

Research Interests

Cyber-physical systems; Optimization-based control; Data-driven modeling and control methods; Gaussian Process; Energy-efficient buildings; Demand response; Smart grids; Real-time embedded control; Formal verification; Control and computation co-design.

Relevant disciplines: control theory, optimization, machine learning, real-time embedded control.

Education

- 2012 **Ph.D. Electrical & Systems Engineering**
University of Pennsylvania, Philadelphia, USA
Advisor: George J. Pappas; Co-advisor: Rahul Mangharam.
- 2003 **B.S. Electrical Engineering (Automatic Control)**
Hanoi University of Technology, Hanoi, Vietnam

Professional and Research Experience

- Postdoc Scientist**, École Polytechnique Fédérale de Lausanne (EPFL) 07/2014 • present
Smart Building Networks (European Research Council): developed data-driven modeling and optimization-based control methods for networks of smart buildings to offer critical services to the power grid; developed software for large-scale simulation of smart building networks and distribution grids.
- Co-founder**, Entelion 09/2016 • present
Co-founded Entelion, a Swiss-based startup developing technologies to optimize, control, and aggregate hybrid energy systems (electrical and thermal storage + buildings) to provide fast ancillary services to the grid.
- Technical Advisor**, WiSilica, Inc. 07/2014 • 12/2015
Advised WiSilica, Inc. on technical matters related to engineering and R&D of products for smart homes, residential and commercial energy control and management.
- Postdoc Researcher**, Electrical & Systems Eng., University of Pennsylvania 10/2012 • 12/2014
Led research on energy-efficient buildings, smart grids, anytime estimation and control, and verification of automotive control.
- *The TerraSwarm Research Center (<http://www.terraswarm.org>)*: developed control methods, simulation platforms, and testbeds for energy-efficient buildings and smart grids.
 - *Formal Reasoning Framework for Autonomous Vehicle Controls (Toyota ITC)*: developed theoretical frameworks and tools for formal reasoning of safety properties of autonomous vehicle controls and advanced driver assistance systems.
 - *Co-design of Anytime Computation and Robust Control*: developed a framework for co-designing anytime estimation and robust optimization-based control algorithms, enabling overloaded real-time computation and control on embedded platforms.
- Research Assistant**, Electrical & Systems Eng., University of Pennsylvania 2005 • 2012
Researched on energy-efficient building control, peak demand reduction, temporal logic falsification for hybrid systems, control-computation co-design, medical device verification and validation. Selected projects:

- *Energy Efficient Buildings Hub (U.S. Department of Energy)*: scheduling and control approach for peak demand reduction in buildings; software for simulation, analysis, optimization & control of building energy systems; end-to-end analysis method from sensor data quality to building modeling and control performance.
- *Synthesis of Embedded Software from Hybrid Models (NSF)*: developed methods for quantifying the performance of time-triggered digital implementation of control systems.
- *Pacemaker Formal Methods Challenge*: developed, simulated, and verified a cardiac pacemaker model using timed automata.

Summer Intern, NEC Laboratories America

06 • 09/2008

Developed a U.S. patented symbolic verification technique and tool for Simulink/Stateflow models.

Lecturer, Automatic Control Department, Hanoi University of Technology

2003 • 2005

Main responsibilities: teaching, research, supervising undergraduate students' final projects and theses.

Teaching Experience

- Fall 2016 **Student Supervisor (EPFL)**
Supervised a master student's project to develop models and model predictive controllers for the EPFL's solar-powered house participating in the U.S. DoE's Solar Decathlon competition.
- Spring 2014 **Guest Instructor (University of Pennsylvania)**
ESE-350 Introduction to Embedded Systems.
Two guest lectures on real-time embedded control systems.
- Fall 2013 **Guest Instructor & Project Supervisor (University of Pennsylvania)**
ESE-519 Real-Time Embedded Systems.
Two guest lectures on real-time embedded control systems. Mentored a student group project.
- Spring 2011 **Course Organizer (University of Pennsylvania)**
CIS-800 Green Buildings: Optimization and Adaptation.
Advanced research seminar course on energy-efficient building modeling, simulation, learning, optimization, and controls.
Presented three lectures on building controls. Organized the overall course: reviewed literature, scheduled talks and guest speakers, managed the course website.
- Fall 2009 **Teaching Assistant (University of Pennsylvania)**
CIS-540 Principles of Embedded Computation.
One of the first courses offered at Penn on real-time embedded systems.
Assisted in developing the course materials on control theory and real-time control systems.
- Fall 2007 **Teaching Assistant (University of Pennsylvania)**
ESE-500 Linear Systems Theory.

Honors and Awards

- 03/2014 **Grant to Research Opportunities Week at Technische Universität München, Germany**
- 06/2013 **IEEE CSS Student Travel Award to 2013 American Control Conference**
- 11/2012 **Best Demo Award at the 4th ACM Workshop On Embedded Sensing Systems For Energy-Efficiency In Buildings (BuildSys), Toronto, Canada**
- 07/2012 **IEEE CSS Student Travel Award to 2012 American Control Conference**
- 12/2011 **IEEE CSS Student Travel Award to 2011 IEEE Conference on Decision and Control**
- 2005 • 2012 **Vietnam Education Foundation (VEF) Fellowship**
- 06/2003 **Dean's List at Hanoi University of Technology**

Patents

1. **System and method for feedback-guided test generation for Cyber-physical Systems using Monte-Carlo**
 - Inventors: Sriram Sankaranarayanan, Franjo Ivancic, Aarti Gupta, **Truong X. Nghiem**.
 - Assignees: NEC Laboratories America, Inc.
 - Patent number: US 8,374,840 B2.
 - Patent grant date: February 12, 2013.

Publications

385 citations, h-index 10, i10-index 10 as of January 2017 on Google Scholar (<http://tinyurl.com/tnscholar>).

JOURNAL PAPERS

- [1] **T. X. Nghiem**, G. J. Pappas, R. Alur, and A. Girard, "Time-triggered implementations of dynamic controllers," *ACM Transactions in Embedded Computing Systems*, vol. 11, pp. 58:1–24, 8 2012.

SUBMITTED AND WORKING JOURNAL PAPERS

- [2] **T. X. Nghiem** and C. N. Jones, "Data-driven modeling and stochastic control of buildings for demand response and ancillary services." In preparation for *Applied Energy*, 2016.
- [3] **T. X. Nghiem**, A. Bitlislioglu, and C. N. Jones, "Large-scale distributed co-simulation of cyber-physical energy systems with OpenBuildNet." In preparation, 2016.

CONFERENCE PAPERS

- [4] **T. X. Nghiem**, A. Bitlislioglu, T. Gorecki, F. A. Qureshi, and C. N. Jones, "OpenBuildNet framework for distributed co-simulation of smart energy systems," in *International Conf. on Control, Automation, Robotics and Vision (ICARCV)*, 2016.
- [5] **T. X. Nghiem** and C. N. Jones, "Data-driven demand response modeling and control of buildings with gaussian processes." In review, 2016.
- [6] M. Behl, **T. X. Nghiem**, and R. Mangharam, "DR-Advisor: A data driven demand response recommender system," in *International Conference CISBAT 2015 Future Buildings and Districts Sustainability from Nano to Urban Scale*, 2015.
- [7] W. Bernal, M. Behl, **T. X. Nghiem**, and R. Mangharam, "Campus-wide integrated building energy simulation," in *IBPSA International Building Simulation Conference (BS2015)*, 2015.
- [8] I. Lympelopoulos, F. A. Qureshi, **T. X. Nghiem**, A. A. Khatir, and C. N. Jones, "Providing ancillary service with commercial buildings: the swiss perspective," in *International Symposium on Advanced Control of Chemical Processes (ADCHEM)*, 2015.
- [9] **T. X. Nghiem** and R. Mangharam, "Scalable scheduling of energy control systems," in *ACM & IEEE International conference on Embedded software (EMSOFT)*, 2015.
- [10] Y. V. Pant, K. Mohta, H. Abbas, **T. X. Nghiem**, J. Devietti, and R. Mangharam, "Co-design of anytime computation and robust control," in *IEEE Real-Time Systems Symposium (RTSS)*, 2015.
- [11] B. Aksanli, A. S. Akyurek, M. Behl, M. Clark, A. Donze, P. Dutta, P. Lazik, M. Maasoumy, R. Mangharam, **T. X. Nghiem**, V. Raman, A. Rowe, A. Sangiovanni-Vincentelli, S. Seshia, T. S. Rosing, and J. Venkatesh, "Distributed control of a swarm of buildings connected to a smart grid: Demo abstract," in *The 1st ACM Conference on Embedded Systems for Energy-Efficient Buildings (BuildSys'14)*, pp. 172–173, ACM, 2014.

- [12] M. Behl, **T. X. Nghiem**, and R. Mangharam, "IMpACT: Inverse model accuracy and control performance toolbox for buildings," in *IEEE International Conference on Automation Science and Engineering (CASE)*, 2014.
- [13] M. Behl, **T. X. Nghiem**, and R. Mangharam, "Model-IQ: Uncertainty propagation from sensing to modeling and control in buildings," in *International Conference on Cyber-Physical Systems (ICCPs)*, 2014.
- [14] Y. V. Pant, **T. X. Nghiem**, and R. Mangharam, "Peak power reduction in hybrid energy systems with limited load forecasts," in *American Control Conference*, 2014.
- [15] **T. X. Nghiem**, G. J. Pappas, and R. Mangharam, "Event-based green scheduling of radiant systems in buildings," in *American Control Conference (ACC)*, 2013.
- [16] Y. V. Pant, **T. X. Nghiem**, and R. Mangharam, "Knock NOx: Model-based remote diagnostics of a diesel exhaust control system," in *Work-in-Progress IEEE Real-Time and Embedded Technology and Applications Symposium (RTAS)*, pp. 17–20, 2013.
- [17] M. Behl, **T. X. Nghiem**, and R. Mangharam, "Green scheduling for energy-efficient operation of multiple chiller plants," in *IEEE Real-Time Systems Symposium (RTSS)*, pp. 195–204, 2012.
- [18] W. Bernal, M. Behl, **T. Nghiem**, and R. Mangharam, "MLE+: Design and deployment integration for energy-efficient building controls (demo abstract)," in *The Fourth ACM Workshop on Embedded Sensing Systems for Energy-Efficiency in Buildings (BuildSys'12)*, pp. 215–216, ACM, 2012. Demo Abstract – **Best Demo Award**.
- [19] W. Bernal, M. Behl, **T. X. Nghiem**, and R. Mangharam, "MLE+: a tool for integrated design and deployment of energy efficient building controls," in *The 4th ACM Workshop on Embedded Sensing Systems for Energy-Efficiency in Buildings (BuildSys'12)*, pp. 123–130, ACM, 2012.
- [20] **T. X. Nghiem**, M. Behl, G. J. Pappas, and R. Mangharam, "Green scheduling for radiant systems in buildings," in *IEEE Conference on Decision and Control (CDC)*, pp. 7577–7582, 2012.
- [21] **T. X. Nghiem**, M. Behl, R. Mangharam, and G. J. Pappas, "Scalable scheduling of building control systems for peak demand reduction," in *American Control Conference (ACC)*, pp. 3050–3055, 2012.
- [22] Z. Li, P.-C. Huang, A. K. Mok, **T. X. Nghiem**, M. Behl, G. J. Pappas, and R. Mangharam, "On the feasibility of linear discrete-time systems of the green scheduling problem," in *The 32nd IEEE Real-Time Systems Symposium (RTSS)*, pp. 295–304, 2011.
- [23] **T. X. Nghiem** and G. E. Fainekos, "Computing schedules for time-triggered control using genetic algorithms," in *The 18th IFAC World Congress*, 2011.
- [24] **T. X. Nghiem**, M. Behl, R. Mangharam, and G. J. Pappas, "Green scheduling of control systems for peak demand reduction," in *IEEE Conference on Decision and Control (CDC)*, pp. 5131–5136, 2011.
- [25] **T. X. Nghiem**, M. Behl, G. J. Pappas, and R. Mangharam, "Green scheduling: Scheduling of control systems for peak power reduction," in *International Green Computing Conference and Workshops (IGCC)*, pp. 1–8, 2011.
- [26] **T. X. Nghiem** and G. J. Pappas, "Receding-horizon supervisory control of green buildings," in *American Control Conference*, pp. 4416–4421, 2011.
- [27] **T. X. Nghiem**, S. Sankaranarayanan, G. Fainekos, F. Ivancic, A. Gupta, and G. J. Pappas, "Monte-carlo techniques for falsification of temporal properties of non-linear hybrid systems," in *The 13th ACM international conference on Hybrid systems: computation and control (HSCC)*, pp. 211–220, Springer, 2010.
- [28] **T. X. Nghiem**, G. J. Pappas, R. Alur, and A. Girard, "Time-triggered implementations of dynamic controllers," in *The 6th ACM & IEEE International conference on Embedded software (EMSOFT)*, pp. 2–11, ACM, 2006.

TECHNICAL REPORTS AND OTHER PUBLICATIONS

- [29] **T. X. Nghiem**, Y. V. Pant, and R. Mangharam, "Robust model predictive control with anytime estimation," Tech. Rep. ESE-UPenn-14-TR12, Department of Electrical and Systems Engineering, University of Pennsylvania, 2014.
- [30] Y. V. Pant, **T. X. Nghiem**, and R. Mangharam, "Peak power control of battery and super-capacitor energy systems in electric vehicles," tech. rep., Department of Electrical and Systems Engineering, University of Pennsylvania, 2014.
- [31] M. Behl, **T. X. Nghiem**, and R. Mangharam, "Uncertainty propagation from sensing to modeling and control in buildings," tech. rep., University of Pennsylvania, 2013.
- [32] **T. X. Nghiem**, *Green Scheduling of Control Systems*. PhD thesis, University of Pennsylvania, 2012.
- [33] **T. X. Nghiem** and S. M. Hoang, "Real-time and interactive simulation of industrial processes for education and research," in *The 6th Vietnam Conference on Automation (VICA VI)*, 2005. In Vietnamese.
- [34] S. M. Hoang and **T. X. Nghiem**, "PLCs and the IEC 61131-3 standard (part 2)," *Automation Today (Vietnamese)*, vol. 7, 7 2004. In Vietnamese.
- [35] S. M. Hoang and **T. X. Nghiem**, "PLCs and the IEC 61131-3 standard (part 1)," *Automation Today (Vietnamese)*, vol. 5, 5 2004. In Vietnamese.

Software Artifacts

- **OpenBuildNet (Lead Developer)** (<https://sites.google.com/site/buildnetproject/software>)
A co-simulation platform that provides a framework for large-scale distributed control and simulation of complex multi-agent systems. The platform is capable of coupling and synchronising different external computation agents, which can include simulation and control software processes running on separate processors. The target applications are large-scale complex cyber physical energy systems.
- **MLE+ (Lead Developer)** (<http://txn.name/mleplus.html>)
A Matlab/Simulink toolbox for building energy simulation, analysis, optimization and control. It won the **Best Demo Award** at the 4th ACM Workshop On Embedded Sensing Systems For Energy-Efficiency In Buildings (BuildSys) in 2012. *It has been popularly used in both academic and industrial research projects.*
- **MLS2Sim (Lead Developer)** (<https://github.com/mlab/mls2sim>)
A Matlab toolbox for interfacing with S²Sim and OpenDSS for large-scale, distributed co-simulation of loads on the grid and the smart grid. The toolbox was used by the TerraSwarm research center to develop a large-scale, inter-institution simulation framework of smart grid control.
- **Automatic extraction of linear hybrid models from Simulink/Stateflow models**
Lead developer. This was an internal Matlab tool of NEC Laboratories America for automatic instrumentation & extraction of linear hybrid models from Simulink/Stateflow models.

Services

JOURNAL REVIEWER

- INFORMS Journal on Computing.
- IEEE Transactions on Automatic Control.
- IEEE Control Systems Magazine.
- IEEE Transactions on Industrial Informatics.
- IEEE Transactions on Control Systems Technology.
- Systems & Control Letters.

CONFERENCE REVIEWER

- IEEE Conference on Decision and Control (CDC).
- European Conference on Wireless Sensor Networks (EWSN).
- International Conference on Information Processing in Sensor Networks (IPSN).
- ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS).
- American Control Conference (ACC).
- IEEE Multi-conference on Systems and Control (MSC).
- ACM International Conference on High Confidence Networked Systems (HiCoNS).
- International Conference on Computer Aided Verification (CAV).
- IEEE Real-Time Systems Symposium (RTSS).
- Design, Automation & Test in Europe (DATE).
- ACM Workshop On Embedded Systems For Energy-Efficiency In Buildings (BuildSys).
- International Conference on Embedded Software (EMSOFT).
- IFAC Conference on Analysis and Design of Hybrid Systems (ADHS).
- Mediterranean Conference on Control and Automation (MED).
- IFAC World Congress.
- International Conf. on Tools and Algorithms for the Construction and Analysis of Systems (TACAS).
- IEEE International Conference on Automation Science and Engineering (CASE).
- International Symposium on Automated Technology for Verification and Analysis (ATVA).
- International Conference on Distributed Computing Systems Workshops (ICDCS).

RESEARCH FUNDING PROPOSAL REVIEWER

- The Research Council of Norway (RCN) grant program: 2015.
- The 2013 Kentucky Science and Engineering Foundation (KSEF) R&D Excellence Award.

PANELIST AND SESSION CHAIR

- ACM & IEEE International Conference on Embedded Software (EMSOFT), *Amsterdam, The Netherlands*, 2015. Session Chair "Verification and Analysis of Hybrid Systems"

ADMINISTRATIVE SERVICES

- Organized the *2016 Research Day* of the Automatic Control Laboratory at EPFL: a two-day research workshop for lab members in Leysin, Switzerland (September 2016).
- Organized the seminar series of the Automatic Control Laboratory at EPFL in Fall 2016 and Spring 2017: 7–8 speakers in each semester.

SOCIAL SERVICES

- VEFFA Vietnam Book Drive Project (2008–2009): Served on the core committee in strategy and logistics of the Vietnam Book Drive project of the Vietnam Education Foundation Fellows and Alumni Association (VEFFA). Campaigned for donations of English textbooks in STEM from the United States to universities in Vietnam, to improve Vietnamese students' access to up-to-date knowledge and the quality of college education in Vietnam.

Professional Memberships

- IEEE Member since 2013; IEEE Graduate Student Member from 2007 to 2012.
- IEEE Control Systems Society Member since 2009.
- ASHRAE Student Member: 2010–2011.

References

1. Colin N. Jones

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2. Rahul Mangharam

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