Siqi Zhou

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Research Interests

The goal of my research is to develop the mathematical foundation and algorithmic tools that enable robots to safely and efficiently perform versatile tasks in dynamic and unstructured environments. My research interests include safe learning-based control for robotics, neural networks, control theory, and multiagent systems.

Education

Ph.D. in Aerospace Science and Engineering 09/2016 – 11/2022
Dynamic Systems Lab, Institute for Aerospace Studies, University of Toronto
Other affiliations: Vector Institute for Artificial Intelligence; University of Toronto Robotics Institute
Advisor: Prof. Angela P. Schoellig. Thesis title: "Neural networks for robot control". GPA: 4.0/4.0
Relevant Courses: Nonlinear System Control, State Estimation, Convex Optimization, Probabilistic Learning and Reasoning, CIFAR Deep Learning and Reinforcement Learning Summer School

B.A.Sc. in Engineering Science (with High Honours) 09/2011 – 06/2016
Division of Engineering Science, University of Toronto
Major in Aerospace Engineering, Minor in Robotics and Mechatronics
CGPA: 3.94/4.00
Relevant Courses: Mobile Robotics and Perception, Robot Modeling and Control, Linear System Control, Aircraft Design, Space System Design

Awards, Scholarships, and Recognitions

RSS Pioneers 06/2022
One of the 30 top graduate students selected to participate in the RSS Pioneers Workshop (35% acceptance rate)
Robotics: Science and Systems Conference

MIT Rising Stars in Aerospace 05/2021
One of the 35 top graduate students selected to participate in the MIT Rising Stars Workshop
Department of Aeronautics and Astronautics, Massachusetts Institute of Technology

Alexander Graham Bell Canada Graduate Scholarship ($105,000 CAD) 05/2018 – 05/2021
Full doctoral research support (ranked 6 out of 133 preselected applications in Computing Sciences)
Natural Sciences and Engineering Research Council of Canada

People's Choice Award in Three-Minute Thesis Competition 11/2020
Best presentation chosen by the attendees
University of Toronto Robotics Institute

Dean's Honour List (for every semester) 09/2011 – 06/2016
Full academic load with average of individual sessions above 80%
Faculty of Applied Science and Engineering, University of Toronto

The 2016 Award of Excellence 04/2016
CGPA of first 7 academic sessions above 3.90 (one of the 14 recipients out of 200 students)
Division of Engineering Science, University of Toronto

Undergraduate Student Research Award ($6,000 CAD) 05/2014 – 08/2014
Undergraduate research scholarship
Natural Sciences and Engineering Research Council of Canada

Undergraduate Student Research Award ($6,000 CAD) 05/2013 – 08/2013
Undergraduate research scholarship
Natural Sciences and Engineering Research Council of Canada

John Macara, Barrister of Goderich, Scholarship ($1,500 CAD) 09/2012
Scholarship in recognition of academic excellence
University of Toronto

External Awards ($750 CAD) 11/2011
Award in recognition of academic excellence
University of Toronto

Toronto and Area Road Builders Association Scholarship ($2,000 CAD) 10/2011
Scholarship in recognition of academic excellence
Department of Civil Engineering, University of Toronto

University of Toronto Scholar ($5,000 CAD) 09/2011
University entrance award
University of Toronto

Contributions

During my Ph.D. (since 09/2016), I have published 7 journal articles (4 as first author or co-first author) and 8 peer-reviewed conference papers (5 as first author or co-first author).

Journal Articles

[1] Z. Yuan, A. W. Hall, **S. Zhou**, L. Brunke, M. Greeff, J. Panerati, and A. P. Schoellig, "`safe-control-gym`: a unified benchmark suite for safe learning-based control and reinforcement learning," *IEEE Robotics and Automation Letters (RA-L)*, vol. 7, no. 4, pp. 11142-11149, 2022, doi: 10.1109/LRA.2022.3196132 [pdf]

[2] M. Greeff, **S. Zhou**, and A. P. Schoellig, "Fly out the window: exploiting discrete-time flatness for fast vision-based multirotor flight," *IEEE Robotics and Automation Letters (RA-L)*, vol. 7, no. 2, pp. 5023-5030, 2022, doi: 10.1109/LRA.2022.3154008. [pdf]

[3] **S. Zhou**, K. Pereida, W. Zhao, and A. P. Schoellig, "Bridging the model-reality gap with Lipschitz network adaptation," *IEEE Robotics and Automation Letters (RA-L)*, vol. 7, no. 1, pp. 642-649, 2022, doi: 10.1109/LRA.2021.3131698. [pdf]

[4] L. Brunke*, M. Greeff*, A. W. Hall*, Z. Yuan*, **S. Zhou***, J. Panerati, and A. P. Schoellig, "Safe learning in robotics: From learning-based control to safe reinforcement learning," *Annual Review of Control, Robotics, and Autonomous Systems*, vol. 5, no. 1, pp. 411-444, 2022, doi: 10.1146/annurev-control-042920-020211. *Equal contribution. [pdf]

[5] **S. Zhou**, M. K. Helwa, and A. P. Schoellig, "Deep neural networks as add-on modules for enhancing robot performance in impromptu trajectory tracking," *International Journal of Robotics Research (IJRR)*, vol. 39, no. 12, pp. 1397-1418, 2020, doi: 10.1177/0278364920953902. [pdf]

[6] M. J. Sorocky, **S. Zhou**, and A. P. Schoellig, "To share or not to share? Performance guarantees and the asymmetric nature of cross-robot experience transfer," *IEEE Control Systems Letters (L-CSS)*, vol. 5, no. 3, pp. 923-928, 2020, doi: 10.1109/LCSYS.2020.3005886. [pdf]

[7] **S. Zhou**, M. K. Helwa, and A. P. Schoellig, "An inversion-based learning approach for improving impromptu trajectory tracking of robots with non-minimum phase dynamics," *IEEE Robotics and Automation Letters (RA-L)*, vol. 3, no. 3, pp. 1663-1670, 2018, doi: 10.1109/LRA.2018.2801471. [pdf]

Conference Papers

[1] L. Brunke, **S. Zhou**, and A. P. Schoellig, "Robust predictive output-feedback safety filter for uncertain nonlinear control systems," in *Proc. of the IEEE Conference on Decision and Control (CDC)*, 2022, pp. 3051–3058, doi: 10.1109/CDC51059.2022.9992834. [pdf]

[2] L. Brunke*, **S. Zhou***, and A. P. Schoellig, "Barrier Bayesian linear regression: Online learning of control barrier conditions for safety-critical control of uncertain systems," in *Proc. of the Annual Learning for Dynamics and Control Conference*, 2022, pp. 168:881-892. *Equal contribution. [pdf]

[3] L. Brunke, **S. Zhou**, and A. P. Schoellig, "RLO-MPC: Robust learning-based output feedback MPC for improving the performance of uncertain systems in iterative tasks," in *Proc. of the IEEE Conference on Decision and Control (CDC)*, 2021, pp. 2183–2190, doi: 10.1109/CDC45484.2021.9682940. [pdf]

[4] J. Panerati, H. Zheng, **S. Zhou**, J. Xu, A. Prorok, and A. P. Schoellig, "Learning to fly: A Gym environment with PyBullet physics for reinforcement learning of multi-agent quadcopter control," in *Proc. of the IEEE International Conference on Intelligent Robots and Systems (IROS)*, 2021, pp. 7489–7496, doi: 10.1109/IROS51168.2021.9635857. [pdf]

[5] M. J. Sorocky*, **S. Zhou***, and A. P. Schoellig, "Experience selection using dynamics similarity for efficient multi-source transfer learning between robots," in *Proc. of the International Conference on Robotics and Automation (ICRA)*, 2020, pp. 2739–2745, doi: 10.1109/ICRA40945.2020.9196744. *Equal contribution. [pdf]

[6] **S. Zhou** and A. P. Schoellig, "Active training trajectory generation for inverse dynamics model learning with deep neural networks," in *Proc. of the IEEE Conference on Decision and Control (CDC)*, 2019, pp. 1784–1790, doi: 10.1109/CDC40024.2019.9029973. [pdf]

[7] **S. Zhou**, A. Sarabakha, E. Kayacan, M. K. Helwa, and A. P. Schoellig, "Knowledge transfer between robots with similar dynamics for high-accuracy impromptu trajectory tracking," in *Proc. of the European Control Conference (ECC)*, 2019, pp. 1-8, doi: 10.23919/ECC.2019.8796140. [pdf]

[8] **S. Zhou**, M. K. Helwa, and A. P. Schoellig, "Design of deep neural networks as add-on blocks for improving impromptu trajectory tracking," in *Proc. of the IEEE Conference on Decision and Control (CDC)*, 2017, pp. 5201-5207, doi: 10.1109/CDC.2017.8264430. [pdf]

Extended Abstracts

[1] **S. Zhou**, A. Sarabakha, E. Kayacan, M. K. Helwa, and A. P. Schoellig, "Knowledge transfer between robots with online learning for enhancing robot performance in impromptu trajectory tracking," in *Proc. of the IEEE International Conference on Robotics and Automation (ICRA) Resilient Robot Teams Workshop*, 2019. [pdf]

[2] **S. Zhou**, M. K. Helwa, and A. P. Schoellig, "Deep neural networks as add-on modules for high- accuracy impromptu trajectory tracking," in *Proc. of the Conference on Robot Learning (CoRL)*, 2017. [pdf]

[3] **S. Zhou**, "A comparison of probabilistic population code and sampling-based code in neural state estimations," in *Proc. of the Conference on Cognitive Computational Neuroscience (CCN)*, 2017. [pdf]

Other Contributions

[1] S. Michael, **S. Zhou***, and A. P. Schoellig, "Experience selection using dynamics similarity for efficient transfer learning between robots," *Vector Institute Research Symposium*, 2021. *Equal contribution.

[2] **S. Zhou** and A. P. Schoellig, "Deep neural networks for robot control," *UofT Robotics Institute 3MT Competition*, 2020. Received the *People's Choice Award*.

[3] ——, "Deep neural networks for robot control," *NSERC Canada Robotics Network Annual Meeting*, 2020.

[4] **S. Zhou**, A. Sarabakha, E. Kayacan, M. K. Helwa, and A. P. Schoellig, "Knowledge transfer between robots for high-accuracy impromptu trajectory tracking," *Vector Institute Research Symposium*, 2019.

[5] **S. Zhou** and A. P. Schoellig, "Learning inverse dynamics with neural networks for enhancing robot performance in impromptu trajectory tracking," *Pan-Can. Self-Organizing Conf. on Machine Learning*, 2019.

[6] **S. Zhou**, A. Sarabakha, E. Kayacan, M. K. Helwa, and A. P. Schoellig, "Transferring deep inverse models across robots for high-accuracy impromptu trajectory tracking," *Intl. Aerial Robotics Research Symp.*, 2019.

[7] **S. Zhou**, M. K. Helwa, and A. P. Schoellig, "High-accuracy impromptu trajectory tracking with deep neural networks," *CIFAR Deep Learning Reinforcement Learning (DLRL) Summer School*, 2018.

[8] ——, "High-accuracy impromptu trajectory tracking with deep neural networks," *International Aerial Robotics Research Symposium*, 2017.

[9] **S. Zhou**, B. A. Francis, and A. P. Schoellig, "Transformation between kinematic point and unicycle model for leader-follower formation problems," *Undergraduate Engineering Research Day (UnERD)*, 2014.

Invited Talks and Lectures

- **Vector Institute for Artificial Intelligence**, Toronto, Canada 06/2022
  Invited speaker at the Vector Institute Endless Summer School for Trustworthy AI. Title: "Integrating machine learning and control theory for safe and efficient robot decision making."
- **Vector Institute for Artificial Intelligence**, Toronto, Canada 04/2022
  Guest lecturer for the Safe Learning in Robotics Workshop. Title: "Reinforcement learning tutorial."
- **University of Toronto**, Toronto, Canada 03/2022
  Guest lecturer for "SCS3253: Machine Learning". Title: "Integrating machine learning and control theory for safe and efficient robot decision making."
- **University of Toronto Robotics Institute**, Toronto, Canada 02/2022
  Invited speaker at the Toronto AI in Robotics Seminar. Title: "Integrating machine learning and control theory for safe and efficient robot decision making."
- **Queen's University**, Kingston, Canada 02/2022
  Invited speaker at the ECE Department Research Seminar. Title: "Integrating machine learning and control theory for safe and efficient robot decision making."
- **Vector Institute for Artificial Intelligence**, Toronto, Canada 01/2022
  Invited speaker at the Vector Institute Talk Series. Title: "Integrating machine learning and control theory for safe and efficient robot decision making."
- **University of California San Diego**, San Diego, USA 11/2021
  Guest lecturer for "MAE207: Safety for Autonomous Systems" instructed by Prof. Sylvia Herbert. Title: "Safe learning in robotics: from learning-based control to safe reinforcement learning." Co-presenters: Angela Schoellig, Lukas Brunke, Melissa Greeff, Adam Hall, Jacopo Panerati, and Zhaocong Yuan.

- **International Conference on Intelligent Robots and Systems Workshop**, Prague, Czech Republic 09/2021
  Invited speaker at the workshop "Safe Real-World Robot Autonomy". Title: "Safe learning in robotics." Co-presenters: Angela Schoellig, Lukas Brunke, Melissa Greeff, Animesh Garg, and Somil Bansal.

Successful Funding Proposals

During my Ph.D., I contributed to the following grant proposals that supported different collaborative research projects in our lab. These grants were awarded by the University of Toronto and the Natural Sciences and Engineering Research Council of Canada (NSERC).

- **CARTE Seed Funding** ($120K), University of Toronto 2020 – 2022
  "Giving robots a sense of touch: safe, high-performance robot manipulation combining novel skin-like sensors with high-rate, learning-based feedback control." Principal Investigator: Prof. Angela Schoellig. Co-applicant: Prof. Xinyu Liu.
- **Collaborative Research and Development Grant** ($274K), NSERC 2019 – 2022
  "Networked drones for concrete structure, environmental, and radiation surveys." Principal Investigator: Prof. Angela Schoellig. Co-applicants: Prof. Doug Hooton, Prof. Karl Peterson, and Ontario Power Generation (OPG).
- **Research Tools and Instruments Grant** ($150K), NSERC 2018 – 2022
  "The University of Toronto Robotics Innovation Garage: a collaborative space for interdisciplinary research in mobile robotics." Principal Investigator: Prof. Angela Schoellig. Co-applicants: Prof. Kamran Esmaeili, Prof. Brenda McCabe, and Prof. Mireille Broucke.

Student Supervision

- Vivek Adajania, M.Eng. Project, Aerospace Engineering, University of Toronto 09/2021 – 05/2022
  Topic: "Adaptive virtual structure for multiagent formation flight through cluttered environments" Topic: "Multiagent reinforcement learning and transfer learning in robotics"
- Michael Sorocky, M.A.Sc. Thesis, Aerospace Engineering, University of Toronto 09/2018 – 10/2020
  Topic: "System similarity, performance guarantees, and asymmetry in transfer learning for robotics"
- James Xu, B.A.Sc. Summer Research, Engineering Science, University of Toronto 05/2020 – 09/2020
  Topic: "Motion composition for real-time multiagent music synchronization"
- Dhruv Sirohi, B.A.Sc. Summer Research, Engineering Science, University of Toronto 05/2020 – 09/2020
  Topic: "Hardware pipeline for synchronizing a swarm of quadrotors with real-time music"
- Hshmat Sahak, B.A.Sc. Summer Research, Engineering Science, University of Toronto 05/2020 – 09/2020
  Topic: "Music interpretor for coordinating robots based on human keyboard controller inputs"

Teaching Experience

Teaching Assistant, University of Toronto 09/2016 – Present

Robotics Courses

- **AER1517 Control for Robotics** (Spring 2020 and 2022)
  A graduate course introducing optimal control and reinforcement learning techniques for robot decision making. Enrollment: 23 students. This course was first offered in Spring 2020. My responsibilities included curriculum development, creating assignments, compiling course notes, developing a benchmark repository for course projects, and grading assignments. Instructor: Prof. Angela Schoellig.

- **AER1513 State Estimation for Aerospace Vehicles** (Fall 2018)
  A graduate course introducing practical state estimation techniques (e.g., unscented Kalman filtering and particle filtering). Enrollment: 43 students. My responsibilities included grading assignments as well as providing feedback on the course projects. Instructor: Prof. Steven Waslander.
- **ECE470 Robot Modeling and Control** (Fall 2017 and 2021)
  An EngSci/ECE technical elective course introducing modeling, planning and control techniques for robot manipulators. Enrollment: approximately 70 students. My responsibilities included teaching practical sessions and grading exams. Instructor: Prof. Mireille Broucke.
- **ROB310 Mathematics for Robotics** (Fall 2020 and 2021)
  An EngSci course introducing fundamental mathematics tools for robotics. Enrollment: between 50-70 students. My responsibilities included marking weekly assignments and exams, addressing questions from the students, and drafting exam questions. Instructors: Prof. Angela Schoellig and Prof. Tim Barfoot.

Control Courses

- **ECE1643 Stochastic Control, Safety Analysis, and Reinforcement Learning** (Spring 2021)
  A graduate course covering mathematical background and state-of-the-art literature on safety analysis and reinforcement learning for stochastic systems. Enrollment: 8 students. I was responsible for grading paper critiques and providing feedback on course project proposals. Instructor: Prof. Margaret Chapman.
- **ECE557 Linear Systems Control** (Fall 2018-2021)
  A graduate/undergraduate course on state-space linear control techniques. Enrollment: approximately 70 students. My responsibilities included teaching practical sessions, and grading lab reports and exams. Instructors: Prof. Manfredi Maggiore and Prof. Margaret Chapman.
- **AER372 Control Systems** (Spring 2018-2020)
  An EngSci introductory control course on frequency domain control design techniques. Enrollment: between 55-80 students. I was responsible for marking assignments and exams as well as drafting exam questions in a particular year. Instructors: Prof. Tim Barfoot, Prof. Hugh Liu, and Prof. Reza Emami.
- **ECE311 Introduction to Control Systems** (Spring 2019-2021)
  An ECE undergraduate course on frequency domain control design techniques. Enrollment: approximately 100 students. I was responsible for teaching practical sessions and grading exams. Instructors: Prof. Mireille Broucke and Prof. Manfredi Maggiore.

Other Courses

- **AER210 Vector Calculus and Fluid Mechanics** (Fall 2016)
  An EngSci course covering fundamentals of integral and vector calculus and providing an introduction to continuum fluid mechanics. Enrollment: approximately 200 students. I supervised approximately 100 students in flow visualization labs. Instructor: Prof. James Davis.
- **MAT290 Advanced Engineering Mathematics** (Fall 2016-2017)
  An ECE undergraduate course on complex analysis and ordinary differential equations. Enrollment: 320-360 students. I was responsible for grading weekly quizzes and exams. Instructor: Prof. Adrian Nachman.

Organizing Experience

- **RSS Pioneers Workshop** 01/2023 – 05/2023
  General chair of this workshop to be held at the 2023 Robotics: Science and Systems Conference (RSS). Co-organizers: George Kontoudis (Univ. of Maryland), Lilly Chin (MIT), Aaquib Tabrez (Univ. of Colorado Boulder), Anqi Li (Univ. of Washington), Oier Mees (Univ. of Freiburg), Fanta Camara (Univ. of Leeds), Andrew Morgan (Yale Univ.), Youngwoon Lee (USC), Nelson Rosa (Univ. of Stuttgart), et al.

- **IROS Safe Robot Learning Competition** 01/2022 – 10/2022
  Co-organizer of this competition to be held at the 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). Co-organizers: Prof. Angela Schoellig (UofT), Jacopo Panerati (UofT), Melissa Greeff (UofT), Prof. Davide Scaramuzza (UZH), Prof. Nicholas Roy (MIT), Prof. Vijay Kumar (UPenn), Prof. Todd Murphey (Northwestern Univ.), Prof. Sebastian Trimpe (RWTH Aachen Univ.), Prof. Mark Mueller (UCB), et al. [webpage]
- **ICRA Workshop on Releasing Robots into the Wild** 09/2021 – 05/2022
  Co-organizer of this workshop held at the 2022 IEEE International Conference on Robotics and Automation (ICRA). Co-organizers: Prof. Angela Schoellig (UofT), Prof. Davide Scaramuzza (UZH), Adam Hall (UofT), Zhaocong Yuan (UofT), Jacopo Panerati (UofT), Lukas Brunke (UofT), and Melissa Greeff (UofT). [webpage]
- **NeurIPS Workshop on Deployable Decision Making in Embodied Systems** 05/2021 – 12/2021
  Co-organizer of this workshop held at the 2021 Conference on Neural Information Processing Systems (NeruIPS). Co-organizers: Prof. Angela Schoellig (UofT), Prof. Animesh Garg (UofT), Prof. Somil Bansal (USC), Lukas Brunke (UofT), and Melissa Greeff (UofT). [webpage]
- **IROS Workshop on Safe Real-World Robot Autonomy** 03/2021 – 09/2021
  Co-organizer of this workshop held at the 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). Co-organizers: Prof. Angela Schoellig (UofT), Prof. Animesh Garg (UofT), Prof. Somil Bansal (USC), Lukas Brunke (UofT), and Melissa Greeff (UofT). [webpage]
- **RSS Robotics for People Workshop: Perspectives on Interaction, Learning and Safety** 02/2021 – 07/2021
  Co-organizer of this workshop held at the 2021 Robotics: Science and Systems Conference (RSS). Co-organizers: Prof. Matthew Gombolay (Georgia Tech), Shreyas Kousik (Stanford), Tesca Fitzgerald (CMU), Amir Aly (University of Plymouth), Kim Baraka (Vrije Universiteit Amsterdam), Filipa Correia (Univ. of Lisbon), Prof. Andrea Bajcsy (UCB), Prof. David Fridovich-Keil (UT Austin), Prof. Angela Schoellig (UofT), Nakul Gopalan (Georgia Tech), Ransalu Senanayake (Stanford), *et al.* [webpage]

Professional Activities

Invited Reviewer for Major Robotics and Control Venues 09/2016 – Present

IEEE Robotics and Automation Letters (RA-L), Neurocomputing, IEEE Conference on Decision and Control (CDC), IEEE International Conference on Intelligent Robots and Systems (IROS), IEEE/RSJ International Conference on Robotics and Automation (ICRA), EUCA European Control Conference (ECC), AACC/IFAC American Control Conference (ACC), and Learning for Dynamics and Control Conference (L4DC).

Institute Outreach Events 09/2016 – Present

I was involved in different institution-level outreach events. For instance, I have given research demonstrations to over 100 visitors, including researchers, industrial partners, and prospective students, in 14 different outreach events. I also supported the local arrangements of the Aerial Robotics International Research Symposium.

Lab Administrative Tasks 09/2016 – Present

During my Ph.D., I was responsible for several lab administrative tasks that included hardware management, regular equipment purchases, and assisting research grant applications.

Research Projects

Neural Networks for Robot Control, Ph.D. Thesis 09/2016 – Present

Advisor: Prof. Angela P. Schoellig

Dynamic Systems Lab, University of Toronto Institute for Aerospace Studies

In my Ph.D. research, I explored approaches that leveraged control theory and machine learning techniques for

efficiently enhancing the performance of robots. This included *(i)* deriving platform-independent guidelines for designing neural networks as add-on modules to safely enhance the tracking performance of robots, *(ii)* proposing an active training trajectory generation framework for sample efficient learning, *(iii)* introducing procedures for effectively transferring the learned experience across different robots, and *(iv)* developing a neural network adaptation approach to bridge the model-reality gap in uncertain robot systems. In addition to developing learning-based control techniques, with other colleagues, we completed a review paper on safe learning in robotics and proposed a benchmark suite for evaluating safe robot learning approaches.

Admissibility of Distributed Control Law, B.A.Sc. Thesis 09/2015 – 06/2016
Advisor: Prof. Angela P. Schoellig
Division of Engineering Science, University of Toronto

This B.A.Sc. thesis is an extension of the summer research project below, in which I studied an approach for transforming leader-follower distributed control law based on kinematic points to unicycle models, provided preliminary stability analysis, and experimentally verified the approach using a wheeled ground robot.

Admissibility of Distributed Control Law, Undergraduate Summer Research 05/2014 – 08/2014
Advisors: Prof. Angela P. Schoellig and Prof. Bruce A. Francis
Dynamic Systems Lab, University of Toronto Institute for Aerospace Studies

In this summer research, I analyzed the admissibility of applying distributed control laws to nonlinear nonholonomic robots and derived upper bounds of tracking error in a leader-follower formation problem.

Computational Fluid Dynamics, Undergraduate Summer Research 05/2013 – 08/2013
Advisor: Prof. David W. Zingg
Computational Aerodynamics Lab, University of Toronto Institute for Aerospace Studies

In this summer research, I explored a B-spline-based mesh movement algorithm for generating 3D computational meshes from 2-patch flat plates and analyzed the trade-off between accuracy and computational cost of using higher-order methods for solving 2D inviscid flow problems.

Course Projects

Neural State Estimation, Computational Neuroscience 01/2017 – 04/2017
Instructor: Prof. R. Zemel, Department of Computer Science, University of Toronto

In this project, I studied biologically plausible neural state estimators derived based on different probability representations (probabilistic population code and sampling-based code).

Nonlinear State Estimation for Robotics, State Estimation for Aerospace Vehicles 09/2016 – 12/2016
Instructor: Prof. T. Barfoot, Institute for Aerospace Studies, University of Toronto

In this project, I investigated the robustness and accuracy of three techniques for estimating the states of a ground robot based on range data (Particle Filter, Sigma-Point Kalman Filter, and Extended Kalman Filter).

Canada's Next Generation Robotics, Space Systems Design 09/2015 – 12/2015
Instructor: Prof. C. Damaren, Institute for Aerospace Studies, University of Toronto
The course is in coordination with MacDonald, Dettwiler and Associates (MDA).

This was a capstone project which, with four team members, we provided a conceptual design of a space manipulator for performing autonomous station reconfiguration, capture and berthing, and maintenance tasks.

Other Experience

Junior Project Coordinator, Rowan Williams Davies and Irwin Inc. 09/2014 – 08/2015
I carried out stack effect studies for seven high-rise buildings, supported the thermal comfort study for a master-planning project, and investigated turbulent flow solvers for building performance analysis.

Community Volunteers 05/2009 – Present

I volunteered at different local community events including being a special event photographer at community gatherings (South Burnaby Neighbourhood House), an assistant at a summer art camp (Burnaby Art Gallery), and a coach for junior post-school reading and running club (Kidsfest).

Skills

- **Programming Languages:** Python, Matlab, and C/C++
- **Frameworks:** Robot Operating System (ROS) and PyTorch
- **Operating Systems:** Linux, Windows, and macOS
- **Drafting:** AutoCAD
- **Graphic Design:** Adobe Photoshop and Adobe Illustrator
- **Computational Fluid Dynamics:** OpenFoam, Tecplot, and Paraview
- **Project Management:** Microsoft Project

Personal Information

- **Citizenship:** Canadian
- **Languages (written and spoken fluently):** English and Mandarin
- **Interests:** Chess, Badminton, and Photography

References

- **Prof. Angela P. Schoellig** | angela.schoellig@tum.de
  Alexander von Humboldt Professor, Technical University of Munich
  Faculty Member, Vector Institute and University of Toronto Robotics Institute
  Board of Directors, Munich Institute of Robotics and Machine Intelligence
- **Prof. Timothy D. Barfoot** | tim.barfoot@utoronto.ca
  Professor, University of Toronto Institute for Aerospace Studies
  Associate Director, University of Toronto Robotics Institute
- **Prof. Jonathan Kelly** | jonathan.kelly@robotics.utias.utoronto.ca
  Associate Professor, University of Toronto Institute for Aerospace Studies
  Faculty Affiliate, Vector Institute