Akshay Rajhans | Curriculum Vitae

MathWorks – 3 Apple Hill Drive, Natick, MA 01760
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Professional Experience

MathWorks **Natick, MA**
Senior Research Scientist *Jul 16–*
Advanced research and technology development with a focus on *cyber-physical systems*, co-organize MathWorks research conferences, co-manage a collaborative research grant program, support cultivation of intellectual property, contribute to long-term research strategy, represent MathWorks in the research community.

MathWorks **Natick, MA**
Senior Software Engineer *Jul 13–Jul 16*
Work on core semantics of Simulink, particularly related to *initialization* semantics, *conditional subsystems* semantics, and *Simulink in Stateflow* semantics for graphical modeling of hybrid dynamics. Research community engagement in the domain of *cyber-physical systems*.

Bosch Research and Technology Center **Pittsburgh, PA**
Intern *Aug 09–Dec 09*
Developed a new approach to non-intrusive load monitoring using hybrid system state estimation. *Co-inventor on a U.S. and worldwide patent*. See the **Patents** section for the citation.

University of Pennsylvania **Philadelphia, PA**
Research Staff, GRASP Laboratory *Jan 08–Jun 08*
Worked on improving the STRONG Toolbox originally developed during my masters thesis. See the **Publications** section for the citation. This toolbox formed the basis of the Ph.D. thesis of a student at Rensselaer Polytechnic Institute. I served on her Ph.D. Thesis Committee. See the **Ph.D. Thesis Committee** section for the citation.

Cummins India Limited **Pune, India**
Manager, IBU Application Engineering *Aug 05–Dec 05*
Application engineering for electronic control of diesel engines in mining, marine, defense, rail, compressors, oil rigs, fire pumps, automotive and off-highway construction equipment. ***One of only two*** engineers in charge of Electronic Controls of all of IBU Applications in India.

Cummins India Limited **Pune, India**
Operations Management Program Participant *Aug 03–Aug 05*
Research, development and application engineering of electronic controls for diesel engines and their applications.

Education

Degrees

- **Ph.D.**, Electrical and Computer Engineering, *Carnegie Mellon University*, Pittsburgh, PA, U.S.A.
- **M.S.**, Electrical Engineering, *University of Pennsylvania*, Philadelphia, PA, U.S.A.
- **B.E.**, Electronics and Telecommunication, *University of Pune*, Pune, India.

Coursework, Certificates, and Continuing Education

At MathWorks

• Leadership is Everyone's Business • Model-Based Design Labs

Independent

• Introduction to Marketing (Coursera)

At Carnegie Mellon University

• Hybrid Systems Analysis and Theorem Proving • Introduction to Model Checking • Architectures for Software Systems • Real Analysis • Linear Systems • Formal Languages Automata, Computability and Complexity • Numerical Methods for Engineering Design and Optimization

At University of Pennsylvania

• Hybrid Systems • Control of Systems • Engineering Entrepreneurship • Artificial Intelligence and Machine Learning • Introduction to Optimization • Digital Signal Processing • Advanced Artificial Intelligence and Machine Learning • Advanced Robotics: Motion Planning and Control • Advanced Topics in Electrical and Systems Engineering: Systems Biology

At Cummins India Limited

• Operations Management Program • Young Leadership Development Program • Common Approach to Continuous Improvement • Six Sigma • Seven Habits of Highly Effective People • Cummins Production System

Invited Talks and Panels

Invited Talks

- "*Heterogeneous Model-Based Design of Tomorrow's Cyber-Physical Systems,*" ECE Department Colloquia, Tufts University, Medford, MA, November 2017. **Host**: Prof. Usman Khan.
- "*Model-Based Design of Next Generation Cyber-Physical Systems,*" MIT LIDS, IDSS, MITei, Lincoln Labs, NSF and IWR Workshop on Rethinking Modeling, Simulations and Control for the Changing Electric Energy Industry, Massachusetts Institute of Technology, Camridge, MA, September 2017. **Hosts**: Prof. Marija Ilić and Prof. Ekaterina Kostina.
- "*Challenges and Opportunities for Intelligent Transportation Systems,*" Robotica 2017, Newton, MA, June 2017. **Host**: Dr. Waseem Naqvi, AUVSI New England Chapter President (Chair).
- "*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).
- "*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).
- "*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).
- "*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.
- "*Verification of Systems Using Robust Temporal Logic Testing*", Specification and Verification Center, School of Computer Science, Carnegie Mellon University, September 2008. **Host**: Prof. Ed Clarke.
- "*Robustness of Temporal Logic Specifications for Testing of Signals*", Specification and Verification Center, School of Computer Science, Carnegie Mellon University, August 2008. **Host**: Prof. Ed Clarke.

Panels

- **Panelist**, *Why do we need holistic concern-driven engineering?*, CPS Framework Open Source Workshop, National Institute for Standards and Technology (NIST), Rockville, MD, September 2017.
- **Panelist**, *Safety of Connected Autonomous Vehicles*, First International Workshop on the Safety of Connected Autonomous Vehicles (SCAV), CPS Week, Pittsburgh, PA, May 2017.
- **Student Panelist**, *Prospective Student Open House*, ECE Department, Carnegie Mellon University, February 2012.

Technical Community Service

Technical Committees

- IEEE Technical Committee on Homeland Security

Industry Advisory Committees and Boards

- **Autonomous Vehicles Industrial Advisory Committee**, Worcester Polytechnic Institute
- **Industry Vice Chair**, 2018 IFAC Conference on Analysis and Design of Hybrid Systems (ADHS)
- **Industry Advisory Board**, 2018 International Symposium on Circuits and Systems (ISCAS)
- **Global Professional Advisory Community**, Association for Computing Machinery

Conference Program Committee (PC) Leadership

- (2018) **Awards Chair**, Hybrid Systems: Computation and Control (HSCC), **PC Member**, Hybrid Systems: Computation and Control (HSCC), International Conference on Informatics in Control, Automation and Robotics (ICINCO)
- (2017) **PC Chair**, MathWorks Research Summit, **PC Chair**, MathWorks Asia Research Summit, **CPS Track Chair**, Winter Simulation Conference (WSC), **Demo and Poster Chair**, Hybrid Systems: Computation and Control (HSCC), **PC Member**, Summer Simulation Multi-Conference (SummerSim), Hybrid Systems: Computation and Control (HSCC), International Conference on Informatics in Control, Automation and Robotics (ICINCO), Computational Intelligence Techniques for Testing and Validating Complex CPS (CITest_CPS), Workshop on Formal Co-Simulation of Cyber-Physical Systems (CoSim-CPS)
- (2016) **PC Member**, Hybrid Systems: Computation and Control (HSCC)
- (2015) **PC Member**, International Conference on Cyber-Physical Systems (ICCPS), Conference on Analysis and Design of Hybrid Systems (ADHS), Summer Simulation Multi-Conference (SummerSim)
- (2014), **PC Member**, Summer Simulation Multi-Conference (SummerSim), **Repeatability Evaluation Committee Member**, Hybrid Systems: Computation and Control (HSCC)

Editorial Duties

- **Editorial Advisory Board** Member for an upcoming Springer book on Resilience in Cyber-Physical Systems
- **Editor**, "*EGO Insider's Guide*", ECE Graduate Organization (EGO), Carnegie Mellon University, 2012. Available at `http://www.ece.cmu.edu/~ego/files/insiders/guide2012.pdf`.
- **Reviewer** (excluding reviewing as a Conference PC Member)
  - Technological Forecasting & Social Change
  - Nonlinear Analysis: Hybrid Systems
  - Simulation: Transactions of the Society for Modeling and Simulation International
  - (2017) Tools and Algorithms for the Construction and Analysis of Systems (TACAS)
  - (2013, 2009) American Control Conference (ACC)
  - (2011) Conference on Decision and Control (CDC)
  - (2011) Intelligent Transportation Systems Conference (ITSC)
  - (2010) Hybrid Systems: Computation and Control (HSCC)

Publications and Patents

Theses

T1. **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.

T2. **Akshay Rajhans**, "Development of a Robust Testing Toolbox for Hybrid Systems", M.S.E. 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. Patent # 8209062, granted on June 26,

2012. Also filed as European and International Patents # EP 2514068 A1 and # WO 2011084390 A1.

Journal Papers

J1. **Akshay Rajhans**, Ajinkya Bhave, 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 for the October 2013 issue***.

J3. **Akshay Rajhans**, Shang-Wen Cheng, Bradley Schmerl, David Garlan, Bruce H. Krogh, Clarence Agbi, and Ajinkya Bhave, "*An Architectural Approach to the Design and Analysis of Cyber-Physical Systems*", Electronic Communications of the EASST, Volume 21, 2009.

Book Chapters

B1. Yi Deng, **Akshay Rajhans**, and A. Agung Julius, "*STRONG: A Trajectory-Based Verification Toolbox for Hybrid Systems*", in Kaustubh Joshi, Markus Siegle, Mariëlle Stoelinga and Pedro R. D'Argenio, editors, Lecture Notes in Computer Science, *10th International Conference, QEST 2013, Buenos Aires, Argentina, August 27-30, 2013. Proceedings*, Volume 8054, Pages 165-168, Springer, 2013.

B2. Alexandre Donzé, Bruce H. Krogh, and **Akshay Rajhans**, "*Parameter Synthesis for Hybrid Systems with an Application to Simulink Models*", in Rupak Majumdar and Paulo Tabuada, editors, Lecture Notes in Computer Science, *Hybrid Systems: Computation and Control, 12th International Conference, HSCC 2009, San Francisco, CA, USA, April 13-15,2009. Proceedings*, Volume 5469, Pages 165-179, Springer, 2009.

Conference Papers

C1. **Akshay Rajhans** and Bruce H. Krogh, "*Compositional Heterogeneous Abstraction*", in Proceedings of the 16th ACM International Conference on Hybrid Systems: Computation and Control (HSCC), 2013.

C2. **Akshay Rajhans** and Bruce H. Krogh, "*Heterogeneous verification of cyber-physical systems using behavior relations*", in Proceedings of the 15th ACM International Conference on Hybrid Systems: Computation and Control (HSCC), 2012.

C3. **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*", in Proceedings of the 50th IEEE Conference on Decision and Control (CDC), 2011.

C4. 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*", in Proceedings of the IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2011. ***William J. McCalla Best Paper Award***.

C5. Ajinkya Bhave, David Garlan, Bruce H. Krogh, **Akshay Rajhans**, and Bradley Schmerl, "*Augmenting Software Architectures with Physical Components*", in Proceedings of the Embedded Real Time Software and Systems Conf. (ERTS^2), 2010.

Peer Reviewed Abstracts

A1. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li, Larry Pileggi, "*Using Continuization in Rechability 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, Snowbird, UT.

A2. Ajinkya Bhave, David Garlan, Bruce H. Krogh, Sarah Loos, André Platzer, **Akshay Rajhans**, Bradley Schmerl, "*Multi-View Consistency in Architectures for Cyber-Physical Systems*", Safe and Secure Systems & Software Symposium (S5) 2011, Beavercreek, OH.

Other Miscellaneous Writing

O1. **Akshay Rajhans**, "*EGO Insider's Guide*", ECE Graduate Organization (EGO), Carnegie Mellon University, 2012. Contributor and Editor. Available at `http://www.ece.cmu.edu/~ego/files/insiders/guide2012.pdf`.

Student Advising and Teaching

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

- (2017) **MathWorks Technical Lead**, *CAT Vehicle Challenge*, an autonomous vehicle student research competition: simulation rounds hosted online in the Cyber-Physical Systems Virtual Organization (CPS-VO) Portal, along with the final round held on an actual autonomous vehicle (CAT Vehicle) at the University of Arizona, **Instructor**: Prof. Jonathan Sprinkle.
- (2017, 2016) **Judge**, *CPS V&V Grand Prix*, Formal Methods Research Course Competition for 15-424/15-624/15-824: Foundations of Cyber-Physical Systems, Carnegie Mellon University, **Instructor**: Prof. André Platzer.

Teaching Assistantship

- **18-474: Embedded Control Systems**, Electrical and Computer Engineering Department, Carnegie Mellon University, Spring 2011.
- **18-474: Embedded Control Systems**, Electrical and Computer Engineering Department, Carnegie Mellon University, Spring 2010.
- **MATH 114: Calculus II**, Mathematics Department, University of Pennsylvania, Spring 2008.
- **MATH 114: Calculus II**, Mathematics Department, University of Pennsylvania, Fall 2007.
- **ESE 210: Introduction to Dynamic Systems**, Electrical and Systems Engineering Department, University of Pennsylvania, Spring 2007.
- **ESE 301: Introduction to Probability**, Electrical and Systems Engineering Department, University of Pennsylvania, Fall 2006.
- (Grader) **OPIM 101: Introduction to Computer as an Analysis Tool**, Operations and Information Management Department, (now called the Operations, Information and Decisions Department), Wharton School, University of Pennsylvania, Spring 2006.

Guest Instructor

- (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*.

Honors

- Selected on ACM's **Global Practitioner Advisory Community**, 2017.
- Work featured as **Research Highlight** in *Communications of the ACM* magazine, 2013.
- Work featured in ***Innovation with Impact***, Carnegie Mellon University, 2013.
- William J. McCalla **Best Paper Award**, ACM/IEEE International Conference on Computer-Aided Design, 2011.
- Carnegie Institute of Technology **Dean's Fellowship**, August 2008–May 2013.
- Ranked in **top 0.48%** in India (percentile score of 99.52), Common Admission Test, 2005.
- National Talent Search (NTS) Scholarship, finalist, India, 1997.
- Maharashtra Talent Search (MTS) Scholarship, State-level rank: **35** (1996), **15** (1995).
- Middle School Scholarship, Maharashtra, India. State-level rank: **16** (1991-1994).

Service for Social Cause

- (2017-2019) **Member, Core Organizing Committee**, *New England Marathi Mandal*, a non-profit, www.nemm.org.
- (2008-2011) **Member, Board of Directors**, *Maharashtra Mandal Pittsburgh*, a non-profit, www.mmpgh.org.

Software

Developer: Simulink, Stateflow, SimEvents, STRONG.

Languages: MATLAB, C++, C, some Java.