DEPARTMENT OF COMPUTER SCIENCE | LUND UNIVERSITY | PRESENTED 2024-04-04

MASTER THESIS Skill-Based Multi-Objective Reinforcement Learning for Dual-Arm Robotic Assembly
STUDENT Sulthan Suresh Fazeela
SUPERVISORS Matthias Mayr (LTH), Faseeh Ahmad (LTH)
EXAMINER Jacek Malec (LTH)

Intelligent Manufacturing: Skilled Dual-Arm Robot Learns Collaborative Assembly

POPULAR SCIENCE SUMMARY **Sulthan Suresh Fazeela**

Industrial robots have been efficient but inflexible machines programmed to perform repetitive tasks. However, the future of manufacturing is changing and industrial robots need to transform to skilled workers that can learn and adapt like humans to perform complex assembly tasks.

The fourth industrial revolution is transforming the manufacturing industry, demanding robots to be more flexible, adaptive, and intelligent. Robots traditionally seen as repetitive and inflexible machines are now being re-imagined as intelligent collaborative partners capable of continuous learning and improvement. This transformation requires robots to learn and adapt like humans to perform complex assembly tasks in unstructured environments.

To address this challenge, we propose a skill-based multi-objective reinforcement learning (MORL) approach. It combines the benefits of skill-based programming and MORL to tackle complex assembly tasks. This approach is then applied to a classic yet intricate cooperative assembly task: the peg-in-block insertion. Unlike traditional programming methods that hard-code every robot movement, our approach allows the robot to learn from experience, optimizing its skills for performance and safety, similar to a human learning a skill through practice and refinement. Furthermore, we use transfer learning to generalize to task variations such as changes in object size or assembly clearance by transferring knowledge learned from the original task.

Our experiments show that the dual-arm robot learns to perform the peg-in-hole assembly task efficiently using our skill-based MORL approach. Additionally, the transfer learning approach accelerates the adaptation to task variations.

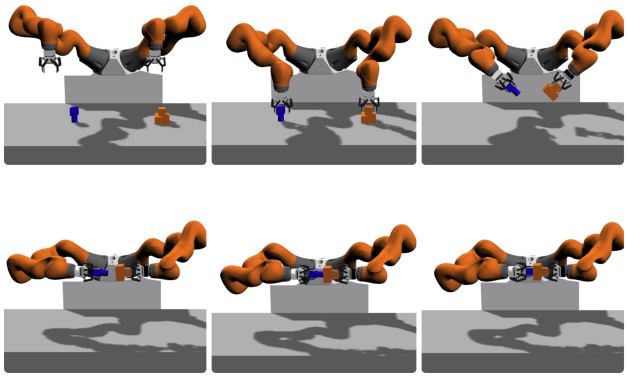

Figure 1: A dual-arm robot learns to perform cooperative peg-in-hole assembly task.

The results demonstrate that our approach enables robots to learn, adapt, and perform complex assembly tasks efficiently, making them more flexible and intelligent. This work can be applied to a wide range of assembly tasks and is a step towards transforming industrial robots into skilled and intelligent workers.