a rack mount. Here, the challenge lies in the low clearance of the mount which requires highly precise motion based on force feedback to avoid jamming the disk. The task has to be solved based on demonstrations from a human expert, and we will consider a simulated version and the real setup.

Tasks

- Getting familiar with imitation learning, diffusion models, and our existing simulation and robot pipeline.
- Development and preliminary evaluation in simulation by building on the code base provided by[2].
- Deployment of the approach on the real robot.
- Data collection and large-scale evaluation on the real robot.

References

[1] 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.

[2] Moritz Reuss, Maximilian Li, Xiaogang Jia, and Rudolf Lioutikov. Goal conditioned imitation learning using score-based diffusion policies. In *Robotics: Science and Systems*, 2023.