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EDUCATION

PhD, Electrical and Computer Engineering — **University of Illinois at Urbana-Champaign**

May 2013 (expected) — Urbana, IL

- Tentative dissertation title: *Verification for Distributed Cyber-Physical Systems*
- Adviser: Sayan Mitra
- Preliminary exam expected: Spring 2012
- Qualifying exam passed: May 2010

MSc, Electrical and Computer Engineering — **University of Illinois at Urbana-Champaign**

May 2010 — Urbana, IL

- Adviser: Sayan Mitra
- Thesis: *Fault-Tolerant Distributed Cyber-Physical Systems: Two Case Studies*

BSc, Electrical and Computer Engineering — **Rice University**

May 2008 — Houston, TX

- Senior Project (with Frank Havlak and Elica Skorcheva at Rice, and Fadi Abousleiman, Farès Hantous, and Slim Besbes at Supélec, Gif-sur-Yvette, France): *Sensorless Synchronous Motor Control in Downhole Tools*.
- Advisers: Albert Hoefel and Peter Swinburne (Schlumberger); J.D. Wise and Fathi Ghorbel (Rice)

RESEARCH INTERESTS

- Formal methods and verification
- Cyber-physical systems: distributed, embedded, real-time control systems and software
- Distributed computing and distributed systems
- Hybrid systems
- Fault-tolerance and models of failures

Research Statement: My research focuses on verifying that distributed systems that interact with the physical world—called distributed cyber-physical systems (DCPS)—satisfy their requirements specifications, and I have initiated two directions of research on this problem. The first focus is on developing tools and techniques for *developmental verification* to ensure that systems being designed meet their requirements. We have developed tools to automatically abstract hybrid systems with nonlinear, periodic dynamics to simpler dynamics that current hybrid systems reachability tools can handle, and applied this tool to the verification of satellite orbital maneuvers. Currently I am developing a tool for automatic developmental verification of DCPS using abstraction and relying on logical techniques (particularly satisfiability modulo theories (SMT) solvers).

The second focus is *operational verification* to ensure that once a system has been designed and deployed, it continues to meet its specification in spite of degradation of the system and its subcomponents (due to environmental factors, component failure, malicious agents in the distributed system, bugs, etc.). We have performed several case studies on failures in distributed traffic control protocols—mobile robots platooning on the line where robots could fail with

stuck actuators and a distributed factory conveyor system where the computers controlling some conveyors could crash. Through these case studies, we developed techniques relying on self-stabilization and failure detectors to verify that the systems still satisfy the problem specification in spite of failures (or when it is impossible to do so).

RESEARCH EXPERIENCE

University of Illinois at Urbana-Champaign — *Research Assistant for Prof. Sayan Mitra*

Urbana, IL — Fall 2008—present

Performing research in the Coordinated Science Lab on the modeling and verification of distributed and hybrid systems.

Air Force Research Laboratory — *Graduate Researcher through the Air Force Summer Faculty Fellowship Program*

Albuquerque, NM — Summer 2011

Applied hybrid systems verification techniques to Air Force problems, particularly verification of satellite rendezvous maneuvers.

INDUSTRY EXPERIENCE

Schlumberger Technology Corporation — *Intern in Electrical Engineering*

Sugar Land, TX — Summer 2010

Design, implementation, and analysis of a state estimator for maximum available power produced by a turbo-alternator, used for stalling protection of the turbine in a power control loop added outside already cascaded velocity and torque control loops for permanent magnet synchronous motor (PMSM) control. This work resulted in a conference publication (PECI 2011) and patent application.

Etudes et Productions Schlumberger — *Intern in Electrical Engineering*

Clamart, France — Summer 2009

Analyzed and modeled existing analog and mixed-signal electronics PCBs for correctness.

Schlumberger Technology Corporation — *Intern in Computer Engineering*

Sugar Land, TX — Summer 2007

Implemented new features on FPGAs in VHDL used in Space Vector Pulse Width Modulation (SV-PWM) control of permanent magnet synchronous motors (PMSMs).

Schlumberger Technology Corporation — *Intern in Computer Engineering*

Sugar Land, TX — Summer 2006

Designed, implemented, tested, and documented a networked boot loader and common application framework in 8051 assembly and C for a microcontroller, utilizing CAN for networking via an SPI interface to a CAN transceiver.

Schlumberger Technology Corporation — *Intern in Computer Science*

Sugar Land, TX — Summer 2005

Designed, implemented, and documented an automated system to gather, store, and report metrics on embedded systems source code through a database-driven intranet web application.

Blue Bell Creameries, L.P. — *Business Application Programmer*

Brenham, TX — May 2002—May 2004

Designed and developed ASP.NET intranet web applications with SQL database backend to replace aging desktop-based programs.

TEACHING EXPERIENCE

University of Illinois at Urbana-Champaign *Teaching Assistant*

Urbana, IL 2008-2010

- Introduction to Computing Systems (ECE190), Spring 2009 and Spring 2010. Led discussion sections on programming, held office hours, wrote test questions and homeworks, graded tests and programming assignments, and developed new programming assignments.
- Introduction to Electrical and Computer Engineering (ECE110), Fall 2008. Co-led a section of the lab, which culminates in students building a simple robotic car which navigates an environment using line-following.

Rice University *Lab Assistant*

Houston, TX 2006—2008

- Aided professors and graduate teaching assistants in grading, leading lab and discussion sessions, holding office hours, for the following courses.
- Applied Algorithms and Data Structure (COMP314), Spring 2008.
- Intermediate Programming (COMP212), Spring 2006, Spring 2007, Spring 2008.
- Digital Logic Design (ELEC326), Fall 2007.
- Microcontroller and Embedded Systems Laboratory (ELEC226), Spring 2007.

PUBLICATIONS AND PRESENTATIONS

Conference Papers Submitted and Pending Decisions

(1) Taylor T. Johnson, Jeremy Green, Sayan Mitra, Rachel Dudley, and R. Scott Erwin. "Verifying Satellite Rendezvous and Conjunction Avoidance: A Formal Approach to Autonomy in Space," (Pending Decision), October 2011.

(2) Taylor T. Johnson and Sayan Mitra. "Parameterized Verification of Distributed Cyber-Physical systems: An Aircraft Landing Protocol Case Study," (Pending Decision), October 2011.

Journal Papers

(3) Taylor T. Johnson and Sayan Mitra. "Safe Flocking in Spite of Actuator Faults Using Directional Failure Detectors," in *Journal of Nonlinear Systems and Applications*, Watam Press, Waterloo, 2011.

Conference Papers

(4) Taylor T. Johnson, Sayan Mitra, and Cedric Langbort. "Stability of Digitally Interconnected Linear Systems," (To Appear) in *Proceedings of the 50th IEEE Conference on Decision and Control and European Control Conference (CDC/ECC)*, Orlando, Florida, December 2011.

(5) Taylor T. Johnson and Albert E. Hoefel. "Turbo-Alternator Stalling Protection using Available Power Estimate," in *Proceedings of the 2nd IEEE Power and Energy Conference at Illinois (PECI)*, Urbana, Illinois, February 2011. **(Best Paper Award)**.

(6) Taylor T. Johnson and Sayan Mitra. "Safe Flocking in Spite of Actuator Faults," in *Proceedings of the 12th International Symposium on Stabilization, Safety, and Security of Distributed Systems (SSS)*, New York, New York, September 2010.

(7) Taylor T. Johnson, Sayan Mitra, and Karthik Manamcheri. "Safe and Stabilizing Distributed Cellular Flows," in *Proceedings of the 30th IEEE International Conference on Distributed Computing Systems (ICDCS)*, Genoa, Italy, June 2010.

Conference and Other Presentations

(1) Presented the poster "Verification of Distributed Cyber-Physical Systems: Stability of Digitally Interconnected Linear Systems," at the Coordinated Science Laboratory 60th Anniversary Symposium, October 28, 2011, University of Illinois at Urbana-Champaign, Urbana, IL.

(2) Presented the poster "Verification of Distributed Cyber-Physical Systems: Stability of Digitally Interconnected Linear Systems," at the The Symposium on Emerging Topics in Control and Modeling: Cyber-Physical Systems, October 20, 2011, University of Illinois at Urbana-Champaign, Urbana, IL.

(3) Presented "Turbo-Alternator Stalling Protection using Available Power Estimate," at the *2nd IEEE Power and Energy Conference at Illinois (PECI)*, February 25, 2011, University of Illinois at Urbana-Champaign, Urbana, IL.

(4) Presented "Automatic parameterized verification of distributed algorithms" at 6th CSL Student Conference, January 28, 2011, Urbana, IL.

(5) Presented "Safe Flocking in Spite of Actuator Faults," at *12th International Symposium on Stabilization, Safety, and Security of Distributed Systems (SSS)*, September 22, 2010, Columbia University, NY.

(6) Presented "Safe and Stabilizing Distributed Cellular Flows" to the Multi-Robot Systems Lab, Rice University, July 15, 2010, Houston, TX.

(7) Presented "Safe and Stabilizing Distributed Cellular Flows" at 5th CSL Student Conference, January 29, 2010, Urbana, IL.

(8) Presented the position paper, "Handling Failures in Cyber-Physical Systems: Potential Directions" at PhD Student Forum on Cyber-Physical Systems, 30th IEEE Real-Time Systems Symposium (RTSS), December 1, 2009, Washington, D.C.. **(Award for *Most Interesting Cyber-Physical Systems Research Problem*)**.

(9) Presented the poster, "Power Usage of Time and Event-Triggered Paradigms: A Case Study" at Poster Session, April 13, 2009, 15th IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS), San Francisco, CA.

Patent Applications

(1) Application Submitted, *Control of a Downhole Sampling-While-Drilling Pump*, Albert Hoefel, Francois Bernard, Kent D. Harms, Sylvain Ramshaw, Shayan Darayan, and Taylor T. Johnson. Serial Number 61/415006, Docket No. IS10.0880-US-PSP, November 18, 2010.

PROFESSIONAL ACTIVITIES AND SERVICE

Conference Organization and Service

- Reviewer,
  - International Conference on Hybrid Systems: Computation and Control (HSCC), 2010, 2011, 2012.
  - NASA Formal Methods Seminar (NFM), 2011.
- Conference Organization,
  - Designed program booklet for CPSWeek 2011, Chicago, IL.

Mentoring

- Research Mentor, University of Illinois at Urbana-Champaign
  - Fall 2011: Zhongdong Zhu, Project: Safe and Stabilizing Distributed Cellular Flows; I am advising Zhongdong in writing a simulator for the journal version of this conference paper. **(Nominated for the Computing Research Association Outstanding Undergraduate Researchers Award.)**
- Graduate Mentor, Promoting Undergraduate Research in Engineering (PURE), University of Illinois at Urbana-Champaign. Through this program, I have had the pleasure of mentoring the following undergraduate students on research projects:
  - Fall 2011: Akash Kapoor, Project: Reachability Analysis of Switched-Mode Power Converters.
  - Spring 2011: Hershed Tilak, Project: Implementation of a Boundary Detection Algorithm; Jeffrey Lale, Project: A Randomized Algorithm for Deadlock-Free Robot Routing; and Zhihao (Ted) Hong: Modeling Parameterized Power Converters using Timed Automata.

  - Fall 2010: Hershed Tilak, Project: Simulating Coupled Inverted Pendulums in Matlab.
  - Fall 2009: Jerry Sun and Dongeek Shin, Joint Project: Simulating a Planar Factory in Matlab.
  - Spring 2009: Rohan Bali, Project: Simulating Coupled Inverted Pendulums in Matlab; and Patrick Gu, Project: Extending Giotto on nxtOSEK for Lego Mindstorms to xGiotto.
  - Fall 2008: Haeran Lee, Soonwoo (Daniel) Chang, Youngho (Ryan) Park, and Yosub Shin, Joint Project: Reachability Analysis of Switched-Mode Power Converters.
- Graduate Mentor, Information Trust Institute Undergraduate Summer Intern Program, University of Illinois at Urbana-Champaign
  - Summer 2009: Shashank Gupta, Indian Institute of Technology, Kharagpur.
- Mentor, DREAM Program, Rice University, 2007-2008. Through this program, I had the pleasure of helping mentor several underrepresented high school students on an engineering design challenge project, and on science and engineering fair projects.

Professional Organizations

- Student Member, Institute of Electrical and Electronics Engineers (IEEE), 2004—Present. Chapter Vice President, 2007.
- Student Member, Association for Computing Machinery (ACM), 2003—Present.

AWARDS AND HONORS

- Best Paper, Power and Energy Conference at Illinois (PECI) 2011.
- Most Interesting Cyber-Physical Systems Research Problem, IEEE Real-Time Systems Symposium (RTSS), 2009.
- Travel grants to the following conferences from the organizations in parentheses:
  - IEEE Conference on Decision and Control, December 2011 (Univ. of Illinois Graduate College and Rockwell Collins).
  - International Symposium on Stabilization, Safety, and Security of Distributed Systems, September 2010 (NSF).
  - IEEE Real-Time Systems Symposium, December 2009 (NSF).
  - IEEE Real-Time and Embedded Technology and Applications Symposium, April 2009 (NSF).
- AMD Digital Logic Design Competition, Rice University, ELEC326, First Place Team, 2006.
- Coca-Cola Scholars Scholarship Competition, Finalist Recipient, 2004.