Karlsruhe Institute of Technology

Machine Intelligence and Robotics Lab

Master/Bachelor Thesis – Reinforcement Learning Controller for Mobile Manipulation

Reinforcement Learning has led to major improvements in many control applications, like in Locomotion for legged robots. Given these promising results, RL appears well suited to address the next challenge in robotics: Mobile Manipulation, with the aim of learning low-level control policies that support agile and versatile motion.

Research Area and Background

A natural extension of walking robots is the addition of one or more arms, resulting in what is known as a mobile manipulator. This evolution enables robots to actively interact with their environment, but introduces significant control challenges due to nonlinear, redundant and strongly coupled dynamics. The central research question is how to effectively control such robots so that they can achieve performance levels comparable to those of static manipulators, in terms of pose or force tracking accuracy, despite their increased kinematic and dynamical complexity.

Ma, Yuntao, et al. "Learning coordinated badminton skills for legged manipulators." Science Robotics 10.102 (2025)

Your Tasks and Research Challenges

- **Literature research on state of the art**
  - Reinforcement Learning
  - Mobile Manipulation and force control
- **Development and Implementation**
  - Develop an RL environment for Mobile Manipulation
  - Implement and develop approaches for successful training
- **Evaluation and Documentation**
  - Deploy your trained policy on the ANYmal robot
  - Evaluate and summarize your results in a thesis

Liu, Minghuan, et al. "Visual whole-body control for legged loco-manipulation." arXiv preprint arXiv:2403.16967 (2024)

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-/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)!

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Your Tasks and Research Challenges

- **Literature research on state of the art**
  - Reinforcement Learning
  - Mobile Manipulation
- **Development and Implementation**
  - Develop an RL environment for Mobile Manipulation
  - Define different designs for the controller architecture
- **Evaluation and Documentation**
  - Deploy and compare your trained policies in simulation
  - Evaluate and summarize your results in a thesis

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