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

Domain Randomization in Simulated Contact Manipulation Tasks

Description

Contact-rich manipulation tasks are critical in robotics and automation, enabling robots to interact with the physical world effectively. However, simulating accurate contact interactions remains challenging due to the complex nature of real-world dynamics. Domain randomization techniques[3] offer a promising avenue to address these challenges by generating diverse simulated environments for training robotic systems. In this bachelor thesis project aimed at investigating domain randomization for simulated contact-rich manipulation tasks, such as screwing (see Fig. 1).

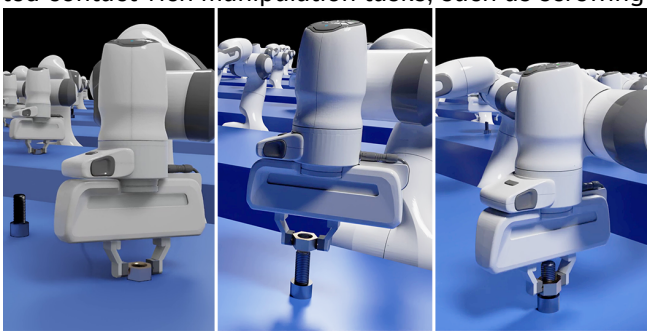

Figure 1: Illustration taken from [2] to illustrate the Bolt Screwing task.

This bachelor thesis proposes an investigation into domain randomization techniques for simulated contact-rich manipulation tasks in robotics using the Orbit framework[1] and Nvidia IsaacSim platform[2]. By exploring the impact of randomization on task performance and generalization, this research aims to contribute to the development of more robust and adaptable robotic systems. The findings of this study have the potential to inform future research and practical applications in the field of robotics and automation.

Tasks

The tasks in this project will involve:

- Review State of the Art: Explore existing literature and techniques related to domain randomization in robotic simulations.
- Implementation Implement contact-rich manipulation tasks in the IsaacSim Framework [2]. Identify key parameters to be randomized, such as object properties, surface textures, and friction coefficients.
- Training and Evaluation. Train robotic agents using reinforcement learning or other suitable techniques on randomized environments and evaluate their performance across various levels of randomization.

References

[1] 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.

[2] Yashraj Narang, Kier Storey, Iretiayo Akinola, Miles Macklin, Philipp Reist, Lukasz Wawrzyniak, Yunrong Guo, Adam Moravanszky, Gavriel State, Michelle Lu, Ankur Handa, and Dieter Fox. Factory: Fast contact for robotic assembly. *Robotics: Science and Systems (RSS)*, 2022.

[3] Nikita Rudin, David Hoeller, Philipp Reist, and Marco Hutter. Learning to walk in minutes using massively parallel deep reinforcement learning. *Conference on Robot Learning (CoRL)*, 2022.