

# Hantao Cui, Ph.D.

Department of Electrical Engineering and Computer Science (EECS) • The University of Tennessee, Knoxville  
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## RESEARCH INTERESTS

- Open-source computing software, power system dynamics and high-performance computing.
  - Cyber-physical power grid and communication co-simulation, and hardware-in-the-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.
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## 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
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## EDUCATION

- **The University of Tennessee, Knoxville** Knoxville, TN, USA  
*PhD, Department of Engineering and Computer Science, GPA 3.9/4.0* August 2013 - December 2018  
*Dissertation: Large-Scale Simulations of Modern Electric Power Systems* Advisor: Dr. Fangxing Li
  - **Southeast University** Nanjing, Jiangsu, China  
*M.S. in Electrical Engineering, School of Electrical Engineering, GPA 3.7/4.0* September 2011 - June 2013  
*B.S. in Electrical Engineering, Chien-Shiung Wu Honor College, GPA 3.7/4.0* September 2007 - June 2011
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## Funded Projects

- **Co-PI, \$152K**, "Model Free Adaptive Control (MFAC) for Autonomous and Resilient Operation of Military Microgrids", *Department of Defense*, 05/2020-01/2023.
  - **Co-PI: \$18K**, "Rapidly Attainable Increases in Transmission Capacity Using Power-Electronics", *Department of Energy*, 09/2020-08/2021.
  - **Co-PI: \$20K**, "Intelligent Control of Refrigerating Load for Peak Reduction", *State of Tennessee Appropriations*, 09/2020-08/2021.
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## RESEARCH PROJECTS

- **Technical Lead and Architect of Large-Scale Testbed (LTB)** 08/2014 - Present, UT Knoxville  
Design and implement an integrated cyber-physical hardware-in-the-loop testing platform for large-scale power systems with energy management, communication emulation, control, and visualization [J3, J4, P1, P2].  
**CURENT LTB won the 2020 R&D 100 Award.**
  - 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 C37-118.2011 PMU Simulator; implement measurement-based controls in PDCs.
  - Integrate heterogeneous cyber-physical research modules using data streaming with OPAL-RT hardware.
  - Developed CPS simulation tools: [ANDES](#); [OpalAPIControl](#); [DiME](#); [LTBNet](#); [LTBVis](#)

- **Author of ANDES, Python Software for Symbolic Power System Modeling and Numerical Analysis**  
A unique hybrid symbolic-numeric framework for that enables descriptive DAE modeling and automatic numerical code generation for simulation [J2].
  - Features high-performance computing, rapid model prototyping, data streaming, strict verification with commercial simulation tools, and integration with various solvers [J1]
  - a rich library of transfer functions and discontinuous components (including limiters, deadbands, and saturation) available for prototyping models, which can be effortlessly instantiated as multiple devices for system analysis
  - the only open-source tool with the industry-grade full models for solar PV and wind generator models.
  - Open-source and available on GitHub: <https://www.github.com/cuihantao/andes> (51 Stars, 30 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.
  - Provides interfaces to *Mininet* and *OpenFlow* controllers for cybersecurity studies.
  - Interfaces to PMU and PDC simulators with ANDES and OpalApiControl.
  - Open-source and available on GitHub: <https://www.github.com/curent/lbnet>

## SELECT PUBLICATIONS [Citations: 880, $h$ -index: 15, $i_{10}$ -index: 16]

### • Journal Publications

- [J1] **Hantao Cui**, Fangxing Li, and Joe H Chow. Mass-matrix differential-algebraic equation formulation for transient stability simulation. *arXiv preprint arXiv:2008.03883*, under review by IEEE PES Letter.
- [J2] **Hantao Cui**, Fangxing Li, and Kevin Tomsovic. Hybrid symbolic-numeric framework for power system modeling and analysis. *IEEE Transactions on Power Systems*, in press, 2020.
- [J3] **Hantao Cui**, Fangxing Li, and Kevin Tomsovic. Cyber-physical system testbed for power system monitoring and wide-area control verification. *IET Energy Systems Integration*, 2(1):32–39, 2019.
- [J4] Fangxing Li, Kevin Tomsovic, and **Hantao Cui**. A large-scale testbed as a virtual power grid: For closed-loop controls in research and testing. *IEEE Power and Energy Magazine*, 18(2):60–68, 2020.
- [J5] **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.
- [J6] **Hantao Cui**, Fangxing Li, Qinran Hu, Linqun 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.
- [J7] Qiwei Zhang, Fangxing Li, **Hantao Cui**, and et. al. Market-level defense against fdia and a new Imp-disguising attack strategy in real-time market operations. *IEEE Transactions on Power Systems*, in press, 2020.
- [J8] Linqun 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.
- [J9] 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*, 33(6):6355–6367, 2018.
- [J10] 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.
- [J11] 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.

- [J12] 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.
- [J13] Qingxin Shi, **Hantao Cui**, Fangxing Li, and et. al. A hybrid dynamic demand control strategy for power system frequency regulation. *CSEE Journal of Power and Energy Systems*, 3(2):176–185, 2017.

#### • 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.

#### • 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.

## PROFESSIONAL SERVICES

- Secretary-elect, *Computating and Analytics Subcommittee (CAMS)*, IEEE PES Starts in 01/2021
- Webmaster, *Computating and Analytics Subcommittee (CAMS)*, IEEE PES 08/2018 - 12/2020 (exp.)
- 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 Trans. on Power Systems; IEEE Trans. on Smart Grid; and IEEE Trans. on Sust. Energy*
- Reviewer, *Applied Energy*
- Book Reviewer, *Elsevier*

## AWARDS AND HONORS

- **R&D 100 Award of 2020** won by the CURENT Large-Scale Testbed 09/2020
- **Outstanding Reviewer** for 2019 of *IEEE Transactions on Power Systems* 03/2020
- **Highly Cited Paper Award** 2019 of *Applied Energy* 07/2019
- Outstanding Graduate Research Assistant, EECS Gonzalez Family Awards Banquet 04/2018
- **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
- UT Knoxville **Chancellor’s Citation** on Extraordinary Professional Promise 04/2017
- **Best Conference Paper**, 2016 IEEE PES General Meeting 07/2016

## INVITED PRESENTATIONS AND SEMINARS

- *HVDC Overlays in Testbeds*, Panel Session Presentation at 2019 PES GM, Atlanta 08/2019
  - *Cyber-Physical Large-Scale Testbed*, NIST Workshop on Smart Grid Testbeds and Collaborations 04/2019
  - *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
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## TEACHING EXPERIENCES

- **Instructor and Co-Instructor** **Department of EECS, UTK**
    - Co-Instructor: ECE 421, Electric Energy Systems Fall 2019
    - Instructor: ECE 496/691, Power and Energy Systems Seminar Fall 2020, Spring and Fall 2019
  - **Graduate Teaching Assistant** **Department of EECS, UT Knoxville**
    - ECE 453/599: Computer Networking Spring 2014
    - ECE 622: Power System Economics Fall 2013
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## 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 [J9, J13] 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 [J11].
  - 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 CXSpars. 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.
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## 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 REU programs 2014 - Present, Knoxville, TN
  - CURENT Education Outreach - engineering night 12/2016, Knoxville, TN
  - Staff Volunteer, Boy Scouts fall special event at Camp Pellissippi 10/2015, Andersonville, TN
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## REFERENCES

**Prof. Fangxing (Fran) Li** (supervisor, Ph.D. advisor)  
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