

Bachelor Thesis – Improving Robustness of Reinforcement Learning for Insertion Tasks

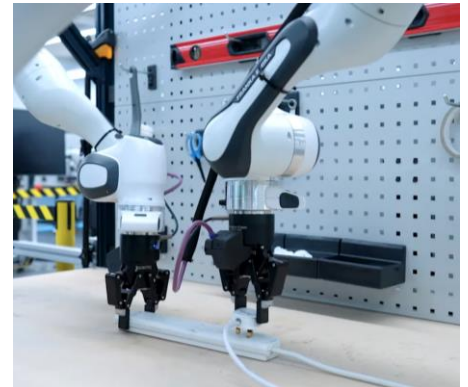
Insertion is a fundamental task in robotics and a key component of automated assembly. Reinforcement Learning (RL) approaches achieve promising success rates, but robustness remains limited, particularly with respect to varying controller performance and recovery from failures.

Research Area and Background

In the literature, RL approaches for insertion differ in sensory inputs, action representations, and use of demonstrations. A key design trade-off lies between the amount of information provided and the generality of the policy: less information leads to more transferable solutions. In a minimal information setting, a key challenge is exploiting limited observations to achieve robust behavior, including detecting and reacting to failure cases (e.g. getting stuck) and adapting to varying low-level controller performance using observation history.

Your Tasks and Research Challenges

- **Literature research on state of the art**
 - Reinforcement Learning for Insertion
 - Force-based control
- **Development and Implementation**
 - Improve an existing RL environment for insertion
 - Adapt ROS 2 controller for deployment
- **Evaluation and Documentation**
 - Deploy and compare your trained policies on a real robot
 - Evaluate and summarize your results in a thesis



Google DeepMind, Gemini Robotics Demo: Electrical Socket. YouTube, uploaded by Google DeepMind, 12 Mar. 2025, <https://www.youtube.com/watch?v=nB0KRTYmuDs>



Tang, Bingjie, and Yashraj Narang, Transferring Industrial Robot Assembly Tasks from Simulation to Reality. NVIDIA Developer Blog, 26 May 2023, <https://developer.nvidia.com/blog/transferring-industrial-robot-assembly-tasks-from-simulation-to-reality/>

What we offer at the Machine Intelligence and Robotics Lab!

- You'll get to learn a lot about our current research and gain some real hands-on experience
- We use the latest robotics hardware and the newest ML libraries, as well as tools like Isaac Lab, ROS 2, etc.
- We are a team of international, motivated robotics enthusiasts and would be happy to have you join us.
- You will get encouraging support from your supervisor and honest feedback to improve your skills
- We offer a great working environment in our Mairo Lab

Type: Bachelor thesis

Date: As soon as possible

Supervisors: Prof. Dr. Arne Rönnau, M. Sc. Vincenzo Di Pentima

Do you want to work on cutting edge robotics research?

Contact: Vincenzo Di Pentima, vincenzo.pentima@kit.edu

We look forward to receiving your application (incl. current grade transcript)!

