Ralf Römer

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Research Interests

Generative foundation models and vision-language-action models (VLAs) to achieve embodied AI in dynamic, real-world environments. Algorithms for uncertainty quantification and uncertainty-aware decision-making, continual learning, safe imitation and reinforcement learning for VLAs.

Research Experience

- **Technical University of Munich (TUM), Learning Systems and Robotics Lab [🌐]** *Dec. 2023 - Present*
  PhD Student, Advisor: Prof. Angela Schoellig Munich, Germany
  - Developing algorithms for safe robot learning under dynamic and uncertain operating conditions using generative policies (diffusion, flow matching, VLAs); successfully validated experimentally for manipulation (e.g., building Lego, human-robot-interaction)
  - Publications at major conferences and journals, such as NeurIPS, ICRA, L4DC, RA-L
- **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 experimentally with a quadrotor
- **École Polytechnique Fédérale de Lausanne (EPFL), Learning Algorithms and Systems Lab [🌐]** *Sep. 2022 - Jan. 2023*
  Research Internship, Advisor: Prof. Aude Billard Munich, Germany
  - Designed and implemented Gaussian process models for probabilistic learning of object flying dynamics
  - Calculated of reliable robot throwing configurations using uncertainty propagation methods
- **Technical University of Munich (TUM), Chair of Information-Oriented Control [🌐]** *Oct. 2021 - Aug. 2022*
  Semester Project, Advisor: Prof. Sandra Hirche Munich, Germany
  - Developed of a framework for uncertainty-aware visual perception using probabilistic semantic segmentation with deep ensembles and safe motion planning using a scenario chance-constrained RRT* algorithm
  - Experimentally validated with a KUKA iiwa manipulator to demonstrate safe operation
- **Technical University of Munich (TUM), Chair of Information-Oriented Control [🌐]** *Oct. 2021 - Feb. 2022*
  Research Assistant Munich, Germany
  - Implemented distributed Bayesian online learning algorithms for cooperative robot manipulation
  - Experimentally validated on two KUKA iiwa manipulators
- **Bosch Research [🌐]** *Apr. 2021 - Sep. 2021*
  Research Internship, Advisors: Dr. Thomas Specker, Dr. Felix Berkel Renningen, Germany
  - Developed a software toolbox for set-based robust optimal control with safety guarantees
  - Presented the toolbox to autonomous driving teams who subsequently adopted it
- **Fraunhofer IISB [🌐]** *Oct. 2017 - Oct. 2019*
  Working Student Erlangen, Germany
  - Development, PCB-design and assembly of electronic speed controllers for BLDC motors
  - Testing and deployment in an autonomous vertical take-off and landing drone (Project Evolonic)

Education

- **Technical University of Munich (TUM)** *Oct. 2021 - Oct. 2023*
  M.Sc., Electrical Engineering and Information Technology 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
  - Semester Project: "Uncertainty-Aware Visual Perception for Safe Motion Planning", advised by Prof. Sandra Hirche
- **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 and physics

[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, T=THESIS

[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*, 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*, 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%), in *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 (), in *AI.BAY - Bavarian International Conference on AI*, 2023.

[T.1] **R. Römer**, "The Role of Control Frequency for the Stability and Closed-Loop Performance of Uncertain Systems", Master Thesis, Technical University of Munich, 2023. [pdf]

[T.2] **R. Römer**, "Control Perspective on Catching Objects in Flight with a Robotic Manipulator", Bachelor Thesis (in German), Friedrich-Alexander University Erlangen-Nuremberg, 2020. [pdf]

SKILLS

- **Programming:** Python, C/C++, MATLAB/Simulink, Java, Git
- **Deep Learning:** PyTorch, TensorFlow, OpenCV, SciPy
- **Robotics:** ROS2, MuJoCo, Gymnasium, LeRobot

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€
- **Gifted Student Development Program** *2019*
  Faculty of Engineering, Friedrich Alexander University Erlangen-Nuremberg (FAU)
  ◦ Mentoring program for especially gifted students, my mentor: 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 6 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 decision-making with University of Technology Nuremberg and KIT.
- **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, L-CSS, ACC