

Sven Lilge

Curriculum Vitae

University of Toronto Robotics Institute
Toronto, Ontario, Canada

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Professional Experience

- from 09/23 **Postdoctoral Fellow**, *Autonomous Space Robotics Laboratory*, University of Toronto, Canada
- 05/19 – 08/23 **Research Assistant**, *Continuum Robotics Laboratory*, University of Toronto Mississauga, Canada
- 08/18 **Visiting Graduate Student**, *REACH Laboratory*, University of Tennessee Knoxville, United States
- 02/17 – 04/19 **Research Assistant**, *Laboratory for Continuum Robotics*, Leibniz University Hannover, Germany
- 11/15 – 02/16 **Internship**, *WABCO Vehicle Control Systems*, Hanover, Germany
- 01/13 – 09/16 **Student Assistant**, *Institute of Electrical Engineering and Measurement Technology*, Leibniz University Hannover, Germany
- 10/12 – 12/12 **Student Assistant**, *Institute of Microelectronic Systems*, Leibniz University Hannover, Germany
- 08/11 – 09/11 **Internship**, *J. Helmke & Co.*, Hanover, Germany

Education

- 05/19 – 08/23 **Doctor of Philosophy**, *University of Toronto*, Canada
Computer Science
Thesis: Tendon-Driven Parallel Continuum Robots: Modeling, Characterization and State Estimation
- 10/14 – 11/16 **Master of Science**, *Leibniz University Hannover*, Germany
Electrical Engineering and Information Technology, Specialization: Automation Engineering, Graduation with distinction
Thesis: Conception and Implementation of a System for Obstacle Avoidance in Pedestrian Navigation with Electrical Muscle Stimulation
- 10/11 – 12/14 **Bachelor of Science**, *Leibniz University Hannover*, Germany
Electrical Engineering and Information Technology, Specialization: Microelectronics
Thesis: Conception and Implementation of a Hardware-interface for Real-time Visualization of Audio-analysis Results

Publications

Journal Articles

- [1] S. Lilge and J. Burgner-Kahrs. Kinetostatic modeling of tendon-driven parallel continuum robots. *IEEE Transactions on Robotics*, 39(2):1563–1579, 2023.
- [2] S. Lilge, T. D. Barfoot, and J. Burgner-Kahrs. Continuum robot state estimation using gaussian process regression on $SE(3)$. *The International Journal of Robotics Research*, 41(13-14):1099–1120, 2022.
- [3] S. Lilge, K. Wen, and J. Burgner-Kahrs. Singularity analysis of 3-dof planar parallel

continuum robots with constant curvature links. *Frontiers in Robotics and AI*, 9, 2022.

- [4] S. **Lilge**, K. Nuelle, G. Boettcher, S. Spindeldreier, and J. Burgner-Kahrs. Tendon Actuated Continuous Structures in Planar Parallel Robots: A Kinematic Analysis. *Journal of Mechanisms and Robotics*, 13(1):011025, 2021.
- [5] G. Böttcher, S. **Lilge**, and J. Burgner-Kahrs. Design of a reconfigurable parallel continuum robot with tendon-actuated kinematic chains. *IEEE Robotics and Automation Letters*, 6(2):1272–1279, 2021.
- [6] K. Nuelle, T. Sterneck, S. **Lilge**, D. Xiong, J. Burgner-Kahrs, and T. Ortmaier. Modeling, calibration, and evaluation of a tendon-actuated planar parallel continuum robot. *IEEE Robotics and Automation Letters*, 5(4):5811–5818, 2020.
- [7] M. T. Chikhaoui, S. **Lilge**, S. Kleinschmidt, and J. Burgner-Kahrs. Comparison of modeling approaches for a tendon actuated continuum robot with three extensible segments. *IEEE Robotics and Automation Letters*, 4(2):989–996, 2019.
- [8] P. Rao, Q. Peyron, S. **Lilge**, and J. Burgner-Kahrs. How to model tendon-driven continuum robots and benchmark modelling performance. *Frontiers in Robotics and AI*, 7:223, 2021.
- [9] H. Donat, S. **Lilge**, J. Burgner-Kahrs, and J. J. Steil. Estimating tip contact forces for concentric tube continuum robots based on backbone deflection. *IEEE Transactions on Medical Robotics and Bionics*, 2(4):619–630, 2020.
- [10] D. Black, S. **Lilge**, C. Fellmann, A. V. Reinschluessel, L. Kreuer, A. Nabavi, H. K. Hahn, R. Kikinis, and J. Burgner-Kahrs. Auditory display for telerobotic transnasal surgery using a continuum robot. *Journal of Medical Robotics Research*, 4(02):1950004, 2019.

Peer-Reviewed Conference Publications

- [11] S. **Lilge**, D. Black, A. Nabavi, and J. Burgner-Kahrs. Comparison of Haptic and Auditory Feedback Methods for the Teleoperation of Concentric Tube Continuum Robots. *Proceedings of the 17th Annual Meeting of the German Society for Computer- and Robot-Assisted Surgery e.V.*, 2018.
- [12] L. Kreuer, S. **Lilge**, and J. Burgner-Kahrs. Entwicklung von Kontrollalgorithmen für die Teleoperation von tubulären Kontinuumsrobotern. *Proceedings of the 16th Annual Meeting of the German Society for Computer- and Robot-Assisted Surgery e.V.*, 2017.
- [13] N. Liang, R. M. Grassmann, S. **Lilge**, and J. Burgner-Kahrs. Learning-Based Inverse Kinematics from Shape as Input for Concentric Tube Continuum Robots. *IEEE International Conference on Robotics and Automation*, 2021.
- [14] H. J. Zhang, S. **Lilge**, M. T. Chikhaoui, and J. Burgner-Kahrs. Cooperative Control of Dual-Arm Concentric Tube Continuum Robots. *International Conference on Manipulation, Automation and Robotics at Small Scales*, 2022.

Workshop Publications

- [15] S. **Lilge**, and J. Burgner-Kahrs. Derivation and Evaluation of a Kinetostatic Modeling Approach for Spatial Tendon Driven Parallel Continuum Robots. *Parallel Robots or not Parallel Robots? New Frontiers of Parallel Robotics Workshop at IEEE International Conference on Robotics and Automation*, 2022.

- [16] S. **Lilge**, and J. Burgner-Kahrs. Design, Modeling and Evaluation of Tendon Driven Parallel Continuum Robots. *Parallel Robots or not Parallel Robots? New Frontiers of Parallel Robotics Workshop at IEEE International Conference on Robotics and Automation*, 2021.
- [17] S. **Lilge**, and J. Burgner-Kahrs. Enforcing Shape Constraints during Motion of Concentric Tube Continuum Robots. *Open Challenges and State-of-the-Art in Control System Design and Technology Development for Surgical Robotic Systems Workshop at IEEE International Conference on Robotics and Automation*, 2019.
- [18] H. Donat, S. **Lilge**, J. Burgner-Kahrs, and J. J. Steil. Towards Learning Force Sensing for a Concentric Tube Continuum Robot. *Open Challenges and State-of-the-Art in Control System Design and Technology Development for Surgical Robotic Systems Workshop at IEEE International Conference on Robotics and Automation*, 2019.
- [19] R. M. Grassmann, S. **Lilge**, P. Le, and J. Burgner-Kahrs. CTCR Prototype Development: An Obstacle in the Research Community? *Robotics Retrospective Workshop at Robotics: Science and Systems Conference*, 2020.

Manuscripts In Review

- [20] S. **Lilge**, K. Nuelle, J. Childs, K. Wen, D. C. Rucker, and J. Burgner-Kahrs. Parallel Continuum Robots: A Survey. *IEEE Transactions on Robotics*, Revision Under Review.

Talks and Presentations

Invited Talks

- 08/23 *Continuum Robot State Estimation Using Gaussian Process Regression on SE(3)*, Department of Mechanical Engineering, McGill University, Canada
- 11/20, 03/22 & 04/23 *Lie Theory in Robotics*, Invited Guest Lecturer, Computer Science Course MAT305H5S: Elementary Lie Theory, University of Toronto Mississauga, Canada
- 03/23 *Continuum Robot State Estimation Using Gaussian Process Regression on SE(3)*, Toronto AI Robotics Seminar, University of Toronto, Canada
- 05/22 *Tendon-Driven Parallel Continuum Robots*, Toronto AI Robotics Seminar, University of Toronto, Canada
- 03/22 *Mathematical and Computational Modeling of Continuum Robots*, Invited Guest Lecturer, Student Robotics Club, University of Toronto Mississauga, Canada
- 09/18 *Human Computer Interaction in Continuum Robotics*, Human Computer Interaction Workshop at 17th Annual Meeting of the German Society for Computer- and Robot-Assisted Surgery e.V., Leipzig, Germany

Other Presentations

- 05/22 *Tendon-Driven Parallel Continuum Robots*, Graduate Research Colloquium, University of Toronto Mississauga

Awards

- 05/22 **Graduate Student Conference Grant**, *School of Graduate Studies, University of Toronto*
- 11/22 **3 Minute Thesis Competition Winner**, *Robotics Institute University of Toronto*, Parallel Continuum Robots: Collaboration in Confined Spaces
- 07/22 **Best Robotics Paper Award Finalist**, *International Conference on Manipulation, Automation and Robotics at Small Scales*, Cooperative Control of Dual-Arm Concentric Tube Continuum Robots

- 05/22 **Graduate Student Travel Grant**, *Department of Mathematical and Computational Sciences, University of Toronto Mississauga*
- 09/18 **Best Paper Award, 2nd Place**, *17th Annual Meeting of the German Society for Computer- and Robot-Assisted Surgery e.V.*, Comparison of Haptic and Auditory Feedback Methods for the Teleoperation of Concentric Tube Continuum Robots
- 09/18 **Travel Scholarship**, *17th Annual Meeting of the German Society for Computer- and Robot-Assisted Surgery e.V.*, Top 30% of the paper rankings
- 12/17 **Third best graduate M. Sc. Electrical Engineering**, *Leibniz University Hannover*
- 10/15 – 09/16 **Deutschlandstipendium**, *Leibniz University Hannover*
The Deutschlandstipendium supports highly talented students at universities in Germany. Selection criteria include academic achievement, social commitment and personal achievements. Across Germany, 24,276 students received this scholarship in 2015.
- 12/15 **Third best graduate B. Sc. Electrical Engineering**, *Leibniz University Hannover*
- 10/14 – 03/15 **Lower Saxony Scholarship**, *Leibniz University Hannover*
The Lower Saxony Scholarship is awarded to students with outstanding academic achievements at universities in Lower Saxony, Germany.
- 10/11 – 09/12 **Faculty internal scholarship**, *Leibniz University Hannover*
This scholarship was awarded by the Faculty of Electrical Engineering and Computer Science to the most competitive first-year students in terms of personal and academic achievements.

Teaching

Courses

- Fall 2022 **Fundamentals of Robotics**, *University of Toronto Mississauga*
Head TA, designing course material and assignments, tutoring and supervising students in a practical exercise, grading, design and delivery of selected lectures
- Fall 2021 **Fundamentals of Robotics**, *University of Toronto Mississauga*
Head TA, designing course material and assignments, tutoring and supervising students in a practical exercise, grading, design and delivery of selected lectures
- Winter 2021 **Introduction to Continuum Robotics**, *University of Toronto Mississauga*
Head TA, designing course material and assignments, tutoring and supervising students in a practical exercise, grading, design and delivery of selected lectures
- Fall 2020 **Fundamentals of Robotics**, *University of Toronto Mississauga*
Head TA, designing course material and assignments, tutoring and supervising students in a practical exercise, grading, design and delivery of selected lectures
- Fall 2019 **Fundamentals of Robotics**, *University of Toronto Mississauga*
Head TA, designing course material and assignments, tutoring and supervising students in a practical exercise, grading, design and delivery of selected lectures
- Fall 2017/ **Continuum Robotics**, *Leibniz University Hannover*
- Winter 2018 Tutoring and supervising students in a practical exercise
- Fall 2017/ **Journalclub Continuum Robotics**, *Leibniz University Hannover*
- Winter 2018 Tutoring and supervising students
- 2013 – 2016 **Electrical Engineering Laboratory**, *Leibniz University Hannover*
Tutoring, supervising and examining students in the conduction of electrical engineering laboratory experiments
- Fall 2012 **First Semester Project: Circuit Engineering**, *Leibniz University Hannover*
Tutoring and supervising students during a circuit engineering project

Student Mentoring

Mentoring students in their individual research projects and theses: Conceptualizing research projects, holding weekly meetings, supervising and advising in research and writing.

Leibniz University Hannover, Germany

Simon Kleinschmidt (M.Sc. Mechanical Engineering), Xueyang Zhang (M.Sc. Electrical Engineering), Anton Sauer (M.Sc. Mechanical Engineering), Georg Böttcher (M.Sc. Mechatronics), Wenkang Yang (B.Sc. Mechatronics)

University of Toronto, Canada

Hanna Zhang (B.Sc. Engineering Science), Michael Shanks-Marshall (B.Sc. Engineering Science), Jiajie Xu (B.Sc. Electrical Engineering), Syeda Sani-e Zehra (B.Sc. Computer Science), Kyrel Jerome (B.Sc. Computer Science), Paul Zhang (B.Sc. Computer Science), Travis Shao (B.Sc. Computer Science), Spencer Teetaert (B.Sc. Engineering Science)

Grant Writing Experiences

2022 **CFI (Canada Foundation for Innovation) John R. Evans Leaders Fund**

PI: Jessica Burgner-Kahrs

Project #42138

Collaborating Continuum Robots

2022-2025

400,000 CAD

Assisted in grant writing by helping with the conceptualization of the research questions and project, writing the state-of-the-art section and drafting the methodology section.

2019 **CNRS - UofT Joint Research Programme**

PI: Jessica Burgner-Kahrs (UofT), M. Taha Chikahoui (CNRS)

Dual-arm Continuum Robots for Single-port Interventions

2019 (12 months)

7,000 CAD (Uoft) plus 4,800 Euro (CNRS)

Assisted in grant writing by helping with the conceptualization of the research questions and project, writing the state-of-the-art section and drafting the methodology section.

Professional Development

07/23 **RSS Pioneers 2023 Workshop**, *Scientific Workshop*, Daegu, South Korea

Offered to the world's top early-career researchers, 22% acceptance rate (30/135)

05/22 - 07/23 **Robotics Leadership Program**, *Graduate Training Program*, University of Toronto, Canada

07/18 **Control of Surgical Robots (COSUR)**, *Summer School*, University of Verona, Italy

07/18 **Basics of Rhetoric for Research Assistants**, *Seminar*, Leibniz University Hannover, Germany

Service

Organization of Scientific Conferences

05/22 Co-Organization of the New Frontiers of Parallel Robotics Workshop with Dr. Sébastien Briot, Prof. Jessica Burgner-Kahrs, Prof. Marco Carricato and Prof. Giuseppe Loianno at the IEEE International Conference on Robotics and Automation, Philadelphia, US

10/17 Organization of the Poster Session at the 16th Annual Meeting of the German Society for Computer- and Robot-Assisted Surgery e.V., Hanover, Germany

University Service

- 03/23 Invited Q&A Panelist at the UTRAHacks 2023 Hackathon organized by the University of Toronto Robotics Association, University of Toronto
- 04/22 Interviewing Ukrainian Students for a Research Summer Program, Department of Computer Science, University of Toronto
- 03/22 Participant of Graduate Student Panel and Research Blitz, Computer Science Graduate Visit Week, University of Toronto
- 11/20 Assisting in Conducting the 3MT Competition of the Robotics Institute Fall Workshop, University of Toronto

Outreach

- 05/23 Organization and Conduction of a Robotics Event and Workshop for High School Students at the Robotics Institute, University of Toronto
- 04/23 Representation of the Robotics Institute of the University of Toronto at the Ontario Association for Mathematics Education Conference, Toronto, Canada
- 11/17 & 02/18 Organization and Conduction of Full-Day Robotics Events for High School Students at the Laboratory for Continuum Robotics, Leibniz University Hannover

Reviewer

IJRR, IEEE T-MECH, ASME JMR, Frontiers in Robotics and AI, IEEE T-RO, IEEE RA-L, IEEE L-CSS, IEEE IROS, IEEE ICRA

Member

IEEE Robotics and Automation Society (RAS) Student Member