Karlsruhe Institute of Technology

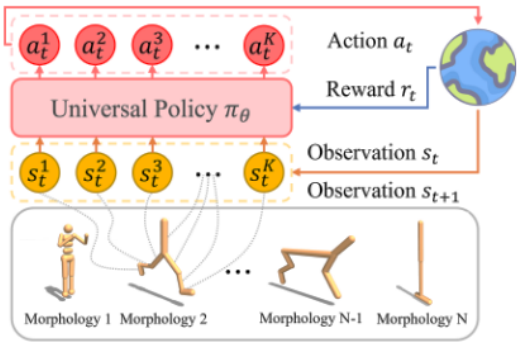
Machine Intelligence and Robotics Lab

Master Thesis – Learning Admittance Control Across Multiple Robot Arms

Reinforcement Learning (RL) has shown strong results in robotics, yet contact-rich tasks require precise force control. Classical admittance controllers suffer from model inaccuracies and do not perform consistently across different robots. This motivates research toward general policies that achieve accurate and consistent interaction across robot arms.

Research Area and Background

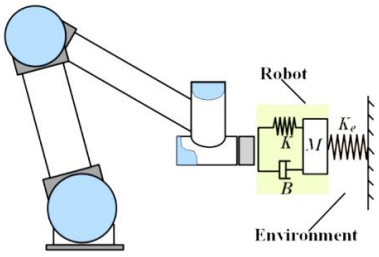
Many manipulation tasks benefit from force-based control due to environmental interaction. Classical admittance controllers can track Cartesian forces but suffer from model inaccuracies, leading to tracking errors and inconsistent behavior across robots. This motivates learning-based approaches that model interaction behavior and support higher-level skills (e.g. insertion). Key challenges include generalizing across robot embodiments and estimating interaction forces from past observations without force/torque sensors, either explicitly or through learned representations.



Luo, Yingbo, Meibao Yao, and Xueming Xiao. "GCNT: graph-based transformer policies for morphology-agnostic reinforcement learning." arXiv preprint arXiv:2505.15211 (2025).

Your Tasks and Research Challenges

- **Literature research on state of the art**
  - Admittance and force estimation
  - Multi-embodiment RL control
- **Development and Implementation**
  - Develop an RL environment for general Admittance control
  - Define different force estimator solutions
- **Evaluation and Documentation**
  - Deploy and compare your policy on different real robots
  - Use policy as low-level controller for force-based skills
  - Evaluate and summarize your results in a thesis



Li, Zhisen, et al. "A fuzzy adaptive admittance controller for force tracking in an uncertain contact environment." IET control theory & applications 15.17 (2021): 2158-2170.

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: **Master 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)!