Abraham P. Vinod

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Research Interests

Constrained control of dynamical systems under uncertainty (reachability, motion planning, model predictive control), optimization (convex, stochastic, combinatorial), and data-driven and learning-based control

Academic Research Positions

2019–Present **Postdoctoral Fellow at Oden Institute for Computational Engineering & Sciences**.
The University of Texas at Austin, Austin, TX, USA
Advisor: Dr. Ufuk Topcu
Data-driven near-optimal constrained control of systems with unknown dynamics

Education

2014–2018 **Ph.D. in Systems and Control (with distinction)**.
The University of New Mexico, Albuquerque, NM, USA
Advisor: Dr. Meeko M. K. Oishi
Thesis: *Scalable Stochastic Reachability: Theory, Computation, and Control*

2009–2014 **Bachelor & Master of Technology in Electrical Engineering**.
Indian Institute of Technology Madras, Chennai, TN, India
Advisor: Dr. Arun D. Mahindrakar
Thesis: *Deterministic Attitude Estimation*

Honors and Awards

2018 **Finalist for Best Paper Award**, 21st ACM International Conference on Hybrid Systems: Computation and Control
For the paper "Scalable Underapproximative Verification of Stochastic LTI Systems using Convexity and Compactness" co-authored with Dr. Meeko M. K. Oishi. A major award recognizing the best paper at HSCC 2018

2017 **Best Student Paper Award**, 20th ACM International Conference on Hybrid Systems: Computation and Control
For the paper "Forward stochastic reachability analysis for uncontrolled linear systems using Fourier Transforms" co-authored with Dr. Baisravan HomChaudhuri and Dr. Meeko M. K. Oishi. A major award recognizing the best paper written by a student at HSCC 2017

2014 **Prof. Achim Bopp prize for the best student hardware project (M.Tech thesis)**
Selected by faculty of Electrical Engineering and awarded during the convocation at the Indian Institute of Technology, Madras

2009 **Central Board of Secondary Education merit scholarship**
Nationwide scholarship scheme in India that partially covers the expenses of undergraduate studies

Publications

Journal Publications

[J6] J. D. Gleason, **A. P. Vinod**, and M. M. K. Oishi, "Lagrangian approximations for stochastic reachability of a target tube," submitted to *Automatica*.
In re-review, last updated: February, 2020   https://arxiv.org/abs/1810.07118

[J5] **A. P. Vinod**, A. J. Thorpe, P. Olaniyi, T. H. Summers, and M. M. K. Oishi, "Trust-based user-interface design for human-automation systems," submitted to *IEEE Transactions on Control Systems Technology*.
In re-review, last updated: April, 2020   https://arxiv.org/abs/2004.07176

[J4] **A. P. Vinod** and M. M. K. Oishi, "Stochastic reachability of a target tube: Theory and computation," submitted to *Automatica*.
In re-review, last updated: February, 2020   https://arxiv.org/abs/1810.05217

[J3] **A. P. Vinod** and M. M. K. Oishi, " Probabilistic occupancy via forward stochastic reachability," submitted to *IEEE Transactions on Automatic Control*.
In re-review, last updated: October, 2019   https://arxiv.org/abs/1803.07180

[J2] **A. P. Vinod** and M. M. K. Oishi, " Scalable underapproximation for stochastic reach-avoid problem for high-dimensional LTI systems using Fourier transforms," in *IEEE Control Systems Letters (L-CSS)*, vol. 1, no. 2, pp. 316–321, Oct. 2017.
Selected for presentation at *IEEE Conference on Decision and Control, 2017*, Melbourne, Australia. (pp. 4297–4302)

[J1] **A. P. Vinod**, A. D. Mahindrakar, S. Bandyopadhyay, and V. Muralidharan, "A deterministic attitude estimation using a single vector information and rate gyros," in *IEEE/ASME Transactions on Mechatronics*, vol. 20, no. 5, pp. 2630–2636, Oct. 2015.

Refereed Conference Publications

* denotes equal contribution among the authors.

[C22] F. Djeumou, **A. P. Vinod**, E. Goubault, S. Putot, U. Topcu, "On-the-fly reachability and control of unknown smooth systems," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Jeju Island, Republic of Korea, 2020. (submitted)

[C21] **A. P. Vinod**, A. Israel, and U. Topcu, "Constrained Global Optimization of Functions with Lipschitz Continuous Gradients," in *Proceedings of Uncertainty in Artificial Intelligence (UAI)*, Toronto, Canada 2020. (submitted)

[C20] **A. P. Vinod**, A. Israel, and U. Topcu, "Convexified contextual optimization for on-the-fly control of smooth systems," in *Proceedings of American Control Conference (ACC)*, Denver, CO, USA 2020. (accepted)

[C19] S. Bharadwaj, **A. P. Vinod**, R. Dimitrova, and U. Topcu, "Near-optimal reactive synthesis incorporating runtime information," in *Proceedings of IEEE International Conference on Robotics and Automation (ICRA)*, Paris, France 2020. (accepted)

[C18] **A. P. Vinod** and M. M. K. Oishi, "Affine controller synthesis for stochastic reachability via difference of convex programming," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Nice, France, pp. 7273–7280, 2019.

[C17] V. Sivaramakrishnan, O. Thapliyal, **A. P. Vinod**, M. M. K. Oishi, and I. Hwang, "Predicting mode confusion through mixed-integer linear programming," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Nice, France, pp. 2442–2448, 2019.

[C16] M. Khaledyan, **A. P. Vinod**, and M. M. K. Oishi, "Optimal coverage control and stochastic multi-target tracking," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Nice, France, pp. 2467–2472, 2019.

[C15] J. D. Gleason, **A. P. Vinod**, and M. M. K. Oishi, "The maximal hitting-time stochastic reachability problem," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Nice, France, pp. 7266–7272, 2019.

[C14] **A. P. Vinod***, V. Sivaramakrishnan*, and M. M. K. Oishi, "Piecewise-affine approximation-based stochastic optimal control with Gaussian joint chance constraints", in *Proceedings of American Control Conference (ACC)*, Philadelphia, PA, USA, pp. 2942–2949, 2019.

[C13] H. Sartipizadeh, **A. P. Vinod**, B. Açıkmeşe, and M. M. K. Oishi, "Voronoi partition-based scenario reduction for fast sampling-based stochastic reachability computation of linear systems", in *Proceedings of American Control Conference (ACC)*, Philadelphia, PA, USA, pp. 37–44, 2019.

[C12] **A. P. Vinod**, J. D. Gleason, and M. M. K. Oishi, "SReachTools: a MATLAB stochastic reachability toolbox," in *Proceedings of ACM International Conference on Hybrid Systems: Computation and Control (HSCC)*, Montreal, Canada, pp. 33–38, 2019.

[C11] **A. P. Vinod***, S. Rice*, Y. Mao, M. M. K. Oishi, and B. Açıkmeşe, "Stochastic motion planning using successive convexification and probabilistic occupancy functions" in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Miami, FL, USA, pp. 4283–4290, 2018.

[C10] **A. P. Vinod**, B. HomChaudhuri, C. Hintz, A. Parikh, S. P. Buerger, M. M. K. Oishi, G. Brunson, S. Ahmad, and R. Fierro, "Multiple pursuer-based threat intercept via forward stochastic reachability," in *Proceedings of American Control Conference (ACC)*, Milwaukee, WI, USA, pp. 1559–1566, 2018.

[C9] **A. P. Vinod** and M. M. K. Oishi, "Optimal trade-off analysis for efficiency and safety in the spacecraft rendezvous and docking problem," in *NAASS, IFAC-PapersOnLine*, 2018.

[C8] **A. P. Vinod** and M. M. K. Oishi, "Scalable underapproximative verification of stochastic LTI systems using convexity and compactness," in *Proceedings of ACM Hybrid Systems: Computation and Control (HSCC)*, Porto, Portugal, pp. 1–10, 2018.

[C7] J. Gleason*, **A. P. Vinod***, and M. M. K. Oishi, "Underapproximation of reach-avoid sets for discrete-time stochastic systems via Lagrangian methods," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Melbourne, Australia, pp. 4283–4290, 2017.

[C6] B. HomChaudhuri*, **A. P. Vinod***, and M. M. K. Oishi, "Computation of forward stochastic reach sets: Application to stochastic, dynamic obstacle avoidance," in *Proceedings of American Control Conference (ACC)*, Seattle, WA, USA, pp. 4404–4411, 2017.

[C5] H.T. (Lewis) Chiang, B. HomChaudhuri, **A. P. Vinod**, M. M. K. Oishi, and L. Tapia, "Dynamic risk tolerance: Motion planning by balancing short-term and long-term stochastic dynamic predictions," in *Proceedings of IEEE International Conference on Robotics and Automation (ICRA)*, Singapore, Singapore, pp. 3762–3769, 2017.

[C4] **A. P. Vinod**, B. HomChaudhuri, and M. M. K. Oishi, "Forward stochastic reachability analysis for uncontrolled linear systems using Fourier transforms," in *Proceedings of ACM Hybrid Systems: Computation and Control (HSCC)*, Pittsburg, PA, USA, pp. 35–44, 2017.

[C3] J. Gleason, **A. P. Vinod**, M. M. K. Oishi, and R. S. Erwin, "Viable set approximation for linear-Gaussian systems with unknown, bounded variance," in *Proceedings of IEEE Conference on Decision and Control (CDC)*, Las Vegas, USA, pp. 7049–7055, 2016.

[C2] **A. P. Vinod**, Y. Tang, M. M. K. Oishi, K. Sycara, C. Lebiere, and M. Lewis, "Validation of cognitive models for collaborative hybrid systems with discrete human input," in *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, pp. 3339–3346, 2016.

[C1] **A. P. Vinod**, T. H. Summers, and M. M. K. Oishi, "User-interface design for MIMO LTI human-automation systems through sensor placement," in *Proceedings of American Control Conference (ACC)*, Boston, MA, USA, pp. 5276–5283, 2016.

Book Chapters

[B1] **A. P. Vinod** and A. D. Mahindrakar, "Deterministic Attitude Estimation," Multisensor Attitude Estimation: Fundamental Concepts and Applications, H. Fourati and D. E. C. Belkhiat (Eds.), CRC Press, 2016.

Theses

[T2] **A. P. Vinod**, "Scalable stochastic reachability: Theory, computation, and control", Ph.D. dissertation, The University of New Mexico, 2018.

[T1] **A. P. Vinod**, "Deterministic Attitude Estimation", Master's thesis, Indian Institute of Technology, Madras, 2014.

Software

SReachTools — An open-source, repeatability-evaluated stochastic reachability toolbox for MATLAB that provides scalable techniques to verify and synthesize controllers for stochastic linear systems. http://sreachtools.github.io

Invited Talks

Summer 2018 — *Scalable stochastic reachability: Theory, computation, and control*,
University of University of California, Berkeley, USA

Spring 2018 — *Scalable stochastic reachability: Theory, computation, and control*,
University of Washington, Seattle, USA

Spring 2018 — *Safe autonomy via stochastic reachability*,
The University of Texas at Austin, USA

Spring 2018 — *Safe autonomy via stochastic reachability*,
Indian Institute of Sciences, Bangalore, India

Teaching

Guest Lecturer

2018 — ECE 514: Nonlinear Control at *The University of New Mexico* (2 classes)

2017 — ECE 546: Multivariate Control Theory at *The University of New Mexico* (4 classes)

Teaching Assistant

2014 — ECE 101: Introduction to Electrical Engineering at *The University of New Mexico*

2014 — Advanced Control Systems Lab at *Indian Institute of Technology, Madras*

Industry Experience

Summer 2017 — **Graduate Student Intern — R&D (Connected cars)**
Nissan Research Center — Silicon Valley, Sunnyvale, California, USA
Developed location estimation techniques using CAN and GPS data for cars.

Summer 2012	**Interim Engineering Intern**
	Qualcomm Incorporated, Hyderabad, India
	Analyzed performance of the DRAM with the existing mobile platform builds.

Programming Languages

Proficient	Python, MATLAB
Familiar	C, C++, HTML, CSS, JavaScript

Professional Activities

Program Committee

Poster/Demo	ACM Hybrid Systems: Computation and Control, 2020

Peer Review

Journals	IEEE Transactions on Automatic Control, Automatica, and IEEE Robotics and Automation Letters
Conferences	IEEE Conference on Decision and Control, American Control Conference, ACM Hybrid Systems: Computation and Control, IEEE International Conference on Robotics and Automation, IEEE/RSJ InternationalConference on Intelligent Robots and Systems, International Conference on Computer-Aided Verification, and IFAC World Congress

Volunteer

Organization of American Control Conference, 2016