

# Valentin Peretroukhin

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## Current position

PH.D. CANDIDATE, Space and Terrestrial Autonomous Robotic Systems Lab  
University of Toronto  
Thesis: *On Learning Deep, Probabilistic Measurement Models for State Estimation*  
Supervised by Professor Jonathan Kelly

## Areas of specialization

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

## Education

- 2014 M.A.Sc. (Direct transfer to Ph.D.) in Aerospace Robotics  
Institute for Aerospace Studies, University of Toronto, GPA: 4.00/4.00
- 2013 B.A.Sc. in Engineering Science, Aerospace Major  
University of Toronto, GPA: 3.86/4.00.  
Senior Thesis: *Optimal Camera Perspective for Stereo Visual Odometry*  
Supervised by Professor Tim Barfoot

## Grants, honours & awards

- 2015 NSERC Alexander Graham Bell Canada Graduate Scholarship-Doctoral  
CGS-D3, 3 years, \$105 000 total value
- 2015 Ontario Centre of Excellence SmartStart Seed Grant  
Awarded to Diem Medical, \$25 000 total value
- 2013 NSERC Canada Graduate Scholarships-Master's Program  
CGS-M, 1 year, \$17 500 total value
- 2012 Canadian Space Agency Student Travel Bursary  
Student travel to the International Symposium for Physical Sciences in Space, \$2 000 total value
- 2010 NSERC Undergraduate Summer Research Award  
For research in the Flight Systems and Control Lab, \$4 500 total value

## Publications

- 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 (CCRV’14)*, Montreal, Quebec, Canada, May 7–9 2014, pp. 1–7

# 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*

## 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*

## Leadership Experience

- 2018-2019 **ICRA 2019 Workshop: Debates on the Future of Robotics**  
*Co-organizer, [roboticsdebates.org](http://roboticsdebates.org)*
- Currently organizing a full-day workshop at the upcoming International Conference on Robotics and Automation in Montreal.
  - Created successful workshop proposal from scratch with two other Ph.D. students based on the need for structured debate about pressing issues in the robotics community.
  - Invited and curated a diverse list of leading researchers from leading institutions like MIT, Harvard, TUM, EPFL, and QUT.
- 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.

## Professional Experience

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.*