

# Valentin Peretroukhin

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## Current Position

POSTDOCTORAL ASSOCIATE, Robust Robotics Group  
Computer Science & Artificial Intelligence Laboratory  
Massachusetts Institute of Technology

## Areas of Specialization

Deep Learning for State Estimation • Uncertainty Quantification • Visual-Inertial Navigation

## Education

- 2020 DOCTOR OF PHILOSOPHY  
*Learned Improvements to the Visual Egomotion Pipeline*  
University of Toronto  
Institute for Aerospace Studies, Direct Transfer from Masters of Applied Science (2014)  
Supervised by Professor Jonathan Kelly  
Advised by Tim Barfoot and Angela Schoellig (with external readers Animesh Garg, John Leonard)
- 2013 BACHELOR OF APPLIED SCIENCE IN ENGINEERING SCIENCE, Aerospace Major  
University of Toronto  
Senior Thesis: *Optimal Camera Perspective for Stereo Visual Odometry*  
Supervised by Professor Tim Barfoot

## Grants, Honours & Awards

- 2020 BEST STUDENT PAPER AWARD, ROBOTICS: SCIENCE AND SYSTEMS  
*Awarded to 'A Smooth Representation of  $SO(3)$  for Deep Rotation Learning with Uncertainty'*
- 2020 UNIVERSITY OF TORONTO ENGINEERING GRAD TO WATCH  
*One of 16 graduating students selected based on 'creativity, innovation and global impact'*
- 2019 PIONEER, ROBOTICS: SCIENCE AND SYSTEMS  
*One of 23 senior Ph.D. students and postdocs selected for the 2019 Pioneers workshop*
- 2015 NSERC ALEXANDER GRAHAM BELL CANADA GRADUATE SCHOLARSHIP-DOCTORAL  
*CGS-D3, 3 years, \$105 000 total value*
- 2013 NSERC CANADA GRADUATE SCHOLARSHIPS-MASTER'S PROGRAM  
*CGS-M, 1 year, \$17 500 total value*
- 2010 NSERC UNDERGRADUATE SUMMER RESEARCH AWARD  
*For research in the Flight Systems and Control Lab, \$4 500 total value*

## Publications

- 2020 V. Peretroukhin, M. Giamou, D. Rosen, W. N. Greene, N. Roy, and J. Kelly, “A Smooth Representation of  $SO(3)$  for Deep Rotation Learning with Uncertainty,” in *Proceedings of Robotics: Science and Systems (RSS’20)*, Boston, Massachusetts, USA, Jul. 12–16 2020, **Best Student Paper Award**
- 2020 B. Wagstaff, V. Peretroukhin, and J. Kelly, “Robust Data-Driven Zero-Velocity Detection for Foot-Mounted Inertial Navigation,” *IEEE Sensors Journal*, vol. 20, no. 2, pp. 957–967, Jan. 2020
- 2019 L. Clement, V. Peretroukhin, M. Giamou, J. Leonard, H. Kress-Gazit, J. How, M. Milford, O. Brock, R. Gariepy, N. Roy, H. Siegel, L. Righetti, A. Billard, and J. Kelly, “Where Do We Go From Here? Debates on the Future of Robotics Research at ICRA 2019 [From the Field],” *IEEE Robotics & Automation Magazine*, vol. 26, no. 3, pp. 7–10, Sep. 2019
- 2019 V. Peretroukhin, B. Wagstaff, and a. Jonathan Kelly, “Deep Probabilistic Regression of Elements of  $SO(3)$  using Quaternion Averaging and Uncertainty Injection,” in *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, June 2019
- 2018 M. Giamou, Z. Ma, V. Peretroukhin, and J. Kelly, “Certifiably Globally Optimal Extrinsic Calibration from Per Sensor Egomotion,” *IEEE Robotics and Automation Letters*, 2018
- 2018 V. Peretroukhin, L. Clement, and J. Kelly, “Inferring Sun Direction to Improve Visual Odometry: A Deep Learning Approach,” *International Journal of Robotics Research*, 2018
- 2018 V. Peretroukhin and J. Kelly, “DPC-Net: Deep Pose Correction for Visual Localization,” *IEEE Robotics and Automation Letters*, 2018
- 2017 B. Wagstaff, V. Peretroukhin, and J. Kelly, “Improving Foot-Mounted Inertial Navigation Through Real-Time Motion Classification,” in *Proceedings of the International Conference on Indoor Positioning and Indoor Navigation (IPIN’17)*, Sapporo, Japan, Sep. 18–21 2017
- 2017 V. Peretroukhin, L. Clement, and J. Kelly, “Reducing Drift in Visual Odometry by Inferring Sun Direction Using a Bayesian Convolutional Neural Network,” in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA’17)*, Singapore, May 29–Jun. 3 2017, pp. 2035–2042
- 2017 L. Clement, V. Peretroukhin, and J. Kelly, “Improving the Accuracy of Stereo Visual Odometry Using Visual Illumination Estimation,” in *2016 International Symposium on Experimental Robotics*, ser. Springer Proceedings in Advanced Robotics, D. Kulic, Y. Nakamura, O. Khatib, and G. Venture, Eds. Berlin Heidelberg: Springer International Publishing, 2017, vol. 1, pp. 409–419, invited to Journal Special Issue
- 2016 V. Peretroukhin, W. Vega-Brown, N. Roy, and J. Kelly, “PROBE-GK: Predictive robust estimation using generalized kernels,” in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA’16)*, Stockholm, Sweden, May 16–21 2016, pp. 817–824
- 2015 V. Peretroukhin, L. Clement, M. Giamou, and J. Kelly, “PROBE: Predictive robust estimation for visual-inertial navigation,” in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS’15)*, Hamburg, Germany, Sep. 28–Oct. 2 2015, pp. 3668–3675
- 2015 V. Peretroukhin, L. Clement, and J. Kelly, “Get to the point: Active covariance scaling for feature tracking through motion blur,” in *Proceedings of the IEEE International Conference on Robotics and Automation Workshop on Scaling Up Active Perception*, Seattle, Washington, USA, May 30 2015

- 2015 L. Clement, V. Peretroukhin, J. Lambert, and J. Kelly, “The Battle for Filter Supremacy: A Comparative Study of the Multi-State Constraint Kalman Filter and the Sliding Window Filter,” in *Proceedings of the 12th Conference on Computer and Robot Vision (CRV’15)*, Halifax, Nova Scotia, Canada, Jun. 3–5 2015, pp. 23–30
- 2015 B. Stenning, L. Bajin, C. Robson, V. Peretroukhin, G. R. Osinski, and T. D. Barfoot, *Towards autonomous mobile robots for the exploration of steep terrain*. Springer International Publishing, 2015, pp. 33–47
- 2014 V. Peretroukhin, J. Kelly, and T. D. Barfoot, “Optimizing Camera Perspective for Stereo Visual Odometry,” in *Proceedings of the Canadian Conference on Computer and Robot Vision (CRV’14)*, Montreal, Quebec, Canada, May 7–9 2014, pp. 1–7

## Invited Talks

- 2019 **MIT CSAIL, Cambridge, Mass., USA**  
*Data-driven Models for Extracting Latent Information from Vision*
- 2019 **Oxford Robotics Institute, Oxford, UK**  
*Using deep learning to improve visual localization*
- 2019 **Imperial College, London, UK**  
*Using deep learning to improve visual localization*
- 2019 **NASA Jet Propulsion Laboratory, Pasadena, California**  
*Using deep learning to improve visual odometry in terrestrial and extraterrestrial environments*

## Community Service

- 2020 **2020 Conference on Robot Learning (CoRL)**  
*Web chair*
- 2020 **Power-On-And-Go Robots (RSS Virtual Workshop)**  
*Co-organizer*
- 2020 **2020 RSS Pioneers (Virtual Workshop)**  
*General chair*
- 2020 **2020 Debates on the Future of Robotics Research (ICRA Virtual Workshop)**  
*Co-organizer; three formal debates*
- 2019 **2019 Debates on the Future of Robotics Research (ICRA Full-Day Workshop)**  
*Co-organizer; three formal debates and a series of lightning talks*

## Teaching

COURSE INSTRUCTOR

- 2018 **ROB501: Computer Vision for Robotics**  
*Fall 2018, Co-Instructor*
- Fourth year / graduate course in computer vision for mobile robotics.
  - Presented lectures on camera models, inverse image operations, and image filtering.
- 2018 **AER521: Mobile Robotics and Perception**  
*Winter 2018, Co-Instructor*

- Fourth year / graduate course in mobile robotics control, motion planning, and state estimation.
- Presented lectures on vehicle modelling, path tracking control, path planning, visual odometry, SLAM, and machine learning for robotics (Deep Learning and Gaussian Processes).

#### TEACHING ASSISTANT

2018

##### **Coursera Specialization on Self-Driving Cars**

*Summer 2018, Subject Matter Expert*

- Coursera self-driving car specialization consisting of five courses developed in collaboration with University of Toronto and Waterloo.
- Developed lecture material, detailed scripts and helped in creation of assessments for course two: state estimation for self driving cars.
- Material included development of least squares, (extended) Kalman filters for pose estimation, and introduction to GNSS, IMU and Lidar sensors.

2013-2018

##### **ESC103: Engineering Mathematics and Computation**

*Fall 2013-2018, Tutorial and Lab Teaching Assistant, 2 sections, 20+ Students in each*

- Taught weekly tutorials and labs with engaging discussions and interactive lessons on topics in linear algebra and scientific programming in MATLAB.
- Led the creation and administration of MATLAB lab assignments and final examination in 2016.
- Consistently highly ranked in Teaching Assistant evaluations. Nominated for Teaching Excellence Award.

2017-2018

##### **Engineering Problem Solving and Mathematics**

*Summer 2017, 2018, Teaching Assistant and Co-Organizer*

- Co-organized a week-long summer preparatory course for incoming first year engineering students.
- Introduced scientific computing through MATLAB. Created and facilitated a laboratory exercise that implemented differential equations through circuits.

2014

##### **CSC190: Computer Algorithms and Data Structures**

*Winter 2014, Lab & Teaching Assistant*

- Lead bi-weekly labs for two sections of 100+ first year engineering students. Taught fundamental data structures and algorithms in C.

#### GUEST LECTURES

2019

##### **ROB311: Introduction to Artificial Intelligence**

*A taxonomy of intelligent agents; case studies of successful robotic systems*

## Professional Experience

2015-2017

### **Diem Medical (formerly Pillsy)**

*Co-founder and CTO*

- Created Diem Pouch: a smart pill pouch and app that helps patients take medication consistently. Lead development of iOS app and integration with Bluetooth-enabled hardware.
- Accepted into two accelerators: Start at UTIAS and Hatchery. Received funding from the Ontario Centre of Excellence. Invited to open Toronto Stock Exchange.
- Press from University of Toronto Press, the Toronto Star, and Wired Magazine.

2013-2016

### **Aerospace Students' Association**

*Executive Member 2013-2016, President (2015-2016)*

- Served on executive committee for a student body of over 120 graduate students at the University of Toronto Institute for Aerospace Studies.
- Lead the organization of several events and committees at the Institute, including a comprehensive student feedback report, an interactive booth at the *Science Rendezvous*, and an invited speaker seminar series.

2013

### **Autonomous Space Robotics Lab**

*Research Assistant, University of Toronto*

- Adapted Visual Teach & Repeat algorithm to work on quadrotor in collaboration with a student at ETH, Zurich.
- Extended and re-constructed instrumented ascender assembly on rover to better assist in high gradient descents.

2011-2012

### **Canadian Space Agency**

*Student Researcher, Physical Sciences in Space, St.Hubert, Quebec.*

- Developed parallel software toolkit in Mathematica to analyze residual gravity levels from the International Space Station, Parabolic Aircraft and recoverable satellites.
- Participated in 2 different campaigns onboard the Falcon 20 parabolic aircraft, accumulating over an hour of reduced gravity time.
- Presented a research poster at International Symposium for Physical Sciences in Space in Bonn, Germany.
- Lead an interactive zero gravity workshop for over 60 French and English secondary school teachers at a Space Educators Conference.

## Language Fluency

English (*native*), Russian (*fluent*), French (*working knowledge*)

## Other Interests & Hobbies

- General Aviation  
*I hold a Canadian Private Pilot's License and love flying Cessna 172s for fun!*
- Philosophy  
*I am an avid reader of primary and secondary philosophical texts (from Aristotle to Camus). I sometimes write about them in a blog/podcast called [NeverFromConcentrate](#).*
- Athletics & the Outdoors  
*I play soccer, hockey, basketball, and tennis. I am an avid snowboarder, and love to hike and camp.*