Hantao Cui, Ph.D.

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RESEARCH INTERESTS

- **Cyber-physical power system modeling, co-simulation, security and resilience analysis.**
- **Large-scale cyber-physical power grid monitoring and wide-area closed-loop control.**
- **Deep learning methods and applications in nonlinear dynamic system operation and control.**
- **Microgrid and smart distribution system control with distributed energy resources.**
- **Operation and optimization for electricity markets and smart grid under uncertainty.**

RESEARCH POSITIONS

- **Research Assistant Professor** **April 2019 - Present**
  Research Associate **January 2017- April 2019**
  University of Tennessee, Knoxville *Knoxville, TN*
  Technical lead of the CURENT Large-Scale Testbed (LTB) project

EDUCATION

- **The University of Tennessee, Knoxville** **Knoxville, TN**
  PhD, Department of Engineering and Computer Science, GPA 3.9 *August 2013 - December 2018*
  Dissertation: *Large-Scale Simulations of Modern Electric Power Systems* Advisor: Dr. Fangxing (Fran) Li
- **Southeast University** **Jiangsu, China**
  M.S. in Electrical Engineering, School of Electrical Engineering, GPA 3.7 *September 2011 - June 2013*
  B.S. in Electrical Engineering, Chien-Shiung Wu Honor College, GPA 3.7 *September 2007 - June 2011*

Funded Proposal(s)

- **Model Free Adaptive Control (MFAC) for Autonomous and Resilient Operation of Military Microgrids**,
  - Funded by the *Environmental Security Technology Certification Program (ESTCP), Department of Defense*
  - Performance period: 2020-2023
  - $700 K in total, **40% share as a co-PI**

RESEARCH PROJECTS

- **Technical Lead of Large-Scale Testbed (LTB)** **08/2014 - Present, UT Knoxville**
  Project Goal: Design and implement an integrated cyber-physical testing platform for large-scale power systems with energy management, measurement-based control, communication emulation, and visualization.
  - Develop North American test systems models with high renewable generation.
  - Develop VSC-based multi-terminal HVDC for power flow and transient stability studies.
  - Emulate North American communication networks considering topology, delay and bandwidth.
  - Develop IEEE C37-118 PMU Simulator; implement measurement-based controls in PDCs.
  - Integrate heterogeneous cyber-physical research modules using data streaming.
  - CPS simulation tools developed: ANDES; OpalAPIControl; DiME; LTBNet; LTBVis
- **Lead Developer of ANDES, A Python-based Power System Simulation Package**
  - ANDES is a Python-based power system simulation engine for large-scale systems with renewable, FACTS, and power electronic-interfaced devices.

  - Features high-performance computing, fast model prototyping, and data streaming.
  - Set up the framework for an extensible, object-oriented power system dynamic simulation package, including data parsing, routines, devices, core algorithms, and outputs.
  - Open source and available on GitHub: `https://www.github.com/curent/andes` (30 Stars, 11 Forks)

- **Lead Developer of OpalApiControl, APIs for OPAL-RT RT-LAB Real-Time Simulation**
  - OpalApiControl provides convenient APIs for RT-LAB-based real-time simulation and data streaming.
  - An inter-operable simulation tool with ANDES in the LTB environment.
  - Originated from the work with a *summer research undergraduate student*.
  - Open source and available on GitHub: `https://www.github.com/curent/opalapicontrol`

- **Lead Developer of LTBNet, A Process-Based Network Emulation for PMU-Based Streaming and Control**
  - LTBNet is a tool for emulating arbitrary network topology for PMU data streaming.
  - Provide interfaces to *Mininet* and *OpenFlow* controllers for cybersecurity studies.
  - Capable of interfacing PMU and PDC simulators with ANDES and OpalApiControl.
  - Open source and available on GitHub: `https://www.github.com/curent/ltbnet`

SELECT PUBLICATIONS [Citations: 603, h-index: 13, i_{10} -index: 14]

- **Journal Publications**

[J1] **Hantao Cui**, Fangxing Li, and Kevin Tomsovic. Hybrid symbolic-numeric library for power system modeling and analysis. *Submitted to IEEE Transactions on Power Systems, arXiv preprint arXiv:2002.09455*, 2020.

[J2] **Hantao Cui**, Fangxing Li, and Kevin Tomsovic. A cyber-physical system testbed for power system monitoring and wide-area control verification. *IET Energy Systems Integration, **accepted**, doi: 10.1049/iet-esi.2019.0084*, 2019.

[J3] Fangxing Li, Kevin Tomsovic, and **Hantao Cui**. A large-scale test bed as a virtual power grid for closed-loop controls. *IEEE Power and Energy Magazine, March-April Issue, 2020*.

[J4] **Hantao Cui**, Fangxing Li, Xin Fang, Hao Chen, and Honggang Wang. Bilevel arbitrage potential evaluation for grid-scale energy storage considering wind power and lmp smoothing effect. *IEEE Transactions on Sustainable Energy*, 9(2):707–718, 2018.

[J5] **Hantao Cui**, Fangxing Li, Qinran Hu, Linquan Bai, and Xin Fang. Day-ahead coordinated operation of utility-scale electricity and natural gas networks considering demand response based virtual power plants. *Applied Energy*, 176(15):183–195, 2016.

[J6] Linquan Bai, Fangxing Li, **Hantao Cui**, and et. al. Interval optimization based operating strategy for gas-electricity integrated energy systems considering demand response and wind uncertainty. *Applied energy*, 167:270–279, 2016.

[J7] Qingxin Shi, Fangxing Li, and **Hantao Cui**. Analytical method to aggregate multi-machine sfr model with applications in power system dynamic studies. *IEEE Transactions on Power Systems*, 2018.

[J8] Xue Li, **Hantao Cui**, Tao Jiang, and et. al. Multichannel continuous wavelet transform approach to estimate electromechanical oscillation modes, mode shapes and coherent groups from synchrophasors in bulk power grids. *International Journal of Electrical Power & Energy Systems*, 96:222–237, 2018.

[J9] Haiteng Han, **Hantao Cui**, Shan Gao, and et. al. A remedial strategic scheduling model for load serving entities considering the interaction between grid-level energy storage and virtual power plants. *Energies*, 11(9):2420, 2018.

[J10] Xue Li, Fangxing Li, Haoyu Yuan, **Hantao Cui**, and Qinran Hu. Gpu-based fast decoupled power flow with preconditioned iterative solver and inexact newton method. *IEEE Transactions on Power Systems*, 32(4):2695–2703, 2017.

[J11] Qingxin Shi, **Hantao Cui**, Fangxing Li, Yilu Liu, Wenyun Ju, and Yonghui Sun. A hybrid dynamic demand control strategy for power system frequency regulation. *CSEE Journal of Power and Energy Systems*, 3(2):176–185, 2017.

[J12] Yu Liu, Shan Gao, **Hantao Cui**, and Le Yu. Probabilistic load flow considering correlations of input variables following arbitrary distributions. *Electric Power Systems Research*, 140:354–362, 2016.

[J13] Xin Fang, Fangxing Li, Yanli Wei, and **Hantao Cui**. Strategic scheduling of energy storage for load serving entities in locational marginal pricing market. *IET Generation, Transmission & Distribution*, 10(5):1258–1267, 2016.

- **Conference Papers**

[C1] **Hantao Cui** and Fangxing Li. Andes: A python-based cyber-physical power system simulation tool. In *2018 North American Power Symposium (NAPS)*, pages 1–6. IEEE, 2018.

[C2] **Hantao Cui**, Fangxing Li, and Haoyu Yuan. Control and limit enforcements for vsc multi-terminal hvdc in newton power flow. In *Power & Energy Society General Meeting, 2017 IEEE*, pages 1–5. IEEE, 2017.

[C3] **Hantao Cui**, Fangxing Li, Xin Fang, and Runsha Long. Distribution network reconfiguration with aggregated electric vehicle charging strategy. In *Power & Energy Society General Meeting, 2015 IEEE*, pages 1–5. IEEE, 2015.

[C4] Fangxing Li, Kevin Tomsovic, and **Hantao Cui**. An integrated testbed for power system monitoring, modeling, control and actuation. 2018.

[C5] Alec Yen, **Hantao Cui**, and Kevin Tomsovic. Cxsparse-based differential algebraic equation framework for power system simulation. In *2018 North American Power Symposium (NAPS)*, pages 1–6. IEEE, 2018.

[C6] Xin Fang, Fangxing Li, **Hantao Cui**, Linquan Bai, Haoyu Yuan, Qinran Hu, and Beibei Wang. Risk constrained scheduling of energy storage for load serving entities considering load and lmp uncertainties. *IFAC-PapersOnLine*, 49(27):318–323, 2016.

[C7] Riyasat Azim, **Hantao Cui**, and Fangxing Li. Power management strategy combining energy storage and demand response for microgrid emergency autonomous operation. In *Power and Energy Engineering Conference (APPEEC), 2016 IEEE PES Asia-Pacific*, pages 2620–2625. IEEE, 2016.

- **Patents**

[P1] Fangxing Li, **Hantao Cui**, and Kevin Louis Tomsovic. A controller for real-time distributed cyber-physical power system simulation using rapid distributed data streaming and communication network emulation, 2019. Application pending.

[P2] Fangxing Li, **Hantao Cui**, MohammadReza AhmadzadehRaji, Kevin Louis Tomsovic, Yilu Liu, and Jian Huang. Real-time simulator and controller of power system using distributed data streaming server, September 13 2018. US Patent App. 15/457,428.

INVITED PRESENTATIONS AND SEMINARS

- *HVDC Overlays in Testbeds*, Panel Session Presentation at 2019 PES GM, Atlanta 08/2019
- Transactions Paper Presentation at the 2019 IEEE PES General Meeting, Atlanta 08/2019
- Conference Paper Presentation at 2018 NAPS, Fargo, ND 09/2018
- *LTB for Closed-Loop Cyber-Physical Simulation*, FUTA-USAID Workshop, Nigeria 08/2018
- Transactions Paper Presentation at the 2017 IEEE PES General Meeting, Chicago 07/2017
- Conference Paper Presentation at the 2016 IFAC CTDSG, Prague 09/2016

PROFESSIONAL SERVICES

- Secretary, *Ultra-Wide-Area HVDC Overlay Studies* Task Force, IEEE PES 08/2018 - Present
- Associate Editor, *Journal of Modern Power Systems and Clean Energy* (MPCE) 01/2019 - Present
- Reviewer, *IEEE Transactions on Smart Grid (13 reviews)*
- Reviewer, *Applied Energy (6 reviews)*
- Reviewer, *IEEE Transactions on Power Systems (4 reviews)*
- Reviewer, *IEEE Transactions on Sustainable Energy (5 reviews)*
- Reviewer, *International Journal of Electric Power & Energy Systems (2 reviews)*

TEACHING EXPERIENCES

- **Co-Instructor** — **Department of EECS, UTK**
  - ECE 421: Electric Energy Systems — Fall 2019
  - ECE 496/691: Power and Energy Systems Seminar — Spring and Fall 2019
- **Graduate Teaching Assistant** — **Department of of EECS, UT Knoxville**
  - ECE 453/599: Computer Networking — Spring 2014
  - ECE 622: Power System Economics — Fall 2013

MENTORING EXPERIENCES

- Mentored a few junior Ph.D. students or junior visiting students: Qingxin Shi, Haiteng Han and Qiwei Zhang.
  - I mentored Qingxin Shi on the topic of frequency regulation using demand response and aggregated frequency models. I worked with him on the modeling and simulation in large-scale systems, the WECC system. We coauthored two journal papers [J7, J11] on the topic.
  - I mentored Haiteng Han, a visiting student. I worked with him on the day-ahead coordinated operation with renewable energy and energy storage and offered ideas on the algorithm for strategic scheduling. We coauthored one journal paper [J9].
- Mentored over 10 summer REU Students for CURENT since 2014.
  - With Runsha Long, a summer REU student in 2014. **Topic: Electric Vehicle Optimization**
    - I mentored Runsha on residential electric vehicle usage pattern analysis using data from *Bureau of Transportation Statistics*. We proposed a conic programming model for distribution system reconfiguration with optimal EV scheduling. Results were published in the 2015 IEEE PES General Meeting.
  - With Alec Yen, an REU student in Spring 2018. **Topic: Sparse Matrix Operation Acceleration**
    - I mentored Alec on improving the efficiency of sparse matrix incremental build algorithms, which is fundamental for power system simulation tools. Experiments are carried out in SuiteSparse CXSparse. Our improved in-place add and set algorithms can accelerate up to 3x depending on the shape of the matrix operands. Results were published in the 2018 NAPS.

AWARDS AND HONORS

- Highly Cited Paper Award 2019 of Applied Energy — 07/2019
- Outstanding Graduate Research Assistant, EECS Gonzalez Family Awards Banquet — 04/2018
- CURENT Best Tutorial Award, topic: "Version Control with git" — 08/2018
- Top Peer Reviewer Award (1%) in Engineering on Publons.com — 09/2018
- Author of Essential Science Indicators (ESI) Highed Cited Papers — 03/2018 and 07/2017
- Best Student Presentation, CURENT Annual Industry Conference and Site Visit — 11/2017
- UT Knoxville Chancellor's Citation on Extraordinary Professional Promise — 04/2017
- Best Conference Paper, 2016 IEEE PES General Meeting — 07/2016
- Graduate School Senate Travel Award — 10/2016
- ESPN Outstanding Graduate Student Scholarship — 2013 - 2016

VOLUNTEER EXPERIENCES

- Chair, Transactions Paper Forum on Microgrid, IEEE PES General Meeting — August 2019
- Chair, Student Career Development Forum, Power Industry Division, ISA — June 2018
- Mentor, CURENT Research Experienced Undergraduate (REU) program — 2014 - Present, Knoxville, TN
- CURENT Education Outreach - Sequoyah elementary school engineering night — 12/2016, Knoxville, TN
- Staff Volunteer, Boy Scouts fall special event at Camp Pellissippi — 10/2015, Andersonville, TN
- CURENT Education Outreach - Lake City elementary school engineering night — 09/2014, Lake City, TN