25th October 2023

Rahul Mangharam

University of Pennsylvania, Philadelphia, PA, USA 19104
Tel: (217) 573-3636 | Email: rahulm@seas.upenn.edu | Web: http://www.seas.upenn.edu/~rahulm

ACADEMIC EXPERIENCE

Associate Professor (Tenured) May 2014 – present
Dept. of Electrical and Systems Engineering
Dept. of Computer and Information Science (Secondary)
University of Pennsylvania, Philadelphia, PA

Stephen J. Angello Term Chair Assistant Professor March 2008 – May 2014
University of Pennsylvania, Philadelphia, PA
Department of Electrical and Systems Engineering
Department of Computer and Information Science (Secondary)

EDUCATION

Ph.D. in Electrical and Computer Engineering March 2008
Carnegie Mellon University, Pittsburgh, PA
Dissertation: "Real-Time Embedded Wireless Networks: Algorithms and Experiences"
Advisor: Prof. Ragunathan (Raj) Rajkumar

M.S. in Electrical and Computer Engineering August 2002
Carnegie Mellon University, Pittsburgh, PA
Thesis: "Size Matters: Size-based Scheduling for MPEG-4 over Wireless Channels"
Advisor: Prof. Ragunathan (Raj) Rajkumar

B.S. in Electrical and Computer Engineering May 2000
Carnegie Mellon University, Pittsburgh, PA

RESEARCH INTERESTS

Building safe autonomous systems for life-critical cyber-physical system domains in medical devices and autonomous vehicles. Applied formal verification of learning-based perception, planning and control systems.

LEADERSHIP

Penn Director, Safety21 DoT University Transportation Center ($20 million center) May 2023–present
Director, Autoware Center of Excellence for Autonomous Driving (22 University Consortium) May 2021–present
Board Member, The Autoware Foundation (70+ Industry Consortium) May 2021–present
Founding Director, F1Tenth Foundation (80+ university education and outreach program) May 2016–present
Penn Director, Mobility21 DoT University Transportation Center ($17 million center) May 2016– 2023
Director, xLAB, Safe Autonomous Systems Laboratory May 2008–present
Founding Member, PRECISE Center May 2008–present

AWARDS AND HONORS

US Presidential Early Career Award for Scientists and Engineers (PECASE) May 2016
Highest honor bestowed by the United States government on outstanding scientists and engineers in the early stages of their independent research careers. For developing techniques to make medical device software safe.

Department of Energy CLEANTECH $50K Prize (Regional) March 2016
For Data-driven modeling, control and tools for Demand Response

IEEE Benjamin Franklin Key Award April 2014
For outstanding technical innovation and contributions that have had significant practical applications

NSF CAREER Award March 2013
Foundations of Medical Cyber-Physical Systems

Intel Early Faculty Career Award November 2012
Selected as one among top 20 academics internationally

National Academy of Engineers, US Frontiers of Engineering Symposium September 2012 and 2017
Awarded to top 15 engineers under 45 years, nation-wide.

1st Prize in World Embedded Software Competition (Medical Devices), Korea November 2012
Korean Ministry of Knowledge Economy and Electronics and Telecommunications Research Institute (ETRI)

1st Prize in Honeywell User Group OneWireless Competition June 2011
Awarded for innovation in next generation of wireless control for industrial automation

1st Prize in World Embedded Software Competition, Korea November 2010
Korean Ministry of Knowledge Economy and Electronics and Telecommunications Research Institute (ETRI)

Stephen J. Angello Term Chair in Electrical & Systems Engineering Fall 2008
University of Pennsylvania

Best Paper Award Summer 2006
IEEE Conference on Sensor, Mesh and Ah hoc Communications and Networks (SECON)

Sixth Annual Lockheed Martin ECE Project Award Spring 2006
ECE Department, Carnegie Mellon University

Sigma Xi Award Spring 2006
ECE Department, Carnegie Mellon University

Eta Kappa Nu Research Award Spring 2002
Meeting of the Minds University Research Award, Carnegie Mellon University

RESEARCH AWARDS with my students

1. **First Prize Autonomous Electric Go-karting Competition** 2023
   US Autonomous Karting Series at Purdue University
2. **Winner 10th International F1Tenth Autonomous Racing Competition at ICRA** 2023
   International Conference on Robotics and Automation
3. **Winner International JSAE Autonomous Driving Competition** 2022
   Japan Society of Automotive Engineers
4. **DASD Best of Session Award** 2020
   Drone Conflict Management at the 39th Digital Avionics Systems Conference
5. **SIGCSE** 2nd **Best Paper Award** for Curricula Initiatives 2020
   ACM Technical Symposium on Computer Science Education (SIGCSE)
6. **NeurIPS Best Demonstration Award** (Runner-up) 2019
   34th Annual Conference on Neural Information Processing Systems (NeurIPS)

7. **ICCPS Best Paper Award** 2018
   ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)
8. **ACC Best Paper Award** (Energy Systems) 2017
   American Control Conference (ACC)
9. **BUILDSYS Best Presentation Award** 2016
   ACM International Conference on Embedded Systems for Energy-Efficient Built Environments (BUILDSYS)
10. **TECHCON Best in Session Award** 2015
    SRC TECHCON for Data-Predictive Control of Smart Buildings
11. **1st Prize in World Embedded Software Competition, Korea** 2014
    Korean Ministry of Knowledge Economy and Electronics and Telecom Research Institute (ETRI)
12. **TECHCON Best in Session Award** 2015
    SRC TECHCON for Model-based Medical Cyber-Physical Systems
13. **RTAS IEEE Best Student Paper Award** 2012
    IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS) at CPS Week, Beijing
14. **BuildSys Best Demonstration Award** 2012
    ACM International Conference on Embedded Systems for Energy-Efficient Built Environments (BUILDSYS)
15. **IPSN Best Paper Presentation Award** 2012
    ACM IPSN Conference, Cyber-Physical Systems Week, Beijing
16. **9th World Embedded Systems Programming Contest,** Seoul, Korea – 3rd Prize 2012
    ProtoDrive Electric Vehicle Platform (William Price, Harsh Jain, Yash Pant)
17. **1st Prize Winner of SEAS Senior Design Project** 2012
    Pacemaker Verification System (Varun Sampath, Shilpa Sarode and Sriram Radhakrishnan)
18. **Intel Innovators $50K Award -** Haptic belt for the blind (Eric Berdinis and Jeff Kiske, CE). 2012
19. **IEEE President's Award**, Finalist 2012
    Pacemaker Verification System (Varun Sampath, Shilpa Sarode and Sriram Radhakrishnan).
20. **Honorable Harold Berger Award** for Best ESE Senior Design Project 2012
    Pacemaker Verification System (Varun Sampath, Shilpa Sarode and Sriram Radhakrishnan)
21. **Intel/Cornell Embedded Systems Cup – People's Choice Award** 2012
    Haptic Belt for the Blind (Eric Berdinis and Jeff Kiske, CE)
22. **Intel/Cornell Embedded Systems Cup – Project Award** 2012
    HAWK: Helicopter Aircraft Wielding Kinect by K. Conley, M. Hale, P. Gurniak and T. Zhang
23. **Honorable Mention Award** for Senior Design Project 2012
    HAWK: Helicopter Aircraft Wielding Kinect by K..Conley, M. Hale, P. Gurniak and T. Zhang
24. **TACAS Best Paper Award Nominee** 2012
    18th Intl. Conf. on Tools and Algorithms for the Construction & Analysis of Systems (TACAS)
25. **Accenture Health 2.0 Conference Winners** 2012
    viSparsh: Haptic Belt for the Blind by J. Sharma, T. Chugh, R. Seth of Young India Fellowship Program
26. **Frederick Ketterer Memorial Award for Best Senior Design Project** 2011
    RAVEN: Remote Aerial Vehicle for Search and Rescue (Paul Martin and William Etter Jr., ESE)
27. **Winner of 1st Prize Senior Design Award**, CIS Department 2011

AutoPlug: Automotive Architectures for Remote Vehicle Controls Testing by G. Torres, R. Boczar & J. Suapengco

28. **Google Zeitgeist Young Minds Award** 2011
Haptic Belt for the Blind by Eric Berdinis and Jeff Kiske

29. **Accenture Innovation Jockeys** (Powered by Yahoo!) **Grand Finale Winner** 2011
viSparsh – Haptic belt for the blind by J. Sharma, T. Chugh and R. Seth, from Young India Fellowship Program

30. **8th World Embedded Programming Competition**, **Grand Prize Winner** 2010
AutoPlug: Plug-n-Play Architectures for Automotive Systems (Kevin Conley, ESE)

31. **Provost's Distinguished International Research Award**, University of Pennsylvania. 2010

32. **Wharton Interactive Media Initiative Award**, University of Pennsylvania. 2009

33. **University Research Foundation Award**, University of Pennsylvania. 2009

34. **Honorable Harold Berger Award for Best ESE Senior Design Project** 2009
Vehicle-to-Vehicle Communications Networks by Brandon Duick, Danny Lustig and Andrew Avrin, ESE

RESEARCH GROUP

1. Jiyue He (Ph.D. Candidate, ESE) Expected graduation Dec 2023
CyberCardia: Patient-specific electrophysiological heart model for assisting left atrium arrhythmia ablation therapy.
2. Hongrui Zheng (Ph.D. Candidate, ESE) Expected graduation May 2025
MAD-Games: Multi-Agent Dynamic Games
3. Nandan Tumu (Ph.D. Candidate, ESE) Expected graduation Dec 2025
Physics-Informed Machine Learning
4. Zirui Zang (Ph.D. Candidate, CIS) Expected graduation Dec 2025
Learning-based localization and perception in autonomous machines
5. Shuo Yang (Ph.D. Candidate, ESE) Expected graduation Dec 2025
Safe Learning-based Control
6. Ahmad Amine (Ph.D. Candidate, ESE) Expected graduation May 2026
Learning Introspective Control
7. Luigi Berducci (Visiting Ph.D. Candidate, TU Vienna)
Learning Adaptive Safety for Multi-Agent Systems
8. Raj Anadkat (MS, MEAM-Robotics)
Shared Autonomy for Cognitively Compromised Drivers
9. Jason Friedman (MS, MEAM-Robotics)
Autonomous Electric Go-Kart vehicle development
10. Jonathan Schoeffling (MS, MEAM-Robotics)
Autonomy Essentials Kit for autonomous vehicles
11. Tejas Agarwal (MS, Robotics)
AV4EV Open-source Autonomous Vehicle software for Open-standards Electric Vehicle platforms
12. Mingyan Zhou (MS, Robotics)
MEGA-DAgger: Imitation Learning with Multiple Imperfect Experts

13. Hoyil Lai (MS, ESE)
    All-wheel steering vehicle with torque vectoring for stability control
14. Stephanie (Yujie) Wu (Undergraduate, Mathematics, Economics (honors), English)
    Multi-Agent Games
15. Eshan Singhal (Undergraduate, VIPER Program)
    All-wheel steering vehicle with torque vectoring for stability control
16. Chandravaran Kunjeti (MS, Robotics)
    LiDAR Mapping algorithms for Construction Robots
17. Jason Xie (MS, Robotics)
    LiDAR Mapping systems for Construction Robots
18. Zain Khan, Riju Datta, Anshul Sukhlecha, George Wang (Undergraduate, CIS)
    GitHealth Senior Design Project

ALUMNI

1. **[Faculty]** Dr. Johannes Betz (Postdoctoral Fellow, 2020-2022)
   Designing Safe Autonomous Systems.
   Currently Assistant Professor at Technical University of Munich.
2. [**Postdoc**] Kuk Jang (Ph.D., ESE, 2021)
   Dissertation: "Computer-Aided Clinical Trials".
   Currently post-doc with Prof. Insup Lee, UPenn.
3. **[Startup]** Matthew O'Kelly (Ph.D. ESE, 2021)
   Dissertation: "Accelerated Risk Assessment and Domain Adaptation for Autonomous Vehicles".
   Startup Trustworthy.AI acquired by Waymo/Google. Currently Senior Scientist at Waymo.
4. **[Faculty]** Yash V. Pant (ESE, 2019)
   Dissertation: "Safe Planning and Control of Autonomous Systems: Robust Predictive Algorithms".
   Postdoc at Berkeley (Sanjit Seshia, Claire Tomlin & Shankar Sastry).
   Currently Tenure-track Assistant Professor at University of Waterloo.
5. **[Faculty]** Houssam Abbas (Postdoctoral Fellow, 2015-2018)
   Hybrid Systems and Formal Verification
   Currently Tenure-track Assistant Professor at Oregon State Uni., Electrical Engineering & Computer Science.
6. [**Industry**] Marco Beccani (Postdoctoral Fellow, ESE, 2015-2017)
   Medical devices for Computer-Aided Clinical Trials
   Currently at Sr. Hardware Engineer at Apple
7. **[Faculty]** Zhihao Jiang (CIS, 2017)
   Dissertation: "From Verified Model to Verified Code for Safe Medical Devices".
   Currently Tenure-track Assistant Professor at ShanghaiTech University, School of Info. Science & Tech.
8. **[Faculty]** Madhur Behl (ESE, 2017)
   Dissertation: "Data-Driven Modeling, Control and Tools for Cyber-Physical Energy Systems."
   Currently, Associate Professor (Tenured) at University of Virginia, Department of Computer Science and Department of Systems & Information Engineering
9. **[Faculty]** Miroslav Pajic (ESE, 2012)
   Dissertation: "Closing the Loop: Architectures and Algorithms for Real-Time Control over Wireless Networks" Joseph and Rosaline Wolf Best Dissertation Award. Network Controlled Cyber-Physical Systems.
   Currently, Associate Professor (Tenured) at Duke.

10. **[Faculty]** Truong X. Nghiem (ESE, 2012)
    Dissertation: "Green Scheduling for Energy Systems" (co-advised with George Pappas). Post-doc at EPFL
    Currently, Associate Professor (Tenured) at Northern Arizona University
11. [**Industry**] Dr. Jinsung Kim, (Visiting Scholar, 2020) - Senior Research Engineer, Powertrain Performance Development Center, R&D Division, Hyundai Motor Company, Republic of Korea

PUBLICATIONS (JOURNALS)

My students are underlined

1. Jiyue He, Arkady Pertsov, John Bullinga, **Rahul Mangharam**, "Individualization of atrial tachycardia models for clinical applications: Performance of fiber-independent model", *IEEE Trans. on Biomedical Eng, 2023.*
2. Yang, Shuo; Chen, Shaoru; Preciado, Victor M; **Mangharam, Rahul**; "Differentiable Safe Controller Design through Control Barrier Functions." *IEEE Control Systems Letters + IEEE Conf. on Decision & Control,* 2023
3. He, Jiyue; Pertsov, Arkady M; Cherry, Elizabeth M; Fenton, Flavio H; Roney, Caroline H; Niederer, Steven A; Zang, Zirui; **Mangharam, Rahul**; "Fiber Organization has Little Effect on Electrical Activation Patterns during Focal Arrhythmias in the Left Atrium", *IEEE Transactions on Biomedical Engineering, 2023.* **Feature Article**
4. Betz, Johannes; Zheng, Hongrui; Liniger, Alexander; Rosolia, Ugo; Karle, Phillip; Behl, Madhur; Krovi, Venkat; **Mangharam, Rahul**; "Autonomous vehicles on the edge: A survey on autonomous vehicle racing." *IEEE Open Journal of Intelligent Transportation Systems*, 2022.
5. Qiao, Zhijie; Loeb, Helen; Gurrla, Venkata; Lebermann, Matt; Betz, Johannes; Mangharam, Rahul; "Drive Right: Promoting Autonomous Vehicle Education Through an Integrated Simulation Platform", *SAE International Journal of Connected Autonomous Vehicles* 5(4):357-366, 2022.
6. Y. V. Pant, M. Z. Li, A. Rodionova, R. A. Quaye, H. Abbas, M. Ryerson, **R. Mangharam**. "FADS: Framework for Autonomous Drone Safety." In *IEEE Transactions on Intelligent Transportation Systems, Special Issue on Unmanned Aircraft System Traffic Management.* Transportation Research Part C: Emerging Technologies, Volume 130, 2021, https://doi.org/10.1016/j.trc.2021.103275
7. A. Rodionova, Y. V. Pant, , C. Kurtz, K. J. Jang, **R. Mangharam**. Learning-'N-Flying: A Learning-based, Decentralized Mission Aware UAS Collision Avoidance Scheme. ACM Transactions on Cyber-Physical Systems (TCPS) 5 (2021): 1 - 26.
8. D. Karthik, M. O'Kelly, H. Zheng, S. Singh, and **R. Mangharam**, "Bridging the Sim-to-Real Gap for Reinforcement Learning with F1/10 Autonomous Racing". *Proceedings of Machine Learning Research (PMLR)*. 2020.
9. F. Smarra, G. D. Di Girolamo, V. De Iuliis, A. Jain, **R. Mangharam**, and A. D'Innocenzo "Data-driven Switching Modeling for MPC using Regression Trees and Random Forests", *Nonlinear Analysis: Hybrid Systems, A journal of IFAC, the International Federation of Automatic Control.* 2020
10. Y. V. Pant, H. Abbas, K. Mohta, R. A. Quaye, T. X. Nghiem, J. Devietti, **R. Mangharam**. Anytime Computation and Control for Autonomous Systems. IEEE Transactions on Control Systems Technology. 2021.
11. Houssam Abbas, Rajeev Alur, Konstantinos Mamouras, **R. Mangharam**, and Alena Rodionova, "Real-time Decision Policies with Predictable Performance", *Proceedings of the IEEE* 106(9). August 2019
12. Francesco Smarra, Achin Jain, Tullio de Rubeis, Dario Ambrosini, Alessandro D'Innocenzo and **R. Mangharam**. Data-driven model predictive control using random forests for building energy optimization and climate control. *Journal of Applied Energy*, 2018.
13. A. Jain, F. Smarra, M. Behl, **R. Mangharam**, "Data-driven Model Predictive Control with Regression Trees – An Application to Building Energy Management" *ACM Transactions on Cyber-Physical Systems*, Volume 2 Issue 1, February 2018.

14. Achin Jain, Madhur Behl, and **R. Mangharam**, "Data Predictive Control for Cyber-Physical Energy Systems", *ACM Transactions on Cyber-Physical Systems*, Vol. 9, No. 4, Article 39. July 2017.
15. Zhihao Jiang, Houssam Abbas, Pieter J. Mosterman, and **Rahul Mangharam**; "Automated closed-loop model checking of implantable pacemakers using abstraction trees". *SIGBED Rev.* 14, 2 (March 2017), 15–23. https://doi.org/10.1145/3076125.3076127
16. Behl, M. and **Mangharam, R**. "Data-Driven Modeling, Control, and Tools for Smart Cities". In *Smart Cities (eds H. Song, R. Srinivasan, T. Sookoor and S. Jeschke)*. 2017. https://doi.org/10.1002/9781119226444.ch9
17. Wendy Nilsen, Emre Ertin, Eric B. Hekler, Santosh Kumar, Insup Lee, **Rahul Mangharam**, Misha Pavel, James M. Rehg, William Riley, Daniel E. Rivera & Donna Spruijt-Metz; "Modeling Opportunities in mHealth Cyber-Physical Systems". *Mobile Health. Springer*, Cham. https://doi.org/10.1007/978-3-319-51394-2_23
18. Madhur Behl, Francesco Smarra, and **R. Mangharam**, "DR-Advisor: A Data-Driven Demand Response Recommender System", *Journal of Applied Energy*. January 2016.
19. Zhihao Jiang; Houssam Abbas; Kuk Jin Jang; Rahul Mangharam; "The Challenges of High-Confidence Medical Device Software*". IEEE Computer* (Volume: 49, Issue: 1, January 2016)
20. Z. Jiang and **R. Mangharam**. "High-Confidence Medical Device Software Development". *Foundations and Trends in Electronic Design Automation*, Vol. 9, No. 4 (2015) 309–391. December 2015
21. M. Pajic, Z. Jiang, I. Lee, O. Sokolsky and **R. Mangharam**. "Safety-critical Medical Device Development using the UPP2SF Model Translation Tool" *ACM Transactions of Embedded Computing Systems* (TECS). Special issue containing the best papers from RTAS 2012. January 2015.
22. M. Pajic, **R. Mangharam**, O. Sokolsky, D. Arney, J. M. Goldman and I. Lee "Model-Driven Safety Analysis of Closed-Loop Medical Systems", *IEEE Transactions of Industrial Informatics* (TII), *Special Section on Cyber-Physical Systems.* Vol.10, Issue:1 Feb 2014.
23. **R. Mangharam** and M. Pajic. "Distributed Control for Cyber-Physical Systems" *Journal of the Indian Institute of Science, Special Issue on Cyber-Physical Systems,* Vol.93, No.3. September 2013.
24. Z. Jiang, M. Pajic, S. Moarref, R. Alur, and **R. Mangharam**, "Closed-loop Verification of Medical Devices with Model Abstraction and Refinement". *International Journal of Software Tools for Technology Transfer (STTT), Special Issue containing the Best Papers from TACAS 2012*. March 2013.
25. M. Pajic, **R. Mangharam**, G. J. Pappas, and S. Sundaram, "Topological Conditions for In-Network Stabilization of Dynamical Systems," *IEEE J. on Selected Areas in Communications,* Volume:31, Issue:4. 2013.
26. M. Pajic, A. Chernoguzov and **R. Mangharam**. "Robust Architectures for Embedded Wireless Network Control and Actuation" *ACM Transactions of Embedded Computing Systems* (TECS). Vol.11 Issue 4, 2012.
27. Z. Jiang, M. Pajic, and **R. Mangharam**, "Cyber-Physical Modeling of Implantable Cardiac Medical Devices". *Proceedings of the* IEEE 100(1): 122-137. January 2012.
28. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**. "The Wireless Control Network: A New Approach for Control over Networks" *IEEE Transactions in Automatic Control* (TAC), Vol.56, Issue:10. October 2011.
29. M. Pajic and **R. Mangharam**, "Spatio-Temporal Techniques for Anti-Jamming in Embedded Wireless Networks" *EURASIP Journal on Wireless Communications and Networking*, March 2010.
30. A. Rowe, **R. Mangharam** and R. Rajkumar, "FireFly: A Time Synchronized Real-Time Sensor Networking Platform." *Wireless Ad Hoc Networking: Personal-Area, Local Area, and Sensor Networks, CRC Press. 2007.*
31. **R. Mangharam**, A. Rowe and R. Rajkumar, "FireFly: A Cross-Layer Platform for Wireless Sensor Networks", *Real Time Systems Journal, Sp. Issue on Real-Time Wireless Sensor Networks* (RTSJ). 2006.

32. A. Rowe, **R. Mangharam** and R. Rajkumar, ""Global Time-Synchronized Link Protocols for Energy Constrained Multi-hop Wireless Networks" *Elsevier Ad hoc Networks, Special Issue on Energy-efficient Design in Wireless Ad hoc and Sensor Networks*. 2007.

33. S. Pollin, **R. Mangharam**, B. Bougard, R. Rajkumar, F. Catthoor, L. Van der Perre, I. Moerman "MEERA: Cross-Layer Methodology for Energy-Efficient Resource Allocation for Wireless Networks", *IEEE Transactions in Wireless Communication.* Jan 2008.

34. S. Pollin, B. Bougard, **R. Mangharam**, F. Catthoor, R. Rajkumar, I. Moerman, L. Van der Perre "Optimizing transmission and shutdown for energy-efficient real-time packet scheduling in clustered ad hoc networks" *EURASIP Journal on Wireless Communications and Networking, Special Issue on Cross-layer Design for Ad Hoc Networks*, vol. 2005, no. 5, pp. 698-711, 2005.

PUBLICATIONS (CONFERENCES, Under review)

1. Shuo Yang, Mitchell Black, Georgios Fainekos, Bardh Hoxha, Hideki Okamoto, **Rahul Mangharam**; "Safe Control Synthesis for Hybrid Systems through Local Control Barrier Functions", 2023 (under review)
2. Luigi Berducci, Shuo Yang, **Rahul Mangharam**, Radu Grosu; "Learning Adaptive Safety for Multi-Agent Systems", 2023 (under review)
3. Jiangwei Wang, Shuo Yang, Ziyan An, Songyang Han, Zhili Zhang, Meiyi Ma, **Rahul Mangharam**, Fei Miao; "Multi-agent reinforcement learning guided by signal temporal logic specifications", 2023 (under review)
4. Sun, Xiatao; Yang, Shuo; **Mangharam, Rahul**; "MEGA-DAgger: Imitation Learning with Multiple Imperfect Experts", 2023 (under submission)
5. Zheng, Hongrui; **Mangharam, Rahul**; "Differentiable Trajectory Generation for Car-like Robots with Interpolating Radial Basis Function Networks", 2023 (under submission)
6. Zheng, Hongrui; Zhuang, Zhijun; Betz, Johannes; **Mangharam, Rahul**; "Game-theoretic Objective Space Planning", 2023 (under submission)
7. Loeb, Helen; **Mangharam, Rahul**; Leveraging the internet to drive a real car in the Virtual Reality Earth Model, 2023 (under submission)
8. Johannes Betz, Hongrui Zheng, Zirui Zang, Florian Sauerbeck, Krzysztof Walas, Velin Dimitrov, Madhur Behl, Rosa Zheng, Joydeep Biswas, Venkat Krovi, **Rahul Mangharam**; "Teaching autonomous systems hands-on: Leveraging modular small-scale hardware in the robotics classroom", 2023 (under submission)

PUBLICATIONS (CONFERENCES)

9. Yang, Shuo; Pappas, George J; **Mangharam, Rahul**; Lindemann, Lars; "Safe Perception-Based Control under Stochastic Sensor Uncertainty using Conformal Prediction", *IEEE Conf. on Decision & Control (CDC), 2023*
10. Nagy, Tomás; Amine, Ahmad; Nghiem, Truong X; Rosolia, Ugo; Zang, Zirui; **Mangharam, Rahul**; "Ensemble Gaussian Processes for Adaptive Autonomous Driving on Multi-friction Surfaces", *22nd World Congress of the International Federation of Automatic Control (IFAC)*, 2023.
11. Chen, Yu; Yang, Shuo; **Mangharam, Rahul**; Yin, Xiang; "You Don't Know When I Will Arrive: Unpredictable Controller Synthesis for Temporal Logic Tasks," *22nd World Congress of the International Federation of Automatic Control (IFAC)*, 2023.
12. Evans, Benjamin; Betz, Johannes; Zheng, Hongrui; Engelbrecht, Herman A; **Mangharam, Rahul**; Jordaan, Hendrik W; "Accelerating Online Reinforcement Learning via Supervisory Safety Systems", Proceedings of 2023 International Conference on Advanced Robotics (ICAR), December 5-8, 2023, Abu Dhabi, UAE.

13. Zheng, Hongrui; Zang, Zirui; Yang, Shuo; **Mangharam, Rahul**; "Towards Explainability in Modular Autonomous Vehicle Software," *IEEE Intelligent Vehicles Symposium*, 2023

14. Sun, Xiatao; Zhou, Mingyan; Zhuang, Zhijun; Yang, Shuo; Betz, Johannes; **Mangharam, Rahu**l; "A Benchmark Comparison of Imitation Learning-based Control Policies for Autonomous Racing," *IEEE Intelligent Vehicles Symposium*, 2023

15. Tumu, Nandan; Lindemann, Lars; Nghiem, Truong, **Mangharam, Rahul**; "Physics constrained motion prediction with uncertainty quantification," *IEEE Intelligent Vehicles Symposium*, 2023

16. Qiao, Zhijie; Sun, Xiatao; Loeb, Helen; **Mangharam, Rahul**; "Drive Right: Shaping Public's Trust, Understanding, and Preference Towards Autonomous Vehicles Using a Virtual Reality Driving Simulator," *IEEE Intelligent Vehicles Symposium*, 2023

17. Jiyue He, Arkady Pertsov, John Bullinga, **Rahul Mangharam**, "Tachycardia activation pattern predictivity of a fiber-independent left atrium model", *Cardiac Physiome Society.* 2023.

18. Jiyue He, Arkady Pertsov, **Rahul Mangharam**, "Real-time atrial tachycardia ablation guidance with a left atrium model", *Heart Rhythm Society*. 2023.

19. Zang, Zirui; Zheng, Hongrui; Betz, Johannes; **Mangharam, Rahul**; "Local_INN: Implicit Map Representation and Localization with Invertible Neural Networks", *Intl. Conf. on Robotics and Automation (ICRA) 2023*

20. Sun, Xiatao; Yang, Shuo; **Mangharam, Rahul**; "MEGA-DAgger: Imitation Learning with Multiple Imperfect Experts", *Humans in Cyber-Physical Systems Workshop at CPS-IOT Week, 2023*

21. Qiao, Zhijie; Sun, Xiatao; Loeb, Helen; Mangharam, Rahul; "Drive Right: Promoting Autonomous Vehicle Education Through an Integrated Simulation Platform", *Humans in Cyber-Physical Systems Workshop at CPS-IOT Week, 2023*

22. Pant, Yash Vardhan; Abbas, Houssam; **Mangharam, Rahul**; "Distributed Trajectory Planning for Multi-rotor UAVs with Signal Temporal Logic Objectives." *IEEE Conference on Control Technology and Applications (CCTA).* 2022

23. Zang, Zirui; Tumu, Renukanandan; Betz, Johannes; Zheng, Hongrui; **Mangharam, Rahul**; "Winning the 3rd Japan Automotive AI Challenge-Autonomous Racing with the Autoware Auto Open Source Software Stack." *IEEE Intelligent Vehicles Symposium (IV).* 2022.

24. Stanley Bak; Johannes Betz; Abhinav Chawla; Hongrui Zheng; **Rahul Mangharam**; "Stress Testing Autonomous Racing Overtake Maneuvers with RRT," *IEEE Intelligent Vehicles Symposium (IV).* 2022.

25. Zheng, Hongrui; Betz, Johannes; Ramamurthy, Arun; Jin, Hyunjee; **Mangharam, Rahul**; Combinatorial and Parametric Gradient-Free Optimization for Cyber-Physical System Design. *IEEE Workshop on Design Automation for CPS and IoT (DESTION).* 2022

26. Bhargav, Jayanth; Betz, Johannes; Zheng, Hongrui; **Mangharam, Rahul**; Deriving spatial policies for overtaking maneuvers with autonomous vehicles.14th International Conference on COMmunication Systems & NETworkS (COMSNETS). 2022

27. Qiao, Zhijie; Loeb, Helen; Gurrla, Venkata; Lebermann, Matt; Betz, Johannes; **Mangharam, Rahu**l; "Drive Right: Autonomous Vehicle Education through an Integrated Simulation Platform." SAE International Journal of Connected and Automated Vehicles. 2022

28. J. He, A. Pertsov, S. Dixit, K. Walsh, E. Toolan and **R. Mangharam**, " Patient-specific heart model towards atrial fibrillation", *Proc. ACM/IEEE 12th Intl. Conf. on Cyber-Physical Systems (ICCPS)*. May 2021.

29. Huang, S., Diep, M., Jang, K., Cherry, E. M, Fenton, F. H, Cleaveland, R., Lindvall, M., **Mangharam, R**., & Porter, A "Towards Automated Comprehension and Alignment of Cardiac Models at the System Invariant

Level" *In CSBio'20: Proceedings of the Eleventh International Conference on Computational Systems-Biology and Bioinformatics*, 2020.

30. K. J. Jang, A. Rodionova, Y. V. Pant, and R. Mangharam, " Learning-to-Fly RL: Reinforcement Learning-based Collision Avoidance for Scalable Urban Air Mobility", AIAA/IEEE 39th Digital Avionics Systems Conference (DASC) 2020. **Best of Session Award!**
31. M. O'Kelly, H. Zheng, **R. Mangharam**, et. al. "FormulaZero: Distributionally Robust Online Adaptation via Offline Population Synthesis". 37th International Conference on Machine Learning (ICML), 2020.
32. A. Rodionova, I. Alvarez, M. S. Elli, F. Oboril, J. Quast, and **R. Mangharam**, "How Safe is Safe Enough? Automatic Safety Constraints Boundary Estimation for Decision-Making in Automated Vehicles". IEEE Intelligent Vehicles Symposium (IV), 2020.
33. A. Rodionova, Y. V. Pant, K. J. Jang, H. Abbas, R. Quaye, and R. Mangharam, "Learning-to-Fly: Learning-based Collision Avoidance for Scalable Urban Air Mobility", 23rd Intelligent Transportation Systems Conference (IEEE ITSC 2020).
34. A. Agnihotri, M. O'Kelly, H. Abbas and **R. Mangharam**. "Teaching Autonomous Systems at 1/10th-scale: A project-based course and community". *ACM Special Interest Group on Computer Science Education (SIGCSE).* February 2020. 2nd **Best Paper Award!**
35. Matthew O'Kelly, Hongrui Zheng, Achin Jain, Joseph Auckley, Kim Luong, **Rahul Mangharam**, "TunerCar: A Superoptimization Toolchain for Autonomous Racing", IEEE International Conference on Robotics and Automation (ICRA), 2020.
36. J. He, K. J. Jang, K. Walsh, J. Liang, S. Dixit, and **R. Mangharam**, "Electroanatomic Mapping to Determine Scar Regions in Patients with Atrial Fibrillation", *41st International Engineering in Medicine and Biology Conference (IEEE EMBC)*. July 2019.
37. Y. V. Pant, R. Quaye, H. Abbas, A. Varre and **R. Mangharam**, "Fly-by-Logic: A Tool for Unmanned Aircraft System Fleet Planning using Temporal Logic", *11th NASA Formal Methods Symposium*, Houston, TX. 2019.
38. H. Abbas, Y. V. Pant and **R. Mangharam**, "Temporal Logic Robustness for General Signal Classes", in *10th ACM/IEEE International Conference on Cyber-Physical Systems* (ICCPS '19), Montreal, QC, Canada. April 2019.
39. H. Abbas, Y. V. Pant and **R. Mangharam**, "Temporal Logic Robustness for General Signal Classes" in *ACM International Conference on Hybrid Systems: Computation and Control (HSCC/CPSWeek)*. Montreal, QC, Canada. April 2019.
40. Houssam Abbas, Matthew O'Kelly, Alena Rodionova, **Rahul Mangharam**; "Safe at any speed: A simulation-based test harness for autonomous vehicles", *Cyber Physical Systems. Design, Modeling, and Evaluation: 7th International Workshop, CyPhy* 2019
41. A. Jain, D. Nong, T. X. Nghiem, **R. Mangharam**, "Digital Twins for Efficient Modeling and Control of Buildings – An Integrated Solution with SCADA Systems" *ASHRAE/IBPSA-USA Building Performance Analysis Conference and SimBuild*. September 2018.
42. Yash V. Pant, Houssam Abbas, Rhudii A. Quaye, and **Rahul Mangharam**, "Fly-by-Logic: Control of Multi-Drone Fleets with Temporal Logic Objectives" in *Proceedings of the 9th ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*, April 2018.
43. Achin Jain, Truong X. Nghiem, Manfred Morari, and **Rahul Mangharam**. "Learning and Control using Gaussian Processes" in *Proceedings of the 9th ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS)*, April 2018. **Best Paper Award!**

44. Kuk Jin Jang, James Weimer, Houssam Abbas, Zhihao Jiang, Jackson Liang, Sanjay Dixit, **Rahul Mangharam**, "Computer Aided Clinical Trials for Implantable Cardiac Devices", *40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, July 2018.

45. Houssam Abbas, Konstantinos Mamouras, Alena Rodionova, Alur Rajeev, Jackson Liang, Sanjay Dixit, and **Rahul Mangharam**, "A novel programming language to reduce energy consumption by arrhythmia monitoring algorithms in implantable cardioverter-defibrillators", *Heart Rhythm Journal*. May 2018.

46. Houssam Abbas and **Rahul Mangharam**, "Generalized Robust MTL Semantics for Problems in Cardiac Electrophysiology", In *IEEE American Control Conference*. March 2018.

47. Francesco Smarra, Achin Jain, **Rahul Mangharam** and Alessandro D'Innocenzo. "Data-Driven Switched Affine Modeling for Model Predictive Control". In *Proceedings of the 6th IFAC Conference on Analysis and Design of Hybrid Systems*, 2018.

48. Yash Pant, Houssam Abbas, and **Rahul Mangharam**, "Smooth Operator: Control Using the Smooth Robustness of Temporal Logic", *IEEE Conf. on Control Technology and Applications.* Dec 2017.

49. Matthew O'Kelly, Houssam Abbas, and Rahul Mangharam, "Computer-Aided Design for Safe Autonomous Vehicles", IEEE International Symposium on Resilient Control Systems. September 2017

50. Achin Jain, Madhur Behl, and **Rahul Mangharam**, "Data predictive control for building energy management". *American Control Conference (ACC).* June 2017. **Best Paper Award (Energy Systems)**

51. Abbas, H., Jang K.J., Liang J., Dixit S., and **Mangharam R**. "A novel ICD morphology discriminator to improve discrimination between Ventricular and Supraventricular tachycardias" *Heart Rhythm Society Scientific Sessions*, Chicago. May 2017

52. Houssam Abbas, Matthew O'Kelly, and **Rahul Mangharam**, "Relaxed decidability and the robust semantics of Metric Temporal Logic", *Proceedings of the 20th ACM Intl. Conf. on Hybrid Systems: Computation and Control (HSCC).* February 2017

53. Alena Rodionova, Matthew O'Kelly, Houssam Abbas, Vincent Pacelli and **Rahul Mangharam**; "An Autonomous Vehicle Control Stack", 4th International Workshop on Applied Verification of Continuous and Hybrid Systems (ARCH), vol 48, pages 44—51. 2017.

54. Islam, M.A., Lim, H., Paoletti, N., Abbas, H., Jiang, Z., Cyranka, J., Cleaveland, R., Gao, S., Clarke, E., Grosu, R. and Mangharam, R., 2016, December. CyberCardia project: Modeling, verification and validation of implantable cardiac devices. In *IEEE International Conference on Bioinformatics and Biomedicine (BIBM),* (pp. 1445-1452). 2016

55. Yash Pant, Houssam Abbas, and **Rahul Mangharam**, "Robust Model Predictive Control for Non-Linear Systems with Input and State Constraints Via Feedback Linearization", *IEEE Conference on Decision and Control (CDC).* Las Vegas, USA, Dec 2016

56. Achin Jain, Madhur Behl, and **Rahul Mangharam**, "Data Predictive Control for Peak Power Reduction". *ACM International Conference on Embedded Systems for Energy-Efficient Built Environments (BUILDSYS)*. Nov 2016. **Best Presentation Award**

57. Zhihao Jiang, Houssam Abbas, Kuk Jin Jang, Marco Beccani and **Rahul Mangharam**, "Computer aided clinical trials for implantable cardiac devices", *Modeling, Design and Safety Analysis in Physiological Closed-Loop Systems Symposium at 53rd Society of Engineering Science Annual Technical Meeting, U. Maryland.* Oct 2016.

58. Zhihao Jiang, Houssam Abbas, Kuk Jin Jang, Marco Beccani and **Rahul Mangharam**, "In-silico Pre-clinical Trials for Implantable Cardioverter Defibrillators", *38th International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).* August 2016.

59. Zhihao Jiang, Houssam Abbas, Kuk Jin Jang, Marco Beccani and **Rahul Mangharam**, "Modeling and Simulation for In-silico Pre-clinical Trials for Implantable Cardiac Devices", *BMES/FDA Frontiers of Medical Devices Conference.* May 2016.

60. Houssam Abbas, Kuk Jin Jang, Zhihao Jiang, and **Rahul Mangharam**, "Towards Model Checking of Implantable Cardioverter Defibrillators", *19th ACM International Conference on Hybrid Systems: Computation and Control* (HSCC). March 2016.

61. Houssam Abbas; Zhihao Jiang; Kuk Jin Jang; Marco Beccani; Jackson Liang; **Rahul Mangharam**; "High-level modeling for computer-aided clinical trials of medical devices", *IEEE International High Level Design Validation and Test Workshop (HLDVT)*, 2016.

62. Houssam Abbas, Kuk Jin Jang, and **Rahul Mangharam**, "Benchmark: Nonlinear Hybrid Automata Model of Excitable Cardiac Tissue", *Applied Verification for Continuous and Hybrid Systems, Cyber-Physical Systems Week*. April 2016.

63. Madhur Behl, Achin Jain, and **Rahul Mangharam**, "Data-Driven Modeling, Control and Tools for Cyber-Physical Energy Systems", *ACM/IEEE 7th International Conference on Cyber-Physical Systems (ICCPS)*. 2016.

64. Zhihao Jiang, Houssam Abbas, Pieter J. Mosterman, and **Rahul Mangharam**, "Automated Closed-Loop Model Checking of Implantable Pacemakers using Abstraction Trees ", *IEEE Medical Cyber-Physical Systems*, CPS Week. April 2016.

65. Matthew O'Kelly, Houssam Abbas, Sicun Gao, Shin'ichi Shiraishi, Shnipei Kato, and **Rahul Mangharam**, "APEX: Autonomous Vehicle Plan Verification and Execution", SAE World Congress, April 2016.

66. **Rahul Mangharam**, Houssam Abbas, Madhur Behl, Kuk Jang, Miroslav Pajic and Zhihao Jiang, "Three Challenges in Cyber-Physical Systems," *8th Intl. Conf. on Communication Sys and Networks (COMSNETS)*, 2016.

67. Houssam Abbas, Zhihao Jiang, Kuk Jin Jang, Marco Beccani, Jackson Liang, Sanjay Dixit, **Rahul Mangharam**; "Computer aided clinical trials for implantable cardiac devices". *SES Symposium F-2: Modeling, Design and Safety Analysis in Physiological Closed-Loop Systems*, 2016.

68. Madhur Behl and **Rahul Mangharam**, "Sometimes, Money Does Grow on Trees: Data-Driven Demand Response with DR-Advisor", *ACM International Conference on Embedded Systems for Energy-Efficient Built Environments (BUILDSYS)*. November 2015.

69. Yash Pant, Houssam Abbas, Kartik Motha, Joseph Divetti and **Rahul Mangharam**, "Co-design of Anytime Computation and Control Systems", *IEEE Real-Time Systems Symposium (RTSS),* December 2015.

70. K. N. Nischal; Paritosh Kelkar; Dhruva Kumar; Yash Vardhan Pant; Houssam Abbas; Joseph Devietti; **Rahul Mangharam.** "Hardware Optimizations for Anytime Perception and Control," *IEEE Real-Time Systems Symposium*, San Antonio, TX, USA, 2015, pp. 380-380, doi: 10.1109/RTSS.2015.49.

71. Yash Vardhan Pant, Houssam Abbas, K. N. Nischal, Paritosh Kelkar, Dhruva Kumar, Joseph Devietti and **Rahul Mangharam**, "Power-efficient algorithms for autonomous navigation", *IEEE Complex Systems Engineering (ICCSE),* November 2015.

72. Madhur Behl, Truong Nghiem, Willy Bernal and Rahul Mangharam, "Campus-Wide Integrated Building Energy Simulation" 14th International Conference of the International Building Performance Simulation Association (*IBPSA*), Dec 2015.

73. Truong Nghiem and **Rahul Mangharam**, "Scalable Scheduling of Energy Control Systems," *Proceedings of the 12th International Conference on Embedded Software (EMSOFT)* , 137-146. October 2015.

74. Madhur Behl and **Rahul Mangharam**, "Sometimes money does grow on trees: Data Driven Demand

Response With Regression Trees", *SRC TECHCON*. September 2015. **Best in Session Award**

75. Madhur Behl, Truong Nghiem and **Rahul Mangharam**, "DR-Advisor: A Data Driven Demand Response Recommender System". *CISBAT International Building Simulation Association IBPSA*, Sept 2015.
76. Kuk Jang, Jungmin Ryoo, Orkan Telhan and **Rahul Mangharam**, "CloudMat: Context-aware Personalization of Fitness Content," *IEEE 12th International Conference on Services Computing (SCC),* June 2015.
77. M. Behl, T. Nghiem and **R. Mangharam**. "IMpACT: Inverse Model Accuracy and Control Performance Toolbox for Buildings". *IEEE International Conference on Automation Science and Engineering (CASE)*, August 2014.
78. Z. Jiang and **R. Mangharam** "Integrated Functional and Formal Modeling for Medical Device Software". *SRC TECHCON*. September 2014. **Best in Session Award**
79. Y. Pant, T. Nghiem and **R. Mangharam**. "Peak Power Reduction in Hybrid Energy Systems with Limited Load Forecasts". *American Control Conference (ACC).* June 2014
80. M. Behl, T. Nghiem and **R. Mangharam**. "Model-IQ: Uncertainty Propagation from Sensing to Modeling and Control in Buildings". *ACM/IEEE International Conference on Cyber-Physical Systems* (ICCPS). April 2014.
81. T. Nghiem, G. J. Pappas and **R. Mangharam**. "Event-based Green Scheduling of Radiant Systems in Buildings." *American Control Conference (ACC).* June 2013.
82. F. Miao, M. Pajic, **R. Mangharam** and G. J. Pappas. "Networked Realization of Discrete-Time Controllers." *American Control Conference (ACC).* June 2013.
83. Z. Jiang, S. Radhakrishnan, V. Sampath, S. Sarode, and **R. Mangharam**. "Heart-on-a-Chip: A Closed-loop Testing Platform for Implantable Pacemakers" Third Workshop on *Design, Modeling and Evaluation of Cyber Physical Systems (CyPhy'13) at CPSWeek*. Philadelphia, April 2013. **SEAS Senior Design Competition Winner**
84. M. Pajic, O. Sokolsky, R. Alur, **R. Mangharam**, N. Michael, G. J. Pappas, P. Tabuada, S. Weirich and I. Lee, "SPARCS: Synthesis of Platform-aware Attack-Resilient Control Systems", *ACM International Conference on High Confidence Networked Systems (HiCoNS)*, at CPSWeek. Philadelphia, April 2013.
85. T. Nghiem, M. Behl, G. J. Pappas and **R. Mangharam**. "Green Scheduling for Radiant Systems in Buildings" *51st IEEE Conference on Decision and Control (CDC).* Maui, Hawaii, Dec 2012.
86. T. Nghiem, M. Behl and **R. Mangharam**. "Green Scheduling for Energy-Efficient Operation of Multiple Chiller Plants" *33rd IEEE Real-Time Systems Symposium (RTSS).* Puerto Rico, Dec 2012.
87. W. H. Bernal, M. Behl, T. Nghiem and **R. Mangharam**. "MLE+: A Tool for Integrated Design and Deployment of Energy Efficient Building Controls" *4th ACM BuildSys Workshop on Embedded Sensing Systems For Energy-Efficiency In Buildings.* Toronto, Canada, Nov 2012. **Best Demonstration Award.**
88. **R. Mangharam**. "The Car and The Cloud: Automotive Architectures for 2020" The Bridge on Frontiers of Engineering, National Academy of Engineering. Winter 2012, Vol 42. Number 4.
89. M. Pajic, S. Sundaram, J. L. Ny, G. J. Pappas and **R. Mangharam**. "Closing the Loop: A Simple Distributed Method for Control over Wireless Networks." *ACM International Conference on Information Processing in Sensor Networks* (IPSN). April 2012. (Acceptance rate 11/99). **Best Presentation Award.**
90. M. Pajic, Z. Jiang, I. Lee, O. Sokolsky, and **R. Mangharam**. "From Verification to Implementation: A Model Translation Tool and a Pacemaker Case Study". *18th IEEE Real-Time and Embedded Technology and Applications Symposium* (IEEE RTAS). April 2012. **Best Student Paper Award.**
91. Z. Jiang, M. Pajic, S. Moarref, R. Alur, and **R. Mangharam**, "Modeling and Verification of a Dual Chamber

Implantable Pacemaker". *18th International Conference on Tools and Algorithms for the Construction and Analysis of Systems (TACAS)*. March 2012. **Best Paper Award Nominee.**

92. T. Nghiem, M. Behl, **R. Mangharam** and G. J. Pappas. "Scalable Scheduling of Building Control Systems for Peak Demand Reduction". *American Control Conference (ACC).* June 2012.
93. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**, "Topological Conditions for Wireless Control Networks". *50th IEEE Conference on Decision and Control, (CDC).* Dec 2011.
94. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**, "Network Synthesis for Dynamical System Stabilization." *The 45th Annual IEEE Asilomar Conference on Signals, Systems, and Computers*, 2011.
95. T. Nghiem, M. Behl, **R. Mangharam** and G. J. Pappas. "Green Scheduling of Control Systems for Peak Demand Reduction". *50th IEEE Conference on Decision and Control, (CDC).* Dec 2011.
96. **R. Mangharam** and A. A. Saba, "Anytime Algorithms for GPU Architectures", *IEEE Real-Time Systems Symposium* (IEEE RTSS), Vienna, Austria. Nov 2011.
97. Z. Li, P. C. Huang, A. Mok, T. Nghiem, M. Behl, G. J. Pappas and **R. Mangharam**. "On the Feasibility of Linear Discrete-Time Systems of the Green Scheduling Problem", *IEEE Real-Time Systems Symposium* (IEEE RTSS), Vienna, Austria. Nov 2011.
98. Z. Jiang and **R. Mangharam**, "Modeling Cardiac Pacemaker Malfunctions with the Virtual Heart Model", *33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (IEEE EMBC)*, 2011.
99. T. Nghiem, M. Behl, G. J. Pappas and **R. Mangharam**. "Green Scheduling: Scheduling of Control Systems for Peak Power Reduction". *2nd International Green Computing Conference*, July 2011.
100. Z. Jiang, M. Pajic, and **R. Mangharam**, "Model-based Closed-loop Testing of Implantable Pacemakers". *ACM/IEEE International Conference on Cyber-Physical Systems* (ICCPS). April 2011.
101. M. Pajic, S. Sundaram, G. J. Pappas and **R. Mangharam**, "A Simple Distributed Method for Control over Wireless Networks". *CPS Week Workshop on Real-Time Wireless for Industrial Applications, Real-WIN.* 2011.
102. W. Etter, P. Martin, and **R. Mangharam**, "Cooperative Flight Guidance of Autonomous Unmanned Aerial Vehicles". *CPS Week Workshop on Networks of Cooperating Objects (CONET)*. April 2011.
103. U. Drolia, Z. Wang, Y. Pant and **R. Mangharam**. "AutoPlug: An Automotive Test-bed for Electronic Controller Unit Testing and Verification". *Intelligent Transportation Systems* (ITS). October 2011.
104. M. Pajic, S. Sundaram, J. Le Ny, G. J. Pappas and **R. Mangharam**, "The Wireless Control Network: Synthesis and Robustness." The *49th IEEE Conference on Decision and Control* (CDC), December 2010.
105. S. Sundaram, M. Pajic, C. N. Hadjicostis, **R. Mangharam** and G. J. Pappas, "The Wireless Control Network: Monitoring for Malicious Behavior." The *49th IEEE Conference on Decision and Control* (CDC), December 2010.
106. A. A. Saba and **R. Mangharam**, "Anytime Algorithms for GPU Architectures", *Analytic Virtual Integration of Cyber-Physical Systems Workshop*. Co-located with RTSS. December 2010.
107. Z. Jiang, A. T. Connolly and **R. Mangharam**. "Using the Virtual Heart Model to Validate the Mode-Switch Pacemaker Operation". *32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. August 2010.
108. Voyles, R.M., Povilus, S., **Mangharam, R**. and Kang Li; "RecoNode: A reconfigurable node for heterogeneous multi-robot search and rescue," *Safety Security and Rescue Robotics (SSRR), IEEE International Workshop on* , vol., no., pp.1-7, 26-30. July 2010

109. Z. Jiang, M. Pajic, A. T. Connolly, S. Dixit and **R. Mangharam**. "Real-time Heart Model for Implantable Cardiac Device Validation and Verification". *22nd Euromicro Conference on Real-Time Systems,* (IEEE ECRTS). 2010.

110. D. Arney, M. Pajic, J. M. Goldman, I. Lee, **R. Mangharam** and O. Sokolsky. "Toward Patient Safety in Closed-Loop Medical Device Systems". *ACM/IEEE International Conference on Cyber-Physical Systems* (ICCPS). 2010.

111. M. Pajic and **R. Mangharam**. "Embedded Virtual Machines for Robust Wireless Control and Actuation". *16th IEEE Real-Time and Embedded Technology and Applications Symposium* (IEEE RTAS). April 2010.

112. M. Pajic and **R. Mangharam**. "Anti-Jamming for Embedded Wireless Networks". *ACM International Conference on Information Processing in Sensor Networks* (IPSN'09). April 2009.

113. M. Pajic and **R. Mangharam**. "WisperNet: Anti-Jamming for Wireless Sensor Networks", *2nd Workshop on Embedded Systems Security (WESS), at Embedded Systems Week.* Atlanta, GA. October 2008.

114. **R. Mangharam**, R. Rajkumar, M. Hamilton, P. Mudalige and F. Bai, "Bounded-Latency Alerts in Vehicular Networks", *Mobile Networking for Vehicular Environments, IEEE INFOCOM*, 2007.

115. **R. Mangharam**, A. Rowe and R. Rajkumar, "Voice over Sensor Networks" *27th IEEE Real-Time Systems Symposium (IEEE RTSS).* Sao Paulo, Brazil. Dec 2006.

116. A. Rowe, **R. Mangharam** and R. Rajkumar, "RT-Link: A Time-Synchronized Link Protocol for Energy Constrained Multi-hop Wireless Networks" *IEEE International Conference on Sensors, Mesh and Ad Hoc Communications and Networks (IEEE SECON).* Reston, VA. Sept 2006. **Best Paper Award.**

117. **R. Mangharam** and R. Rajkumar, "MAX: A Maximal Transmission Concurrency MAC for Wireless Networks with Regular Structure" *IEEE Third International Conference on Broadband Communications, Networks and Systems (IEEE BROADNETS)*, San Jose, CA. Oct 2006.

118. **R. Mangharam**, D. S. Weller, R. Rajkumar, P. Mudalige and F. Bai, "GrooveNet: A Hybrid Simulator for Vehicle-to-Vehicle Networks", *2nd Intl. Workshop on Vehicle-to-Vehicle Communications (IEEE V2VCOM)*, 2006.

119. **R. Mangharam**, D. S. Weller, D. D. Stancil, R. Rajkumar, "GrooveSim: A Topography-Accurate Simulator for Geographic Routing in Vehicular Networks" *ACM Mobicom/VANET,* Cologne, Germany. Sept. 2005.

120. **R. Mangharam**, J. Meyers, R. Rajkumar, D. Stancil, J. Parikh, H. Krishnan, and C. Kellum, "A Multi-hop Mobile Networking Test-bed for Telematics" *Society for Automotive Eng. World Congress*, Detroit, MI. August 2005.

121. **R. Mangharam**, S. Pollin, B. Bougard, R. Rajkumar, F. Catthoor, L. Van der Perre, "Optimal fixed and scalable energy management for wireless networks" *IEEE INFOCOM*, March 2005.

122. S. Pollin, B. Bougard, R**. Mangharam**, L. Van der Perre, F. Catthoor, R. Rajkumar, I. Moerman "Optimizing transmission and shutdown for energy-efficient packet scheduling in sensor networks" *European Workshop on Wireless Sensor Networks (EWSN)*. January 2005.

123. **R. Mangharam**, M. Demirhan, R. Rajkumar, and D. Raychaudhuri, "Size matters: Size-based scheduling for MPEG-4 over wireless channels" *SPIE & ACM Proceedings in Multimedia Computing and Networking (ACM MMCN)*. Vol. 3020 pp. 110-122. San Jose, CA, January 2004.

PUBLICATIONS (OTHER)

124. Yash V. Pant, Houssam Abbas and **Rahul Mangharam**, "Distributed planning of Multi-rotor drone fleets using the Smooth Robustness of Signal Temporal Logic" in *4th Workshop on Monitoring and Testing of Cyber-Physical Systems (CPS-IoT Week)*, Montreal, Canada. April 2019.

125. **R. Mangharam**; M. Reyerson; Viscelli, Steve; Balakrishanan, Hamsa; Bayen, Alexandre; Amin, Surabh; Richards, Leslie; Bagley, Leo; Pappas, George, "MOBILITY21: Strategic Investments for Transportation Infrastructure & Technology". *A Computing Community Consortium (CCC) white paper*. eprint arXiv:1705.01923

126. **R. Mangharam**. "Distributed Control-as-a-Service with Wireless Swarm Systems" *International Workshop on Swarm at the Edge of the Cloud, ESWeek*, Montreal, Canada, October 2013.

127. **R. Mangharam**. "Profiling Anytime Algorithms for Real-Time Computing" *Workshop on Benchmarking of Embedded Systems, ESWeek, Montreal*, Canada, October 2013.

128. Y. Pant, T. Nghiem and **R. Mangharam.** "Knock NOx: Model-based offline diagnostics of a Diesel Exhaust Control System" *IEEE Real-Time and Embedded Technology and Applications Symposium WiP* (RTAS), 2013.

129. S. Diaz, H. Jain, Y. Pant, W. Price and **R. Mangharam**. "ProtoDrive: An Experimental Platform for Electric Vehicle Energy Scheduling and Control" *33rd IEEE Real-Time Systems Symposium (RTSS@Work)*, Dec 2012.

130. W. H. Bernal, M. Behl, T. Nghiem and **R. Mangharam**. "MLE+: A Tool for Integrated Design and Deployment of Energy Efficient Building Controls" *33rd IEEE Real-Time Systems Symposium (RTSS@Work).* Dec 2012.

131. V. Sampath, S. Sarode, S. Radhakrishnan, Z. Jiang, M. Pajic and **R. Mangharam**. "Pacemaker Verification System". Demo and Poster at *IEEE/ACM CPSWeek*. April 2012.

132. M. Pajic and **R. Mangharam**. "Architecture for a Fully Distributed Wireless Control Network". Demo, and Poster at *IEEE/ACM CPSWeek*. April 2011.

133. Z. Jiang, M. Pajic and **R. Mangharam**. "Closed-loop Testing for Implantable Cardiac Pacemakers". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.

134. M. Behl, M. Aneja, H. Jain and **R. Mangharam**. "EnRoute: An Energy Router for Energy-Efficient Buildings". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.

135. U. Drolia, Z. Wang, S. Vemuri, M. Behl and **R. Mangharam**. "AutoPlug - An Automotive Test-bed for ECU Testing, Validation and Verification". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.

136. P. Martin, W. Etter and **R. Mangharam**, "R.A.V.E.N. - Remote Autonomous Vehicle Explorer Network". Demo and Poster at *IEEE/ACM CPSWeek*. April 2011.

137. R. Mangharam, "AutoPlug: An Open Experimental Platform for Automotive ECU Testing, Updates and Verification". *NSF/USCAR Automotive CPS Workshop*, Troy, Michigan. March 2011.

138. W. H. Bernal and **R. Mangharam**, "From Control to Scheduling: an Elastic Execution Model" *IEEE Real-Time Systems Symposium (RTSS), Work-in-Progress*. Dec 2010.

139. M. Behl and **R. Mangharam**, "Pacer Cars: Real-Time Traffic Shockwave Suppression" *IEEE Real-Time Systems Symposium (RTSS), Work-in-Progress*. Dec 2010.

140. Z. Jiang, M. Pajic, A. T. Connolly and **R. Mangharam**. "A Platform for Implantable Medical Device Validation". Demo and Poster at *Wireless Health Conference*. October 2010.

141. M. Pajic and **R. Mangharam**. "Embedded Virtual Machines for Wireless Industrial Automation" *Demo and Poster at IEEE/ACM CPSWeek*. April 2009.

142. M. Pajic and **R. Mangharam**. "Runtime Approaches for Embedded Wireless Control-Actuator Networks" at *IEEE Real-Time Systems Symposium (RTSS), PhD Forum*. Dec 2009.

143. M. Pajic, Z. Jiang, A. T. Connolly and **R. Mangharam**. "A Framework for Validation of Implantable Medical Devices". Demo, Poster and Work-in-Progress paper at *IEEE/ACM CPSWeek*. April 2010.

144. A. A. Saba, S. Mohan and **R. Mangharam**. "Anytime Algorithms for Multicore Architectures" in *22nd Euromicro Conference on Real-Time Systems, Work-in-Progress Session, (IEEE ECRTS).* July 2010.

145. **R. Mangharam** and M. Pajic. "Embedded Virtual Machines for Robust Wireless Control Systems". Proc. of the 29th IEEE International Conference on Distributed Computing Systems Workshops. 2009.

146. **R. Mangharam**. "Real-Time Traffic Congestion Prediction". *NSF-NCO/NITRD National Workshop on High Confidence Transportation Cyber-Physical Systems.* Nov 2008.

147. **R. Mangharam**. "Mixed Reality, Now a Reality - Network Virtualization for Real-Time Automotive-CPS Networks". *NSF-NCO/NITRD National Workshop on High Confidence Automotive Cyber-Physical Systems*. 2008.

148. **R. Mangharam** and M. Demirhan, "Performance and simulation analysis of 802.15.3 QoS" *IEEE 802.15.3 Standards Meeting*, Vancouver, Canada. Feb 2002.

PATENTS AWARDED

1. SYSTEMS AND METHODS FOR CONTACTLESS CRANIO-MAXILLO-FACIAL DISTRACTION. US-20190388122
2. CONTROL OF MULTI-DRONE FLEETS WITH TEMPORAL LOGIC OBJECTIVES. US-11429118
3. METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR A DATA-DRIVEN DEMAND RESPONSE (DR) RECOMMENDER. US-20170169344
4. METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA INVOLVING A CONTENT COUPLED PHYSICAL ACTIVITY SURFACE, US-10642360
5. SYSTEMS OF STACKING INTERLOCKING BLOCKS. US-11213747

HARDWARE and SOFTWARE ARTIFACTS

1. AV4EV: Open-source Autonomous Vehicle Software for Open-Standards Electric Vehicle Platforms (2023-) https://av4ev.org
2. F1TENTH: Autonomous Racing Cars (2017-Present) http://f1tenth.org
3. "SMOOTH OPERATOR": Control Using the Smooth Robustness of Temporal Logic. Y. V. Pant, H. Abbas, R. Mangharam https://github.com/yashpant/SmoothOperator
4. "FLY-BY-LOGIC": A Tool for multi-drone planning using Temporal Logic Objectives (2018-Present) Y. V. Pant, R. A. Quaye, H. Abbas, A. Varre, R. Mangharam https://github.com/yashpant/FlyByLogic
5. DR-Advisor: Data-driven Demand Response Recommender System http://mlab.seas.upenn.edu/dr-advisor (2015-2017)
6. *MLE+:* A Tool for Integrated Design and Deployment of Energy Efficient Building Controls at http://mlab.seas.upenn.edu/mlep/ (2012-2018)
7. *ProtoDrive*: An Experimental Platform for Electric Vehicle Energy Scheduling and Control. http://mlab.seas.upenn.edu/protodrive/ (2012-2017)

8. *En-Route Energy Router:* Energy-Efficient Building Control and Scheduling Test-bed. 2010-Present
9. *Open-ISA100.11a*: Open software stack for standardized industrial wireless control automation. http://mlab.seas.upenn.edu/openisa/ (2011-2016)
10. *Pacemaker Verification System:* Platform for closed-loop testing and verification of medical devices. http://pvs.medcps.org/ (2012-Present.)
11. *HAWK:* Platform for Helicopter Aircraft Wielding Kinect for search and rescue in buildings (2012.)
12. *Haptic Belt for Blind:* Platform for indoor and outdoor guidance for blind persons (2011-2016)
13. *AutoPlug*: Open Automotive Architecture for Plug-n-Play Services. Open-source software at http://www.autoplug.org/ (2011-2016)
14. *AirHacks:* Open Unmanned Aerial Vehicle Platform (Quadrotor) at http://airhacks.org/ (2011-2014)
15. *Penn Virtual Heart Model* and Closed-loop Implantable Device Models for medical device software validation and verification. Open-source Matlab/Simulink models (2011-Present)
16. *AutoMatrix:* Large-scale Traffic Congestion Simulator for estimating and predicting congestion with over 16 million vehicles (2011-2014)
17. *GrooveNet 2.0:* Hybrid Network Simulator for Vehicle-to-Vehicle Networking. Both real and simulated vehicles can communicate. Over 65 research institutions have downloaded GrooveNet. http://mlab.seas.upenn.edu/groovenet/ (2011-2017)
18. *RT-Link* TDMA protocol for IEEE 802.15.4 sensor networks. Co-developed with Anthony Rowe. Graduate course taught using RT-Link on the FireFly sensor network platform. http://nano-rk.org/ (2006-2016)
19. *IEEE 802.15 Link-layer Scheduling Framework* for ns-2 network simulator. Co-developed with Mustafa Demirhan. Over 40 research institutions have downloaded the software (2003-2006)

Undergraduate Senior Design, Masters Thesis and Independent Study Projects:

1. *Senior Design:* DataBees: The Datasets You Always Wanted
   Akshay Sharma (CIS), Nischal Poudel (CIS), Sadek Munawar (CMPE & ROBO, Sheon Mwapinza (CMPE & ROBO), Siddharth Panchanadam (EE & ROBO), 2022-2023
2. Yash Rajpal (VIPER)
   Guardian Angel Driver Assistance for Cognitively Compromised Drivers, Summer 2023
3. *MS Thesis:* Maya Guru
   Safety and Ethics-aware Trajectory Planning: An Evaluation of Moral Reasoning, 2023
4. *MS Thesis:* Zhijie Qiao
   Outstanding Master's Research Award, Class of 2022, University of Pennsylvania.
   Winner of the Student Video Essay Competition, ITS World Congress, Oct 2022.
   Drive Right: Shaping Public's Trust, Understanding, and Preference Towards Autonomous Vehicles Using a Virtual Reality Driving Simulator, 2023.
   Published 2 papers. Organized 1 F1Tenth Competition at IEEE Intelligent Vehicles Symposium 2023 and organized 1 tutorial on "An Introduction to Autoware and Its Application Platforms", at the IEEE Intelligent Vehicle Symposium'23. Currently PhD student in University of Michigan
5. Mingyan Zhou -MEGA-DAgger: Imitation Learning with Multiple Imperfect Experts, 2023
6. Jonathan Schoeffling – Autonomy Essentials Kit for autonomous driving, 2023
7. Ahmad Amine – Ensemble Gaussian Processes for Adaptive Autonomous Driving on Multi-friction Surfaces, published in IFAC 2023.

8. Arvind Balaji Narayan – Drive, steer and brake by-wire systems controls for Autonomous Go-Kart, 2023
9. Felix Jahncke – Autonomous Go-Kart: Cone-SLAM and Sensor fusion autonomous driving stack
10. Koichi Imai – Software Defined Vehicles architecture for Autonomous Go-Kart.
11. Tejas Agarwal – Developing the TinyML Tiny Machine Learning for Embedded Systems course.
12. Manasa Sathyan - Developing the TinyML Tiny Machine Learning for Embedded Systems course.
13. Akshaya Bhati – Mechanical design of steer-by-wire system for Autonomous Go-Kart
14. Divyanshu Sahu – Vision-based navigation and pure pursuit tracker for Autonomous Go-Kart
15. Tomas Nagy – Mechanical and Electrical design for the Autonomous Go-Kart
16. Saibernard Yogendran – Multi-friction driving using the Chrono Simulator
17. Saibaba Vinod Nargund – Embedded software for steer-by-wire function in the Autonomous Go-Kart
18. Aamir Abbas Khambaty – Power distribution for F1Tenth Autonomous Racing Platform
19. Archit Hardikar - GNSS-based navigation with Kalman filtering for localization and path tracking in the Autonomous Go-Kart
20. *Master's Thesis*, Aurunima Samaddar - Software Defined Vehicles architecture for Autonomous Go-Kart.
21. Hongyi Lai – Power distribution system design for the Autonomous Go-Kart
22. Rithwik Udayagiri – GNSS-based navigation with Kalman filtering for localization and path tracking in the Autonomous Go-Kart
23. Ankit Prabhu Andrew Zhu Shubham Gupta Adam Alavi Shubh Agarwal William C Francis
24. *Master's Thesis*, Martin Endler
    Embedded software control for the drive, steering and brake by-wire systems in the Autonomous Go-Kart
    Continued Masters at Czech Technical University in Prague (CTU)
25. Xiatao Sun - MEGA-DAgger: Imitation Learning with Multiple Imperfect Experts, Benchmark Comparison of Imitation Learning-based Control Policies for Autonomous Racing, Drive Right: Autonomous Vehicles Using a Virtual Reality Driving Simulator. Published 2 conference papers. Currently PhD student at Yale.
26. Yuntao Hu - Mechanical and Electrical design for the Autonomous Go-Kart
27. Jason Friedman - Mechanical and Electrical design for the Autonomous Go-Kart and Autonomy Essentials Kit for autonomous driving.
28. Akash Sundar, Vision-based Navigation Pipeline for F1Tenth, 2023
29. Zhijun Zhuang, Game-Theoretic Planning in Objective Space, 2023
30. *MS Thesis:* Nicole Chiou,
    Cross-Domain Transfer Learning with Multi-Task Learning for Cardiac Arrhythmia Classification, 2021.
    Continued as a PhD student in Stanford.
31. Kevin Xu, Controlled Environment Agriculture for Precision Plant Phenotyping, IoT4Ag Center, Summer 2021
32. Aditya Gupta, Controlled Environment Agriculture for Precision Plant Phenotyping, IoT4Ag Center, Summer 2021
33. Grant Brewster, Controlled Environment Agriculture for Precision Plant Phenotyping, IoT4Ag Center, Summer 2021
34. Xinlong Zheng, Development of the F1TENTH 3D Environment based on unity, 2021
35. Jayanth Bharghav, Track based Offline Policy Learning for Overtaking Maneuvers with Autonomous Racecar, 2021. Continued as a PhD student in Purdue University.
36. Wesley Yee, Multi Vehicle Coordination for High-Speed Maneuvers with F1Tenth, 2021

37. Lejun Jiang, Multi Vehicle Coordination for High-Speed Maneuvers with F1Tenth, 2021
38. Ravi Konkimalla, Vision Based Navigation (Visual Slam) with F1Tenth, 2021
39. Tom Jose, Vision Based Navigation (Visual Slam) with F1Tenth, 2021
40. Malavika Manoj, Vision-based Navigation with F1Tenth, 2021
41. Junfan Pan, Vision-based Navigation with F1Tenth, 2021
42. Karel Smejkal, Lidar-based Object Tracking for Connected Autonomous Vehicles with F1Tenth, 2021
43. Roshan Benefo, Lidar-based Object Tracking for Connected Autonomous Vehicles with F1Tenth, 2021
44. Raymond Bjorkman, Risk-based Planning and Control for overtaking with improvisation with F1Tenth, 2021
45. David DePauw, Risk-based Planning and Control for overtaking with improvisation with F1Tenth, 2021
46. Tuan Nguyen, The F1Tenth Model Predictive Control Racing Stack, Learning-based MPC, 2021
47. Nagarakshith Makam Sreenivasulu, The F1Tenth Model Predictive Control Racing Stack, Model Predictive Contouring Control, 2021
48. Venkat Varun Velpula, The F1Tenth Model Predictive Control Racing Stack: Hierarchal MPC, 2021
49. Zhihao Ruan, CD2CAV Automapping building blueprints to Indoor Robot Planning, 2021
50. Chris Kennedy, F1Tenth Virtual Racing System, 2021
51. Brandon McBride, Graident-free optimization toolchain for autonomous racing, 2021
52. Dayong Tong, F1Tenth Hardware platform development, 2021
53. Zirui Zang, Autonomous Valet Parking for F1Tenth, 2020
54. Yuwei Wang, Learning Model Predictive Control on F1tenth Race Car, 2020
55. Baihong Zeng, Learning Model Predictive Control on F1tenth Race Car, 2020
56. Yash Trikannad, CD2CAV Automapping building blueprints to Indoor Robot Planning, 2020
57. Dhruv Karthik, LiDAR2Cam – End-to-End Driving via Self Supervised Imitation Learning, 2020
58. Yide Zhao, Fly-by-Logic adaptation for Vicon system and optical flow, 2020
59. Siddharth Singh (MS, Robotics, Mechanical Engineering) – Perception and Control for Safe Autonomous Vehicles, 2020
60. Joseph Auckley (MS, Robotics, Computer Science) – Autonomous Vehicle Simulator and Raceline Optimization, 2020
61. Shashank Prasad (MS, Embedded Systems) – Sensor fusion for Autonomous Navigation, 2020
62. Danyang Li (MS, Electrical Engineering) – Learning to Fly: Experimental testbed for automatic trajectory synthesis from STL temporal logic mission specifications, 2020
63. Matthew Lebermann (BS, Mechanical Engineering) – Multi-vehicle testbed for autonomous racing, 2020
64. Michelle White (BS, Biomedical Engineering) – Thesis: Data-driven algorithms for Anti-Tachycardia Pacing in implantable cardiac devices, 2020
65. Derek Nong, ESE: Interactive Analytics for Demand-side Energy Management, 2017-2019.
66. Akarsh Varre, MS ESE: Fly-by-Logic Toolchain for Multi-Drone Mission Planning, 2018-2019.
67. John Harkins, ESE: F1/10 Autonomous Racing AV Stack for course and community, 2019
68. Christopher Kao, MS Robotics: Near-pose Estimation with Monocular Camera-based AV Navigation, 2019.

69. Yash Palkhiwala, Radhika Katti, Evans Yatich and George Poon: Senior Design: UrbanDrone – Spatial, Temporal and Reactive Gurantees for Multi-drone Missions. 2018-19.
70. Mack Shoer, MS Robotics: Convex Optimization of Trajectories and Speeds for Autonomous Racing, 2019.
71. Ritika Gupta, MS EE: Fly-by-Logic Toolchain for Multi-Drone Mission Planning, 2019.
72. Joseph Hiebert, MS, ESE: Data-driven Model Predictive Control for Smart Buildings, 2018
73. Swetha Subramaniam, Sophomore, ESE: Electricity price analysis in the PJM electric grid. 2018.
74. Rhudii Quaye, MS Robotics: Spatial, Temporal and Reactive guarantees for Autonomous Air Traffic Control. 2017-2019.
75. Arvind Ramesh, MS Embedded Systems: Optimization a Real-Time Operating System for Embedded Controllers. 2017.
76. Archana Ramachandran, MS Embedded Systems: Developing the Arduino-from-Scratch Labs, 2017.
77. Trevor Pennypacker, ESE: Design concepts for the F1/10 Autonomous Race Car, 2017.
78. Thejas Kesari, MS Embedded Systems: Implementation of SLAM algorithms for Autonomous Driving, 2017-18
79. Nitesh Singh, MS Embedded Systems: Implementation of SLAM algorithms on CPU and GPU, 2017-18.
80. Rishab Gupta, MS Embedded Systems: Local Interpretation using Decision Trees, 2017.
81. Nikheel Savant, MS Embedded Systems: Model-exchange Protocol for Connected Autonomous Vehicles, 2017
82. Paril Jain, MS Embedded Systems: Autonomous navigation at the limits of control, 2016-17.
83. Nischal KN, MS, Embedded Systems: Simulation Framework for F1/10 Autonomous Car, 2016-17.
84. Timothy Hu, MS Embedded Systems: Vision-based navigation for the F1/10 Autonomous Racecar. 2016.
85. Carter Sharer, CMU ECE: Building a Robotics Undergraduate Curriculum at Penn, 2015-16.
86. Ashmeet Rekhi, MS Embedded Systems: Immersive and Interactive Entertainment System in xLAB. 2015-16.
87. Zhi Li, MS ESE: Sensor fusion for Autonomous Vehicle Navigation, 2015
88. Srinivas Ekambaram, MS Embedded Systems: Sensor fusion for Autonomous Vehicle Navigation, 2015
89. Klyde Breitton, CS: Interactive and Interconnected Gaming Blocks in xLAB 2015.
90. Honnesh Ramachandra, MS Embedded Systems: Heart on Chip platform for testing implantable cardiac pacemakers. 2015
91. Darshan Lingaraj, MS Embedded Systems: Interactive Entertainment in xLAB. 2014
92. Ashok Vaidyanathan, MS Embedded Systems: Interactive Activity Surfaces in xLAB. 2014
93. Smita Bailur, MS Embedded Systems: Interactive Activity Surfaces in xLAB. 2014
94. Karan Sawahney, MS Embedded Systems: i-TV: The next generation set top box in xLAB. 2014.
95. Arun Venkatraman, MS Embedded Systems: Haptic Vest for Immersive Entertainment in xLAB. 2014.
96. Harsh Jain, MS, ESE. Wireless Control for Industrial Automation and ProtoDrive: Electric Vehicle Test-bed. Winner of Honeywell Wireless Control Automation Award, 2011. 3rd Prize in World Embedded Programming Competition, Korea. 2012. Distinguished Recognition Award in Intel/Cornell Embedded Systems Cup 2013.

97. William Price, Senior, EE & MEAM, ProtoDrive: Electric Vehicle Test-bed. 3rd Prize in World Embedded Programming Competition, Korea. 2012.
98. Tao Lei, MS, ESE. Traffic Signal Scheduling in Philadelphia. Also developed Cloud Services for MLE+ for energy-efficient building modeling and control. 2012-13.
99. Neel Shah, MS, Embedded Systems. En-Route Energy Router Test-bed for Energy Efficient Buildings. 2012-13.
100. Praveen Pitchai, MS, Robotics. Vision Integrated Operating System for Comcast Cable Set-top box of the future. Computer vision and machine learning. 2012-13
101. Rajeev Kumar, MS, Robotics. Vision Integrated Operating System for Comcast Cable Set-top box of the future. Cloud-based interactive processing. 2012-13
102. Abhijeet Mulay, MS, Embedded Systems. ProtoDrive: Electric Vehicle Test-bed. Finalist for Intel/Cornell Cup for Embedded Systems. Developed ZipCare: a wearable wireless EKG heart-monitoring patch. 2012-13.
103. Shashidhar Reddy, MS, EE. Vision Integrated Operating System for Comcast Cable Set-top box of the future. Platform architecture and immersive experience. 2012-13
104. Rajib Dutta, MS, Embedded Systems. ZipCare Wearable Heart and Activity Monitor. 2012-13.
105. Tanvir Ahmed, Junior, Computer Engineering. Vision Integrated Operating System for Comcast Cable Set-top box of the future. User interface and interaction. 2013.
106. Alfredo Muniz, Sophomore, Computer Engineering. ProtoDrive: Electric Vehicle Test-bed. 2013.
107. Parth Patel, Freshman, Electrical Engineering. ProtoDrive: Electric Vehicle Test-bed. 2013.
108. Azriel Samson, MS, Embedded Systems. Open ISA100.11a network stack for industrial automation. 2012-13.
109. Vignesh Anantha Subramanian, MS, Embedded Systems. Open-source ISA100.11a network stack for industrial automation. 2012-13.
110. Eric Berdinis, Senior, CE. Winner of Google Zeitgeist Award, Intel Innovators Award, Intel/Cornell Embedded Systems Cup – People's Choice Award.
111. Jeff Kiske, Senior, CE. Winner of Intel Innovators Award, Intel/Cornell Embedded Systems Cup – People's Choice Award.
112. Chen Zheng, MS EE. Electricity Controller Cloud Architecture. 2011-12.
113. Haofang Yuan, MS EE. SolarSkin for Energy Efficient Buildings. 2011-12.
114. Chenyan Sun, MS EE. Design and development of the ISA 100.11a Wireless Standard for Industrial Automation. 2011-12.
115. Varun Sampath, Senior, CE. Winner of SEAS 2012 Senior Design Competition. Winner of Honorable Harold Berger Senior Design Project Award, 2012. Finalist, World Embedded Competition, Korea.
116. Sriram Radhakrishnan, Senior, ESE. Winner of SEAS 2012 Senior Design Competition. Winner of Honorable Harold Berger Senior Design Project Award, 2012. Finalist, World Embedded Competition, Korea, 2012.
117. Shilpa Sarode, Senior, ESE. Winner of SEAS 2012 Senior Design Competition. Winner of Honorable Harold Berger Senior Design Project Award, 2012. Finalist, World Embedded Competition, Korea, 2012.
118. William Etter, Senior, ESE. Awarded Vagelos Undergraduate Research Grant. Winner of Frederick Ketterer Memorial Award for Best Senior Design Project 2011.

119. Theodore Zhang, Senior, ESE. Intel/Cornell Embedded Systems Cup Winner 2012. Honorable Mention Award, SEAS Senior Design Competition 2012.
120. Kevin Conley, Senior, ESE. Awarded Rachleff Scholar Scholarship. Awarded 1st Prize in World Embedded Software Competition, Korea, November 2010.
121. Teddy Zhang, Matthew Hale and Paul Gurniak, Senior Design Team.
122. Paul Martin, Senior, ESE. Awarded Vagelos Undergraduate Research Grant. Winner of Frederick Ketterer Memorial Award for Best Senior Design Project 2011.
123. Gabe Torres, Senior, CIS. Winner of 1st Prize Senior Design Award, CIS Department 2011.
124. Ross Boczar, Senior, ESE. Winner of 1st Prize Senior Design Award, CIS Department 2011.
125. Jason Suapengc, CIS. Winner of 1st Prize Senior Design Award, CIS Department 2011.
126. Anu Sukumaran, MS, ESE. First job at Lutron Electronics.
127. Utsav Drolia, MS, ESE. Now Ph.D. student at Carnegie Mellon University.
128. Danny Lustig, Winner of Harold Berger Senior Design Project Award, 2009. Ph.D. at Princeton University.
129. Andrew Avrin, Winner of Harold Berger Senior Design Project Award, 2009. Now at Google.
130. Steven Z. Wang, MS, ESE. First job at Motorola, Michigan
131. Srinivas Vemuri, MS, ESE. First job at GE Healthcare, Milwaukee
132. Mansimar Aneja, MS, Robotics. First job at BOSCH Research (Pittsburgh)
133. Brandon Duick (Boeing), Winner of Harold Berger Senior Design Project Award, 2009. Joined Lockheed Martin.
134. Jason DeLisser, 2010. Now at L3 Communications.
135. Avinash Rajput, 2009. First job at MERK, Automation Division.
136. Sunil Sadasivan (Cisco), 2010. CTO of Buffer.com
137. RoopKumar Kalimuthu (Penn), 2009
138. Malolan Shantanakrishnan (MathWorks), MS research on "Dual Radio Platform for Sensor Networks". 2006.
139. Mark Hamilton (CMU), BS Honors research on "Safety Protocols in Vehicular Networks" in Fall 2006.
140. Dan Weller, BS Honors Thesis on "Vehicle Network Simulation" in Spring 2006. Completed Ph.D. at MIT. Winner of Carnegie Institute of Technology Honors Research Competition.
141. Ryohei Suzuki (Tokyo University), Visiting Scholar with focus on "Topology Discovery and Scheduling for TDMA Sensor Networks" in Fall 2005.
142. Jalaja Kurubarahalli (Cisco), Masters Thesis on "GeoRoute: An In-vehicle System for Geographic Routing in Vehicular Networks" in Spring 2005.
143. Chih-Yuan Liao (Qualcomm), Masters Thesis on "Network Tiles for Concurrent Transmission in Wireless Mesh Networks" in Spring 2003.
144. Yoshisato Takeda (Mitsubishi Electric), Masters Thesis on "PAQ-MAC: Power-Aware MAC Protocol for Wireless Networks with a 2-Packet Buffer" in Spring 2002.

Undergraduate REU Students:

1. **Nandan Tumu**, University of Connecticut, Computer Science. 2019
   - Developed Shockingly Effective: Data-Driven Algorithms for Implantable Cardiac Medical Devices
   - Honorable Mention for Best Penn Engineering Summer Project
2. **Santiago Gonzalez**, Case Western Reserve University, Electrical Engineering, 2018
   - Developed Watts App: An Energy Analytics and Demand-Response Advisor Tool
3. **Kevin Volkel**, Wilkes-Barre University, Electrical Engineering. 2016
   - Developed Computer-aided Pre-clinical Trials for Implantable Medical Devices: Test Automation Platform
   - Continued on to Ph.D. at North Carolina State University (2017)
4. **George Chen**, Johns Hopkins University, Biomedical Engineering. 2013
   - *Won Best Summer Research Award in SEAS*.
   - Selected for CRA Engineering Education Awardees Conference, Oct 2013.
   - Continued on to Adecco at Google (Moonshot)
5. **Stephanie Diaz**, SUNY Binghamton, Electrical Engineering. 2012
   - Developed ProtoDrive: Electric Vehicle Platform.
   - *Published research* in *33rd IEEE Real-Time Systems Symposium, RTSS@Work, Puerto Rico, 2012.*
   - Continued on to The Johns Hopkins University Applied Physics Laboratory
6. **Kevin Conley**, Penn, Electrical & Systems Engineering. 2012
   - Awarded Rachleff Scholar Scholarship. *Won Best Summer Research Award in SEAS.*
   - Won 1st Prize in World Embedded Competition, Seoul, Korea in 2010 for the AutoPlug project.
   - Continued on to Stanford for graduate studies.
7. **Peter Malamas**, Johns Hopkins University, Biomedical Engineering. 2011
   - Developed 3D Electrophysiological Heart Model for Real-time Interaction with Pacemakers.
   - Continued on to NYU School of Medicine
8. **Uchenna Kevin Anyanwu**, California State University at San Jose, Electrical Engineering. 2009.
   - Developed GrooveNet 3.0 Vehicular Network Simulator.
   - Continued on to Ph.D. at Virginia Tech.
9. **Allison Connolly**, Johns Hopkins University, Biomedical Engineering. 2009-10
   - Developed the Real-Time Heart Model. Co-authored three papers in IEEE ECRTS, IEEE EMBC and RTAS
   - *Selected for NSF Engineering Education Awardees Conference*, Jan 2010.
   - Continued on to Ph.D. at U. Minnesota (2010).

PROFESSIONAL SERVICE

Conference and Workshop Organization

1. Workshops Chair, IEEE International Conference on Intelligent Transportation Systems (ITSC), September 24 – 27, 2024, Edmonton, Canada
2. Program Co-Chair, MAD Games: Multi-Agent Dynamic Games Workshop, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Detroit, MI. 2023
3. Program Co-Chair, 14th F1Tenth Autonomous Racing International Competition, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Detroit, MI. 2023
4. Program Co-Chair, 5th Workshop on Autoware – ROS-based OSS for Autonomous Driving, IEEE Intelligent Vehicles Symposium (IV), Anchorage, Alaska. 2023
5. Program Co-Chair, IROS 13th F1Tenth Autonomous Racing International Competition, IEEE Intelligent Vehicles Symposium (IV), Anchorage, Alaska. 2023
6. Program Co-Chair, IROS 12th F1Tenth Autonomous Racing International Competition, IEEE/ACM Cyber-Physical Systems and Internet-of-Things Week (CPS-IoT), San Antonio, TX. 2023

7. Program Co-Chair, IROS 11th F1Tenth Autonomous Racing International Competition, IEEE International Conference on Robotics and Automation (ICRA), London, 2023
8. Program Co-Chair, IROS 10th F1Tenth Autonomous Racing International Competition, IEEE International Conference on Robotics and Automation (ICRA), Philadelphia. 2022
9. General Chair, IEEE COMSNETS 13th Intl. Conference on Communication Systems & Networks, 2022
10. Program Co-Chair, ICRA Opportunities and Challenges with Autonomous Racing Workshop, 2021
11. Program Co-Chair, IROS 9th F1Tenth Autonomous Racing International Competition, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Prague. 2021
12. Program Co-Chair, NSF Frontiers CyberCardia Medical Cyber-Physical Systems Workshop, Embedded Systems Week, NY, 2020
13. Program Co-Chair, Workshop on Medical Cyber-Physical Systems (NSF Frontiers Cybercardia), 2019
14. Program Co-Chair, IEEE COMSNETS 9th Intl. Conference on Communication Systems & Networks, 2017
15. Program Co-Chair, ACM SIGBED International Conference on Embedded Software (EMSOFT), 2016
16. Program Co-Chair IEEE Real-Time Systems Symposium (RTSS), December 2015
17. Program Co-Chair, ACM Conf. on Embedded Systems for Energy-Efficiency in Building Environments (BuildSys), November 2015
18. Program Co-Chair, *6th Medical Cyber-Physical Systems Workshop at CPSWeek*, Seattle. April 2015
19. Program Chair (Demos and Posters), *ACM Conference on Embedded Systems for Energy-Efficiency In Buildings* (BuildSys), November 2014
20. Program Co-Chair, *4th MobileHealth Workshop at ACM MobiSys*, Philadelphia, August 2014
21. Program Co-Chair, *5th Medical Cyber-Physical Systems Workshop at CPSWeek*, Berlin. April 2014
22. Program Chair, CPS Industry Track, 19th *IEEE Real-Time and Embedded Technology and Applications Symposium* (RTAS), Philadelphia, April 2013
23. Program Co-Chair, *4th Medical Cyber-Physical Systems Workshop* at CPSWeek, Philadelphia. April 2013
24. Program Co-Chair, 18th *IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*, Beijing, China. April 2012
25. Program Co-Chair, *2nd IEEE Analytic Virtual Integration of Cyber-Physical Systems Workshop*, Co-located with RTSS, Dec 2011
26. Program Chair, 3rd *IEEE Joint Workshop on High-Confidence Medical Devices Software and Systems*, Co-located with CPSweek Chicago, IL. April 2011

Conference Activities

Member of Organizing Committee

1. IEEE Trans. Intelligent Vehicles Steering Committee, RAS Voting Member (2022-)
2. ACM/IEEE EMSOFT(2018-2021)
3. IEEE COMSNETS (2009, 2010, 2012, 2014, 2016, 2018, 2020, 2021, 2022)
4. ACM BuildSys (2017-2020)
5. ACM IPSN (2014)
6. IEEE Medical CPS (2014)
7. AVICPS (2014)
8. IEEE Medical CPS (2013)
9. IEEE RTAS (2013)
10. IEEE HCMDSS (2011)

11. IEEE COMSWARE (2008)
12. IEEE INFOCOM (2010)
13. IEEE INSS (2009)

Member of Program Committee

1. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2024
2. IEEE Intelligent Vehicles Conference (IV), 2023
3. IEEE International Conference on Mobility: Operations, Services, and Technologies (MOST'23) (declined)
4. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2022 (declined)
5. 25th ACM International Conference on Hybrid Systems: Computation and Control (HSCC), 2022 (declined)
6. 27th IEEE International Conference on Embedded and Real-Time Computing Systems and Applications (RTCSA 2021) (declined, sabbatical)
7. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2021
8. IEEE/ACM Hybrid Systems and Control Conference (HSCC), 2021
9. IEEE Workshop on the Internet of Safe Things (SafeThings 2020) (declined)
10. Autonomous Cyber-Physical Systems (AutoCPS) Workshop at ACM/IEEE CPSWeek 2020
11. Autonomous Systems Design Initiative, IEEE Design Automation and Test Conference (DATE) 2020
12. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2020
13. Special Session on Autonomous Driving and Driver Assistance Systems, 4th Iberian Robotics Conference (ROBOT2019) (declined)
14. Model-Based Design of Cyber Physical Systems Workshop (CyPhy'19), ACM Embedded Systems Week
15. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2019
16. ACM e-Energy Conference 2019 (declined)
17. FORMATS'15, E-Energy'15, WFCS'15, LCTES'15,
18. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2016
19. 12th European Conference on Wireless Sensor Networks (EWSN), 2015
20. ACM Conference on Future Energy Systems (E-Energy), 2015
21. ACM SIGPLAN Conference on Languages, Compilers, and Tools for Embedded Systems (LCTES), 2015
22. IEEE Symposium for Reliable Distributed Systems (SRDS), 2015
23. ACM International Conference on Information Processing in Sensor Networks (IPSN), 2015
24. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2015
25. IEEE International Conference on Cyber-Physical Systems, Networks, and Applications (CPSNA), 2014
26. ACM Workshop on Embedded Systems for Energy-Efficiency in Buildings (BuildSys), 2014
27. ACM International Conference on High Confidence Networked Systems (HiCoNS), 2014
28. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2014
29. ACM Workshop on Embedded Systems For Energy-Efficiency In Buildings (BuildSys), 2013
30. IEEE Real-Time Systems Symposium (RTSS), 2013
31. IEEE International Conference on Embedded Software (EMSOFT), 2013
32. IEEE International Conference on Cyber-Physical Systems, Networks, and Applications (CPSNA), 2013.
33. IEEE International Conference on Cyber-Physical Systems (ICCPS), 2013
34. ACM 2ND International Conference on High Confidence Networked Systems (HiCoNS), 2013
35. IEEE Real-Time Systems Symposium (RTSS), 2012

36. ACM International Conference on Information Processing in Sensor Networks (IPSN), 2012
37. IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), 2012.
38. IEEE Real-Time & Embedded Technology and Applications Symposium (RTAS), 2012
39. IEEE Real-Time & Embedded Technology and Applications Symposium (RTAS), 2011
40. IEEE RTSS, Work-in-Progress, 2010
41. IEEE Real-Time Systems Symposium (RTSS), Analytical Virtual Integration of CPS Workshop, 2010
42. IEEE Real-Time & Embedded Technology and Applications Symposium (RTAS), 2010
43. ACM INFOCOM, 2009
44. IEEE Real-Time Systems Symposium (RTSS), 2008
45. IEEE Real-Time & Embedded Technology and Applications Symposium (RTAS), 2008
46. IEEE International Symposium on Wireless Vehicular Communications, 2008
47. IEEE MoVeNet, 2nd International Workshop on Mobile Vehicular Networks, 2008
48. IEEE International Symposium on Vehicular Computing Systems, 2008
49. IEEE Workshop on Mobile Networks for Vehicular Environments, (INFOCOM/MOVE), 2008
50. IEEE Symposium on Selected Areas of Communication of ICC, 2009

Tutorials, Panelist and Session Chair

1. Panelist, Autonomous driving, Artificial Intelligence of Things Summit at Croucher Advanced Study Institute, Hong Kong, July 2023.
2. Tutorial "Autoware Autonomous Driving Software and Systems and Its Application Platforms", at the IEEE Intelligent Vehicle Symposium, Anchorage, Alaska. 2023
3. Panelist, IEEE COMSNETS 2023 Panel on "15 Years of COMSNETS and the past, present, and future of networking"
4. Tutorial, Learn to Drive (and Race!) Autonomous Vehicles at Embedded Systems Week, 2021.
5. Panelist, Wharton Executive Education, "Driverless Cars: What's stopping them?", June 2021.
6. Future Development of Autonomous Systems panel in IEEE International Conference on Autonomous Systems ICAS'21
7. Panelist, ITS World Congress, Cooperative Driving Automation: The latest in U.S. research, resources, and findings for global improvements in safety and mobility, October 2020.
8. Panelist, "AI, Robotics & Future Works", Penn Wharton China Center Five Year Anniversary Special Event, March 2020.
9. Presenter, NSF Blue Ribbon Panel for IoT4Ag Engineering Research Center, December 2019
10. Panelist, "Man versus Machine: Humans Need Not Apply", IEEE COMSNETS, 2019.
11. Panel Moderator, Internet of Safe Things, 2019 (declined)
12. Panelist, 2017 National Cleantech UP Competition Alumni, 2017 (declined)
13. IEEE RTAS, CPSWeek, Philadelphia, PA. April, 2013. Industrial Session Chair.
14. IEEE ICCPS, CPSWeek, Philadelphia, PA. April, 2013. "CPS Applications" Session Chair.
15. Connected Vehicle Test-Bed Development & Integration Workshop, Buffalo, NY. Jun, 2012. Invited Speaker.
16. IEEE Analytic Virtual Integration of Cyber-Physical Systems Workshop, San Diego, CA. Co-located with RTSS, Dec 2010. Panelist.
17. IEEE RTAS, Stockholm, Sweden, April 2010. "Wireless Sensor Networks" Session Chair.
18. IEEE ICDCS, Montreal, Canada, June 2009. "Vehicular Ad hoc Networks" Session Chair.

19. IEEE International Workshop on Cyber-Physical Systems (WCPS), Montreal, Canada, June 2009. Panelist.
20. IEEE RTAS, St. Louis, MO, April 2008. "Quality of Service" Session Chair.
21. IEEE International Workshop on Mobile Vehicular Networks (MoVeNet), Atlanta, GA, September 2008. Panelist.

Conference Reviewer

- IEEE Conference on Robotics and Automation (ICRA), 2022-2024
- IEEE Conference on Decision and Control (CDC), 2015-2024
- IEEE American Control Conference (ACC), 2014-2023
- IEEE Transactions on Control Systems Technology, 2022
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2022-2023
- IFAC World Congress, 2023
- IEEE Engineering in Medicine and Biology Conference (EMBC), 2011-2020
- IEEE International Conference on Embedded Software (EMSOFT), 2010
- IEEE Intelligent Transportation Systems Magazine, 2010
- IEEE Vehicular Networking Conference, 2009
- IEEE International Conference on Embedded Software (EMSOFT), 2009
- IEEE/IFIP International Conference on Embedded and Ubiquitous Computing, 2009
- IEEE International Conference on Computer Communications and Networks, 2009
- IEEE ICC Symposium on Selected Areas in Communications, 2009
- IEEE Wireless Communication Magazine Special Issue on VANET, 2009
- IEEE INFOCOM, 2009
- IEEE Wireless Access in Vehicular Environments, 2008
- IEEE International Workshop on Mobile Vehicular Networks, 2008
- IEEE Communications Magazine, 2008
- IEEE Globecom, 2008
- IEEE Wireless Vehicular Communications, 2008
- IEEE International Symposium on Vehicular Computing Systems, 2008
- IEEE INFOCOM MOVE, 2008
- ACM SECON, 2008
- IEEE Communications Magazine, Automotive Networking Series, 2007
- IEEE RTAS 2007

Journal Editorial Boards

1. Associate Editor, ACM Transactions on Computing for Healthcare (HEALTH), 2022-
2. Associate Editor, IEEE Autonomous Driving Letters (ADL), 2022-
3. Editor, Journal of Field Robotics, Special Issue on Autonomous Racing, 2022-2023
4. Associate Editor, *ACM HEALTH*, 2018-2023
5. Associate Editor, *Elsevier Journal of Smart Health*, 2018-2023
6. Guest Editor, *IEEE Transactions on Embedded Systems*, Special Issue on Best Papers from IEEE RTAS'13.
7. Guest Editor, *Journal of Real Time Systems*, Special Issue on Energy and Sustainability, 2014.
8. Guest Editor, *IEEE Trans. on Emerging Topics in Computing*, Sp. Issue on Wireless Health Comp., 2014.
9. Guest Editor, *IEEE Design & Test*, Special Issue on Cyber-Physical Systems for Medical Applications. 2014.

Journal Reviewer

- IEEE Transactions of Automatic Control, 2012, 2013, 2022, 2023
- Elsevier Journal of Traffic and Transportation Engineering, 2023
- Elsevier Journal of Computational Science, 2023

- Journal of Intelligent & Robotic Systems, 2022
- Cambridge University Press, 2022
- Elsevier Aerospace Science and Technology, 2022
- MDPI Energies, 2021
- MDPI Mathematics, 2021 (declined)
- IEEE Control Systems Letters, 2020
- Elsevier Sustainable Materials and Technologies, 2020
- IEEE Transactions on Vehicular Technology, 2020
- Journal of Building Engineering, 2020
- IEEE Transactions on Neural Networks and Learning, 2019
- Elsevier Energy and Buildings, 2017-2020
- Elsevier Energy, 2016-2019
- PLOS Computational Biology, 2019
- CHAOS, 2018
- IEEE Transactions on Wireless Communications, 2017
- IEEE Transactions on Automation Science and Engineering, 2016
- ACM Transactions on Cyber-Physical Systems, 2016
- IEEE Transactions on Industrial Informatics, 2015
- Foundations and Trends in Electronic Design Automation, 2015
- IEEE Design & Test, 2015
- Journal of Energy Storage, 2015
- IEEE Sensors Journal, 2015
- ACM Transactions on Design Automation of Electronic Systems, 2014
- ACM Transactions on Embedded Computing Systems, 2014
- IEEE Real-Time Systems Journal, 2012, 2013, 2014
- IEEE Transactions on Automatic Control, 2013
- IEEE JSAC Special Issue on In-Network Processing, 2012
- ACM Transactions in Embedded Computing Systems (TECS), 2010
- ACM Computing Surveys Journal, 2010
- IEEE Network Special Issue on "Advances in Vehicular Communications Networks", 2009
- Elsevier Ad hoc Networks, 2009
- ACM Transactions on Sensor Networks, 2008
- IEEE Internet Computing, 2008
- ACM Transactions on Computers, 2008
- ACM Transactions on Mobile Computing, 2008
- ACM Transactions on Mobile Computing, 2007
- UBIROADS Workshop, 2007
- IEEE JSAC Special Issue on Vehicular Networks, 2007

Government Activities

1. Panelist, NSF CSR PI Meeting, Autonomous Driving Panel, at Duke University, October 2023.
2. NSF Panelist, 2009-2023
3. NSF CPS PI Meeting – organized special sessions, breakouts, lightening talks and demos, 2014-2022
4. NSF Workshop on Cloud Computing for Cyber-Physical Systems, Arlington, VA. March 2013. Break-out Session Chair
5. Cyber-physical Systems Panel at NIST Performance Metrics for Intelligent Systems, March 2012. Panelist
6. ARPA-E Energy-efficient Building Technology Workshop, Arlington, VA. December 2009
7. NSF-NCO/NITRD National Workshop on High Confidence Transportation Cyber-Physical Systems, Arlington, VA/. Nov 2008. Break-out Session Chair
8. NSF-NCO/NITRD National Workshop on High Confidence Automotive Cyber-Physical Systems, Detroit, MI. April 2008. Break-out Session Chair.
9. NSF-NCO/NITRD New Research Directions in Composable and Systems Technologies for High Confidence Cyber-Physical Systems, Arlington, VA. July 2007
10. NSF National Workshop on High Confidence Medical Device Software and Safety, Boston, MA. June 2007. Break-out Session Chair.

UNIVERSITY ACTIVITIES

Director, Embedded Systems Master Program

June 2015 – May 2021

University of Pennsylvania, *Philadelphia, PA*
Program with 72 MS students - http://www.cis.upenn.edu/prospective-students/graduate/embs.php

Committees

1. Faculty Council, School of Engineering and Applied Science, 2018 - 2021
2. Founding Committee Member, Undergraduate Program in Computer Engineering. 2009 – Present
3. Founding Committee Member, Master's Program in Embedded Systems. 2009 – 2019
4. Founding Member, PRECISE Center, Penn Research in Embedded Computing Center. 2009 – Present
5. Dean's reappointment committee.
6. ESE Department Chair's reappointment committee.
7. ESE Faculty Search Committee 2015-2019

Major Outreach Impact: *F1Tenth Autonomous Racing*

F1Tenth Autonomous Racing was started as a course, community and competition at Penn in 2016.

- It has grown to 80+ universities which use the open-source F1Tenth platforms for research & education.
- There have been 14 F1Tenth Autonomous Racing Grand Prix Competitions hosted at top conferences in robotics (ICRA, IROS), transportation (IEEE Intelligent Vehicles, IEEE ITSC) and Cyber-Physical Systems (CPS-Week and Embedded Systems Week) with over 150 participants in the most recent competitions.
- This has resulted in several workshops on Multi-Agent Dynamic Games and Opportunities & Challenges in Autonomous Racing
- In 2024, F1Tenth has been invited to host the competition and workshops at 6 international conferences.

Major Industrial Impact: *Autoware Center of Excellence for Autonomous Driving*

The Autoware CoE was started at Pennovation in 2022 to build Open-source autonomous vehicle software for Open-standards electric vehicle platforms.

- 22+ universities which use the open-source Autoware software and systems for research & education.
- 70+ Autoware industrial partners (ARM, AMD, Foxconn, TomTom, Velodyne, ADLink, etc.) for developing next generation autonomous driving software and systems.

Outreach

1. Host to 15 F1Tenth Autonomous Racing Competitions at top conferences including ICRA, IROS, IFAC, CPA-Week, Embedded Systems Week, IEEE Intelligent Vehicles 2017-present. We will host the competition at 5 conferences in 2024. The competition open to public and well attended.
2. Moral Decision Making for Autonomous Systems, AI Ethics Lecture to Trustees' Council of Penn Women conference, March 2023
3. Moral Decision Making for Autonomous Systems, AI Ethics Lecture to students in EAS 2030 Engineering Ethics. Delivered every semester since 2019-present
4. Autoware Center of Excellence Steering Committee Monthly Meeting for outreach to 22 universities, May 2022-present
5. Learn to Drive (and Race!) Self-driving Racecars talk to K-4 students at Free Library, Sept 2022
6. F1Tenth Autonomous Racing Tutorials at Cyber-Physical Systems Week and Embedded Systems Week twice annually 2016-2021.
7. Organized Next Generation of Truck Freight Transport Summit, October 2018
8. Featured in Engineering Professor Video Project, Engineering Deans' Advisory Board (EDAB), Dec 2013
9. Dean's Student Advisory Council. Lecture on "Getting Involved in Undergraduate Research", Nov 2013
10. Guest lecture on Cyber-Physical Systems in Integrated Product Design course, Nov 2013.
11. Gave "Senior Design. Done Right" talk to seniors in ESE and CIS. September 2013.
12. SUNFEST NSF REU. Lecture on "Adventures in Cyber-Physical Systems", August 2013
13. Organized 3-session workshop for Toyota Engineers as part of the Penn English Language summer program, May 2012 and May-September 2013.
14. Women in Computer Science (WICS) High-school Day, Guide and Lecturer. May 2013.
15. Guest lecture on Cyber-Physical Systems in Integrated Product Design course, Nov 2012.
16. SUNFEST NSF REU. Lecture on "Automotive Embedded Systems", August 2012
17. Guest lecture on Cyber-Physical Systems in Architecture Department, Nov 2013.
18. Young India Fellowship: Mentored students on development of technologies for the blind. Team viSparsh won the Accenture Innovation Jockeys Award (France) for the development of a haptic navigation belt. Jan-Dec 2012.
19. Organized International Workshop on Mobile, Wireless and Pervasive Systems in collaboration with NIIT University, India. Jan 2012
20. Summer Academy in Applied Science and Technology. Master Lecture for High-School Students, July 2010
21. High-School Summer Mentorship Program, Faculty Organizer. July 2010
22. Women in Computer Science (WICS) High-school Day, Guide and Lecturer. May 2010.
23. SUNFEST NSF REU. Lecture on "Medical Cyber-Physical Systems", August 2010
24. High School Guidance Counselors and Teachers Day, Guide and Lecturer. November 2009

Ph.D. Thesis Committee Member

1. Ênio Filho, University of Porto, Portugal, 2023
2. Matthew Cleaveland, Computer and Information Science, University of Pennsylvania, 2023
3. DJ Park, Electrical and Systems Engineering. University of Pennsylvania, 2023
4. Logan Beaver, "Decentralized Control Framework for Autonomous Air Traffic Control", University of Delaware, 2022.
5. David Arney, "Medical Device Interoperability with Provable Safety Properties", University of Pennsylvania, 2019
6. Johannes Giesen, "Automated Design Space Exploration of HLS Applications on Heterogeneous Platforms with Reconfigurable Fabrics", University of Pennsylvania. 2019.
7. Yorick De Bock, "Hard real-time scheduling on virtualized embedded multi-core systems", Department of Electronics Engineering, Universiteit Antwerpen, Belgium. 2018.
8. Maryam Rahmaniheris, "Executable Clinical Models for Acute Care", Department of Computer Science, University of Illinois at Urbana-Champaign. 2017.
9. Nipun Batra, "Systems and Analytical Techniques Towards Practical Energy Breakdowns for Homes", Department of Computer Science, Indraprastha Institute of Information Technology, Delhi, India. 2017.
10. Radoslav Ivanov, "Context-Aware Sensor Fusion for Securing Cyber-Physical Systems", University of Pennsylvania. 2017.
11. Jaewoo Lee, "Resource-efficient Scheduling on Cyber-Physical Systems with Mixed-Criticality and Composability". University of Pennsylvania. 2016.
12. Sanjian Chen, "Model-based analysis of user behaviors in medical Cyber-Physical Systems", University of Pennsylvania. 2016.
13. Andrew King, "Foundations for safety-critical on-demand medical systems", University of Pennsylvania, 2016
14. Po-Liang Wu, "Low Complexity System Designs for Medical Cyber-Physical-Human Systems", Department of Computer Science, University of Illinois at Urbana-Champaign. 2014.
15. Alex Styler, "Stochastic Model Predictive Control in Human Driven Systems", Carnegie Mellon University, 2014
16. John M. Mountney, "Particle Filtering Programmable Gate Array Architecture for Brain Machine Interfaces", Department of Electrical and Computer Engineering, Temple University. 2011.
17. Andrew Hilton, "Energy Efficient Load Latency Tolerance: Single-Thread Performance for the Multi-Core Era". University of Pennsylvania, July 2010

Qualifier (WPE-II) Committee Member

1. Baek Gyu Kim, University of Pennsylvania, WPE-II, Dec 2013
2. Svilen Mihaylov, University of Pennsylvania, 2009

Instruction

1. ESE 3600 TinyML Tiny Machine Learning: Fall 2022, Spring 2023
2. ESE 6150 F1/10 Autonomous Racing: Spring 2020, 2022, 2023
3. ESE 680 F1/10 Autonomous Racing: Fall 2019
4. ESE 350 Introduction to Embedded Systems: Spring 2010-2020
5. ESE 519 Real-Time and Embedded Systems: Fall 2010-2019
6. ESE 680 Wireless Embedded Networks: Spring 2009
7. ECE 18848 Graduate Embedded Systems, Carnegie Mellon University: Fall 2006
8. ECE 18-220 Fundamentals of Electrical Engineering, TA, Carnegie Mellon University: Spring 2001

Teaching Workshops and Tutorials

1. Tutorial on Autonomous Racing and Multi-Agent Games at 21st International Conference on Advanced Robotics (ICAR 2023)
2. Tutorial on F1Tenth to Korean University Delegates, 2023
3. 2016-2023 Twice Annual tutorials on F1/10 Autonomous Racing at Cyber-Physical Systems Week and Embedded Systems Week
4. Tutorial to Toyota engineers, Penn English Language Program. "Automotive Cyber-Physical Systems", May-August 2013 and May-August 2014.
5. Engineering Faculty Teaching Forum, Invited Speaker. "Active Learning in Lectures". Nov 2012
6. Tutorial at IEEE ICCAD. "Algorithms for Analysis and Optimization of Future Cyber Physical Systems", (with Radu Marculescu). San Jose, CA. Aug 2012
7. Organized International Workshop on Mobile, Wireless and Pervasive Systems in collaboration with NIIT University, India. Jan 2012.
8. Tutorial to Toyota engineers, Penn English Language Program ."Vehicle to Vehicle Networks". May 2012
9. Sensor Network Workshop, Institute for Information Industry, Taipei, Taiwan. Nov 2005

RESEARCH EXPERIENCE

Visiting Scholar, Athens Information Technology**,** Athens, Greece Summer 2006
Invited to set up a Sensor Network lab with the FireFly platform and help design a course on sensor networks for the resident MS students. An experimental test-bed for tracking, sensing and multi-hop voice streaming was deployed. I conducted a 1-week workshop on network programming, time synchronization, logical topology control and design for predictable lifetime.

International Scholar, Inter-University Microelectronics Center (IMEC), Leuven, Belgium Fall 2003
I worked with Prof. Francky Catthoor on a cross-layer optimization methodology to improve the energy efficiency of next generation wireless transceivers. The scheme determines the lowest energy configuration, at run-time, of the physical layer, communications layer and link layer while delivering high quality video traffic over a fading wireless link. With actual channel measurements, a real power amplifier and turbo decoder, we were able to reduce the energy consumption by 2-5*x,* while streaming real MPEG-4 video for multiple users.

Visiting Researcher, Intel Labs, Hillsboro, OR Fall & Summer 2002
Ultra-Wide Band MAC Protocol: As part of the first design team on UWB, I designed and analyzed a link-layer protocol for multimedia across IEEE 802.15.3. We presented results at IEEE 802 Conference showing a 60% improvement in channel utilization for MPEG-4 streams and non real-time traffic with the addition of just one byte to the draft protocol.

INDUSTRY EXPERIENCE

Member of Board, The Autoware Foundation Dec 2022 -
Open-source Autonomous Vehicle Software & Systems

Principal, Jugaad Labs, Philadelphia, PA May 2021 -
Technology Consulting

Hardware Engineer, Apple Computer Inc., Cupertino, CA Summer 2000
As part of the first Gigabit Ethernet rollout, I developed a performance analysis tool to stress test the Ethernet MAC and PHY across a grid of machines. System programming involved PCI bus, MacOS internals, memory management, TCP/IP stack and the Gigabit Interface.

ASIC Engineer, Marconi Communications (FORE Systems), Warrendale, PA Spring & Summer 1999
As part of a 5-chip ASIC design team for a 250Gbps ATM/IP network switch, I worked on an ASIC. My work focused on implementing register control, state machine blocks and CRC.

Software Engineer, National Instruments Corporation, Austin, TX Summer 1997
Developed GPIB device-driver architecture using COM/DCOM middleware

SELECTED INVITED TALKS

1. *Moral Decision Making for Autonomous Systems* *Oct 2023*
   Stavros Niarchos Foundation (SNF) Paideia Program, University of Pennsylvania
2. *MAD Games – Multi-Agent Dynamic Games* *Oct 2023*
   2nd Korean F1Tenth Autonomous Racing Competition, Korea
3. ***Keynote:*** *MAD Games – Multi-Agent Dynamic Games* *July 2023*
   Artificial Intelligence of Things Summit at Croucher Advanced Study Institute, Hong Kong
4. **Keynote,** 6th IEEE International Workshop on Design Automation for Cyber-Physical Systems (DACPS) at DAC, 2023 (Declined) *July 2023*
5. *Safety Through Agility: What can we learn from autonomous racing?* *May 2023*
   Departmental Colloquium, Department of Computer Science and Engineering, SUNY Buffalo
6. *Transportation Safety Research at Penn – An Overview of the Mobility21 Project* *Feb 2023*
   Center for Injury Research and Prevention, Children's Hospital of Philadelphia
7. *Precision Plant Phonemics in Indoor Farming* *Feb 2023*
   Penn Regenerative Ag Alliance annual retreat, The Kleinman Center for Energy Policy
8. *Safety Through Agility: What can we learn from autonomous racing?* *Jan 2023*
   Penn-India Trustworthy AI Workshop, Microsoft Research India
9. *Safety Through Agility: What can we learn from autonomous racing?* *Jan 2023*
   Departmental Colloquium, Bosch Center for Cyber Physical Systems, Indian Institute of Science
10. *Safety Through Agility: What can we learn from autonomous racing?* *Dec 2022*
    Maryland Robotics Center (MRC) Seminar Series, University of Maryland College Park (UMD)
11. *Safety Through Agility: What can we learn from autonomous racing?* *Oct 2022*
    GRASP Seminar, University of Pennsylvania
12. *Safety Through Agility: What can we learn from autonomous racing* *Jun 2020*

Mathematical Challenges and Opportunities for Autonomous Vehicles workshop,
Institute for Pure and Applied Mathematics (IPAM)

13. *Building the Department of Autonomy* *Jan 2020*
Penn Engineering India Alumni Event, Mumbai, India

14. *Building the Department of Autonomy* *Jan 2020*
Penn Engineering India Alumni Event, Mumbai, India

15. ***Keynote:*** *Learning and Control with Gaussian Processes* *Aug 2019*
Singapore-Berkeley Energy Conference, NTU, Singapore

16. ***Keynote:*** International Conference on Embedded and Real Time Computing Systems and Applications (RTCSA), 2019 (declined) *Aug 2019*

17. *Building Safe Autonomous Vehicles* *Dec 2019*
International Society of Automation (ISA) Symposium, King of Prussia, PA

18. *Autonomous Systems for Smart Cities* *Nov 2019*
Introduction to Smart Cities Seminar, Penn Institute for Urban Research

19. *Foundations of Safe Autonomy* *Nov 2019*
Intel Autonomous Driving Community of Partners Symposium, Portland, OR

20. *Autonomous Racing Research Workshop* *Nov 2019*
NSF Cyber-Physical Systems Principal Investigators Meeting, Washington DC

21. *Autonomous Racing Competition V* *Oct 2019*
Tutorial: Getting started with F1/10 Autonomous Racing at Columbia University, NY
New York City, NY

22. *Computer-Aided Clinical Trials* *Oct 2019*
Internet of Medical Things Conference, Embedded Systems Week, NY

23. *Medical Cyber-Physical Systems Research at Penn* *Oct 2019*
NSF Frontiers CyberCardia Medical CPS Workshop, Embedded Systems Week, NY

24. *Autonomous Systems Research at Penn* *Sep 2019*
Inter-American Development Bank, Transportation Day, Washington DC

25. *Symbiotic Design for Autonomous Systems* *Sep 2019*
Siemens Corporate Research, Princeton, NJ

26. *Autonomous Systems Research at Penn* *Aug 2019*
Chinese University of Hong Kong, Hong Kong

27. **Keynote:** Bridging Machine Learning and Controls *Aug 2019*
SinBERBest Singapore-Berkeley Annual Meeting, Singapore

28. *Autonomous Air Traffic Control* *Aug 2019*
Electrical Engineering and Computer Science, Department Seminar
Nanyang Technology University, Singapore

29. *Autonomous Systems Research at Penn* *August 2019*
UC Berkeley Department Seminar, California

30. *Learning and Control using Gaussian Processes* *August 2019*
Energy Technologies Area Seminar, Lawrence Berkeley National Lab, Berkeley

31. *Data Distribution Systems for Advanced Driver Safety Systems* *August 2019*
Real-Time Innovations, Mountain View, CA

32. *Bridging Machine Learning and Controls* *July 2019*
American Controls Conference, Philadelphia

33. *Autonomous Systems Research at Penn* *June 2019*
General Motors R&D Seminar, Michigan

34. *Autonomous Systems Research at Penn* *May 2019*
Drexel departmental seminar, Philadelphia

35. *Autonomous Air Traffic Controller* *May 2019*
NASA Formal Methods Conference, Houston

36. *Building Safe Autonomous Vehicles* *April 2019*
Young Presidents Organization Annual Meeting, Philadelphia

37. *AI for Smart Buildings* *April 2019*
Vagelos Integrated Program in Energy Research (VIPER) Seminar

38. *Organizer: Autonomous Racing Competition IV* *April 2019*
Tutorial: Getting started with F1/10 Autonomous Racing, Montreal, Canada

39. *F1/10 Autonomous Racing* *April 2019*
Venture Cafe, Philadelphia

40. *Building Safe Autonomous Vehicles* *February 2019*
Rutgers University Department Seminar, NJ

41. *Driver's License Test for Driverless Vehicles* *December 2018*
Conference on Control and Decision Systems (CDC), Miami

42. *Building the Department of Autonomy* *November 2018*
Lecture and Demo in New College House, UPenn

43. *Designing Safe Autonomous Systems: On the Ground and in the Air* *November 2018*
New York University UTC Seminar

44. *Verification of Robot Safety Laws for Autonomous Vehicles* *October 2018*
Intel Science and Technology Center, Annual Review, Santa Clara, CA

45. *Building Safe Autonomous Vehicles* *October 2018*
NJ American Society of Safety Professionals, NJ

46. *Understanding the Power of AI in Retail, Automotive and Energy Markets* *October 2018*
Wharton SAFEA Strategic Leadership Program, Philadelphia

47. *Autonomous Vehicle Software Verification and Safety Certification* *October 2018*
Tech360 Business Technology Conference, Malvern, PA

48. *Mobility21 Research at University of Pennsylvania* *October 2018*
Mobility21 Next-Generation Truck Freight Transportation Summit

49. *Safety Benchmarks for Autonomous Vehicles* *October 2018*
NSF US-German Highly Automated Vehicles Workshop

50. *A Driver's License Test for Driverless Vehicles* *October 2018*
Penn India Symposium

51. *From Verified Models to Verified Code for Implantable Medical Devices* *September 2018*
Penn Management and Technology Lecture, Philadelphia

52. *AI for Smart Buildings* *September 2018*
TEDx Lauder institute, Philadelphia, PA

53. *Safe Autonomy Research at University of Pennsylvania* *July 2018*
University of Antwerp, Belgium

54. *Robustness Guided Testing for Autonomous Vehicles* *July 2018*
Departmental Seminar, Siemens PLC, Leuven, Belgium

55. *Safe Autonomy Research at University of Pennsylvania* *July 2018*
Institute Seminar, IMEC, Leuven, Belgium

56. *Safety Certification for Autonomous Vehicles* *June 2018*
NSF Autonomous Vehicles Trucking Workshop, Washington DC

57. *A Driver's License Test for Driverless Vehicles* *May 2018*
SmartDriving Summit, Princeton University

58. *2nd F1/10 Autonomous Racing International Competition* *April 2018*
Cyber-Physical Systems Week, Portugal

59. *F1/10 Autonomous Racing Tutorial* *April 2018*
Cyber-Physical Systems Week, Portugal

60. *Computer-Aided Clinical Trials: Robustness Analysis* *April 2018*
NSF Frontiers CyberCardia Annual Meeting, Stony Brook, NY

61. *Bridging Machine Learning and Control* *April 2018*
Comcast Labs Connect Security Conference, Philadelphia

62. *AI for Smart Buildings* *February 2018*
ARC Advisory Group, Industry Forum, Orlando, Florida

63. A Driver's License Test for Driverless Vehicles *February 2018*
International Conference on Automotive Engineering, Greenville, SC

64. *Three Challenges in Cyber-Physical Systems in transportation, medical devices and energy* *January 2018*
Computer Science Department Seminar, University of Washington at St. Louis

65. *Demand-side Energy Flexibility as a Service* *November 2017*
ICONICS Summit, Providence RI

66. *Bridging Machine Learning and Control for Volatile Energy Markets* *November 2017*
IP Group Innovation Forum, Philadelphia

67. *Safety with Connected Autonomous Vehicles* *October 2017*
Intel Science and Technology Center Kick-off, Santa Clara, CA

68. *Liability for Autonomous Vehicles* *October 2017*
Penn Law Review on Safe Autonomy, Philadelphia

69. *Anytime, Adaptive and Evolutionary Swarm Control Services* *October 2017*

TerraSwarm Annual Meeting, Berkeley, CA

70. *Computer-Aided Design for Safe Autonomous Vehicles* *August 2017*
Air Force Research Laboratory Safe & Secure Systems and Software Symposium (S5), Dayton, OH

71. *Design of Safe Autonomous Vehicles* *June 2017*
Wharton Connected Truck and Car Symposium, Philadelphia

72. *Computer-Aided Design for Safe Autonomous Vehicles* *June 2017*
Design Automation Conference, Cyber-Physical Systems Design Automation Workshop, Austin, TX

73. *Computer-Aided Design for Safe Medical Device Software and Systems* *June 2017*
Design Automation Conference, Workshop on Autonomous Vehicles, Avionics, Transportation, and Robotics (AVATAR), Austin, TX

74. *Integrated Functional and Formal Models for Medical Cyber-Physical Systems* *April 2017*
NSF Frontiers CyberCardia Annual Meeting, Philadelphia

75. *F1/10 Autonomous Racing Tutorial* *April 2017*
Cyber-Physical Systems Week, Pittsburgh

76. *Bridging Machine Learning and Control for Volatile Electricity Markets* *March 2017*
NAE German-American Frontiers of Engineering Symposium, Cincinnati

77. *Safe Autonomous Transportation Research at Penn* *March 2017*
DoT UTC Mobility21 Partners Meeting, Pittsburgh

78. *Building Safe Autonomous Systems* *March 2017*
Algorithms, Cloud, Internet of Things, and Data (ACID) Symposium
Comcast NBC Universal HQ, Philadelphia

79. *Data Predictive Control for Demand-side Energy Management* *February 2017*
ARPA-E Energy Innovation Summit, Washington DC

80. *Safe Autonomous Transportation Research at Penn* *January 2017*
DoT UTC Mobility21 Penn Consortium Meeting, Philadelphia

81. *Robustness Guided Testing for Autonomous Vehicle Safety* *December 2016*
Distinguished Lecture, CU-ICAR, Clemson University

82. *Data Predictive Control for Demand-side Energy Management* *November 2016*
Seminar, Department of Energy, Washington DC

83. *Closing-the-loop for Safe Medical CPS* *November 2016*
Distinguished Lecture, SUNY Stony Brook University

84. *1st F1/10 Autonomous Racing International Competition* *October 2016*
Embedded Systems Week, Pittsburgh

85. *3 Challenges for Data-driven Cyber-Physical Systems* *September 2016*
Plenary Talk, General Electrical Annual Control Systems Symposium, Schenectady, NY

86. *3 Challenges for Data-driven Cyber-Physical Systems* *July 2016*
Electrical Department Seminar, KU Leuven, Belgium

87. *Integrated Functional and Formal Models for Medical CPS* *July 2016*
Computer Science Departmental Seminar, University of Birmingham, UK

88. *Wireless Communication for Autonomous Systems: Drivers and Requirements* *June 2016*
Strategic IoT Meeting, Intel Labs, Portland

89. *Data-Predictive Control for Building Energy Management* *June 2016*
Energy Systems Seminar, PJM Interconnection

90. *3 Challenges for Data-driven Cyber-Physical Systems* *May 2016*
Tata Consultancy Services, Innovation Summit NYC

91. *Foundations for Safe Autonomy* *May 2016*
NSF PECASE Celebration, Arlington, VA

92. *Computer-Aided Clinical Trials for Implantable Medical Devices* *May 2016*
Podium presentation, BMES/FDA Frontiers in Medical Device Conference, Washington DC

93. *F1/10 Autonomous Racing Tutorial* *April 2016*
Cyber-Physical Systems Week, Austria, Vienna

94. *Medical Cyber Physical Systems Research at Penn* *April 2016*
NSF Frontiers CyberCardia Annual Meeting, SUNY Stony Brook

95. *Data-Predictive Control for Building Energy Management* *March 2016*
DoE CLEANTECH Business Plan Pitch Competition, Pittsburgh

96. *3 Challenges for Data-driven Cyber-Physical Systems* *January 2016*
Invited Talk, COMSNETS Conference, Bengaluru, India

97. *Scalable Scheduling of Energy Systems* *October 2015*
IEEE/ACM EMSOFT Conference, Amsterdam

98. *From Verified Models to Verified Code for Implantable Medical Devices* *October 2015*
FDA Physiological Closed Loop Control Workshop, Washington DC

99. *Keynote: 3 Challenges for Data-driven Cyber-Physical Systems* *October 2015*
Intl. Conf. on Mobile Ad hoc & Sensor Systems (IEEE MASS), Dallas

100. *Medical CPS Research at Penn*
September 2015
NSF Frontiers CyberCardia Kick-off Meeting, Arlington, VA

101. *3 Challenges for Data-driven Cyber-Physical Systems*
September 2015
IEEE Philadelphia Lecture

102. *3 Challenges for Data-driven Cyber-Physical Systems* *June 2015*
MathWorks Faculty Summit, MA

103. *3 Challenges for Data-driven Cyber-Physical Systems* *April 2015*
Seminar, Qualcomm, San Diego

104. *3 Challenges for Data-driven Cyber-Physical Systems* *April 2015*
Department Lecture, Purdue University

105. *From Verified Models to Verified Code for Implantable Medical Devices* *October 2014*
NSF/NIH Joint National Workshop on Computing Challenges in Future Mobile Health Systems

106. *Data-Predictive Control for Cyber-Physical Systems* *October 2014*

TerraSwarm Annual Meeting, Berkeley, CA

107. *Model-IQ: Modeling, Control and Tools for Energy-efficient Buildings* *September 2014*
DIMACS Mathematics for Planet Earth 2013+ Workshop on Data-aware Energy Use, San Diego

108. *From Verified Models to Verified Code for Implantable Medical Devices* *September 2014*
Lecturer, IEEE Philadelphia

109. *xLAB: Experience of Things Lab* *August 2014*
Seminar and Demonstration, ScienceCafe at World Café Live, Philadelphia

110. *From Verified Models to Verified Code for Implantable Medical Devices* *June 2014*
FDA Physiological Closed-Loop Control Workshop, Washington D.C.

111. *Wireless Control Networks for Industrial Automation* *June 2014*
Invited Speaker, Recent Developments in Advanced Control (Special Session)
American Controls Conference, Portland

112. *Cyber-Physical Systems Problems in Medical and Energy Domains* *Sep 2014*
IEEE Philadelphia Section, Invited Speaker

113. *Cyber-Physical Systems Problems in Medical and Energy Domains* *Dec 2013*
Cornell University, ECE Departmental Colloquium

114. *Closing the loop with Cyber-Physical Systems Modeling* *Nov 2013*
Distinguished Lecture, Computer Engineering Colloquium, UC San Diego

115. *Closing the loop with Cyber-Physical Systems Modeling* *Nov 2013*
University of Southern California (USC), Electrical Engineering Colloquium

116. *Vision Interactive Operating System* *Nov 2013*
Penn Design Seminar, University of Pennsylvania

117. *Green Scheduling of Buildings for Peak Power Minimization* *Nov 2013*
University of California, Berkeley. Software Defined Buildings Seminar

118. *Closing the loop with Cyber-Physical Systems Modeling* *Nov 2013*
Computer Science Colloquium, University of Illinois, Urbana-Champaign (UIUC)

119. *Green Scheduling of Buildings for Peak Power Minimization* *Oct 2013*
Distinguished Lecture, Computer Engineering Colloquium, Kansas State University

120. *Closing-the-loop with CPS Modeling: Medical and Energy Systems* *Sep 2013*
Electrical Engineering Seminar, University of California, Los Angeles.

121. *Green Scheduling of Buildings for Peak Power Minimization* *Sep 2013*
University of California, Merced. Electrical Engineering and Computer Science Seminar

122. *Medical and Energy Cyber-Physical Systems* *Sep 2013*
Villanova University, Electrical Engineering and Computer Science Seminar

123. *Cyber-Physical Systems 2.0 -- Automotive, Medical, Energy and Industrial Automation* *Feb 2013*
Drexel University, Robotics Seminar Series

124. *Closing the loop with Medical Cyber-Physical Systems* *Oct 2012*
University of Berkeley, Design of Robotics and Embedded systems, Analysis, and Modeling Seminar

125. *The Car and the Cloud* *Sep 2012*

National Academy of Engineers, US Frontiers of Engineering, GM R&D Center, Michigan

126. *Closing-the-loop for Energy-Efficient Buildings* *Oct 2012*
Architecture Department Seminar, University of Pennsylvania

127. *Integrated Functional and Formal Modeling for Safety-Critical Medical Devices* *Jun 2012*
Formal Methods Seminar, University of Oxford, UK

128. *Cyber-Physical Systems 2.0 -- Automotive, Medical, Energy and Industrial Automation* *Jul 2012*
BOSCH Palo Alto Lab, California

129. *Automotive Cyber-Physical Systems – In vehicle, Vehicle-to-vehicle and Traffic Management* *Jul 2012*
Toyota Information Technology Center (ITC), Mountain View, California

130. *Cyber-Physical Systems and the Cloud* *Jul 2012*
CISCO Systems, Sunnyvale, California

131. *Physiological Control Systems for Networks of Medical Devices* *Jul 2012*
Invited Speaker, 5th annual workshop on "Numerical Software Verification" (NSV), co-located with the 24th International Conference on Computer Aided Verification (CAV 2012).

132. *Closing-the-loop with Medical Device Software and Systems* *Jul 2012*
Invited Speaker, Workshop on Formal Methods for Synthetic Biology at Computer Aided Verification

133. *Automotive Cyber-Physical Systems – In vehicle, Vehicle-to-vehicle and Traffic Management* *Jun 2012*
Invited Speaker, Connected Vehicles Workshop (DoT UTRC), Buffalo, NY

134. *Network Cyber-Physical Systems* *May 2012*
Invited Speaker, Texas Instruments and Kilby Labs, Dallas, TX.

135. *Medical Cyber-Physical Systems: Closed-loop Medical Device Verification and Testing* *May 2012*
Invited Speaker, 15th Conference on Software Design for Medical Devices

136. *Closing the Loop with Cyber-Physical Modeling* *Oct 2011*
Vanderbilt University, Institute for Software Integrated Systems Seminar

137. *Medical Cyber-Physical Systems: Closed-loop Medical Device Verification and Testing* *Sep 2011*
FDA / NHLBI / NSF Workshop on Computer Methods for Medical Devices, Panelist

138. *Automotive Cyber-Physical Systems* *Sep 2011*
Wayne State University, Michigan, CS Departmental Seminar

139. *Closing the Loop with Wireless Control Networks* *Jun 2011*
EU-US Workshop on Networked Monitoring and Control, EU Commission, Brussels

140. *Closing the Loop with Cyber-Physical Modeling* *Apr 2011*
University of California, Irvine, ECE Departmental Seminar

141. *Automotive Cyber-Physical Systems* *Apr 2011*
University of Southern California, ECE Departmental Seminar

142. *Green Scheduling of Buildings for Peak Power Minimization* *Apr 2011*
ARPA-Energy Seminar

143. *Medical Cyber-Physical Systems: New Frontiers* *Mar 2011*
Distinguished Lecture, University of Illinois, Urbana-Champaign (UIUC)

144. *Closing the loop with Networked Cyber-Physical Systems* *Dec 2010*

UCLA, Center for Embedded Networked Sensing

145. *Closing the loop with Networked Cyber-Physical Systems* *Nov 2010*
University of Pennsylvania, CIS Departmental Seminar

146. *Networked Cyber-Physical Systems* *Nov 2010*
Virginia Tech, Center for Embedded Systems for Critical Applications

147. *Generic Pacemaker Project: Closed-loop Software Testing, Validation and Verification* *Nov 2010*
US. Food and Drug Administration (FDA), Special Topics Seminar

148. *Closing the loop with Networked Cyber-Physical Systems* *Nov 2010*
University of Pittsburgh, ECE Departmental Seminar

149. *Closing the loop with Networked Cyber-Physical Systems* *Oct 2010*
Cornell University, ECE Departmental Seminar

150. *Robust Architectures for Wireless Actuation and Control* *Oct 2010*
Honeywell Technical Fellows Seminar

151. *Cyber-Physical Systems Research at Penn* *Oct 2010*
University of Texas, Austin. ECE Colloquium

152. *Medical Cyber-Physical Systems* *Oct 2010*
Temple University, ECE Departmental Colloquium

153. *Recent Research in Cyber-Physical Systems at mLAB-UPenn* *Jul 2010*
IMEC, Leuven, Belgium. Special Speaker Seminar.

154. *Recent Research in Cyber-Physical Systems at mLAB-UPenn* *Jul 2010*
Embedded Systems Institute, Eindhoven, Netherlands

155. *Medical Cyber-physical Systems* *Aug 2009*
IMEC, Leuven, Belgium

156. *Automotive Cyber-Physical Systems* *Jun 2009*
University of Waterloo, Ontario, Canada

157. *Distributed Wireless Control Grids* *May 2009*
Honeywell Technical Symposium, Arizona

158. *Networked Cyber-Physical Systems* *Mar 2009*
Indian Institute of Technology Bombay (IIT-B), Mumbai

159. *Networked Cyber-Physical Systems* *Mar 2009*
Indian Institute of Technology Madras (IIT-M), Chennai

160. *Networked Cyber-Physical Systems* *Mar 2009*
Veermata Jijabai Technological Institute (VJTI), Mumbai

161. *Research Activities at mLAB-UPenn* *Mar 2009*
Infosys SET Labs, Bangalore

162. *Vehicular Wireless Networks for Safety and Congestion Prediction* *Jan 2009*
Arada Systems, Bangalore

163. *Networked Automotive Cyber-Physical Systems* *Dec 2008*
Keynote Speaker, Conference on Wireless Access in Vehicular Environments, U Michigan

164. *Vehicle to Vehicle Wireless Networks* *Nov 2008*
WINLAB Wireless Seminar Series, Rutgers University. New Jersey

165. *Vehicle to Vehicle Wireless Networks* *Nov 2008*
University of Delaware, Delaware

166. *FireFly: Real-Time Sensor Networking Platform* *Oct 2006*
Cornell University, New York

167. *Scalable Time Synchronization for Multi-hop Networks* *Sep 2006*
Microsoft Research – Silicon Valley Center

168. *Scalable Time Synchronization for Multi-hop Networks* *Sep 2006*
Intel Labs, Santa Clara

169. *GrooveNet: Hybrid Network Simulation for Vehicular Networks* *Jun 2006*
Imperial College, London

170. *MAX: Maximal Transmission Concurrency for Wireless Mesh Networks* *Jan 2005*
Microsoft Research, Redmond

171. *RT-Link: Predictable Lifetime in Embedded Wireless Networks* *Dec 2005*
Intel Labs, U.K.

172. *RT-Link: Predictable Lifetime in Embedded Wireless Networks* *Dec 2005*
Cambridge University, U.K.

173. *Tiling for Maximal Concurrency in Regular Wireless Networks'* *Aug 2005*
Bell Labs, New Jersey

174. *Real-Time Services for Multi-hop Wireless Networks* *Mar 2005*
University of York, U.K.

175. *Size-based Scheduling for MPEG-4 Streaming over Wireless Channels* *Mar 2002*
Intel Labs, Oregon

176. *An Architecture for QoS over IEEE 802.11e* *Feb 2002*
Philips Research, New York

RESEARCH FUNDING

Current

1. *Safety21 National University Transportation Center*
US Department of Transportation
Penn PI: Rahul Mangharam ($2,750,000). PI: Raj Rajkumar, Carnegie Mellon University
$20,000,000; 2023-2028

2. *DARPA Symbiotic Design for Cyber Physical Systems*
Penn PI: Rahul Mangharam
$1,000,000; 2020-2023

3. *Mobility21 National University Transportation Center*
US Department of Transportation
Penn PI: Rahul Mangharam ($2,700,000). PI: Raj Rajkumar, Carnegie Mellon University
$17,000,000; 2017-2023

4. *F1/10 Autonomous Racecar: Platforms for Safe, Ethical and Agile Autonomy*
   NSF CISE Computing Research Infrastructure
   PI: Rahul Mangharam
   $1,500,000; 2019-2024

5. *NSF CPS Frontiers on Medical Cyber-Physical Systems*
   Penn PI: Rahul Mangharam
   $1,000,000; 2016-2023

6. *Penn URF*
   Penn PI: Rahul Mangharam
   $70,000; 2023-2024

Gifts with no expiration date

7. *Wireless Autonomous Systems*
   Intel Science and Technology Center
   Co-PI: Rahul Mangharam
   $200,000; 2021- Gift (no expiration date)

8. *xLAB: Experience Design & Technology Lab*
   Comcast Corporation
   PI : Rahul Mangharam
   $160,000; 2014- Gift (no expiration date)

9. *Autonomous Vehicle Plan Verification and Execution*
   Denso Corporation
   PI : Rahul Mangharam
   $50,000; 2017- Gift (no expiration date)

10. *Autonomous Vehicle Plan Verification and Execution*
    Toyota InfoTechnology Center, Mountain View, CA
    PI : Rahul Mangharam
    $375,000; 2014- Gift (no expiration date)

11. *Distributed Wireless Controller Grids*
    Honeywell Process Solutions, Industry Grant
    PI : Rahul Mangharam
    $130,000; 2008- Gift (no expiration date)

12. *Hyundai Automotive*
    Learning and Controls using Gaussian Processes
    PI : Rahul Mangharam
    $120,000; 2021- Gift (no expiration date)

13. *Research Discretionary*
    Cornell Cup, Medical Device Accelerator, Non-startup discretionary
    PI : Rahul Mangharam
    $83,000; no expiration date

Previous

1. *Foundations of Medical Cyber-Physical Systems*
   NSF CAREER Award
   PI : Rahul Mangharam
   $410,000; 3/1/2013-2/28/2018

2. *Heterogeneous, Autonomic Wireless Control Networks for Scalable Cyber-Physical Systems*
   National Science Foundation, Major Research Instrumentation
   PI : Rahul Mangharam
   $570,000; 2009-2017

3. *TERRASWARM Research Center*
   Semiconductor Research Corporation and Department of Defense
   SEAS PIs : Vijay Kumar, Rahul Mangharam and George Pappas
   $2,500,000; 1/1/2013 – 1/1/2018

4. *Greater Philadelphia Innovation Cluster (GPIC) - Energy-Efficient Building HUB*
   Department of Energy (DoE), $169M total
   SEAS PIs: Rahul Mangharam; co-PI(s) : G. Pappas, S. Sarkar
   $2,250,000; 2/1/2011- 3/31/2016.

5. *T-SET University Transportation Center (2.0)*
   US Department of Transportation
   Penn PIs: Dan Lee and Rahul Mangharam. co-PI(s): C. J. Taylor, K. Danilidis and I. Lee
   $5,900,000; 2015-2017

6. *Assuring the Safety, Security and Reliability of Medical Device Cyber Physical Systems* National Science Foundation CISE Cyber-Physical Systems (CPS)
   PI: I. Lee, co-PI(s): R. Alur, O. Sokolsky, C. W. Hanson, G. J. Pappas, R. Mangharam
   $5,000,000; 9/1/2010-8/31/2015.

7. *Quantitative Analysis and Design of Control Networks*
   National Science Foundation CISE Cyber-Physical Systems (CPS)
   PI: G. J. Pappas, co-PI(s): Rahul Mangharam, R. Alur, I. Lee, A. Ribeiro
   $1,500,000; 9/1/2009-8/31/2013.

8. *T-SET University Transportation Center (1.0)*
   US Department of Transportation
   Penn PIs: Dan Lee and Rahul Mangharam. co-PI(s): C. J. Taylor, K. Danilidis and I. Lee
   $6,900,00; 2012-2014

9. *SPARCS: Synthesis of Platform-aware Attack-Resilient Control Systems*
   DARPA High Assurance Cyber Military Systems (HACMS)
   PI: I. Lee, co-PIs: R. Mangharam, N. Michael, G. Pappas, O. Sokoslky, S. Weirich (Penn) and P. Tabuada (UCLA)
   $4,700,000; 2012-2016

10. *Enhanced-Mobile Integrated Diagnostics and Data Analysis System (E-MIDDAS)*
    L3 Communications, Industry Grant

PI: Rahul Mangharam
$65,663; 2012-2013

11. *Robust Composition and Interoperability of CPS Components*
    National Science Foundation CISE Cyber-Physical Systems (CPS)
    PI: I. Lee, co-PIs: R. Mangharam, B. Loo and J. Goldman (Massachusetts General Hospital/Harvard University)
    $900,000; 2008–2013.

12. *Large-scale Testbed and Real-Time Protocols for Vehicle-to-Vehicle Wireless Networks*
    National Science Foundation CISE Cyber-Physical Systems (CPS)
    PI: Rahul Mangharam
    $270,000; 2008-2012

13. *Distributed Control over Wireless Networks*
    DARPA, Multi-Scale Systems Center (MuSyC)
    PI: G. Pappas, co-PI : R. Mangharam
    $125,000; 2010

14. *AutoMatrix: Large-scale Parallel Traffic Simulation*
    NSF Research Experience for Undergraduates
    PI: Rahul Mangharam
    $9,200; 2010-2011

15. *Virtual Heart Model for Closed-loop Medical Device Testing*
    NSF Research Experience for Undergraduates
    PI: Rahul Mangharam (with I. Lee)
    $9,200; 2010-2011

16. *EnRoute - Testbed for Energy-Efficient Building Controls*
    NSF Research Experience for Undergraduates
    PI: Rahul Mangharam (with G. Pappas)
    $6,000; 2010-2011

17. *Embedded Virtual Machines for Next-Generation Wireless Automation*
    University of Pennsylvania, University Research Foundation Award
    PI: Rahul Mangharam
    $9,200; 2010-2011

18. *Cyber-Physical Systems - Tapping into Physical World Analytics*
    Wharton Interactive Media Initiative
    PI: Rahul Mangharam
    $5,000; 2010-2011

19. *Collaboration between Penn and NIIT University, India*
    University of Pennsylvania, Provost International Award
    PI: Rahul Mangharam
    $5,000; 2010-2011