

Kshitij Jerath

My overarching research goal is to advance the understanding of complex dynamics observed in large-scale self-organizing systems, and to develop bottom-up control algorithms that guide such systems to desired states via minimal intervention. My current work focuses on robotic swarms and transportation networks with emphasis on the role of a small set of agents in influencing macro-scale system dynamics. In the future I intend to apply the developed tools to diverse networked systems such as social ensembles, system reliability, and neural systems.

EDUCATION

Ph.D., Mechanical Engineering, The Pennsylvania State University 2014

Location: University Park, PA

Advisors: Dr. Sean Brennan and Dr. Asok Ray

Thesis title: *Influential subspaces in self-organizing multi-agent systems*

M.S., Electrical Engineering, The Pennsylvania State University 2014

Location: University Park, PA

Advisors: Dr. Constantino Lagoa

Paper title: *Sensor noise modeling, characterization and simulation: An Allan variance tutorial*

M.S., Mechanical Engineering, The Pennsylvania State University 2010

Location: University Park, PA

Advisor: Dr. Sean Brennan

Thesis title: *Impact of adaptive cruise control on the formation of self-organized traffic jams on highways*

B.Tech., Mechanical and Automation Engineering, Amity School of Engineering and Technology 2006

Location: New Delhi, India

Advisors: Dr. S B L Garg and Dr. Keshavendra Chaudhary

Thesis title: *Unmanned aerial vehicle for terrain monitoring*

WORK EXPERIENCE

Assistant Professor at Washington State University 2015 – 2018

- Established the Emergent Dynamics, Controls, and Analytics Lab (Exalabs) – advised four graduate and five undergraduate researchers
- Conducted research on complex systems, swarm robotics, connected autonomous vehicles, UAVs, and virtual reality interfaces for controlling robotic swarms
- Taught undergraduate courses on system dynamics (ME 348), mechatronics (ME 401), control systems (ME 481) and Fundamentals of Engineering Exam review course (ME 466); prepared graduate course on swarm robotics
- Submitted research and education proposals to NSF, DoE, DARPA, and WSU
- Faculty advisor for WSU Aerospace club

E-mail: kshitij_jerath@uml.edu

Website: selforganizing.systems

Phone: (978) 934-5657

209 Dandeneau Hall, 1 University Avenue, Lowell, MA 01854

Post-doctoral scholar at The Pennsylvania State University 2014 – 2015

- Incorporated sensor systems into vehicle conceptual design and mission analysis for unmanned aerial systems as a post-doctoral scholar in the Department of Aerospace Engineering

Instructor at The Pennsylvania State University 2013 – 2015

- Primary instructor for senior-level course on Aerospace Control Systems (AERSP 460) and junior-level course on Vibration of Mechanical Systems (ME 370) in Fall 2013
- Held classes and office hours, assigned homework, conducted exams and assessed student performance

Graduate Teaching Assistant at The Pennsylvania State University 2011 – 2013

- Held recitation classes, and graded exams and homework assignments for:
 - Graduate-level course on Digital Signal Processing (ACS 513)
 - Senior-level course on Modeling of Dynamic Systems (ME 450)
 - Junior-level course on Vibration of Mechanical Systems (ME 370)

Graduate Research Assistant at The Pennsylvania State University 2007 – 2011

- Developed theory and performed simulations to study effect of intelligent vehicles on traffic flow
- Implemented and experimentally validated real-time vehicle tracking algorithms using low-cost sensors
- Performed data analysis and generated failure models for transit buses and its components
- Published papers at conferences and in peer-reviewed journals

Research Associate (Intellectual Property) at Evalueserve 2006 – 2007

- Drafted patents for inventions in various domains including navigation/mechanical devices, and web utilities
- Performed invalidation searches for utility and design patents
- Performed patent landscape study of aircraft health monitoring systems for leading aircraft manufacturer

RESEARCH AND ENGINEERING EXPERIENCE

Identifying influential subspaces of agents in self-organizing multi-agent systems 2013 – Present

- Developed framework for evaluating agent influence in networked multi-agent systems
- Identified influential subspaces on highways where connected vehicles impact dynamics of self-organized jams
- Performed observability analysis for reduced order models of complex nonlinear traffic dynamics

Sensor-driven conceptual design for small unmanned aerial system (UAS) 2014 – Present

- Developed simulation framework for photorealistic simulations of UAS waypoint navigation missions
- Performed Monte Carlo simulations of navigation missions with on-board lidars and cameras

Top-down controllers for swarm robotics 2015 – Present

- Created efficient controllers and exploration-coverage algorithms for robotic swarms
- Developed virtual reality capabilities for human gesture based control of robotic swarms using Unreal

E-mail: kshitij_jerath@uml.edu

Website: selforganizing.systems

Phone: (978) 934-5657

209 Dandeneau Hall, 1 University Avenue, Lowell, MA 01854

Studying the effects of intelligent and connected vehicles on traffic flow dynamics	2008 – Present
<ul style="list-style-type: none"> • Generated and analyzed stochastic models of traffic jam dynamics • Analyzed the effect of variations in parametric driver models on the formation of traffic jams • Performed microscopic simulations of traffic flow using statistical mechanics-inspired models 	
Human detection in complex construction environments	2012
<ul style="list-style-type: none"> • Conducted proof-of-concept study for major construction equipment manufacturer to detect humans at construction sites using LIDAR 	
GPS-free terrain-based vehicle tracking	2009 – 2011
<ul style="list-style-type: none"> • Developed noise models for simulating low-cost sensors • Implemented real-time vehicle tracking with simulated low-cost sensors using Sigma Point Kalman filters in absence of GPS • Implemented vehicle tracking on large road networks using multiple model estimation schemes 	
Reliability analysis of in-service transit buses	2007 – 2009
<ul style="list-style-type: none"> • Analyzed failure rate data from transit buses and Larson Transportation Institute bus testing program using regression and Hidden Markov models • Generated performance comparison scheme for bus models and agencies 	
Unmanned aerial vehicle	2006
<ul style="list-style-type: none"> • Designed, built and flew an R/C Unmanned Aerial Vehicle (UAV) • Initiated project idea, formed and managed a group of 10 persons for 5 months • Performed feasibility studies for various design specifications 	
Testing of Hydraulic Control Unit on Airbus A320	2005
<ul style="list-style-type: none"> • Observed assembly, disassembly and maintenance procedures for jet engines (IAE V2500 and Pratt and Whitney JT8D) at the Jet Engine Overhaul Complex (JEOC), New Delhi, India • Helped develop in-house testing setup for the Hydraulic Control Unit (HCU) of the Nose wheel steering system on the Airbus A320 at the Aircraft Accessory Overhaul Shop, Indian Airlines Ltd., New Delhi, India 	
Anti-Lock Braking System (ABS)	2004
<ul style="list-style-type: none"> • Designed and built an anti-lock braking system for hydraulic brakes of a compact car using 3-way solenoid valve and induction proximity sensor 	

GRANTS

NSF: Scale-dependent observability of emergent dynamics (PI: Jerath)	2017 – 2020
<ul style="list-style-type: none"> • Awarded through CMMI Dynamics, Control and System Diagnostics (DCSD) program • Assess optimal scale to observe and predict complex traffic flow dynamics using connected vehicles 	

PUBLICATIONS

Journal Publications

1. **K. Jerath**, S. Brennan, and C. Lagoa, *Bridging the gap between sensor noise modeling and sensor characterization*, Measurement (In Press), 2017
2. **K. Jerath**, A. Ray, S. Brennan, and V. V. Gayah, *Dynamic prediction of vehicle cluster distribution: A statistical mechanics-inspired approach*, IEEE Transactions on Intelligent Transportation Systems, vol. 16, no. 5, 2015
3. **K. Jerath** and S. Brennan; *Analytical Prediction of Self-Organized Traffic Jams as a Function of Increasing ACC Penetration*, IEEE Transactions on Intelligent Transportation Systems, vol. 13, no. 4, 2012
4. J. Yutko, **K. Jerath**, and S. Brennan; *A Failure Rate Analysis of Complex Vehicles*, International Journal of Heavy Vehicles and Systems, vol. 17, no. 1, 2010

Manuscripts submitted for Journal Publication / at Conference Venues

5. T. Kim, and **K. Jerath**; *Congestion-aware Cooperative Adaptive Cruise Control and Mitigation of Self-Organized Traffic Jams*, submitted to IEEE Transactions on Intelligent Transportation Systems
6. M. Scott, and **K. Jerath**; *Sensor-based Conceptual Design of Small UASs in Photorealistic Environments*, submitted to Journal of Aircraft
7. **K. Jerath**, V. V. Gayah, and S. Brennan; *Event Horizons and Influential Subspaces of Connected Vehicles*, submitted to Transportation Research Part B: Methodological
8. H. Haeri, **K. Jerath**, and J. Leachman; *Thermodynamics-inspired Modeling of Macroscopic Swarm States*, submitted to American Control Conference 2019

Publications in Refereed Conference Proceedings

9. M. Scott, and **K. Jerath**, *Multi-robot Exploration and Coverage: Entropy-based Adaptive Maps with Adjacency Control Laws*, American Control Conference 2018, Milwaukee, WI
10. Z. Yang, and **K. Jerath**, *Examining the Observability of Emergent Behavior as a Function of Reduced Model Order*, American Control Conference 2018, Milwaukee, WI
11. M. Scott, and **K. Jerath**; *Mission Performance Evaluation of Low-speed Small Unmanned Aerial Systems using Virtual Range and Stereo Camera Sensors*, AIAA Unmanned Systems Conference, 2018, Kissimmee, FL, USA
12. T. Kim, and **K. Jerath**; *Mitigation of self-organized traffic jams using cooperative adaptive cruise control*, 2016 International Conference on Connected Vehicles and Expo (ICCVE), 2016, Seattle, WA, USA
13. **K. Jerath**, and J. Langelaan; *Simulation Framework for UAS Conceptual Design*, AIAA Modeling and Simulation Technologies Conference, 2016, San Diego, CA, USA
14. **K. Jerath** and S. Brennan; *Identification of locally influential agents in self-organizing multi-agent systems*, American Control Conference 2015, Chicago, IL, USA
15. **K. Jerath**, V. V. Gayah, and S. Brennan; *Influential Subspaces of Connected Vehicles in Highway Traffic*, Symposium Celebrating 50 Years of Traffic Flow Theory, TRB Committee on Traffic Flow Theory and Characteristic, 2014, Portland, OR, USA
16. **K. Jerath**, A. Ray, S. Brennan, and V. Gayah; *Statistical Mechanics-inspired Framework for Studying the Effects of Mixed Traffic Flows on Highways*, Proceedings of American Control Conference, 2014, Portland, OR, USA
17. **K. Jerath** and S. Brennan; *GPS-Free Terrain-based Vehicle Tracking on Road Networks*, Proceedings of American Control Conference, 2012, Montreal, Canada

18. **K. Jerath** and S. Brennan; *GPS-Free Terrain-based Vehicle Tracking Performance as a function of Inertial Sensor Noise Characteristics*, Proceedings of Dynamic Systems and Control Conference, 2011, Arlington, VA, USA
19. **K. Jerath** and S. Brennan; *Adaptive Cruise Control: Towards higher traffic flows, at the cost of increased susceptibility to congestion*, Proceedings of AVEC10, 2010, Loughborough, UK
20. R. Deshpande, D. Johar, A. Kasyap, C. Feng, **K. Jerath**, and Z. Li; *Intellectual Property Monetization by R&D Organizations in India and China*, Proceedings of the International Symposium on the Management of Technology, 2007, Hangzhou, PRC

Technical Reports and Other Publications

21. **K. Jerath**; *Influential subspaces in self-organizing multi-agent systems*, Ph.D. dissertation, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University, 2014
22. S. Brennan, P. Vemulapalli, **K. Jerath**, M. Robinson, M. Guo, *Human detection to increase safety in complex construction environments*, Technical report, Penn State/Volvo Construction Equipment, 2012
23. **K. Jerath**; *Cooperative Intelligent Vehicles: Are we there yet?*, Award-winning entry to the ITSA Student Essay Competition, 2012
24. **K. Jerath**; *Impact of Adaptive Cruise Control on the Formation of Self-Organized Traffic Jams on Highways*, M.S. Thesis, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University, 2010
25. S. Brennan, **K. Jerath**, D. Klinikowski, S. Muthiah, and J. Yutko, *Study of the relationship between results of the Bus Testing Program and in-service performance of buses*, Technical Report, The Pennsylvania State University, 2008

TEACHING EXPERIENCE

University of Massachusetts at Lowell	2018 – Present
<ul style="list-style-type: none"> • MECH 4510: Dynamic Systems Analysis 	
Washington State University	2015 – 2018
<ul style="list-style-type: none"> • ME 348: System Dynamics • ME 401: Mechatronics • ME 481: Control systems (introduced robotics-based projects to enhance learning outcomes) 	
Penn State University	2013 – 2014
<ul style="list-style-type: none"> • AERSP 460: Aerospace Control Systems • ME 370: Vibrations of Mechanical Systems 	

HONORS

- Awarded **Best Presentation in Session** at the American Control Conference, 2014
- Received the **Kulakowski Travel Award** by the Department of Mechanical and Nuclear Engineering at The Pennsylvania State University, 2014
- **Media coverage**: Research mentioned in **Society of Industrial and Applied Mathematics News** – “*Smells like a traffic jam*”, November 2013
- Awarded **Graduate Teaching Fellowship** by Department of Mechanical and Nuclear Engineering at The Pennsylvania State University, 2013

E-mail: kshitij_jerath@uml.edu

Website: selforganizing.systems

Phone: (978) 934-5657

209 Dandeneau Hall, 1 University Avenue, Lowell, MA 01854

- Awarded **Best Presentation in Session** at the American Control Conference, 2012
- Awarded **2nd place in Student Essay Competition** organized by Intelligent Transportation Society of America, 2012 for essay titled “*Cooperative intelligent vehicles: are we there yet?*”
- Awarded **Scholar’s Gold Medal** in 2000 for sustained academic excellence over a period of six years in high school.
- Awarded **National Merit-cum-Means Scholarship** under National Scholarship Scheme of the Govt. of India for ‘outstanding performance in the Board’s Secondary School Examination 2000’.
- Awarded **Certificate of Merit** by CBSE for being among the top 0.1 % of successful candidates in All India Secondary School Examination, 2000, in science.

PROFESSIONAL AND OTHER ACTIVITIES

- **Member of**
 - ASME Automotive and Transportation Systems (ATS) Technical Committee
 - IEEE Intelligent Transportation Systems Society (ITSS)
 - IEEE Systems, Man, and Cybernetics Society (SMC)
 - American Institute of Aeronautics and Astronautics (AIAA)
 - American Society for Engineering Education (ASEE)
- **Reviewer for**
 - IEEE Transactions on Intelligent Transportation Systems
 - IEEE Intelligent Transportation Systems Magazine
 - IEEE Transactions on Vehicular Technology
- **Reviewed proposals** as part of NSF review panel, and for Canada Foundation for Innovation (CFI)
- University and department committees: Member of UAS drone safety committee (WSU Department of Environmental and Health Safety), Undergraduate Studies committee (MME department), and Website redesign committee (MME department)
- Participated in active learning workshop organized by the National Effective Teaching Institute
- Advised WSU Aerospace club for the Intercollegiate Rocket Engineering Competition (IREC) since 2015
- **Organized invited session** titled “*Influence in multi-agent systems*” at the **American Control Conference (ACC)** 2015 in Chicago, IL
- **Session chair** at the College of Engineering Research Symposium, 2014 organized at Penn State for session titled “*Systems, Control and Communication*”
- **Member, Penn State Robotics Club and Intelligent Ground Vehicle Competition (IGVC) Team:** 2007-2009
- **Coordinator of Student Activities, SAE Student Chapter at Amity School of Engineering and Technology:** 2005-2006

COMPUTER SKILLS

- Languages: C, C++, Python, Java, HTML and CSS, R, SQL
- Tools handled: Robot Operating System (ROS), Blender, Modular Open Robot Simulation Engine (MORSE), Matlab, Simulink, Scilab, RePast Symphony, QuaRC, AutoCAD, MiniTab
- Proficient in MS Word, LaTeX, MS PowerPoint, and MS Excel