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　UNIVERSITY OF TORONTO ENGINEERING GRAD TO WATCH
One of 16 graduating students selected based on 'creativity, innovation and global impact'

2019　ROBOTICS: SCIENCE AND SYSTEMS, PIONEER
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

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 *Proceed-*

ings 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   **Pioneers (RSS Virtual Workshop)**
Co-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.