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

Imitation Learning for Soft Objects Manipulation

Description

The field of robotics has made significant strides in rigid object manipulation. However, the manipulation of non-rigid objects remains a substantial challenge due to their complex dynamics. Their underlying physics are non-trivial to simulate, making manipulation with traditional approaches infeasible. *Imitation Learning* is a promising alternative. It can directly extract a policy from demonstrated data, though it is data-intensive. In our recent work, XR-based kinesthetic teleop interface [1], we proposed a new method that allows users to immerse themselves in an XR environment to collect a large amount of data effectively and intuitively. In this thesis, the student will build up-on the existing framework, and explore the possibility of using imitation learning for manipulating complex objects such as soft-body and fluid.

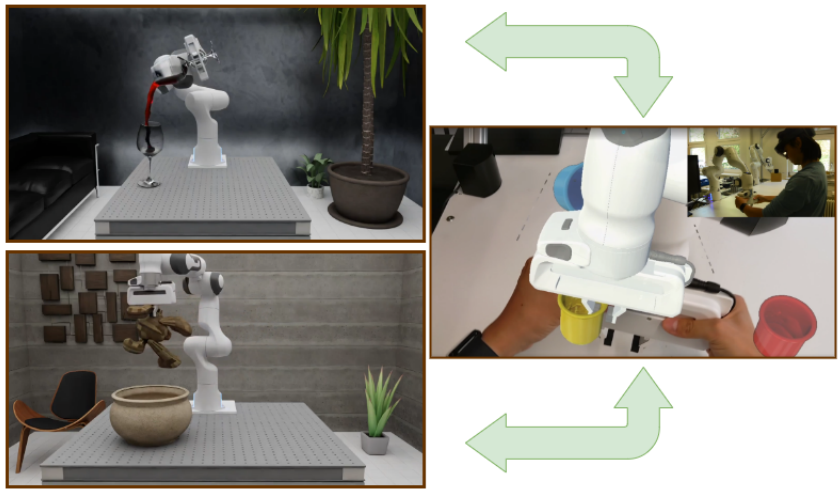

Figure 1: Left: Isaac-Orbit soft-manipulation environment [2]. Right: Our Kinesthetic Teleop system.

Tasks

To explore a novel imitation learning method for manipulating soft objects, this project requires the following tasks:

- Implementation: Implement new learning environments with complex object dynamics and collecting data using Isaac-Orbit [2] and our XR system [1].
- Experiments: Try out state-of-the-art imitation learning algorithms, e.g Diffusion Policy, PointTransformer, PointGPT as backbone architectures or develop your own algorithms.
- Evaluation: Analyze and compare your method against current state-of-the-art methods to investigate the overall performance.
- Writing: Document your work as a scientific paper.

References

[1] Xinkai Jiang, Paul Mattes, Xiaogang Jia, Nicolas Schreiber, Gerhard Neumann, and Rudolf Lioutikov. A comprehensive user study on augmented reality-based data collection interfaces for robot learning. In *Proceedings of the 2024 ACM/IEEE International Conference on Human-Robot Interaction*, page 10, Boulder, CO, USA, 2024. ACM.

[2] Mayank Mittal, Calvin Yu, Qinxi Yu, Jingzhou Liu, Nikita Rudin, David Hoeller, Jia Lin Yuan, Ritvik Singh, Yunrong Guo, Hammad Mazhar, Ajay Mandlekar, Buck Babich, Gavriel State, Marco Hutter, and Animesh Garg. Orbit: A unified simulation framework for interactive robot learning environments. *IEEE Robotics and Automation Letters*, 8(6):3740–3747, 2023.