Connor Holmes

PhD Candidate

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Research interests

I am broadly interested in bringing deep theoretical tools bear on practical problems in robotics, such as how to make algorithms that are safe, efficient, and versatile. To date, my research has focused on the application of convex relaxations to efficiently certify global optimality of problems in robotic state estimation.

Education

2021–present — **PhD. Aerospace Science and Engineering**, *University of Toronto*, Robotics Institute.

Collaborative Specialization in Robotics
Supervisor: Timothy D. Barfoot (Autonomous Space Robotics Laboratory)
Thesis: Convex Relaxations for Optimization Problems in Robotics.

2014–2016 — **MASc. Electrical and Computer Engineering**, *University of Toronto*.

Supervisor: Mireille Broucke (Systems Control Group)
Thesis: Patterned Linear Control Systems

2009–2014 — **BASc. Engineering Science**, *University of Toronto*.

Specialized in Electrical and Computer Engineering
Dean's Honour List, Engineering Business Certificate
Supervisor: Peter Lehn
Thesis: Dynamic State-Space Modeling of a New Class of Modular Multilevel Bidirectional DC/DC Converters for HVDC Applications

Professional Experience

2016–2021 — **Member of Technical Staff (Engineer)**, *MacDonald, Dettwiler and Associates*, Brampton, ON, Canada.

Performed Systems and Controls engineering tasks including control system (architecture and subsystem) design, requirements generation, system identification, control system tuning and stability analysis, simulation, and hardware testing.
Projects:

- Joint control system development for SPIDER Manipulator on OSAM-1 Mission.
- Early phase development for Commercial Robotic Servicing System and Robotic Refuelling System.
- Development of an automated control system tuning tool to maximize performance while adhering to stability and system requirements.

2012–2013 **Electrical Engineering Intern**, *Vale Canada*, Sudbury, ON, Canada.
Worked with programmable logic controllers (PLC) for industrial automation in smelter, mill, railway, and mining environments. Amended standards, guidelines and technical specifications. Designed and executed integration of system components into power generation stations.

Awards

2022–2023 Ontario Graduate Scholarship

2023 Robotics Leadership Award (Honourable Mention)

2023–2024 Ontario Graduate Scholarship

2014 Summer Studentship (Supervisor: Peter Lehn)

Professional Development

2021–present **Robotics Leadership Program**, *University of Toronto Robotics Institute*.
Participated in a series of professional communication and team-building workshops culminating in several outreach activities. Activities involved engagement with grade-school educators to encourage robotics-based learning and hosting classes of students at the Robotics Institute.

Publications

Pre-Prints and Reports

[P1] Connor Holmes, Frederike Dümbgen, and Timothy D. Barfoot. On Semidefinite Relaxations for Matrix-Weighted State-Estimation Problems in Robotics. *arXiv:2308.07275*, August 2023.

[P2] Frederike Dümbgen, Connor Holmes, Ben Agro, and Timothy D. Barfoot. Toward Globally Optimal State Estimation Using Automatically Tightened Semidefinite Relaxations. *arXiv:2308.05783*, August 2023.

[P3] Timothy D. Barfoot, Connor Holmes, and Frederike Dümbgen. Certifiably Optimal Rotation and Pose Estimation Based on the Cayley Map. *arXiv:2308.12418*, August 2023.

Peer-Reviewed

[R1] Connor Holmes and Timothy D. Barfoot. An Efficient Global Optimality Certificate for Landmark-Based SLAM. *IEEE Robot. Autom. Lett.*, 8(3):1539–1546, March 2023.

[R2] Frederike Dümbgen, Connor Holmes, and Timothy D. Barfoot. Safe and Smooth: Certified Continuous-Time Range-Only Localization. *IEEE Robotics and Automation Letters*, 8(2):1117–1124, February 2023.

[R3] Daniil Lisus, Connor Holmes, and Steven Waslander. Towards open world nerf-based slam. In *2023 20th Conference on Robots and Vision (CRV)*, pages 37–44. IEEE, 2023.

[R4] Connor Holmes. Practical Design Considerations for Performance and Robustness in the Face of Uncertain Flexible Dynamics in Space Manipulators. *Frontiers in Robotics and AI*, 8, 2021.

[R5] Connor Holmes, Andrew Allen, and Joseph Bakambu. A Challenge For Academia: Critical Technologies for the Future of On-Orbit Servicing, May 2019

[R6] Connor Holmes and Mireille E. Broucke. Pattern preserving pole placement and stabilization for linear systems. In *2016 American Control Conference (ACC)*, pages 5181–5186, July 2016.

[R7] Gregory J. Kish, Connor Holmes, and Peter W. Lehn. Dynamic modeling of modular multilevel DC/DC converters for HVDC systems. In *2014 IEEE 15th Workshop on Control and Modeling for Power Electronics (COMPEL)*, pages 1–7, June 2014.

Teaching Experience

Course Instructor

Fall 2023 **ROB310 – Mathematics for Robotics**, *University of Toronto*.
Created course content, delivered lectures, designed and administered homeworks and examinations.
Course Description: An introduction to the advanced mathematical concepts particularly relevant for robotics. The mathematical tools covered in this course are fundamental for understanding, analyzing, and designing robotics algorithms that solve tasks such as robot path planning, robot vision, robot control and robot learning. Topics included optimization techniques, signals and filtering, advanced probability theory, and numerical methods.

Teaching Assistant

Fall 2022 **ROB310 – Mathematics for Robotics**, *University of Toronto*.
Delivered lectures (2), marked assignments and exams.

Spring 2021 **ROB498 – Robotics Capstone**, *University of Toronto*.
Guided and assessed students' fourth year culminating design project.

Fall 2015 **ECE470 – Robotic Modeling and Control**, *University of Toronto*.
Guided laboratories, marked laboratory reports and examinations.

Spring 2015 **ECE311 – Dynamic Systems and Control**, *University of Toronto*.
Guided laboratories, marked laboratory reports.

Fall 2014 **MAT188 – Linear Algebra**, *University of Toronto*.
Guided laboratories, marked laboratory reports.

Service

Professional Service

Journal reviewer **IJRR**: International Journal of Robotics Research
T-RO: Transactions on Robotics
RA-L: Robotics and Automation Letters

Conference reviewer **ICRA**: IEEE International Conference on Robotics and Automation
IROS: IEEE/RSJ International Conference on Intelligent Robots and Systems

Community Outreach

Spring 2023 Attended OAME EmpowerMe Conference on behalf of University of Toronto Robotics Institute to establish connections between grade-school educators and the university and to promote the use of robotics as an educational tool in Ontario classrooms.

2021-present	Organized and executed several robotics-centric outreach events for middle and high-school students at the University of Toronto Robotics Institute.
2022	Attended the inaugural Symposium for the Canadian Robotics Council to discuss the future of robotics in Canada with fellow Canadian roboticists from industrial, academic and public spheres.

Languages

English	**Mothertongue**	
Portuguese (Brazilian)	**Advanced**	*Conversationally fluent*
French	**Basic**	*Basic words and phrases only*