

# 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 of Computational Engineering and 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*  
Toolbox: <http://sreachtools.github.io>

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**, 21<sup>st</sup> 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**, 20<sup>th</sup> 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

- [J5] **A. P. Vinod**, A. J. Thorpe, P. Olaniyi, T. H. Summers, M. M. K. Oishi, "Trust based user-interface design for human-automation systems under manual control," submitted to *IEEE Transactions on Control Systems Technology*.  
In review, most recent change of status: August, 2019
- [J4] **A. P. Vinod** and M. M. K. Oishi, "Stochastic reachability of a target tube: Theory and computation," submitted to *Automatica*.  
In re-review, most recent change of status: November, 2019
- [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, most recent change of status: October, 2019
- [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.

- [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 (submitted)
- [C19] S. Bharadwaj, **A. P. Vinod**, R. Dimitrova, Ufuk Topcu, "Near-Optimal Reactive Synthesis Incorporating Runtime Information," in Proceedings of *IEEE International Conference on Robotics and Automation (ICRA)*, Paris, France 2020 (submitted)
- [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, 2019 (accepted)
- [C17] V. Sivaramakrishnan, O. Thapliyal, **A. P. Vinod**, M. M. K. Oishi, I. Hwang, "Predicting Mode Confusion Through Mixed Integer Linear Programming," in Proceedings of *IEEE Conference on Decision and Control (CDC)*, Nice, France, 2019 (accepted)
- [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, 2019 (accepted)
- [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, 2019 (accepted)
- [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," *Proceedings of the 22nd 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, 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, 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

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## Toolboxes

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

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## 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*

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## 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. Also, created a Python code compilation workflow for secure code deployment.
- Summer 2012 **Interim Engineering Intern**  
*Qualcomm Incorporated*, Hyderabad, India  
Analyzed performance of the DRAM with the existing mobile platform builds. Also, created a framework that sped up the debugging process by 30%.

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## Professional activities

### Peer Review

- Journals IEEE Transactions on Automatic Control, and Automatica
- Conferences IEEE Conference on Decision and Control, American Control Conference, ACM Hybrid Systems: Computation and Control, IEEE International Conference on Robotics and Automation

### Volunteer

- ACC 2016 Organization of American Control Conference, 2016