

Master/Bachelor Thesis

Dexterous Teleoperation for Imitation Learning

Background

Dexterous hands have become increasingly popular in the field of robotic manipulation. Compared to traditional two-finger grippers, dexterous hands offer greater flexibility and provide richer contact data. Due to their resemblance to human hands, imitation learning has emerged as a natural and widely used approach for training dexterous manipulation policies. Teleoperation is considered one of the most promising methods for collecting high-quality demonstration data. Previous studies have explored teleoperation through virtual reality and visual motion capture technologies [1][2]. More recently, solutions incorporating exoskeletons have gained attention [3][4][5], offering the added benefit of haptic feedback for more precise control. Demonstration data collected using these methods have been successfully applied to train policies for a variety of tasks, including table arrangement, wire winding, and tool manipulation.

Your Tasks

In this project, you will develop a teleoperation system for dexterous hands to collect data for imitation learning. Specifically, your task will include:

1. implement a teleoperation system to control the movement of a pair of dexterous hands and receive haptic feedbacks,
2. collect multi-modal demonstration data for common manipulation tasks,
3. train dexterous manipulation policy from demonstration.

Requirement

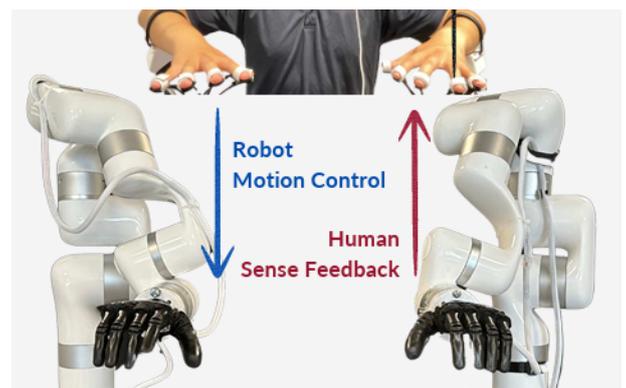
- Self-motivation and love for robots;
- Basic knowledge of robotics and imitation learning;
- At least six-month working time;
- Python and C++ (optional) programming experiences;
- Working experience with dexterous hands or imitation learning will be a plus.

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[1] Shaw K, Bahl S, Sivakumar A, et al. Learning dexterity from human hand motion in internet videos[J]. The International Journal of Robotics Research, 2024, 43(4): 513-532.

[2] Iyer A, Peng Z, Dai Y, et al. Open teach: A versatile teleoperation system for robotic manipulation[J]. arXiv preprint arXiv:2403.07870, 2024.

[3] Wei D, Xu H. A wearable robotic hand for hand-over-hand imitation learning[C]//2024 IEEE International Conference on Robotics and Automation (ICRA). IEEE, 2024: 18113-18119.

[4] Shaw K, Li Y, Yang J, et al. Bimanual dexterity for complex tasks. Conference on Robot Learning (CoRL), 2024.

[5] Ding R, Qin Y, Zhu J, et al. Bunny-visionpro: Real-time bimanual dexterous teleoperation for imitation learning[J]. arXiv preprint arXiv:2407.03162, 2024.