

Tolga-Can Çallar

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Short Biography

Tolga-Can Çallar has been a research associate and doctoral candidate at the Institute of Robotics and Cognitive Systems since 2022, supervised by Prof. Floris Ernst. He completed his M.Sc. in Medical Engineering Science at the Universität zu Lübeck in 2021. His research focuses on trajectory planning and motion control using proprioceptive and image-based models for medical robotics. A particular emphasis lies on the development of autonomous methods for robot-assisted ultrasound imaging.

Current Position

Research Associate and Doctoral Candidate Institute of Robotics and Cognitive Systems, Universität zu Lübeck	2022 – present
• Research on trajectory planning and motion control based on proprioceptive and image-based models for medical robotics • Focus: autonomous robot-assisted ultrasound imaging • Contribution to teaching, including exercises, project supervision, and practical course supervision in medical robotics • Doctoral thesis topic: Development of a force-sensitive assistance system for automated ultrasound imaging • Supervisor: Prof. Dr. Floris Ernst	

Education

M.Sc. Medical Engineering Science, Universität zu Lübeck	Oct. 2018 – Dec. 2021
• Thesis topic: Autonomous force-sensitive motion control for robotic applications in medicine • Thesis supervisor: Prof. Dr. Elmar Rückert	
B.Sc. Medical Engineering Science, Universität zu Lübeck	Oct. 2015 – Nov. 2018
• Thesis topic: Development of a simulation system for the exploration of suitable kinematics for robot-assisted ultrasound imaging • Thesis supervisor: Prof. Dr. Elmar Rückert	
Abitur, Leibniz-Gymnasium Bad Schwartau	June 2006 – June 2015

Research Projects

ConSensUS – Contextual Sensing in Robotic Ultrasound Imaging Institute of Robotics and Cognitive Systems, Universität zu Lübeck	2025 – present
• Development of a multimodal sensing concept for context-dependent acquisition of robotic ultrasound data • Fusion of visual, spatial, and haptic information for robust perception and control • Objective: improvement of autonomy, adaptivity, and clinical applicability of robotic ultrasound systems	
Modeling and Control of Remote Center of Motion (RCM) Mechanisms Institute of Robotics and Cognitive Systems, Universität zu Lübeck	2022 – present
• Analysis and implementation of RCM constraints for medical robotic systems • Development of kinematic and control-based approaches for precise compliance with virtual pivot points • Integration into trajectory planning and motion control methods for minimally invasive applications	
Simulation of Ultrasound Imaging Using Surface-Based Ray Tracing Institute of Robotics and Cognitive Systems, Universität zu Lübeck	2023 – 2025
• Development of a physics-based simulation environment for robot-assisted ultrasound imaging using surface-based ray-tracing methods • Automated estimation of acoustic material parameters from CT data by mapping Hounsfield units to acoustic properties, such as speed of sound and density • Integration into planning and control frameworks for realistic generation and evaluation of ultrasound signals	
Development of a Force-Sensitive Assistance System for Automated Ultrasound Imaging Institute of Robotics and Cognitive Systems, Universität zu Lübeck	Jan. 2022 – present
• Design and implementation of a force-sensitive assistance system for stable and adaptive guidance of ultrasound probes • Integration of proprioceptive and image-based information for robust control of probe contact • Evaluation of the system with regard to reproducibility, stability, and clinical applicability	

Autonomous Force-Sensitive Motion Control for Robotic Applications in Medicine Institute of Robotics and Cognitive Systems, Universität zu Lübeck • Identification of dynamic models and image-guided generation of motion patterns for serial robots using machine learning methods	Apr. 2020 – Oct. 2021
Body Pose Registration from Depth Images Institute of Robotics and Cognitive Systems, Universität zu Lübeck • Generation of body surface models using 3D cameras • Elastic point-cloud registration with generic patient models • Spatial localization of target regions for robot-assisted medical applications	Oct. 2019 – Mar. 2020
Simulation of Optimal Rotational Velocities for Flywheel-Based Inverted Pendulums Institute of Medical Electrical Engineering, Universität zu Lübeck • Physical modeling and simulation of a flywheel-based inverted pendulum • Implementation of a learning algorithm for adaptive control of the optimal flywheel velocity	Oct. 2018 – Feb. 2019
Radiation Protection Course Institute of Biology, Universität zu Lübeck • Conducted experiments and laboratory work with radioactive materials	Feb. 2018 – Mar. 2018

Publications and Research Outputs

Scientific Publications

- [1] T.-C. Çallar, R. Golwalkar, and F. Ernst, "Consensus: Contextual sensing in robotic ultrasound imaging using visual, spatial, and haptic data", in 1st German Robotics Conference, March 13–15, 2025, Nuremberg, Germany, Mar. 2025.
- [2] T.-C. Çallar and S. Böttger, "Hybrid learning of time-series inverse dynamics models for locally isotropic robot motion", IEEE Robotics and Automation Letters, 2022. DOI: [10.1109/LRA.2022.3222951](https://doi.org/10.1109/LRA.2022.3222951).
- [3] T.-C. Çallar, "Learning of inverse dynamics for proprioceptive force estimation during irregular fine-scale robot motion", Masterarbeit, Montanuniversität Leoben, 2021. [Online]. Available: <https://cps.unileoben.ac.at/tolga-can-callar-learning-of-inverse-dynamics-for-proprioeptive-force-estimation-during-irregular-fine-scale-robot-motion/>.
- [4] T.-C. Çallar, S. Böttger, and E. Rueckert, "Generation of 3d body models from single-view range images for robotic applications in medicine", in Student Conference Proceedings Universität zu Lübeck, 2020.
- [5] T.-C. Çallar, E. Rueckert, and S. Böttger, "Efficient body registration using single-view range imaging and generic shape templates", Current Directions in Biomedical Engineering, vol. 6, no. 3, pp. 119–122, 2020. DOI: [10.1515/cdbme-2020-3031](https://doi.org/10.1515/cdbme-2020-3031).
- [6] S. Böttger, T.-C. Çallar, A. Schweikard, and E. Rueckert, "Medical robotics simulation framework for application-specific optimal kinematics", Current Directions in Biomedical Engineering, vol. 5, no. 1, pp. 145–148, 2019. DOI: [10.1515/cdbme-2019-0037](https://doi.org/10.1515/cdbme-2019-0037).
- [7] T.-C. Çallar, "Entwicklung eines simulationssystems zur exploration geeigneter kinematiken für die robotisierte ultraschall-bildgebung", Bachelorarbeit, Universität zu Lübeck, 2018. [Online]. Available: https://ailab.science/wp/theses/Callar_BscThesis_2018.pdf.

Software and Datasets

- [8] T.-C. Çallar, Limodyn, Software, Repository. Begleitende Software zu: Hybrid Learning of Time-Series Inverse Dynamics Models for Locally Isotropic Robot Motion, 2023. [Online]. Available: <https://gitlab.rob.uni-luebeck.de/callar/limodyn>.
- [9] T.-C. Çallar, Propriozeptiver langfristiger zeitreihendatensatz für inversdynamikmodellierung bei lokal isotroper roboterbewegung, Datensatz, Multimodaler Datensatz zur Modellierung, Validierung und zum Benchmarking datengetriebener Inversdynamikmodelle, 2023. [Online]. Available: <https://gitlab.rob.uni-luebeck.de/callar/limodyn>.

Supervised Theses & Internships

Master's Theses

- [10] S. Bhadani, "Position dependent friction identification of a 6-dof robotic manipulator", Betreuung: Tolga-Can Çallar; Erstbetreuung: Prof. Dr. Floris Ernst, Masterarbeit, Universität zu Lübeck, 2026.

Bachelor's Theses

- [11] H. Ünal, "Variable stiffness actuator for contact force control in robotic ultrasound imaging", Betreuung: Tolga-Can Çallar, M.Sc.; Erstbetreuung: Prof. Dr. Floris Ernst, Bachelorarbeit, Universität zu Lübeck, 2025.
- [12] C. Kaluza, "Design of a remote center of motion manipulator attachment for robotic ultrasound imaging", Betreuung: Tolga-Can Çallar; Erstbetreuung: Prof. Dr. Floris Ernst, Bachelorarbeit, Universität zu Lübeck, 2024.

Internships

- [13] S. Bhadani, "Position-dependent friction identification of a 6-dof robotic manipulator", Masterpraktikum, Universität zu Lübeck; Betreuung: Tolga-Can Çallar; Erstbetreuung: Prof. Dr. Floris Ernst, 2025.
- [14] L. M. Gonzalez Villa, "Simulation framework for a collision avoidance inverse kinematics model of a 7 degrees of freedom ultrasound imaging robot", Masterpraktikum, Universität zu Lübeck; Betreuung: Tolga-Can Çallar; Erstbetreuung: Prof. Dr. Floris Ernst, 2025.
- [15] C. Patel, "Development of a kinematic structure for ultrasound guided cannula placement", Masterpraktikum, Technische Hochschule Lübeck; Betreuung: Tolga-Can Çallar; Erstbetreuung: Prof. Dr. Floris Ernst, 2025.

[16] M. Patel, "Development of a remote center of motion manipulator attachment for robotic ultrasound imaging", Masterpraktikum, Betreuung: Tolga-Can Çallar; Erstbetreuung: Prof. Dr. Floris Ernst, 2025.

Seminar Projects

[17] A. Lascano, "Variable stiffness actuators for robotic applications in medicine", Masterseminararbeit, Universität zu Lübeck; Betreuung: Tolga-Can Çallar, 2026.

[18] F. Urbini, "Learning-based approaches to inverse kinematics for serial manipulators", Masterseminararbeit, Universität zu Lübeck; Betreuung: Tolga-Can Çallar, 2026.

[19] J. Brauer, "Collision-avoidant inverse kinematics for robotic arms in a clinical setting", Bachelorseminararbeit, Universität zu Lübeck; Betreuung: Tolga-Can Çallar, 2024.

[20] A. Kabour, "Real-time simulation of ultrasound images", Masterseminararbeit, Universität zu Lübeck; Betreuung: Tolga-Can Çallar, 2024.

[21] L. Martensen, "Model learning for physical human-robot interactions", Masterseminararbeit, Universität zu Lübeck; Betreuung: Tolga-Can Çallar, 2024.

[22] K. Ahmi, "Path planning for robotic arms in clinical settings", Bachelorseminararbeit, Universität zu Lübeck; Betreuung: Tolga-Can Çallar, 2023.

Teaching and Academic Engagement

Medical Robotics	2022 – 2026
Master’s module, Prof. Dr. Achim Schweikard, Prof. Dr. Floris Ernst	
• Contribution to teaching in the fields of medical robotics and control engineering	
• Supervision of exercises and project work, including programming, robotics, and simulation	
• Support in the conception and implementation of courses	
Learning Inverse Dynamics Models	2023 – 2025
Annual guest lecture, Master’s module Advanced Topics in Robotics, Prof. Dr. Ngoc Thinh Nguyen	
• Teaching learning-based approaches for modeling inverse dynamics of robotic systems	
Head of the Student Community	2022 – 2024
Organization of monthly lecture series for student research projects	
• Conceptualization and coordination of a regular lecture series for presenting current student research work	
• Promotion of scientific exchange and interdisciplinary networking between students and researchers	
• Organization, moderation, and content-related support of the events	

Memberships

- IEEE Member
- IEEE Robotics and Automation Society
- Technical Committee, German Society for Biomedical Engineering
- Member, Commission for the Ethics of Security-Relevant Research (KEsF), Universität zu Lübeck

Reviewer for Conferences & Journals

- Humanoids 2023 (Austin, USA) (1 Review), ICRA 2024 (Yokohama, Japan) (1 Review), ICRA 2025 (Atlanta, USA) (1 Review), IROS 2025 (Hangzhou, China) (1 Review), ICRA 2026 (Vienna, Austria) (1 Review), IROS 2026 (Pittsburgh, USA) (2 Reviews), IROS 2027 (Florence, Italy) (1 Review), IEEE RA-L (3 Reviews)

Skills

Technical Skills

Programming Languages: C++, Python, Java, Lua	Robotics & Simulation: ROS, MoveIt, CoppeliaSim, Gazebo, Isaac Sim
Control Methods: Impedance control, admittance control, visual servoing, MPC, trajectory planning	Medical Imaging: 3D Slicer, PLUS Toolkit, DICOM, HL7, ultrasound processing
Machine Learning: Deep learning, time-series models, system identification, PyTorch, TensorFlow	Physics-Based Simulation: Ray tracing, ultrasound simulation, contact modeling
Perception & Computer Vision: OpenCV, RGB-D processing, point-cloud processing, registration	Data Processing: NumPy, SciPy, Pandas, Matplotlib
Optimization: Nonlinear optimization, gradient-based methods, trajectory optimization	Systems & Infrastructure: Linux, Docker, Git, SSH, HPC/parallelization

Languages

German (native), English (fluent, LCCI Level 3), Turkish (native), Latin (advanced Latin certificate), Spanish (basic knowledge)