

Akshay Rajhans

MathWorks – 1 Lakeside Campus Drive, Natick, MA 01760
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Education

- **Ph.D.**, Electrical and Computer Engineering
Carnegie Mellon University, Pittsburgh, PA, U.S.A.
Advisor: Bruce H. Krogh
Thesis Committee: Ken Butts (Toyota), David Garlan, André Platzer
- **M.S.**, Electrical Engineering
University of Pennsylvania, Philadelphia, PA, U.S.A.
Advisor: George J. Pappas
- **B.E.**, Electronics and Telecommunication
University of Pune, Pune, India.

Professional Experience

MathWorks, Natick, MA

July 2013–Present

Helping accelerate the innovation ecosystem at MathWorks

- Founding member of the Advanced Research & Technology Office
- Establishes research and advanced technology collaborations between MathWorks Engineering teams worldwide and universities and research labs around the world
- Represents MathWorks in the research community on research publications, talks, and on advisory boards
- Organizes and chairs MathWorks Research Summits in Boston and Tokyo
- Member of the Patent Review Board

Bosch, Pittsburgh, PA

Aug 2009–Dec 2009

- Research intern. *Co-inventor on U.S. and international patents*

Cummins, Pune, India

Aug 2003–Dec 2005

- Research, development, and Industrial Business Unit (IBU) applications engineering in electronic control of diesel and natural gas engines for *mining, marine, defense, rail, compressors, rigs, pumps, automotive, and construction*

Carnegie Mellon University, Pittsburgh, PA

Jul 2008–May 2013

- Collaborative research with Toyota and others

University of Pennsylvania, Philadelphia, PA

Jan 2006–Jun 2008

- Full time: Research staff at GRASP Lab; Part time: teaching assistant, administrative assistant

Technical Community Service

Industry Advisory Committees and Boards

- **Industry Advisory Board**, MIT's Climate & Sustainability Consortium, 2021–.
<https://impactclimate.mit.edu/people/dr-akshay-rajhans/>.
- **Advisory Committee**, Veni grant titled “CODEC: Correct-by-design Estimation and Control of partially observable stochastic systems”, Principal Investigator: Prof. Sofie Haesaert. Dutch Research Council (NWO), Domain Applied and Engineering Sciences, 2021–.
- **Industry Challenge Technical Program Committee**, Real-Time Systems Symposium (RTSS) 2022.
- **Industry Advisory Committee on Autonomous Vehicles Curriculum**, Robotics Engineering Program at Worcester Polytechnic Institute, 2017–18.

- **Industry Vice Chair**, IFAC Conference on Analysis and Design of Hybrid Systems (ADHS), 2018.
- **Industry Advisory Board**, International Symposium on Circuits and Systems (ISCAS), 2018.
- **Global Professional Advisory Community**, Association for Computing Machinery (ACM), 2017.

Conference Program Committee (PC) Leadership.....

- **Artifact Evaluation Chair**: • Formal Modeling and Analysis of Timed Systems (FORMATS) 2022
- **PC Chair**: • MathWorks Research Summits, Boston edition: 2017–, Tokyo edition: 2016– • Fourth International Workshop on Monitoring and Testing of CPS (MT-CPS), 2019 • Spring Simulation Conference (SpringSim) 2020 and 2019: CPS Track • Winter Simulation Conference (WSC) 2017: CPS Track
- **Awards Chair**: • Hybrid Systems: Computation and Control (HSCC) 2018
- **Demo and Poster Chair**: • Hybrid Systems: Computation and Control (HSCC) 2017
- **PC Member**: • Annual Modeling and Simulation Conference (AnnSim) 2021– • Formal Methods (FM) 2021– • International Conference on Cyber-Physical Systems (ICCPs) 2020–, 2015 • Multi-Paradigm Modeling for Cyber-Physical Systems (MPM4CPS) 2020– • Hybrid Systems: Computation and Control (HSCC) 2016–19 • International Conference on Informatics in Control, Automation and Robotics (ICINCO) 2020, 2017–18 • Winter Simulation Conference (WSC) 2017– • Numerical Software Verification Workshop (NSV) 2018–19 • International Workshop on Formal Co-Simulation of Cyber-Physical Systems (CoSim-CPS) 2017– • Summer Simulation Multi-Conference (SummerSim) 2014– • Conference on Analysis and Design of Hybrid Systems (ADHS), 2015
- **Repeatability Evaluation Committee Member**: • Hybrid Systems: Computation and Control (HSCC) 2014

Editorial Duties.....

- **Associate Editor, Technology Conferences Editorial Board**, IEEE Control System Society, 2020–
- **Editorial Advisory Board Member**, “Resilience in Cyber-Physical Systems: From Risk Modelling to Threat Counteraction,” F. Flammini (Ed.), Springer.
- **Reviewer** for various journals and conferences in addition to those as a **PC Member**.

Technical Committees.....

- IEEE Technical Committee on Homeland Security

Talks

Keynote-Style Talks.....

- K2. “*Challenges and Opportunities in Design and Operation of Intelligent Cyber-Physical Systems*”, 19th International Runtime Verification Conference (RV), Part of 3rd World Congress on Formal Methods, Porto, Portugal. October 2019. **Chairs**: Leonardo Mariani and Bernd Finkbeiner.
- K1. “*Multi-Paradigm Modeling for Design and Operation of Intelligent Cyber-Physical Systems*”, First International Workshop on Multi-Paradigm Modeling for Cyber-Physical Systems (MPM4CPS), co-located with the MODELS Conference, Munich, Germany. September 2019. **Chairs**: Simon Van Mierlo and Hans Vangheluwe.

Invited Talks.....

- T17. “*Formal Methods for Real-World Cyber-Physical Systems: A Model-Based Design Perspective*”, Invited Talk, Brown University, Providence, RI. May 2022. **Hosts**: Profs. Tim Nelson and Shriram Krishnamurthi.
- T16. “*Engineering Learning-Enabled Cyber-Physical Systems: Challenges and Opportunities*”, Workshop on Machine Learning in Control (LEAC), part of Cyber-Physical Systems and Internet of Things (CPS-IoT) Week, remotely in Nashville, TN. May 2021. **Hosts**: Rafal Wisniewski and Manuela-Luminita Bujorianu, Workshop Chairs.
- T15. “*Formal Methods for Real-World Cyber-Physical Systems: A personal perspective*”, Invited Guest Lecture, Brown University course on Logic for Systems (CS 171), remotely in Providence, RI. March 2021. **Hosts**: Profs. Tim Nelson and Shriram Krishnamurthi.

- T14. “Cyber-Physical Systems”, Independent Activities Period (IAP), Massachusetts Institute of Technology, remotely in Cambridge, MA. January 2021.
- T13. “A Model-Based Design Perspective on Challenges and Opportunities in Automated Software Certification”, 20th Software Certification Consortium (SCC) Steering Committee Meeting, Annapolis, MD. May 2019. **Hosts:** Alan Wassyng and Mark Lawford, Organizers.
- T12. “Specification Formalisms for Cyber-Physical Systems: A Tools Perspective”, Dagstuhl Workshop on Specification Formalisms for Modern Cyber-Physical Systems, Dagstuhl, Germany. February 2019. **Hosts:** Jyotirmoy Deshmukh, Oded Maler, Dejan Nickovic, Workshop Organizers.
- T11. “Graphical Modeling of Hybrid Systems with Simulink and Stateflow”, Workshop honoring the retirement of Prof. Bruce Krogh, Carnegie Mellon University, Pittsburgh, PA. May 2018. **Host:** Bruno Sinopoli, Workshop Chair.
- T10. “A Vision for Application-Focused International Collaboration Networks in Cyber-Physical Systems”, NSF Visioning Workshop on International Networks for Advancing CPS Research, Development, and Education Worldwide, part of CPS Week 2018, Porto, Portugal. April 2018. **Hosts:** Seta Bogosyan, Frankie King, Ralph Wachter, National Science Foundation (NSF).
- T9. “Heterogeneous Model-Based Design of Tomorrow’s Cyber-Physical Systems”, ECE Department Colloquia, Tufts University, Medford, MA. November 2017. **Host:** Prof. Usman Khan.
- T8. “Model-Based Design of Next Generation Cyber-Physical Systems”, MIT Workshop on Rethinking Modeling, Simulations and Control for the Changing Electric Energy Industry, Massachusetts Institute of Technology, Cambridge, MA, September 2017. **Hosts:** Prof. Marija Ilić and Prof. Ekaterina Kostina.
- T7. “Challenges and Opportunities for Intelligent Transportation Systems”, Robotica 2017, Newton, MA, June 2017. **Host:** Dr. Waseem Naqvi, AUVSI New England Chapter President, Chair.
- T6. “Model-Based Design of Connected Autonomous Vehicles”, 2nd IEEE Summer School on Connected and Autonomous Vehicles, Worcester Polytechnic Institute, Worcester, MA, May 2017. **Hosts:** Prof. Alexander Wyglinski and Prof. Raghvendra Cowlagi, Program Chairs.
- T5. “Model-Based Design Challenges for Cyber-Physical Systems”, Expeditions in Computer Augmented Program Engineering (ExCAPE) Principal Investigators’ (PI) Meeting, University of Pennsylvania, Philadelphia, PA, May 2017. **Host:** Prof. Rajeev Alur, Principal Investigator.
- T4. “Safety in Freely-Composed Cyber-Physical Systems—Challenges and Opportunities”, with Pieter Mosterman, Exploring the Dimensions of Trustworthiness: Challenges and Opportunities Workshop, National Institute of Standards and Technology (NIST), Gaithersburg, MD, August, 2016. **Host:** Dr. Edward Griffor, Program Chair.
- T3. “Recent Advancements in MathWorks Verification and Validation Tools and Techniques”, CPS V&V I&F Workshop 2016, May 2016, Carnegie Mellon University. **Host:** Prof. André Platzer.
- T2. “Verification of Systems Using Robust Temporal Logic Testing”, Specification and Verification Center, School of Computer Science, Carnegie Mellon University, September 2008. **Host:** Prof. Edmund M. Clarke.
- T1. “Robustness of Temporal Logic Specifications for Testing of Signals”, Specification and Verification Center, School of Computer Science, Carnegie Mellon University, August 2008. **Host:** Prof. Edmund M. Clarke.

Panels.....

- P7. “Challenges in Satisfying the Need and Promotion of Modeling & Simulation Workforce”, Winter Simulation Conference, in hybrid mode at Phoenix, AZ, December 2021.

- P6. “Control for Climate Change Mitigation and Adaptation”, IEEE CSS Workshop on Control for Societal Challenges, online. June 2021.
- P5. “Future Challenges for Autonomous & Intelligent Transportation”, IEEE Situational Awareness for Emerging Transportation Systems (SAFENETS) Workshop, Lowell, MA, October 2019.
- P4. “Hybrid simulation for cyber-physical systems—where are we, and where do we want to go?”, Spring Simulation Conference (SpringSim), Baltimore, MD, April 2018.
- P3. “What are the Challenges Posed to CPS Theory by Modern Applications?”, Joint Panel between the Hybrid Systems: Computation and Control Conference (HSCC) and the International Conference on Cyber-Physical Systems (ICCPs), part of CPS Week, Porto, Portugal, April 2018.
- P2. “Why do we Need Holistic Concern-Driven Engineering?”, CPS Framework Open Source Workshop, National Institute for Standards and Technology (NIST), Rockville, MD, September 2017.
- P1. “Safety of Connected Autonomous Vehicles”, First International Workshop on the Safety of Connected Autonomous Vehicles (SCAV), part of CPS Week, Pittsburgh, PA, May 2017.

Publications and Patents

Theses

- Th2. **Akshay Rajhans**, “Multi-Model Heterogeneous Verification of Cyber-Physical Systems”, Ph.D. Thesis, Department of Electrical and Computer Engineering, Carnegie Mellon University, 2013. **Advisor:** Prof. Bruce H. Krogh.
- Th1. **Akshay Rajhans**, “Development of a Robust Testing Toolbox for Hybrid Systems”, M.S. Thesis, Department of Electrical and Systems Engineering, University of Pennsylvania, 2007. **Advisor:** Prof. George J. Pappas.

Patents

- PP1. Burton Andrews, Diego Benitez, Badri Raghunathan and **Akshay Rajhans**, “Method for Non-Intrusive Load Monitoring using a Hybrid System State Estimation Approach”, U.S., European, and International Patent, 2012.

Journal Papers

- J5. Manuel Rodriguez, Xiangxue Zhao, Hayley Song, Anastasia Mavrommati, Roberto G. Valenti, **Akshay Rajhans**, Pieter J. Mosterman, Yancy Diaz-Mercado, and Hosam Fathy, “A Gradient-Based Approach for Coordinating Smart Vehicles and Traffic Lights at Intersections”, IEEE Control Systems Letters (L-CSS), Volume: 5, Issue: 6.
- J4. Frank Allgöwer, João Borges de Sousa, James Kapinski, Pieter Mosterman, Jens Oehlerking, Patrick Panciatici, Maria Prandini, **Akshay Rajhans**, Paulo Tabuada, Philipp Wenzelburger, “Position Paper on the Challenges Posed by Modern Applications to Cyber-Physical Systems Theory”, Nonlinear Analysis: Hybrid Systems, Volume 34, Pages 147-165.
- J3. **Akshay Rajhans**, Ajinkya Bhawe, Ivan Ruchkin, Bruce H. Krogh, David Garlan, André Platzer and Bradley Schmerl, “Supporting Heterogeneity in Cyber-Physical System Architectures”, IEEE Transactions on Automatic Control, Special issue on Cyber-Physical Systems, Volume 59, Issue 12, Pages 3178-3193.
- J2. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li and Larry Pileggi, “Formal Verification of Phase-Locked Loops Using Reachability Analysis and Continuization”, Communications of the ACM, Volume 56, Issue 10, Pages 97-104. **Research Highlight.**
- J1. **Akshay Rajhans**, Shang-Wen Cheng, Bradley Schmerl, David Garlan, Bruce H. Krogh, Clarence Agbi, and Ajinkya Bhawe, “An Architectural Approach to the Design and Analysis of Cyber-Physical Systems”, Electronic Communications of the EASST, Volume 21, 2009.

Book Chapters.....

- B2. Pieter J. Mosterman, **Akshay Rajhans**, Anastasia Mavrommati, Roberto G. Valenti, "*Simulation of Hybrid Dynamic Systems*", in John Baillieul, Tariq Samad, editors, Encyclopedia of Systems and Control, Springer, Living Edition. First online: August 2020.
- B1. Sebastian Castro, Pieter J. Mosterman, **Akshay Rajhans**, and Roberto G. Valenti, "*Challenges in the Operation and Design of Intelligent Cyber-Physical Systems*", in Saurabh Mittal and Andreas Tolk, editors, Complexity Challenges in Cyber Physical Systems: Using Modeling and Simulation (M&S) to Support Intelligence, Wiley, January 2020.

Peer Reviewed Conference and Workshop Papers.....

- C21. Mattia Di Florio, Vijay Iyer, **Akshay Rajhans**, Stefano Buccelli, Michela Chiappalone, "*Model-based Online Implementation of Spike Detection Algorithms for Neuroengineering Applications*", 44th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS) 2022 . Accepted.
- C20. **Akshay Rajhans**, Anastasia Mavrommati, Pieter J. Mosterman, and Roberto G. Valenti, "*Specification and Runtime Verification of Temporal Assessments in Simulink*", 21st International Conference on Runtime Verification (RV) 2021.
- C19. Anastasia Mavrommati, Carlos Osario, Roberto G. Valenti, **Akshay Rajhans**, and Pieter J. Mosterman, "*An Application of Model Predictive Control to Reactive Motion Planning of Robot Manipulators*", 17th IEEE International Conference on Automation Science and Engineering (CASE) 2021.
- C18. Manuel Rodriguez, Xiangxue Zhao, Hayley Song, Anastasia Mavrommati, Roberto G. Valenti, **Akshay Rajhans**, Pieter J. Mosterman, Yancy Diaz-Mercado, and Hosam Fathy, "*A Gradient-Based Approach for Coordinating Smart Vehicles and Traffic Lights at Intersections*", American Control Conference (ACC) 2021.
- C17. Nikita Visnevski, Teresa Hubscher-Younger, **Akshay Rajhans**, and Baoluo Meng, "*Automatic Synthesis of Information Flow Driven Execution Managers for Embedded Software Applications*", AIAA/IEEE Digital Avionics Systems Conference (DASC) 2020. **Best in Session Award**.
- C16. Zhan Tu, Anastasios Dimas, Mehmet N. Kurt, Anastasia Mavrommati, Pieter J. Mosterman, **Akshay Rajhans**, and Roberto G. Valenti, "*A Simulator for Trading Traffic Privileges by Selfish Driving Cars*", Spring Simulation Conference (SpringSim) 2020.
- C15. Jean-Francois Kempf, Khoo Yit Phang, and **Akshay Rajhans**, "*Specification and Assessment of Temporal Requirements using Simulink Test*", Fourth International Workshop on Monitoring and Testing of Cyber-Physical Systems (MT-CPS 2019), part of CPS-IoT Week 2019.
- C14. Akshay Rajhans and Dan Lluch, "*A Digital Twin Approach to Online Monitoring in Industrial Internet of Things Applications*", Fourth International Workshop on Monitoring and Testing of Cyber-Physical Systems (MT-CPS 2019), part of CPS-IoT Week 2019.
- C13. Andreas Tolk, Fernando Barros, Andrea D'Ambrogio, **Akshay Rajhans**, Pieter J. Mosterman, Sachin S. Shetty, Mamadou K. Traoré, Hans Vangheluwe, and Levent Yilmaz, "*Hybrid Simulation for Cyber-Physical Systems—A Panel on Where we are Going Regarding Complexity, Intelligence, and Adaptability of CPS Using Simulation*", Spring Simulation Multi-Conference (SpringSim) 2018.
- C12. **Akshay Rajhans**, Srinath Avadhanula, Alongkrit Chutinan, Pieter J. Mosterman, and Fu Zhang, "*Graphical Hybrid Automata with Simulink and Stateflow*", 21st ACM International Conference on Hybrid Systems: Computation and Control (HSCC) 2018.

- C11. **Akshay Rajhans**, Srinath Avadhanula, Alongkrit Chutinan, Pieter J. Mosterman, and Fu Zhang, “*Graphical Modeling of Hybrid Dynamics with Simulink and Stateflow*”, 21st ACM International Conference on Hybrid Systems: Computation and Control (HSCC) 2018. **Best Repeatability Evaluation Award Finalist**.
- C10. **Akshay Rajhans** and Pieter J. Mosterman, “*A Vision for Application-Focused International Collaboration Networks in Cyber-Physical Systems*”, NSF Visioning Workshop for International Collaborations for Advancing CPS Research, Development, and Education Worldwide, part of CPS Week 2018.
- C9. Yi Deng, **Akshay Rajhans**, and A. Agung Julius, “*STRONG: A Trajectory-Based Verification Toolbox for Hybrid Systems*”, 10th International Conference on Quantitative Evaluation of SysTems (QEST) 2013.
- C8. **Akshay Rajhans** and Bruce H. Krogh, “*Compositional Heterogeneous Abstraction*”, 16th ACM International Conference on Hybrid Systems: Computation and Control (HSCC) 2013.
- C7. **Akshay Rajhans** and Bruce H. Krogh, “*Heterogeneous Verification of Cyber-Physical Systems Using Behavior Relations*”, 15th ACM International Conference on Hybrid Systems: Computation and Control (HSCC) 2012.
- C6. **Akshay Rajhans**, Ajinkya Bhave, Sarah Loos, Bruce H. Krogh, André Platzer, and David Garlan, “*Using Parameters in Architectural Views to Support Heterogeneous Design and Verification*”, IEEE Conference on Decision and Control (CDC) 2011.
- C5. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li, and Larry Pileggi, “*Formal Verification of Phase-Locked Loops Using Reachability Analysis and Continuization*”, IEEE/ACM International Conference on Computer-Aided Design (ICCAD) 2011. **William J. McCalla Best Paper Award**.
- C4. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li, and Larry Pileggi, “*Using Continuization in Reachability Analysis for the Verification of a Phase-Locked Loop*”, Frontiers in Analog Circuit (FAC) Synthesis and Verification, co-located with Computer-Aided Verification (CAV) 2011.
- C3. Ajinkya Bhave, David Garlan, Bruce H. Krogh, Sarah Loos, André Platzer, **Akshay Rajhans**, and Bradley Schmerl, “*Multi-View Consistency in Architectures for Cyber-Physical Systems*”, Safe and Secure Systems & Software Symposium (S5) 2011.
- C2. Ajinkya Bhave, David Garlan, Bruce H. Krogh, **Akshay Rajhans**, and Bradley Schmerl, “*Augmenting Software Architectures with Physical Components*”, Embedded Real Time Software and Systems Conference (ERTS²) 2010.
- C1. Alexandre Donzé, Bruce H. Krogh, and **Akshay Rajhans**, “*Parameter Synthesis for Hybrid Systems with an Application to Simulink Models*”, 12th International Conference on Hybrid Systems: Computation and Control (HSCC) 2009.

Student Mentoring and Teaching Assistantships

Ph.D. Thesis Committee.....

- Yi Deng, ECSE Department at Rensselaer Polytechnic Institute. **Advisor**: Prof. A. Agung Julius. **Thesis Title**: “*The Application of Trajectory-Based Analysis for Hybrid Systems*”. Defended July 2015.

Student Competitions.....

- **MathWorks Technical Lead**, CAT Vehicle Challenge, online qualification rounds in a simulation environment and a final in-person round at the University of Arizona. **Instructor**: Prof. Jonathan Sprinkle, 2017.
- **Judge**, CPS V&V Grand Prix, 15-424/15-624/15-824: Foundations of Cyber-Physical Systems, Carnegie Mellon University. **Instructor**: Prof. André Platzer, 2017, 2016.

Teaching Assistantships.....

- **18-474: Embedded Control Systems**, ECE Department, Carnegie Mellon University, Spring 2011, Spring 2010.
- **MATH 114: Calculus II**, Mathematics Department, University of Pennsylvania, Spring 2008, Fall 2007.

- **ESE 210: Introduction to Dynamic Systems**, ESE Department, University of Pennsylvania, Spring 2007.
- **ESE 301: Introduction to Probability**, ESE Department, University of Pennsylvania, Fall 2006.

STEM Outreach

- (2021) **Panelist**, *New England Innovation Day*, New England FIRST Robotics (NE First). **Topic:** *STEM@Work*.
- (2009) **Laboratory Instructor**, *Summer Engineering Experience for Girls (SEE)*, a day-long summer camp for high-school students at Carnegie Mellon University. **Primary Instructor:** Prof. Bruno Sinopoli.
- (2002) **Instructor**, *Social Educational Activity*, organized by the IEEE Bombay Section Region 10 to create awareness amongst high-school students. **Topic:** *Mobile Communications*.

Software Skills

Developer: Simulink, Stateflow, SimEvents (at MathWorks), STRONG (at University of Pennsylvania)

User: Formal methods tools SpaceEx, PHAVer, Breach, KeYmaera (at Carnegie Mellon University)

Languages: MATLAB and C++ (professional), C and Java (graduate coursework), Python (beginner).

Professional Society Memberships

- Senior Member, Association for Computing Machinery (ACM), 2019—
- Senior Member, Institute of Electrical and Electronics Engineers (IEEE), 2019—