Ralf Römer

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Research Interests

Multimodal generative foundation models for embodied AI, including vision-language-action models (VLAs). Uncertainty quantification and uncertainty-aware decision-making, continual learning, and safety in imitation and reinforcement learning. Real-world robot learning under distribution shift.

Research Experience

- **Technical University of Munich (TUM), Learning Systems and Robotics Lab [🌐]** *Dec. 2023 - Present*
  PhD Student, Advisor: Prof. Angela Schoellig Munich, Germany
  - Develop safe generative policies to enable robust robot decision-making under dynamic and uncertain conditions.
  - Train diffusion transformers and VLAs on multimodal datasets.
  - Design and conduct extensive real-world experiments, deploying policies on hardware for complex manipulation tasks, such as LEGO assembly and safe human-robot interaction.
  - Published novel contributions on runtime failure prediction and constrained diffusion policies at top-tier venues including NeurIPS 2025 and L4DC 2025.
- **Technical University of Munich (TUM), Learning Systems and Robotics Lab** *Mar. 2023 - Oct. 2023*
  Master Thesis, Advisor: Prof. Angela Schoellig Munich, Germany
  - Developed and theoretically analyzed learning-based sampled-data control algorithms using Gaussian processes.
  - Validated in real-world experiments with a quadrotor, published at ACC 2024.
- **École Polytechnique Fédérale de Lausanne (EPFL), Learning Algorithms and Systems Lab [🌐]** *Sep. 2022 - Jan. 2023*
  Research Internship, Advisor: Prof. Aude Billard Lausanne, Switzerland
  - Designed and implemented Gaussian process models for probabilistic learning of object flying dynamics.
  - Computed optimal and reliable robot throwing configurations using uncertainty propagation techniques.
- **Technical University of Munich (TUM), Chair of Information-Oriented Control [🌐]** *Oct. 2021 - Aug. 2022*
  Semester Project & Research Assistant, Advisor: Prof. Sandra Hirche Munich, Germany
  - Developed a framework for probabilistic semantic segmentation, including data augmentation and model training; experimental validation for safe motion planning with a KUKA manipulator; published at RA-L 2023.
  - Implemented and tested distributed Bayesian online learning algorithms for cooperative robot manipulation.
- **Bosch Research [🌐]** *Apr. 2021 - Sep. 2021*
  Research Internship, Advisors: Dr. Thomas Specker, Dr. Felix Berkel Stuttgart, Germany
  - Developed a software toolbox for set-based robust optimal control with safety guarantees, which is now in active use for developing autonomous driving algorithms.
- **Friedrich-Alexander University Erlangen-Nuremberg, Chair of Automatic Control [🌐]** *Apr. 2020 - Mar. 2021*
  Research Assistant Erlangen, Germany
  - Developed algorithms for catching objects in flight with a robotic manipulator, including state estimation, motion prediction and high-speed robot control.
  - Designed and conducted real-world experiments with a Panda manipulator, published at ACC 2022.
- **Fraunhofer Institute for Integrated Systems and Device Technology IISB [🌐]** *Oct. 2017 - Oct. 2019*
  Working Student Erlangen, Germany
  - Developed and tested electronic speed controllers for an autonomous VTOL drone.

Education

- **Technical University of Munich (TUM)** *Oct. 2021 - Oct. 2023*
  M.Sc., Electrical and Computer Engineering Munich, Germany
  - GPA: 1.0[1] (top 1%)
  - Thesis: "The Role of Control Frequency for the Stability and Closed-Loop Performance of Uncertain Systems", advised by Prof. Angela Schoellig
  - Exchange semester at EPFL; ranked 1st out of 90 students in the "Legged Robots" course by Prof. Auke Ijspeert
- **Friedrich-Alexander University Erlangen-Nuremberg (FAU)** *Oct. 2017 - Oct. 2020*
  B.Sc., Mechatronics Erlangen, Germany
  - GPA: 1.0[1] (Valedictorian)
  - Thesis: "Catching Objects in Flight with a Robotic Manipulator", advised by Prof. Knut Graichen
- **Dietrich-Bonhoeffer-Gymnasium Oberasbach** *Jun. 2017*
  Abitur (High School Diploma) Oberasbach, Germany
  - GPA: 1.0[1] (Valedictorian); 888/900 points; focus on mathematics, physics and computer science
  - Several awards at math competitions, rank 36/4500 in Germany at the International Junior Science Olympiad 2014

[1]The German grading scale ranges from 1.0 (excellent, equals A+) to 5.0 (insufficient, equals F). Grades are given out in 0.1 increments. The minimum score required to pass is 4.0.

PUBLICATIONS [🌐]

C=CONFERENCE, J=JOURNAL, W=WORKSHOP, P=PREPRINT, A=ABSTRACT

[C.1] **R. Römer***, A. Kobras*, L. Worbis, and A. P. Schoellig, "Failure Prediction at Runtime for Generative Robot Policies", *Advances in Neural Information Processing Systems (**NeurIPS**)*, 2025. [pdf] [website]

[C.2] **R. Römer**, A. von Rohr, and A. P. Schoellig, "Diffusion Predictive Control with Constraints", *Learning for Dynamics and Control Conference (**L4DC**)*, 2025. [pdf]

[C.3] **R. Römer**, T. Emmert, and A. P. Schoellig, "Flying through Moving Gates without Full State Estimation", *IEEE International Conference on Robotics and Automation (**ICRA**)*, 2025. [pdf]

[C.4] **R. Römer**, L. Brunke, S. Zhou, and A. P. Schoellig, "Is Data All That Matters? The Role of Control Frequency for Learning-Based Sampled-Data Control of Uncertain Systems", *American Control Conference (**ACC**)*, 2024. [pdf]

[C.5] T. Gold, **R. Römer**, A. Völz, and K. Graichen, "Catching Objects with a Robot Arm using Model Predictive Control", *American Control Conference (**ACC**)*, 2022. [pdf]

[J.1] L. Brunke, Y. Zhang, **R. Römer**, J. Naimer, N. Staykov, S. Zhou, and A. P. Schoellig, "Semantically Safe Robot Manipulation: From Semantic Scene Understanding to Motion Safeguards", *IEEE Robotics and Automation Letters (**RA-L**)*, vol. 10, no. 5, pp. 4810-4817, 2025. [pdf] [website]

[J.2] **R. Römer***, A. Lederer*, S. Tesfazgi, and S. Hirche, "Vision-Based Uncertainty-Aware Motion Planning Based on Probabilistic Semantic Segmentation", *IEEE Robotics and Automation Letters (**RA-L**)*, vol. 8, no. 11, pp. 7825-7832, 2023. [pdf]

[W.1] **R. Römer**, L. Brunke, M. Schuck, and A. P. Schoellig, "Safe Offline Reinforcement Learning using Trajectory-Level Diffusion Models", *Robot Learning going Probabilistic Workshop at the International Conference on Robotics and Automation (**ICRA**)*, 2024. [pdf]

[P.1] **R. Römer***, Y. Zhang, A. P. Schoellig, "CLARE: Continual Learning for Vision-Language-Action Models via Autonomous Adapter Routing and Expansion", *under review*, 2025. [pdf] [website]

[P.2] **R. Römer***, J. Balletshofer*, J. Thumm, M. Pavone, A. P. Schoellig, and M. Althoff, "From Demonstrations to Safe Deployment: Path-Consistent Safety Filtering for Diffusion Policies", *under review*, 2025. [pdf] [website]

[P.3] R. Walia, Y. Wang, **R. Römer**, M. Nishio, A. P. Schoellig, and J. Ota, "ARMimic: Learning Robotic Manipulation from Passive Human Demonstrations in Augmented Reality", *under review*, 2025. [pdf]

[P.4] D. San José Pro, O. Hausdörfer, **R. Römer**, M. Dösch, M. Schuck, and A. P. Schoellig, "CRISP–Compliant ROS2 Controllers for Learning-Based Manipulation Policies and Teleoperation", *under review*, 2025. [pdf] [website]

[A.1] **R. Römer**, A. von Rohr, and A. P. Schoellig, "Diffusion Predictive Control with Constraints", Abstract and Oral Presentation (12% acceptance rate), *German Robotics Conference*, 2025.

[A.2] **R. Römer***, A. Lederer*, S. Tesfazgi, and S. Hirche, "Uncertainty-Aware Visual Perception for Safe Motion Planning", Abstract and Oral Presentation (10% acceptance rate), *AI.BAY - Bavarian International Conference on AI*, 2023.

SKILLS

- **Deep Learning & Generative AI:** PyTorch, Hugging Face (Diffusers), WandB, Slurm
- **Robotics & Embodied AI:** ROS2, MuJoCo, LeRobot, Gymnasium, PyBullet
- **Computer Vision & Data:** OpenCV, NumPy, SciPy, Pandas
- **Programming & Tools:** Python, C/C++, MATLAB/Simulink, Docker, Git

HONORS AND AWARDS

- **Scholarship by the German Academic Scholarship Foundation** *2020*
  Studienstiftung des deutschen Volkes; oldest and most prestigious scholarship organization in Germany [🌐]
  ◦ Awarded to around 0.5% of university students in Germany, €300 per month + funding for stays abroad
- **Baumüller Student Award** *2019*
  Baumüller GmbH: Manufacturer of automation and drive systems [🌐]
  ◦ Awarded for the best undergraduate study performance in Mechatronics, endowed with €1000
- **Elite Student Development Program** *2019*
  Faculty of Engineering, Friedrich Alexander University Erlangen-Nuremberg (FAU)
  ◦ Mentoring program for especially gifted engineering students, mentored by Prof. Knut Graichen
- **Germany Scholarship** *2018*
  Friedrich-Alexander University Erlangen-Nuremberg (FAU) and LEONI AG [🌐]
  ◦ Awarded to less than 1% of FAU students, €300 per month
- **High School Graduation Awards** *2017*
  German Mathematical Society and German Physical Society [🌐]
  ◦ Awarded for exceptional examination performance in mathematics and physics

Professional Activities

- **Bootcamp on Foundational Behavior Models [🌐]** *Nov. 2025*
  Organized by Prof. Rudolf Lioutikov at KIT and the Robotics Institute Germany Karlsruhe, Germany
  - Selected as one of six tutors from across Germany to push research projects on VLAs and foundation models for robotics with 15 fellow PhD students.
  - Resulted in ongoing collaborations on (i) safe VLAs with ETH Zurich and Max Planck Institute for Intelligent Systems, and (ii) world models for robot manipulation with University of Technology Nuremberg and KIT.
- **CoRL Workshop on Mastering Robot Manipulation in a World of Abundant Data [🌐]** *Nov. 2024*
  Held at the Conference on Robot Learning (CoRL) 2024 Munich, Germany
  - Organized this workshop together with A. P. Schoellig (TUM and UofT), A. Garg (Georgia Tech and NVIDIA), O. Mees (UC Berkeley), K. Pereida (Kindred), M. Schuck (TUM), and S. Zhou (TUM).
- **Summer School on Learning-Based Predictive Control** *Jun. 2023*
  ETH Zurich, International Graduate School on Control Zurich, Switzerland
  - Participated in this summer school, which was taught by Prof. Melanie Zeilinger and Prof. Lorenzo Fagiano.
  - Topics: Stochastic model learning, safe learning, predictive safety filters
- **Reviewer** *2020 - Present*
  ICRA, IROS, RA-L, T-ASE, L-CSS, ACC