Mingxi Liu

mingxi.liu@utah.edu
+1 (510) 944-2704, 50 S. Central Campus Dr., Salt Lake City, UT, 84112
www.mingxiliu.com

Appointments

Assistant Professor in Electrical & Computer Engineering — *Sept. 2018 - Present*
University of Utah — *Salt Lake City, UT, USA*

NSERC Postdoc Fellow in Energy & Resources Group — *Sept. 2016 - Sept. 2018*
University of California, Berkeley — *Berkeley, CA, USA*

Education

Ph.D. in Mechanical Engineering — *Apr. 2016*
University of Victoria — *Victoria, BC, Canada*

– Dissertation: "Modeling and Control of Controllable Electric Loads in Smart Grid"

M.A.Sc. in Mechanical Engineering — *Jun. 2012*
University of Victoria — *Victoria, BC, Canada*

– Thesis: "Energy efficient operation strategy design for the combined cooling, heating, and power system"

Exchange in Power Mechanical Engineering — *Sept. 2008 - Jan. 2009*
National Tsing Hua University — *Hsinchu, Taiwan*

– Project: "Fast algorithm for differential image rebuilding"

B.Eng. in Control Science & Engineering — *Jun. 2010*
Harbin Institute of Technology — *Harbin, China*

– Thesis: "ZigBee wireless location technology-based 3D real-time simulation"

Research Interests

- Power and Energy Systems
  - ▷ Dynamic modeling, system identification, time-series analysis, forecasting, and control of renewable distributed energy resources for grid integration
  - ▷ Harmonious vehicle-grid integration for the provision of distribution- and transmission-level services and benefits
  - ▷ Cyber-physical security in smart grid and decentralized power system
  - ▷ Intelligent integrated energy management system design and control for smart buildings and microgrids
  - ▷ High-performance and robust energy storage system development
  - ▷ Pathway to a reliable integrated-decentralized power system
- Optimization and Control
  - ▷ Efficient decentralized and distributed optimization for problems with massive data sets

- ▷ Control theory including optimal control, robust control, and model predictive control (MPC) in both stochastic and deterministic fashions
- ▷ Filtering and control for networked control systems

- Cyber-Physical Systems (CPSs)
  - ▷ Deployment of Internet of Things (IoT) technologies in the context of smart city
  - ▷ Impact-aware proactive cyber defense system
  - ▷ Security-aware resilient controller
  - ▷ Modularization of CPSs in complex environment

Research Experience

- **University of California, Berkeley** Berkeley, CA, USA
  NSERC Postdoc Fellow, Energy & Resources Group *Sept. 2016 – present*
  - ▷ Smart charging control for a large population of electric vehicles (EVs) providing demand response and facilitating renewable energy integration (**PI**: Key State Laboratory of Alternate Electrical Power System with Renewable Energy Sources Open Project LAPS17006)
    - – Development of a decentralized optimal EV charging control framework considering uncertainties from both human and nonhuman factors
    - – Decentralized EV charging control framework for the purpose of mitigating the intermittency of renewable energy generation (in progress)
    - – Energy neutral building (ENB) realization by coordinated charging of EVs (in progress)
  - ▷ An open source architecture software platform for plug-in EV smart charging in California residential and small commercial settings (**Leader of Control Group**: California Energy Commission Award EPC 15-013)
    - – Initiative development of a novel and generic shrunken-primal-dual subgradient (SPDS) algorithm for optimization problems with non-separable objective functions, and globally and locally coupled constraints
    - – Establishment of a decentralized EV charging control framework under distribution network constraints including nodal voltage magnitudes and transformer overloading; Framework tested on IEEE 13 bus test feeder and PG&E D0001 feeder
    - – Development of a decentralized EV charging control framework that can accommodate EV drivers' local objectives and constraints
    - – Distributed and hierarchical coordination to mitigate feeder impacts (in progress)
  - ▷ Achieving clean power system flexibility: Sensing, modeling, and optimal control (NSF CyberSEES)
    - – Development and implementation of a reinforcement learning controller under the supervision of MPC for residential flexible electric loads facilitating renewable energy generation (collaborating with REstore and Itho Daalderop, Belgium)
    - – Scalable data-driven models and control of electric loads (in progress)
    - – Mitigation of under-over voltages which is an indirect mean to balance demand supply locally (in progress)

- **University of Victoria** Victoria, BC, Canada
  Research Assistant, Applied Control & Information Processing Laboratory and Institute for Integrated Energy Systems *Sept. 2010 – Apr. 2016*

- ▷ Aggregation and charging control of EVs
  - Development of a novel aggregation and control framework that well positions EVs in cyber-physical systems
  - Establishment of a charging-index based control paradigm for the provision of valley-filling
- ▷ Modeling and control of thermostatically controlled loads (TCLs) for demand response
  - Development of direct and stochastic aggregation models for a large population of TCLs
  - Development of centralized and cooperative distributed MPC (C-DMPC) for regulation services under device lockout effects
  - Development of practical control dispatching approaches for proposed control schemes
- ▷ Operation strategy design for combined cooling, heating, and power (CCHP) systems
  - Development of a balance-space-based operation strategy for CCHP systems
  - Development of an energy-hub model for CCHP systems and design of optimal operation strategies
  - Design and implementation of an OLS-TSRLS algorithm that accurately identifies the ARMAX short-term load forecasting model
- ▷ Networked control systems (NCSs)
  - Design of T-S fuzzy $\mathcal{H}_2$ and $\mathcal{H}_\infty$ filters for nonlinear sampled-data system considering both input and output time delays
  - Design of $\mathcal{H}_\infty$switched filtering for NCSs
  - Development of $\mathcal{H}_\infty$ tracking controller for nonlinear NCSs

Honors/Awards

- IEEE Transactions on Smart Grid Best Reviewer of 2018 2018
- Nominee of Governor General's Gold Medal 2017
- Natural Sciences and Engineering Research Council of Canada (NSERC) Postdoctoral Fellowship (PDF) ($90,000) 2016-2018
- NSERC Postgraduate Scholarship–Doctoral (PGS–D) ($42,000) 2014-2016
- Howard E. Petch Research Scholarship ($15,000) 2014-2016
- Nominee of David H. Turpin Research Scholarship 2015
- Nominee of David F. Strong Research Scholarship 2015
- IEEE Control Systems Society Student Travel Support ($1,000) 2015
- University of Victoria Travel Grant ($600) 2015
- 3MT® Finalist and 1st place in Engineering Heat ($300) 2015
- President's Research Scholarship ($4,000) 2014
- University of Victoria Travel Grant ($600) 2014
- Albert Hung Chao Hong Scholarship ($3,500) 2013
- Melva J. Hanson Graduate Scholarship ($6,700) 2013
- Nominee of Lieutenant Governor's Silver Medal for Outstanding M.A.Sc. Thesis 2013

- Charles S. Humphrey Graduate Student Award ($2,250) 2012
- University of Victoria Graduate Award (First Class $5,000) 2012
- University of Victoria Travel Grant ($500) 2012
- University of Victoria Graduate Award (First Class $5,000) 2010
- China National Petroleum Corporation (CNPC) Scholarship for Excellent Student ($600) 2008
- Merit Student Scholarship 2007
- First place in Harbin Institute of Technology Scholarship (4 times) 2006-2010
- Harbin Institute of Technology Special Scholarship (5 times) 2006-2010

Teaching Experiences

- **University of Utah** Salt Lake City, UT, USA

  Instructor, Electrical & Computer Engineering *2019 Spring*

  ▷ ECE 6960: Introduction to Model Predictive Control

- **University of California, Berkeley** Berkeley, CA, USA

  Lecturer, Energy & Resources Group *2016 Fall*

  ▷ ER 292A: Tools of the Trade · Evaluation: 6.75/7

- **University of Victoria** Victoria, BC, Canada

  Lecturer, Department of Mechanical Engineering *2013 Fall & Oct. 2011*

  ▷ MECH 380: Automatic Control Engineering · Evaluation: 4.54/5

  Teaching Assistant and Lab Instructor, Department of Mechanical Engineering *2012 Fall & 2011 Fall*

  ▷ MECH 380: Automatic Control Engineering

  Teaching Assistant and Lab Instructor, Department of Mechanical Engineering *2014 Spring & 2013 Spring*

  ▷ MECH 458: Mechatronics

Mentorship

- **University of California, Berkeley** Berkeley, CA, USA

  Phillippe K. Phanivong, *M.A.*, Energy & Resources Group *2016 Fall – present*

Publications

- **Books**

  [B1] Y. Shi, **M. Liu**, and F. Fang, *Combined Cooling, Heating, and Power Systems: Modeling, Optimization, and Operation*, John Wiley & Sons, Aug. 2017, ISBN: 978-1-119-28335-5.

- **Refereed journal papers that have been published/accepted for publication**

[J1] **M. Liu**, B. Claessens, and D. S. Callaway, "Trajectory tracking with an aggregation of domestic hot water heaters: Combining model-based and model-free control in a commercial deployment," *IEEE Transactions on Smart Grid*, accepted, 2018.

[J2] **M. Liu**, P. K. Phanivong, Y. Shi, and D. S. Callaway, "Decentralized charging control of electric vehicles in residential distribution networks," *IEEE Transactions on Control Systems Technology*, doi: 10.1109/TCST.2017.2771307, 2017.

[J3] X. Liu, **M. Liu**, and Y. Shi, "Event triggered model predictive control: A less conservative result," *Journal of the Franklin Institute*, in press, doi: 10.1016/j.jfranklin.2016.10.040, 2016

[J4] **M. Liu**, Y. Shi, and H. Gao, "Aggregation and charging control of PHEVs in smart grid: A cyber-physical perspective," *Proceedings of the IEEE*, vol. 104, no. 5, pp. 1071-1085, 2016.

[J5] **M. Liu** and Y. Shi, "Model predictive control for thermostatically controlled appliances providing balancing service," *IEEE Transactions on Control Systems Technology*, vol. 24, no. 6, pp. 2082-2093, 2016.

[J6] **M. Liu**, Y. Shi, and X. Liu, "Distributed MPC of aggregated heterogeneous thermostatically controlled loads in smart grid," *IEEE Transactions on Industrial Electronics*, vol. 63, no. 2, pp. 1120-1129, 2016.

[J7] **M. Liu** and Y. Shi, "Model predictive control of aggregated heterogeneous second-order thermostatically controlled loads for ancillary services," *IEEE Transactions on Power Systems*, vol. 31, no. 3, pp. 1963-1971, 2016.

[J8] **M. Liu**, Y. Shi and F. Fang, "Load forecasting and operation strategy design for CCHP systems using forecasted loads," *IEEE Transactions on Control Systems Technology*, vol. 23, no. 5, pp. 1672-1684, 2015.

[J9] **M. Liu**, Y. Shi and F. Fang, "Combined cooling, heating and power systems: A survey," *Renewable & Sustainable Energy Reviews*, vol. 35, pp. 1-22, 2014.

[J10] **M. Liu**, Y. Shi and X. Liu, "T-S fuzzy-model-based $\mathcal{H}_2$ and $\mathcal{H}_\infty$ filtering for networked control systems with two-channel Markovian random delays," *Digital Signal Processing*, vol. 27, pp. 167-174, 2014.

[J11] H. Zhang, **M. Liu**, J. Sheng, and Y. Shi, "Extended LMI representatives for stability and stabilization of discrete-time Takagi-Sugeno fuzzy systems," *Optimal Control Applications and Methods*, vol. 35, no. 6, pp. 647-655, 2014.

[J12] **M. Liu**, Y. Shi and F. Fang, "Optimal power flow and PGU capacity of CCHP systems using a matrix approach," *Applied Energy*, vol. 102, pp. 794-802, 2013.

[J13] H. Zhang, Y. Shi and **M. Liu**, "$\mathcal{H}_\infty$ step tracking control for networked discrete-time nonlinear systems with integral and predictive actions," *IEEE Transactions on Industrial Informatics*, vol. 9, no. 1, pp. 337-345, 2013.

[J14] H. Zhang, Y. Shi and **M. Liu**, "$\mathcal{H}_\infty$ switched filtering for networked systems based on delay occurrence probabilities," *ASME Journal of Dynamic Systems, Measurement, and Control*, vol. 135, no. 6, pp. 061002, 2013.

[J15] **M. Liu**, Y. Shi, F. Fang, "A new operation strategy for CCHP systems with hybrid chillers," *Applied Energy*, vol. 95, pp. 164-173, 2012.

- **Refereed conference papers that are under review**

[C1] **M. Liu**, "Chance-constrained shrunken-primal-dual subgradient (CC-SPDS) approach for decentralized electric vehicle charging control," submitted to *IEEE PES Innovative Smart Grid Technology Asia*, 2019.

- **Refereed conference papers that have been accepted or published**

[C2] **M. Liu**, P. K. Phanivong, and D. S. Callaway, "Customer- and network-aware decentralized EV charging control," in *Proceedings of Power Systems Computation Conference*, Dublin, Ireland, June 11–15, 2018.

[C3] **M. Liu**, P. K. Phanivong, and D. S. Callaway, "Electric vehicle charging control in residential distribution network: A decentralized event-driven realization," in *Proceedings of IEEE Conference on Decision & Control*, Melbourne, Australia, December 12–15, 2017.

[C4] **M. Liu** and Y. Shi, "Optimal control of aggregated heterogeneous thermostatically controlled loads for regulation services," in *Proceedings of IEEE Conference on Decision & Control*, Osaka, Japan, December 15–18, 2015.

[C5] **M. Liu** and Y. Shi, "Distributed model predictive control of thermostatically controlled appliances for providing load balancing service," in *Proceedings of IEEE Conference on Decision & Control*, Los Angeles, California, USA, December 15–17, 2014.

[C6] **M. Liu** and Y. Shi, "An energy efficient optimal operation strategy design for CCHP systems," in *Proceedings of CSME International Congress*, Winnipeg, Manitoba, Canada, June 4–6, 2012.

Presentations

- **Talks**
  - ▷ "Decentralized and Distributed Control and Optimization in Large-Scale Power Systems," invited by *Department of Automation, Shanghai Jiaotong University*, Shanghai, China, 2018.
  - ▷ "Decentralized and Distributed Control and Optimization in Large-Scale Power Systems," invited by *China State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources*, Beijing, China, 2018.
  - ▷ "Decentralized and Distributed Control and Optimization in Large-Scale Power Systems," invited by *Transportation Science and Engineering Department, Beihang University*, Beijing, China, 2018.
  - ▷ "Customer- and network-aware decentralized EV charging control," in *Power System Computation Conference*, Dublin, Ireland, 2018.
  - ▷ "Electric vehicle charging control in residential distribution network: A decentralized event-driven realization," in *IEEE Conference on Decision & Control*, Melbourne, Australia, 2017.
  - ▷ "Decentralized charging control of electric vehicles in residential distribution networks," invited by *Department of Mechanical Engineering*, University of Victoria, Victoria, BC, Canada, 2017.
  - ▷ "Decentralized charging control of electric vehicles in residential distribution networks," invited by *Berkeley Energy & Climate Institute*, University of California, Berkeley, Berkeley, CA, USA, 2017.
  - ▷ "Optimal control of aggregated heterogeneous thermostatically controlled loads for regulation services," in *IEEE Conference on Decision & Control*, Osaka, Japan, 2015.
  - ▷ "Make smart grid smarter," in *UVic Graduate Student Orientation*, University of Victoria, Victoria, BC, Canada, 2015.

- ▷ "Make smart grid smarter," in *3MT® Competition*, University of Victoria, Victoria, BC, Canada, 2015.
- ▷ "Distributed model predictive control of thermostatically controlled appliances for providing load balancing service," in *IEEE Conference on Decision & Control*, Los Angeles, CA, USA, 2014.
- ▷ "An energy efficient optimal operation strategy design for CCHP systems," in *CSME International Congress*, Winnipeg, MB, Canada, 2012.

- **Poster**
  - ▷ "Modelling and control in demand response," in *IESVic Alumni Workshop*, Victoria, BC, Canada, 2015.
  - ▷ "A new optimal operation strategy for CCHP systems," in *Canada–China Clean Energy Conference: Sustainable Transportation*, Victoria, BC, Canada, 2013.

Professional Activities

- **Conference Chair for**

  2017 IEEE Conference on Decision and Control – Smart Grid I

- **Associate Editor for**

  Conferences:

  2019 IEEE International Symposium on Industrial Electronics
  2017 IEEE International Conference on Control & Automation
  2017 IEEE Conference on Control Technology & Applications
  2017 International Conference on Intelligent Systems and Control

- **Reviewer for**

  Journals:

  IEEE Transactions on Industrial Electronics
  IEEE Transactions on Control Systems Technology
  IEEE Transactions on Power Systems
  IEEE Transactions on Mechatronics
  IEEE Transactions on Smart Grid
  IEEE Transactions on Cybernetics
  IEEE Transactions on Fuzzy Systems
  Proceedings of the IEEE
  IEEE Access
  IEEE Power Engineering Letters
  ASME Journal of Dynamic Systems, Measurement and Control
  Journal of Mechanical Science and Technology
  Circuits, Systems & Signal Processing
  Journal of the Franklin Institute
  Energies
  Information Sciences
  Journal of Control Science and Engineering
  Journal of Modern Power System and Clear Energy
  Journal of Electrical Power & Energy Systems

Journal of Environmental Informatics

KSII Transactions on Internet and Information Systems

Conferences:

IEEE Conference on Decision and Control (CDC)

American Control Conference (ACC)

IEEE International Conference on Advanced Intelligent Mechatronics

European Control Conference

ASME Dynamic Systems and Control Conference

- **Committee Member of**

  Technical Committee on Industrial Cyber-Physical Systems: Industrial Engineering Society, IEEE, 2016-present.

  Department Chair Search Committee: Department of Mechanical Engineering, University of Victoria, 2016.

  Wighton Engineering Product Development Fund: Faculty of Engineering, University of Victoria, 2014.

- **Member of**

  Institute of Electrical and Electronics Engineers (IEEE): *Member* of CSS, PES, and IES (since 2010)