Akshay Rajhans

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Professional Experience

The MathWorks, Inc., Natick, MA
Senior Software Engineer, Jul 2013–

- Develop and maintain the subsystem and initialization semantics of Simulink
- Develop and maintain source code in C++ and test cases in MATLAB

Bosch Research and Technology Center, Pittsburgh, PA
Intern, Aug 2009–Dec 2009

- Developed a new approach to non-intrusive load monitoring using hybrid system state estimation
- Developed a laboratory prototype in MATLAB coupled to an existing set up in LabView
- Inventor on **U.S. Patent # 8209062**. See the section on Patents for the citation.

Cummins India Limited, Pune, India
Manager, Electronic Controls, IBU Application Engineering Aug 05-Dec 05
Operations Management Program Participant, Research Development and Engineering Aug 03-Aug 05

- Worked on various projects focused on research, development and application engineering of electronic control system solutions for diesel engines, their testing cells and their application in Industrial and Power-Generation Business Units (IBU, PGBU). IBU applications include mining, marine, defense, rail, compressors, oil rigs, fire pumps, automotive and off-highway construction equipment.
- Worked in cross-functional teams with personnel from marketing, engineering, sourcing and service. Visited several customers with marketing teams, several suppliers with sourcing teams and several original-equipment manufacturers with support teams as a technical expert in electronic controls as per various project needs.
- Served as a nationwide (India) front-end technical expert (*one of only two persons*) for electronics and control systems in IBU applications.
- Oversaw the scheduling of machinery, testing cells and human resources for these projects and introduction and maintenance of electronic entries of controls-related equipment in the computer inventory system GIEA.
- Won **Vice President's Quarterly Recognition Award** for a test-cell automation project to upgrade an old test cell from a manual control and command-line data acquisition interface to a new programmable logic controller (PLC) and human-machhine interface (HMI)-based control and monitoring system with real-time trending.

Education

Ph.D.	Electrical and Computer Engineering	Carnegie Mellon University	May 2013
M.S.E.	Electrical Engineering	University of Pennsylvania	Dec. 2007
B.E.	Electronics and Telecommunication	University of Pune	May 2003

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.

Professional Service

Program Committee Member

• Hybrid Systems: Computation and Control (HSCC) 2016 • Summer Simulation Multi-Conference (SummerSim) 2015 • Conference on Analysis and Design of Hybrid Systems (ADHS) 2015 • International Conference on Cyber-Physical Systems (ICCPS) 2015 • Hybrid Systems: Computation and Control (HSCC) 2014: Repeatability Evaluation Committee • Summer Simulation Multi-Conference (SummerSim) 2014

Reviewer (Journals and Conferences)

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

Panelist

- **Student Panelist**, Prospective Student Open House, Electrical and Computer Engineering Department, Carnegie Mellon University, 2012

Service for Social Cause

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

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.

Publications

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.

Journal Publications

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 Proceedings

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 Extended 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), Beavercreek, 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.

Technical Talks (excluding conference presentations)

S1. **Akshay Rajhans**, "*Robustness of Temporal Logic Specifications for Testing of Signals*", Specification and Verification Center, School of Computer Science, Carnegie Mellon University, August 2008. **Seminar host**: Prof. Ed Clarke.

S2. **Akshay Rajhans**, "*Verification of Systems Using Robust Temporal Logic Testing*", Specification and Verification Center, School of Computer Science, Carnegie Mellon University, August 2008. **Seminar host**: Prof. Ed Clarke.

Teaching Assistantship Experience

At Carnegie Mellon University

• 18-474: Embedded Control Systems

At University of Pennsylvania

• MATH 114: Calculus II (Multivariate Calculus) • ESE 210: Introduction to Dynamic Systems • ESE 301: Introduction to Probability • OPIM 101: Introduction to Computer as an Analysis Tool (Grader)

Honors

- Work featured as **Research Highlight** in *Communications of the ACM* magazine, 2014.
- Work featured in *Innovation with Impact*, an interdisciplinary exhibition of graduate student research and projects held annually at Carnegie Mellon University, 2013.
- William J. McCalla **Best Paper Award**, ACM/IEEE International Conference on Computer-Aided Design (ICCAD), 2011.
- Invited to give talks at the *Specification and Verification Center* by **Prof. Ed Clarke**, August 2008.
- 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).

Programming Skills

- Modeling, simulation and formal analysis software:
  - **Contributed as a developer to**: Simulink, Stateflow, STRONG, AcmeStudio
  - **User-level experience**: SpaceEx, PHAVer, Breach, KeYmaera (used during research)
  - **Preliminary user-level experience**: Yices, Z3, UPPAAL (tried out during research)
- Programming languages: C++, MATLAB, C, basics of Java