

# Akshay Rajhans

Senior Research Scientist

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## Education

- May 2013 **Ph.D.**, *Electrical and Computer Engineering*, Carnegie Mellon University, Pittsburgh, PA.  
**Thesis Title:** *Multi-Model Heterogeneous Verification of Cyber-Physical Systems*  
**Thesis Advisor:** Prof. Bruce H. Krogh.
- Dec. 2007 **M.S.E.**, *Electrical Engineering*, University of Pennsylvania, Philadelphia, PA.  
**Thesis Title:** *Development of a Robust Testing Toolbox for Hybrid Systems*  
**Thesis Advisor:** Prof. George J. Pappas.
- May 2003 **B.E.**, *Electronics and Telecommunication*, University of Pune, Pune, India.

## Professional Experience

- Jul 16– **Senior Research Scientist**, *Advanced Research & Technology Office*, MathWorks, Natick, MA.  
Advanced research and technology development with a focus on *cyber-physical systems*.
- Jul 13–Jul 16 **Senior Software Engineer**, *Control Design Automation*, MathWorks, Natick, MA.  
Developed and maintained the subsystem and initialization semantics of Simulink.
- Aug 09–Dec 09 **Intern**, *Bosch Research and Technology Center*, Pittsburgh, PA.  
Developed a new approach to non-intrusive load monitoring using hybrid system state estimation. Co-inventor on **U.S. Patent # 8209062**. See the section on Patents for the citation.
- Aug 05–Dec 05 **Manager**, *IBU Application Engineering*, Cummins India Limited, Pune, India.  
Application engineering for electronic control of diesel engines in mining, marine, defense, rail, compressors, oil rigs, fire pumps, automotive and off-highway construction equipment.
- Aug 03–Aug 05 **Operations Management Program Participant**, Cummins India Limited, Pune, India.  
Research, development and application engineering of electronic controls for diesel engines and their applications.

## Teaching Assistantship

### At Carnegie Mellon University

- Spring 2011, **18-474: Embedded Control Systems.**  
Spring 2010 Set up laboratory experiments, held office hours, graded homework and mid-terms

### At University of Pennsylvania

- Spring 2008, **MATH 114: Calculus II.**  
Fall 2007 Taught recitations, held office hours, graded homework, mid-terms and finals
- Spring 2007 **ESE 210: Introduction to Dynamic Systems.**  
Held office hours, graded mid-terms and finals
- Fall 2006 **ESE 301: Introduction to Probability.**  
Held office hours, graded mid-terms and finals
- Spring 2011 **OPIM 101: Introduction to Computer as an Analysis Tool.**  
Grader for final exams

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## Professional Service

### Conference Program Committee

- 2017 **Program Committee Member**, *Hybrid Systems: Computation and Control (HSCC)*.
- 2016 **Program Committee Member**, *Hybrid Systems: Computation and Control (HSCC)*.
- 2015 **Program Committee Member**, *International Conference on Cyber-Physical Systems (ICCPs)*, *Conference on Analysis and Design of Hybrid Systems (ADHS)*, *Summer Simulation Multi-Conference (SummerSim)*.
- 2014 **Program Committee Member**, *Summer Simulation Multi-Conference (SummerSim)*.
- 2014 **Repeatability Evaluation Committee Member**, *Hybrid Systems: Computation and Control (HSCC)*.

### Review

- **Reviewer**, *Nonlinear Analysis: Hybrid Systems*.
- **Reviewer**, *Simulation: Transactions of the Society for Modeling and Simulation International*.
- 2013 **Reviewer**, *American Control Conference (ACC)*.
- 2011 **Reviewer**, *Conference on Decision and Control (CDC)*.
- 2011 **Reviewer**, *Intelligent Transportation Systems Conference (ITSC)*.
- 2010 **Reviewer**, *Hybrid Systems: Computation and Control (HSCC)*.
- 2009 **Reviewer**, *American Control Conference (ACC)*.

### Judge

- May 2016 **Judge**, *CPS V&V Grand Prix*, Course Competition for 15-424/15-624/15-824: Foundations of Cyber-Physical Systems, Carnegie Mellon University, **Instructor**: Prof. André Platzer.

### Service for Social Cause

- 2008-2011 **Member, Board of Directors**, Maharashtra Mandal Pittsburgh, a non-profit organization based in Pittsburgh.
- Summer 2009 **Laboratory Instructor**, *Summer Engineering Experience for Girls (SEE)*, a day-long summer camp for high-school students at Carnegie Mellon University, **Instructor**: Prof. Bruno Sinopoli.

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## 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.

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## Journal Publications

- J1. **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 for the October 2013 issue**.
- J3. **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.

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## 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<sup>2</sup>)*, 2010.

## Peer Reviewed Extended Abstracts

- A1. Matthias Althoff, **Akshay Rajhans**, Bruce H. Krogh, Soner Yaldiz, Xin Li, 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, 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, Beaver Creek, OH.

## Posters

- P1. Ivan Ruchkin, Stefan Mitsch, **Akshay Rajhans**, Bruce H. Krogh, David Garlan, André Platzer, Bradley Schmerl, James Kapinski, Prashant Ramachandra and Ken Butts, "*An Architectural Approach to Heterogeneous Modeling and Verification of Cyber-Physical Systems*", *NSF CPS PI Meeting*, Arlington, VA, October 16-18, 2013.
- P2. Yi Deng, **Akshay Rajhans**, and A. Agung Julius, "*STRONG: A Trajectory-Based Verification Toolbox for Hybrid Systems*", *Hybrid Systems: Computation and Control (HSCC)*, Philadelphia, PA, April 8-11, 2013.
- P3. **Akshay Rajhans**, "*Addressing Heterogeneity in Model-Based Development of Cyber-Physical Systems*", *Innovation with Impact*, Carnegie Mellon University, Pittsburgh PA, April 4, 2013.
- P4. **Akshay Rajhans**, "*Addressing Heterogeneity in Model-Based Development of Cyber-Physical Systems*", *Google Regional PhD Summit*, Google Pittsburgh, Mar 21, 2013.
- P5. **Akshay Rajhans** and Bruce H. Krogh, "*Heterogeneous Verification of Cyber-Physical Systems using Behavior Semantics*", *NSF CPS PI Meeting*, Annapolis, MD, October 3-5, 2012.
- P6. Ajinkya Bhave, Ken Butts, Derek Caveney, David Garlan, Bruce H. Krogh, Sarah Loos, André Platzer, **Akshay Rajhans**, Prashant Ramachandra, Bradley Schmerl, "*An Architecture Approach to Heterogeneous Verification of Cyber-Physical Systems*", *NSF CPS PI Meeting*, Annapolis, MD, August 1-2, 2011.
- P7. **Akshay Rajhans**, Matthias Althoff, Bruce H. Krogh, Larry Pileggi, Xin Li, "*Investigation of Formal Verification Methods for Self-Healing Analog/RF Systems*", *C2S2 Annual Review* 2010, Atlanta, GA.
- P8. Shang-Wen Cheng, David Garlan, Bruce H. Krogh, **Akshay Rajhans**, Bradley Schmerl and Bruno Sinopoli, "*Design and Analysis of Cyber-Physical Architectures*", *CPS Forum*, co-located with the *CPSWeek 2009*, San Francisco, CA.

## Other Miscellaneous Writings

- O1. **Akshay Rajhans**, “*EGO Insider’s Guide*”, ECE Graduate Organization (EGO), Carnegie Mellon University, 2012. Edited. Available at <http://www.ece.cmu.edu/~ego/files/insiders/guide2012.pdf>.

## Invited Talks

- T1. “*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. “*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.
- T3. “*Verification of Systems Using Robust Temporal Logic Testing*”, Specification and Verification Center, School of Computer Science, Carnegie Mellon University, August 2008. **Host**: Prof. Ed Clarke.

## Honors

- 2014 **Work featured as Research Highlight**, *Communications of the ACM magazine*.
- 2013 **Work featured in Innovation with Impact**, an interdisciplinary exhibition of graduate student research and projects held annually at Carnegie Mellon University.
- 2014 **William J. McCalla Best Paper Award**, ACM/IEEE International Conference on Computer-Aided Design (ICCAD).
- 2008 **Dean’s Fellowship**, Carnegie Institute of Technology, Carnegie Mellon University.
- 2005 **Ranked in top 0.48% in India**, Common Admission Test.  
Percentile score: **99.52**
- 1997 **Finalist**, National Talent Search (NTS) Scholarship, India.
- 1996 **Scholarship**, Maharashtra Talent Search (MTS), India.  
State-level rank: **35**
- 1995 **Scholarship**, Maharashtra Talent Search (MTS), India.  
State-level rank: **15**
- 1991-1994 **Scholarship**, Middle School Scholarship, Maharashtra, India.  
State-level rank: **16**

## Software

- Developer Simulink, Stateflow, STRONG, AcmeStudio
- User SpaceEx, PHAVer, Breach, KeYmaera
- Languages MATLAB, C++