Abhishek Halder

CONTACT INFORMATION

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PROFESSIONAL APPOINTMENTS

Assistant Professor October 2017 – Current

Department of Applied Mathematics and Statistics
University of California, Santa Cruz

Postdoctoral Scholar February 2017 – September 2017

Department of Mechanical and Aerospace Engineering
University of California, Irvine
- Topic: *Stochastic control, filtering and optimal transport*
- Host: Tryphon T. Georgiou

Postdoctoral Research Associate June 2014 – January 2017

Department of Electrical and Computer Engineering
Texas A&M University
- Topic: *Demand response in smart grid, unmanned aerial systems traffic management*
- Host: P.R. Kumar

Global Research Innovation and Technology Intern Summer 2013

Systems Modeling and Control
Eaton Corporation, Eden Prairie, Minnesota
- Topic: *Voltage Control in UPS: Modeling, Controller Synthesis, and Hardware-in-loop Simulation*
- Host: Yigang Wang
- Projects: (1) Model Based Design in Power Electronics
  (2) Co-operative Control of Generator and UPS

Visiting Researcher Summer 2012

Dynamics and Control, Coordinated Science Laboratory
University of Illinois at Urbana-Champaign
- Topic: *Nonlinear Estimation as Gradient Flow*
- Host: Prashant Mehta

Research Intern Summer 2006

Advanced Systems Development Section, Control Systems Group
Indian Space Research Organization Satellite Center (ISAC), Bangalore INDIA
- Topic: *A Study of Petri Nets: Modeling, Analysis and Simulation*
- Host: Dr. A. Venkateswarlu, Deputy Director, CSG, ISAC

EDUCATION

Ph.D. in Aerospace Engineering May 2014

Texas A&M University, College Station, Texas USA

- Dissertation: *Probabilistic Methods for Model Validation* (**Outstanding Doctoral Student Award**)
- Advisor: Raktim Bhattacharya

Bachelors and Masters in Aerospace Engineering July 2008

Indian Institute of Technology Kharagpur, West Bengal INDIA

- Thesis: *Development of An Autonomous Reconfigurable UAV* (**Best Dual Degree Thesis Award**)
- Advisor: Manoranjan Sinha

Research Interests

Broad area

Systems, control and optimization

Theory focus

- Dynamics and control of stochastic systems
- Uncertainty propagation and nonlinear estimation
- Monge-Kantorovich optimal transport
- Randomized algorithms
- Density control

Application focus

- Application of density control in aerial robotics, and energy systems
- Cyberphysical systems
- Model validation, controller robustness verification, model reduction
- Data driven modeling for control, optimization and machine learning

Grants

2019

- Lead PI: Abhishek Halder, *Fast Computation of Stochastic Reachability for Provably Safe Planning and Control in Automated Driving.* Ford PI: Baljeet Singh. **University Research Project, Ford Motor Company**.

2018

- Lead PI: Abhishek Halder, *Cloud-based Anytime Computation of Reachable Tubes for Provably Safe Unmanned Aerial Systems Traffic Management.* Co-Investigators: Mark Mueller [UC Berkeley], Ricardo Sanfelice [UC Santa Cruz], Claire Tomlin [UC Berkeley]. **Center for Information Technology Research in the Interest of Society (CITRIS) Seed Fund Award**.

- PI: Abhishek Halder, *Real-time Computation of Reachable Tubes for Provably Safe Unmanned Aerial Systems Traffic Management.* **UCSC Committee on Research (COR) New Faculty Research Grant**.

Journal Publications

J12. A. Halder, X. Geng, F.A.C.C. Fontes, P.R. Kumar, and L. Xie. Optimal Power Consumption for Demand Response of Thermostatically Controlled Loads. *Optimal Control Applications and Methods*. In press, 2018. doi:10.1002/oca.2467

J11. A. Halder, X. Geng, P.R. Kumar, and L. Xie. Architecture and Algorithms for Privacy Preserving Thermal Inertial Load Management by A Load Serving Entity. *IEEE Transactions on Power Systems*. 32(4):3275–3286, 2017. [**Paper selected**

by the IEEE Power & Energy Society (PES) Technical Committee for presentation in 2017 PES General Meeting.]
doi:10.1109/TPWRS.2016.2628055

J10. A. Halder, K. Lee, and R. Bhattacharya. A Probabilistic Method for Nonlinear Robustness Analysis of F-16 Controllers. *Journal of Guidance, Control, and Dynamics*. 38(10):1935–1946, 2015.
doi:10.2514/1.G000386

J9. P. Dutta, **A. Halder**, and R. Bhattacharya. Nonlinear Estimation with Perron-Frobenius Operator and Karhunen-Loève Expansion. *IEEE Transactions on Aerospace and Electronic Systems*. 51(4):3210-3225, 2015.
doi:10.1109/TAES.2015.140591

J8. K. Lee, **A. Halder**, and R. Bhattacharya. Performance and Robustness Analysis of Stochastic Jump Linear Systems using Wasserstein Metric. *Automatica*. 51:341–347, 2015.
doi:10.1016/j.automatica.2014.10.080

J7. A. Halder, and R. Bhattacharya. Probabilistic Model Validation for Uncertain Nonlinear Systems. *Automatica*. 50(8):2038–2050, 2014.
doi:10.1016/j.automatica.2014.05.026

J6. T. Kalmár-Nagy, P. Wahi, and **A. Halder**. Dynamics of a Hysteretic Relay Oscillator with Periodic Forcing. *SIAM Journal on Applied Dynamical Systems*. 10(2):403–422, 2011.
doi:10.1137/100784606

J5. A. Halder, and R. Bhattacharya. Dispersion Analysis in Hypersonic Flight During Planetary Entry Using Stochastic Liouville Equation. *Journal of Guidance, Control and Dynamics*, 34(2):459–474, 2011.
doi:10.2514/1.51196

J4. S. Ghosh, **A. Halder**, and M. Sinha. Micro Air Vehicle Path Planning in Fuzzy Quadtree Framework. *Applied Soft Computing*, 11(8):4859–4865, 2011.
doi:10.1016/j.asoc.2011.06.014

J3. S. Zhao, **A. Halder**, and T. Kalmár-Nagy. Nonlinear Dynamics of Unicycles in Leader-Follower Formation. *Communications in Nonlinear Science and Numerical Simulations*, 14(12):4204–4219, 2009.
doi:10.1016/j.cnsns.2009.02.028

J2. S. Chauhan, C. Patil, M. Sinha, and **A. Halder**. Fuzzy State Noise Driven Kalman Filter for Sensor Fusion. *Journal of Aerospace Engineering, Proceedings of the Institution of Mechanical Engineers, Part G*, 223(8):1091–1097, 2009.
doi:10.1243/09544100JAERO536

J1. A. Halder, R. Garhwal, V. Agarwal, and M. Sinha. Determination of Inertial Characteristics of A High Wing Unmanned Air Vehicle. *Journal of Institute of Engineers (India)*, 89:3–8, 2008.

Conference Publications

C26. A. Halder. On the Parameterized Computation of Minimum Volume Outer Ellipsoid of Minkowski Sum of Ellipsoids. *57th IEEE Conference on Decision and Control*, Miami, 2018.
doi:

C25. **A. Halder**, and T.T. Georgiou. Gradient Flows in Filtering and Fisher-Rao Geometry. **Invited Paper**, *American Control Conference*, Milwaukee, 2018.
doi:

C24. **A. Halder**, and T.T. Georgiou. Gradient Flows in Uncertainty Propagation and Filtering of Linear Gaussian Systems. *56^{th} IEEE Conference on Decision and Control*, Melbourne, 2017.
doi:10.1109/CDC.2017.8264109

C23. **A. Halder**, and E.D.B. Wendel. Finite Horizon Linear Quadratic Gaussian Density Regulator with Wasserstein Terminal Cost. *American Control Conference*, Boston, 2016.
doi:10.1109/ACC.2016.7526817

C22. **A. Halder**, X. Geng, G. Sharma, L. Xie, and P.R. Kumar. A Control System Framework for Privacy Preserving Demand Response of Thermal Inertial Loads. *IEEE International Conference on Smart Grid Communications (SmartGridComm 2015)*, Miami, 2015, pp. 181–186.
doi:10.1109/SmartGridComm.2015.7436297

C21. **A. Halder**, K. Lee, and R. Bhattacharya. A Dynamical System Pair with Identical First Two Moments But Different Probability Densities. **Invited Paper**, *53^{rd} IEEE Conference on Decision and Control*, Los Angeles, 2014.
doi:10.1109/CDC.2014.7040335

C20. **A. Halder**, and R. Bhattacharya. Geodesic Density Tracking with Applications to Data Driven Modeling. **Invited Paper**, *American Control Conference*, Portland, 2014.
doi:10.1109/ACC.2014.6859361

C19. K. Lee, **A. Halder**, and R. Bhattacharya. Probabilistic Robustness Analysis of Stochastic Jump Linear Systems. *American Control Conference*, Portland, 2014.
doi:10.1109/ACC.2014.6859432

C18. **A. Halder**, and R. Bhattacharya. Frequency Domain Model Validation in Wasserstein Metric. *American Control Conference*, Washington DC, 2013.
doi:10.1109/ACC.2013.6580754

C17. **A. Halder**, K. Lee, and R. Bhattacharya. Probabilistic Robustness Analysis of F-16 Controller Performance: An Optimal Transport Approach. *American Control Conference*, Washington DC, 2013.
doi:10.1109/ACC.2013.6580708

C16. P. Dutta, **A. Halder**, and R. Bhattacharya. Nonlinear Filtering with Transfer Operator. *American Control Conference*, Washington DC, 2013.
doi:10.1109/ACC.2013.6580302

C15. **A. Halder**, and R. Bhattacharya. Further Results on Probabilistic Model Validation in Wasserstein Metric. *51^{st} IEEE Conference on Decision and Control (CDC)*, Maui, Dec. 2012.
doi:10.1109/CDC.2012.6425987

C14. P. Dutta, **A. Halder**, and R. Bhattacharya. Uncertainty Quantification for Stochastic Nonlinear Systems with Perron-Frobenius Operator and Karhunen-Loève Expansion. *IEEE Multi-Conference on Systems and Control*, Dubrovnik, Croatia, Oct. 2012.
doi:10.1109/CCA.2012.6402455

C13. **A. Halder**, and R. Bhattacharya. Model Validation: A Probabilistic Formulation. *50^{th} IEEE Conference on Decision and Control (CDC) and European Control Conference (ECC)*, Orlando, Dec. 2011.
doi:10.1109/CDC.2011.6161465

C12. **A. Halder**, and R. Bhattacharya. Beyond Monte Carlo: A Computational Framework for Uncertainty Propagation in Planetary Entry, Descent and Landing. *AIAA Guidance, Navigation and Control Conference*, Toronto, Aug. 2010.
doi:10.2514/6.2010-8029

C11. S. Zhao, **A. Halder**, and T. Kalmár-Nagy. Leader-Follower Dynamics for Unicycles. *American Control Conference*, St. Louis, June 2009.
doi:10.1109/ACC.2009.5160706

C10. S. Zhao, **A. Halder**, and T. Kalmár-Nagy. Nonlinear Dynamics of Unicycles in Leader-Follower Formation. *8th MSU-UAB Conference on Differential Equations and Computational Simulations*, Mississippi State University, May 2009.

C9. T. Kalmár-Nagy, **A. Halder**, and S. Zhao. Delay Tuned Phase Locking in A Pair of Coupled Limit Cycle Oscillators. *6^{th} International Conference on Mathematical Modeling*, Vienna, Feb. 2009.

C8. S. Chauhan, C. Patil, **A. Halder**, and M. Sinha. FLIER: A Novel Sensor Fusion Algorithm. *3^{rd} IEEE International Conference on Industrial and Information Systems*, IIT Kharagpur, Dec. 2008.
doi:10.1109/ICIINFS.2008.4798459

C7. M. Sinha, **A. Halder**, R. Garhwal, N. S. Gopinath, and N. K. Malik. Lunar Satellite Observation Vector Construction using Non-rotating Origin and IAU2000A Precession-Nutation Model. *Conference on Advances in Space Science and Technology*, IIT Kharagpur, Jan. 2008.

C6. M. Sinha, **A. Halder**, R. Garhwal, A. K. Ghosh, N. S. Gopinath, and N. K. Malik. Lunar Gravity Field Modeling: A Critical Survey. *Conference on Advances in Space Science and Technology*, IIT Kharagpur, Jan. 2008.

C5. V. Agarwal, **A. Halder**, R. Garhwal, A. Gupta, S. Ghosh, S. Saxena, and M. Sinha. Inertial Characterization of Unmanned Aerial Vehicle AX-1. *4^{th} International Conference on Theoretical, Applied, Computational and Experimental Mechanics*, IIT Kharagpur, Dec. 2007.

C4. **A. Halder**, S. Ghosh, and M. Sinha. Fuzzy Quadtree based Path Planner and Trajectory Smoother for A Low Cost Unmanned Aerial Vehicle. *3^{rd} Indian International Conference on Artificial Intelligence*, Pune, Dec. 2007.

C3. R. Garhwal, **A. Halder**, and M. Sinha. Sensitivity Analysis using Neural Network for Estimating Aircraft Stability and Control Derivatives. *IEEE International Conference on Intelligent and Advanced Systems*, Kuala Lumpur, Nov. 2007.
doi:10.1109/ICIAS.2007.4658380

C2. R. Garhwal, **A. Halder**, and M. Sinha. An Adaptive Fuzzy State Noise Driven Extended Kalman filter for Real-time Orbit Determination. *58^{th} International Astronautical Congress*, Hyderabad, Sep. 2007.

C1. S. Ghosh, **A. Halder**, and M. Sinha. Path Planning for A Fixed Wing Micro Air Vehicle in Fuzzy Quadtree Framework. *7^{th} European Micro Air Vehicle Conference*, Toulouse, Sep. 2007.

Papers under review/revision

A. Halder. DeGroot-Friedkin Map in Opinion Dynamics is Mirror Descent.

K.F. Caluya, and **A. Halder**. Gradient Flow Algorithms for Density Propagation in Stochastic Systems.

K.F. Caluya, and **A. Halder**. Proximal Recursion for Solving the Fokker-Planck Equation.

A. Halder. Smallest Ellipsoid Containing p-Sum of Ellipsoids with Application to Reachability Analysis.

Z. Askarzadeh, R. Fu, **A. Halder**, Y. Chen, and T.T. Georgiou. Stability Theory in ℓ_1 for Nonlinear Markov Chains and Stochastic Models for Opinion Dynamics over Influence Networks.

Poster Presentations

P4. "Control of Large Scale Cyberphysical Systems". *IEEE CDC*, Las Vegas, NV, Dec. 12, 2016.

P3. "Boolean Microgrid: A Theory of Operation for the Load Serving Entity". *NSF CPS PI Meeting*, Arlington, VA, Oct. 31–Nov. 1, 2016.

P2. "Boolean Microgrid". *NSF CPS PI Meeting*, Arlington, VA, Nov. 16–17, 2015.

P1. "A Control System Framework for Privacy Preserving Demand Response of Thermal Inertial Loads". *Winedale Workshop*, Round Top, TX, Oct. 9, 2015.

Professional Activities

Referee Service

Journal (39)

- *IEEE Transactions on Automatic Control (1)*
- *Automatica (4)*
- *IEEE Transactions on Information Theory (1)*
- *IEEE Transactions on Control of Network Systems (1)*
- *AIAA Journal of Guidance, Control, and Dynamics (1)*
- *ASME Journal on Dynamic Systems, Measurement and Control (21)*
- *IET Control Theory & Applications (1)*
- *IEEE Transactions on Power Systems (2)*
- *IEEE Transactions on Smart Grid (4)*
- *IEEE Internet of Things Journal (1)*
- *Proceedings of the Royal Society A (1)*
- *Advances in Space Research (1)*

Conference (44)

- *American Control Conference 2019 (2)*
- *Indian Control Conference 2019 (2)*
- *IEEE Conference on Decision and Control 2018 (3)*
- *Mathematical Theory of Networks and Systems 2018 (1)*
- *American Control Conference 2018 (3)*
- *IEEE Conference on Decision and Control 2017 (3)*
- *IEEE Power & Energy Society General Meeting 2017 (1)*
- *American Control Conference 2017 (1)*
- *IEEE Conference on Decision and Control 2016 (3)*
- *American Control Conference 2016 (3)*
- *American Control Conference 2015 (4)*
- *IEEE Multi-conference on Systems and Control 2014 (1)*
- *IEEE Conference on Decision and Control 2014 (1)*
- *American Control Conference 2014 (3)*

- *IEEE Conference on Decision and Control 2013 (1)*
- *American Control Conference 2013 (4)*
- *American Control Conference 2012 (2)*
- *ASME Dynamic Systems and Control Conference 2012 (1)*
- *IEEE Conference on Decision and Control 2011 (1)*
- *IEEE Conference on Robotics and Automation 2010 (2)*
- *American Control Conference 2009 (1)*
- *IEEE International Conference on Intelligent and Advanced Systems 2007 (1)*

Synergistic Activities

- *Co-Chair*, Session: "Computational Methods II", IEEE Conference on Decision and Control 2018.
- *Chair*, Session: "Filtering", American Control Conference 2018.
- *Organizer (with R. Sanfelice, K. Goldberg, and R. Berenstein)*, CITRIS/CPAR Control Theory and Automation Symposium and 1st Norcal Control Workshop, University of California Santa Cruz, April 27, 2018.
- *Member* of the IEEE Control Systems Society (CSS) Technical Committee on "Systems with Uncertainty" (Jan 2018 – current).
- *Organizer (with P.R. Kumar and L. Xie)*, Invited Session: "Recent Advances in Control of Thermal Inertial Loads and DC Microgrid Stability", American Control Conference 2017.
- *Co-Chair*, Session: "Modeling", IEEE Conference on Decision and Control 2014.

Awards

Research Awards

- Outstanding Doctoral Student Award
  Department of Aerospace Engineering, Texas A&M University, 2014.
- Best Presentation in Session Award
  Session: 'Filtering', American Control Conference, Washington, D.C., 2013.
- Best Thesis Award (Dual Degree)
  Development of An Autonomous Reconfigurable UAV
  Department of Aerospace Engineering, IIT Kharagpur, INDIA 2008.

Travel Awards

- IMA Travel Support Award
  Workshop on Control at Large Scales: Energy Markets and Responsive Grids, IMA Thematic Year on Control Theory and its Applications, Minneapolis, 2016.
- IEEE Control Systems Society Student Travel Award
  American Control Conference, Portland, 2014.
- IEEE Control Systems Society Student Travel Award
  American Control Conference, Washington, D.C., 2013.
- IEEE Control Systems Society Student Travel Award
  51st IEEE Conference on Decision and Control, Maui, 2012.

Invited Talks (excluding conference talks)

T14. Mathematics/Statistics colloquium, San Jose State University, San Jose, CA, October 10, 2018.

T13. Center for Information Technology in the Interest of Society (CITRIS) "People and Robots" and "Design of Robotics and Embedded systems, Analysis, and Modeling" (DREAMS) Seminar, University of California, Berkeley, CA, February 12, 2018.

T12. Special Seminar at Jack Baskin School of Engineering, University of California Santa Cruz, CA, December 4, 2017.

T11. Second Annual Center for Research in Open Source Software (CROSS) Research Symposium, University of California Santa Cruz, CA, October 4, 2017.

T10. 32nd Southern California Control Workshop, Caltech, CA, April 21, 2017.

T9. Department of Aerospace Engineering, Mississippi State University, MS, April 13, 2017.

T8. Department of Mechanical and Aerospace Engineering, Syracuse University, NY, March 31, 2017.

T7. Department of Mechanical Engineering, University of Texas at Dallas, TX, March 20, 2017.

T6. Department of Applied Mathematics and Statistics, University of California Santa Cruz, CA, January 27, 2017.

T5. Comverge Inc., Denver, CO, December 5, 2016.

T4. Workshop on Architecture and Economics of the Future Grid, Texas A&M University, College Station, TX, November 3, 2016.

T3. Electric Power and Power Electronics Institute Seminar, Department of Electrical and Computer Engineering, Texas A&M University, College Station, TX, October 26, 2015.

T2. Schlumberger-Doll Research Center, Cambridge, MA, July 8, 2014.

T1. Department of Mechanical and Aerospace Engineering, University of Florida, Gainesville, FL, May 15, 2012.

Teaching Experience

University of California, Santa Cruz, Santa Cruz, California USA

Instructor for AMS 229: Convex Optimization **Fall 2018**

- Graduate level course: 12 students.
- Recognizing, analyzing and transforming convex optimization problems with focus on solving the same using `cvx` in MATLAB, Python or Julia.
- Course website: AMS229-F18

Instructor for AMS 20: Mathematical Methods for Engineers II **Spring 2018**

- Undergraduate level course: 131 students.
- Ordinary differential equations.
- Course website: AMS20-S18

Instructor for AMS 231: Nonlinear Control Theory **Winter 2018**

- Graduate level course: 16 students.
- Control of finite dimensional nonlinear systems.
- Course website: AMS231-W18

University of California, Irvine, Irvine, California USA

Co-lecturer for MAE 295: Networks and Control **Spring 2017**

- Graduate level course.
- Delivered in-class lectures on dynamics and control of multi-agent systems over networks.

Texas A&M University, College Station, Texas USA

Teaching Assistant for AERO 320: Numerical Methods **Fall 2013**

- Junior level undergraduate course.
- Designed and graded homeworks and tests.
- Designed lab assignments and conducted lab sessions for implementing the numerical methods in C++.
- Held help sessions.
- Course material: abhishekhalder.org/Aero320Fall2013

Grader for ENGR 111: Foundations of Engineering **Fall 2009**

- Freshman level undergraduate course.
- Graded weekly assignments on engineering mechanics and statistics.
- Held weekly help sessions.

Indian Institute of Technology Kharagpur, West Bengal INDIA

Instructor for AE21008: Introduction to Flight Vehicle Controls **Spring 2008**

- Sophomore level undergraduate course.
- Delivered in-class lectures on the basics of feedback control systems, block diagrams, dynamic system modeling and response, designing PID controller, root-locus design, frequency response design, state space design.

Mentoring and Advising

Doctoral Students

- Primary supervisor: Kenneth Caluya (Applied Mathematics). Fall 2017 – present.
- Ph.D. Committee Member: Dawn Hustig-Schultz (Electrical and Computer Engineering). Fall 2018 – present.
- Ph.D. Committee Member: Richard Shaffer (Applied Mathematics). Fall 2017 – present.

Masters Students

- Primary supervisor: Lia Gianfortone (Applied Mathematics). Fall 2017 – Summer 2018.
- M.S. Thesis Committee Member: Wuyuan Chen (Electrical and Computer Engineering). Fall 2018 – present.
- M.S. Thesis Committee Member: Yegeta Zeleke (Electrical and Computer Engineering). Fall 2018 – present.
- M.S. Thesis Committee Member: Marcello Guarro (Electrical and Computer Engineering). Spring 2018 – present.

Professional Membership

IEEE Control Systems Society (CSS)