Ivan Papusha, PhD

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Experience

Senior Technical Advisor · Washington, DC	2021–
Senior Professional Staff · Space Exploration Sector, JHU/APL, Laurel, MD	2018–2021
Postdoctoral Fellow · Oden Institute, UT Austin, TX	2016–2018
Graduate Researcher · Control and Dynamical Systems Department, Caltech, Pasadena, CA	2011–2016
Research Analyst · Prediction and Bidding Team, AOL Inc., Palo Alto, CA	2011
Researcher · Stanford AI Laboratory, Stanford University, Stanford, CA	2010
Researcher · Center for Integrated Systems, Stanford University, Stanford, CA	2009
Engineering Technician · Naval Research Laboratory, Washington, DC	2006, 2008

Education

California Institute of Technology · Pasadena, CA
  - PhD, Control and Dynamical Systems, 2016
    Thesis: Robustness, Adaptation, and Learning in Optimal Control
    Advisor: Richard M. Murray

Stanford University · Stanford, CA
  - MS, Electrical Engineering, 2011
  - BS, Electrical Engineering (physics minor), 2011

Thomas Jefferson High School for Science and Technology · Alexandria, VA
  - Advanced Studies Diploma, 2007

Tools and expertise

Software*: Python, C, C++, JavaScript, Cloud (AWS/Azure), DevOps, Docker, SQL, Bash, etc.
Data Analysis*: numpy/scipy/pandas, Matlab, convex optimization, high performance computing
Machine Learning/Statistics*: modeling, regression, classification, neural networks, fundamental research
Control Systems[†]: robust/adaptive/model predictive control, constraint satisfaction, trajectory generation, hybrid systems, formal methods, model checking, interactive theorem proving, SMT/Z3, Lean, Coq
Mechanical Design[†]: SolidWorks, Creo, PCB design, 3D printing, mill/shop
Electrical Design[†]: Verilog, ModelSim, Cadence, Eagle, SPICE, microcontrollers
Earth and Space[†]: AGI Systems Tool Kit, NAIF SPICE, ArcGIS

*core tools   [†]specialized tools

Teaching

Instructor · Caltech	2015

  - CDS270–2: Mathematical Methods in Control and System Engineering, Spring 2015 (Self)

Teaching Assistant · Stanford, Caltech	2010–2014

  - EE364A: Convex Optimization I, Winter 2011 (w/Stephen Boyd)
  - EE263: Linear Dynamical Systems, Fall 2010 (w/Stephen Boyd)
  - EE102B: Signal Processing and Linear Systems II, Spring 2011 (w/Joseph M. Kahn)
  - CDS101/110A: Introductory Control Theory, Fall 2013, Fall 2014 (w/Douglas MacMartin)

Awards and activities

Packard Award for Excellence in Acquisition, 2019
National Defense Science and Engineering Graduate Fellowship (NDSEG), 2012–2015
Caltech Powell Foundation Fellowship, 2011
AFCEA Scholarship, 2008–2010
Professional: IEEE member
Personal: STEM outreach, mentoring students, scuba, rock climbing

Sample Software

- latern-smt: ("Safer than a torch") Utility functions for encoding PyTorch modules as Z3 constraints.
  `https://github.com/JHUAPL/lantern-smt`
- amnet: Python toolbox for affine multiplexing networks.
  `https://github.com/ipapusha/amnet`
- sydar: (Synthesis Done Approximately Right) approximate control synthesis for hybrid automata.
  `https://github.com/u-t-autonomous/sydar`
- boxqp: primal-dual quadratic program solver for Matlab with explicit offline factorization analysis.
  `https://github.com/ipapusha/boxqp`
- pcpadmm: solver for the robust PCA problem via principal component pursuit.
  `http://ivanpapusha.com/code/pcp_admm.m`

Publications

Autonomy and Machine Learning

[1] Y. Kouskoulas, T. J. Machado, D. Genin, A. Schmidt, I. Papusha, and J. Brulé. Envelopes and waves: Safe multivehicle collision avoidance for horizontal non-deterministic turns. *Software Tools for Technology Transfer*, 24:371–394, May 2022. doi: `10.1007/s10009-022-00654-2`.

[2] D. Genin, I. Papusha, J. Brulé, T. Young, G. Mullins, Y. Kouskoulas, R. Wu, and A. Schmidt. Formal verification of neural network controllers for collision-free flight. In *Workshop on Numerical Software Verification (NSV), part of International Conference on Computer-Aided Verification (CAV)*. Jul. 2021. doi: `10.1007/978-3-030-95561-8_9`.

[3] Y. Kouskoulas, D. Genin, A. Schmidt, I. Papusha, R. Wu, G. Mullins, T. Young, and J. Brulé. Verification of safety in artificial intelligence and reinforcement learning systems. *Johns Hopkins APL Technical Digest*, 35(4):434–437, 2021.

[4] I. Papusha, R. Wu, J. Brulé, Y. Kouskoulas, D. Genin, and A. Schmidt. Incorrect by construction: Fine tuning neural networks for guaranteed performance on finite sets of examples. In *3rd Workshop on Formal Methods in ML-Enabled Autonomous Systems (FoMLAS)*. Jul. 2020. `arXiv:2008.01204 [cs.LG]`.

[5] D. Genin, E. Dietrich, Y. Kouskoulas, A. Schmidt, M. Kobilarov, K. Katyal, S. Sefati, S. K. Mishra, and I. Papusha. A safety fallback controller for improved collision avoidance. In *IEEE International Conference on Assured Autonomy (ICAA)*. Jun. 2023. `https://icaa-conf.github.io/icaa2023/`.

Air and Space Systems

[6] M. A. Kelly, J. L. Carr, D. L. Wu, A. C. Goldberg, I. Papusha, and R. T. Meinhold. Compact midwave imaging system: Results from an airborne demonstration. *Remote Sensing*, 14(4), 2022. doi: `10.3390/rs14040834`.

[7] M. A. Kelly, D. Wu, A. Goldberg, I. Papusha, J. Wilson, J. Carr, J. Boldt, J. Greenberg, F. Morgan, S. Yee, A. Heidinger, and L. Mehr. Compact Midwave Imaging System (CMIS) for retrieval of Cloud Motion Vectors (CMVs) and Cloud Geometric Heights (CGHs). In *Proceedings of the SPIE*, vol. 10776. Oct. 2018. doi: `10.1117/12.2324612`.

[8] M. Cubuktepe, N. Jansen, S. Junges, J.-P. Katoen, I. Papusha, H. A. Poonawala, and U. Topcu. *Sequential Convex Programming for the Efficient Verification of Parametric MDPs*, pp. 133–150. Springer, Apr. 2017. doi: `10.1007/978-3-662-54580-5_8`.

[9] S. S. Farahani, I. Papusha, C. McGhan, and R. M. Murray. Constrained autonomous satellite docking via differential flatness and model predictive control. In *IEEE Conference on Decision and Control (CDC)*, pp. 3306–3311. Dec. 2016. doi: 10.1109/CDC.2016.7798766.

Control Theory and Convex Optimization

[10] I. Papusha, U. Topcu, S. Carr, and N. Lauffer. Affine multiplexing networks: System analysis, learning, and computation, Apr. 2018. `arXiv:1805.00164 [math.OC]`.

[11] I. Papusha, M. Wen, and U. Topcu. Inverse optimal control with regular language specifications. In *American Control Conference (ACC)*, pp. 770–777. Jun. 2018. doi: 10.23919/ACC.2018.8431646.

[12] M. Wen, I. Papusha, and U. Topcu. Learning from demonstrations with high-level side information. In *International Joint Conference on Artificial Intelligence (IJCAI)*, pp. 3055–3061. Aug. 2017. doi: 10.24963/ijcai.2017/426.

[13] J. Fu, I. Papusha, and U. Topcu. Sampling-based approximate optimal control under temporal logic constraints. In *ACM International Conference on Hybrid Systems: Computation and Control (HSCC)*, pp. 227–235. Apr. 2017. doi: 10.1145/3049797.3049820.

[14] I. Papusha, J. Fu, U. Topcu, and R. M. Murray. Automata theory meets approximate dynamic programming: Optimal control with temporal logic constraints. In *IEEE Conference on Decision and Control (CDC)*, pp. 434–440. Dec. 2016. doi: 10.1109/CDC.2016.7798307.

[15] I. Papusha. *Robustness, Adaptation, and Learning in Optimal Control*. Ph.D. thesis, California Institute of Technology, May 2016. doi: 10.7907/Z9F18WPB.

[16] I. Papusha and R. M. Murray. Analysis of control systems on symmetric cones. In *IEEE Conference on Decision and Control (CDC)*, pp. 3971–3976. Dec. 2015. doi: 10.1109/CDC.2015.7402836.

[17] M. B. Horowitz, I. Papusha, and J. W. Burdick. Domain decomposition for stochastic optimal control. In *IEEE Conference on Decision and Control (CDC)*, pp. 1866–1873. Dec. 2014. doi: 10.1109/CDC.2014.7039670.

[18] I. Papusha, E. Lavretsky, and R. M. Murray. Collaborative system identification via parameter consensus. In *American Control Conference (ACC)*, pp. 13–19. Jun. 2014. doi: 10.1109/ACC.2014.6858938.