Hantao Cui

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Electrical and Computer Engineering
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Research Interests	**Computational and analytical techniques for power systems – modeling, simulation, stability analysis, control, and software engineering**

- Modeling and analysis of sustainable grids with converter-interfaced renewables
- Open-source software, computer simulation, numerical methods, software architecture, and high-performance computing
- Microgrid and distribution system control with distributed energy resources
- Cyber-physical system, co-simulation, and hardware-in-the-loop control
- Machine learning and AI with applications to system modeling and control
- Energy technology entrepreneurship

Education

University of Tennessee, Knoxville, Tennessee, USA   2013 – 2018
Ph.D. in Electrical Engineering and Computer Science
Dissertation: Large-Scale Simulation of Modern Electric Power Systems
Advisor: Fangxing (Fran) Li

Southeast University, Nanjing, China   2011 – 2013
M.S. in Electrical Engineering

Southeast University, Nanjing, China   2007 – 2011
B.S. in Electrical Engineering with Chien-Shiung Wu Honor College

Research Appointments

Associate Professor   Aug. 2024 to date
Department of Electrical and Computer Engineering
North Carolina State University

Assistant Professor   Aug. 2021 to Aug. 2024
School of Electrical and Computer Engineering
Oklahoma State University

Research Assistant Professor   Apr. 2019 - Jul. 2021
Department of Electrical Engineering and Computer Science
University of Tennessee, Knoxville

Research Associate   Jan. 2017 - Apr. 2019
Center for Ultra-Wide-Area Resilient Electric Transmission Networks (CURENT)
University of Tennessee, Knoxville

Teaching Experience

Oklahoma State University – ECE
- ECEN 5113: Power System Analysis by Computer Methods   S'23, F'21
- ECEN 4153: Power System Analysis and Design   F'22, S'24
- ECEN 4283: Computer Networks   S'22, F'23

University of Tennessee, Knoxville – EECS
- ECE 421, Electric Energy Systems (co-instructor)   F'19
- ECE 496/691, Power and Energy Systems Seminar   F'19 – S'21

Research Grants and Projects	**Active Projects**

Research Grants and Projects

Active Projects

1. Cui, H. (co-PI), James D. McCalley (PI), "HVDC-Learn: Modular Education & Workforce Training in High Voltage Direct Current Electric Transmission". Sub-award from *Iowa State University*, $700,000, 1/2024–12/2026, (Cui's share: $48,875).

2. Cui, H. (PI), Zhang, Y. (Co-PI at UT Arlington), Li, F. (co-PI at UT Knoxville), "POSE: Phase I: Toward an Open-Source Ecosystem for Power Systems Research, Education, and Industry Applications". *National Science Foundation*, Directorate for Technology, Innovation, and Partnership, $300,000, 9/2024–8/2025. (Cui's share: $220,000).

3. Cui, H. (PI), "CAREER: Multi-Timescale Dynamics Modeling, Simulation, and Analysis of Converter-Dominated Power Systems". *National Science Foundation*, $500,000, 09/2024 – 08/2029.

4. Cui, H. (Lead PI), "Collaborative Research: CyberTraining: Pilot: PowerCyber: Computational Training for Power Engineering Researchers". *National Science Foundation*, $180,000, 01/2024–12/2025.

5. Cui, H. (PI), "High-Performance Transient Stability Simulation of Power Systems on Modern Parallel Computing Hardware". *National Science Foundation*, $320,000, 09/2022–08/2025.

Completed Projects ($18,000)

1. Cui, H. (co-PI), "Heterogeneous Communication-Delay-Resilient Secondary Frequency Regulation from Aggregated Electric Vehicles". Sub-award from *National Renewable Energy Laboratory for DOE*, $8,956, 06/2022–05/2024.

2. Cui, H. (co-PI), "Model-Free Adaptive Control for Autonomous and Resilient Operation of Military Microgrids". Sub-award from *University of Tennessee for DOD ESTCP*, $60,000, 04/2022–03/2024.

3. Cui, H. (co-PI), Sun, K. (PI), "Rapidly Attainable Increases in Transmission Capacity Using Power-Electronics". Sub-award from *University of Tennessee for DOE*, $18,000, 09/2020-08/2021.

Open-Source Software

ANDES – Python Software for Power System Modeling and Simulation

- ANDES provides a unique hybrid symbolic-numeric framework that enables descriptive DAE modeling, numerical code generation, and just-in-time compilation for simulation.

- Since 2015, ANDES has received over 4,000 code commits, 170 stars, and 80 forks on GitHub. ANDES is currently being used for multiple projects sponsored by NSF and DOE.

Awards and Honors

IEEE PES PSOPE Committee Prize Paper Award [J11]	02/2024
National Science Foundation CAREER Award	01/2024
Best Conference Paper [C2], *3rd Place*, 2023 North American Power Symposium (NAPS)	10/2023
Best Conference Paper, 2022 IEEE PES General Meeting	07/2022
Outstanding Reviewer for 2020 of *IEEE Trans. on Power Systems*	01/2021
R&D 100 Award of 2020 won by the CURENT Large-Scale Testbed	09/2020
Outstanding Reviewer for 2019 of *IEEE Trans. on Power Systems*	03/2020
Highly Cited Paper Award 2019 of *Applied Energy*	07/2019
Top Peer Reviewer Award (1%) in Engineering on Publons.com	09/2018
Author of Essential Science Indicators (ESI) Highly 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

Research Outcome

Citations: 2,364, *h*-index: 23, i_{10}-index: 38   [Google Scholar Link](#)

My research areas and contributions include:

1. Advanced Grid Modeling, Simulation, and Stability Analysis
- Proposed a symbolic-numeric framework for rapid prototyping of dynamic models [J15]; implemented in the open-source [ANDES](#) simulator.
- Proposed a communication-in-the-loop testbed architecture for wide-area control [J16, J17].
- Reviewed power electronics control and cybersecurity challenges in [J8]
- Studied disturbance propagation (electromechanical waves) in systems with grid-following and grid-forming converters [J9]

2. High-Performance Computing
- Effective parallelism for accelerating equation and Jacobian evaluation in power flow [J13]
- Revisit the computational performance of the Ybus method on modern computers with data parallelism [J2]
- Understanding the performance of preconditioned iterative methods for fast-decoupled power flow on GPUs [J24]

3. Emerging Learning Techniques for Control
- Development of open-source Andes-Gym environment to support reinforcement learning-based control in power systems [C3]; using machine learning to integrate dynamic response in a unit-commitment problem [J10]
- Transmission and distribution co-simulation and control [C1, J11]

Journal Publications

[J1] Buxin She, Jianzhe Liu, Feng Qiu, **Hantao Cui**, Nattapat Praisuwanna, Jingxin Wang, Leon M. Tolbert, and Fangxing Li. Systematic controller design for inverter-based microgrids with certified large-signal stability and domain of attraction. *IEEE Transactions on Smart Grid*, pages 1–1, 2023.

[J2] **Hantao Cui**. Bus admittance matrix revisited: Performance challenges on modern computers. *IEEE Open Access Journal of Power and Energy*, 11:83–93, 2024.

[J3] Oroghene Oboreh-Snapps, Buxin She, Shah Fahad, Haotian Chen, Jonathan Kimball, Fangxing Li, **Hantao Cui**, and Rui Bo. Virtual synchronous generator control using twin delayed deep deterministic policy gradient method. *IEEE Transactions on Energy Conversion*, pages 1–15, 2023.

[J4] Buxin She, Fangxing Li, **Hantao Cui**, Hang Shuai, Oroghene Oboreh-Snapps, Rui Bo, Nattapat Praisuwanna, Jingxin Wang, and Leon M. Tolbert. Inverter pq control with trajectory tracking capability for microgrids based on physics-informed reinforcement learning. *IEEE Transactions on Smart Grid*, pages 1–1, 2023.

[J5] Buxin She, Fangxing Li, **Hantao Cui**, Jinning Wang, Liang Min, Oroghene Oboreh-Snapps, and Rui Bo. Decentralized and coordinated v-f control for islanded microgrids considering der inadequacy and demand control. *IEEE Transactions on Energy Conversion*, 38(3):1868–1880, 2023.

[J6] Buxin She, Fangxing Li, **Hantao Cui**, Jingqiu Zhang, and Rui Bo. Fusion of microgrid control with model-free reinforcement learning: Review and vision. *IEEE Transactions on Smart Grid*, 14(4):3232–3245, 2023.

[J7] Jinning Wang, Fangxing Li, **Hantao Cui**, Qingxin Shi, and Trey Mingee. Electricity consumption variation versus economic structure during COVID-19 on metropolitan statistical areas in the US. *Nature Communications*, 13(1):7122.

[J8] **Hantao Cui**, Yichen Zhang, Kevin L. Tomsovic, and Fangxing (Fran) Li. Power electronics-interfaced cyber-physical power systems: A review on modeling, simulation, and cybersecurity. *WIREs Energy and Environment*, 11(6):e448, 2022.

[J9] **Hantao Cui**, Stavros Konstantinopoulos, Denis Osipov, Jinning Wang, Fangxing Li, Kevin L. Tomsovic, and Joe H. Chow. Disturbance propagation in power grids with high converter penetration. *Proceedings of the IEEE*, pages 1–18, 2022.

[J10] Yichen Zhang, **Hantao Cui**, Jianzhe Liu, Feng Qiu, Tianqi Hong, Rui Yao, and Fangxing Li. Encoding frequency constraints in preventive unit commitment using deep learning with region-of-interest active sampling. *IEEE Transactions on Power Systems*, 37(3):1942–1955, 2022.

[J11] Wenbo Wang, Xin Fang, **Hantao Cui**, Fangxing Li, Yijing Liu, and Thomas J. Overbye. Transmission-and-distribution dynamic co-simulation framework for distributed energy resource frequency response. *IEEE Transactions on Smart Grid*, 13(1):482–495, 2022.

[J12] Mingjian Cui, Fangxing Li, **Hantao Cui**, Siqi Bu, and Di Shi. Data-driven joint voltage stability assessment considering load uncertainty: A variational bayes inference integrated with multi-cnns. *IEEE Transactions on Power Systems*, 37(3):1904–1915, 2022.

[J13] **Hantao Cui**, Fangxing Li, and Xin Fang. Effective parallelism for equation and jacobian evaluation in large-scale power flow calculation. *IEEE Transactions on Power Systems*, 36(5):4872–4875, 2021.

[J14] **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*.

[J15] **Hantao Cui**, Fangxing Li, and Kevin Tomsovic. Hybrid symbolic-numeric framework for power system modeling and analysis. *IEEE Transactions on Power Systems*, 36(2):1373–1384, 2021.

[J16] **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.

[J17] 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.

[J18] **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.

[J19] **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.

[J20] Qiwei Zhang, Fangxing Li, **Hantao Cui**, and et. al. Market-level defense against fdia and a new lmp-disguising attack strategy in real-time market operations. *IEEE Transactions on Power Systems*, in press, 2020.

[J21] 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.

[J22] 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.

[J23] 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.

[J24] 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.

[J25] 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 (Student advisees are underscored)

[C1] Ahmad Ali, **Hantao Cui**, Wenbo Wang, and Xin Fang. Power sharing-based framework for allocating automatic generation control in distributed energy resources. In *2024 IEEE Power & Energy Society T&D Conference*, pages 1–5.

[C2] Nicholas Parsly, Jinning Wang, Nick West, Qiwei Zhang, **Hantao Cui**, and Fangxing Li. Dime and agvis: A distributed messaging environment and geographical visualizer for large-scale power system simulation. In *2023 North American Power Symposium (NAPS)*, pages 1–5, 2023.

[C3] **Hantao Cui** and Yichen Zhang. Andes_gym: A Versatile Environment for Deep Reinforcement Learning in Power Systems. In *2022 IEEE Power & Energy Society General Meeting*, pages 1–5 [Best Conference Paper].

[C4] **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.

[C5] **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.

[C6] **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.

[C7] Fangxing Li, Kevin Tomsovic, and **Hantao Cui**. An integrated testbed for power system monitoring, modeling, control and actuation. 2018.

[C8] 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.

Patent

[P1] 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, October 20 2020. US Patent. 10,809,753.

Mentees	**Graduate Students**

Graduate Students
- Ahmad Ali (Ph.D. program, enrolled in Spring 22)
- Zaid Mahmood (Ph.D. program, enrolled in Spring 22)
- Haya Monawwar (Ph.D. program, enrolled in Fall 23)

Undergraduate Researchers
- Karter Caves (Fall 23, Spring 24, Freshman Research Scholar)
- Evelyn Wilson (Spring 22, Fall 23)
- Paul Magna (Fall 21)

Presentations and Outreach

Invited Talks
- Webinar for the IEEE Young Professional Phoenix Chapter — 11/2024
- Webinar for Stony Brook University — 05/2024
- Seminar at NC State University — 03/2024
- Webinar for Clarkson University — 03/2024
- Seminar at SNYY Buffalo — 03/2024
- Seminar at Southern Methodist University — 03/2024
- Seminar at Rowan University — 02/2024
- Seminar at University of Georgia — 02/2023
- Webinar for University of Houston — 11/2022
  "Symbolics-Assisted Modeling for High-Performance Power System Simulation"
- Webinar for Washington State University — 10/2022
  "Composable, Expressive and Portable Modeling for High-Performance Power System Simulation"
- CURENT Presentation to Industry Members — 06/2022
  "Disturbance Propagation in Power Grids With High Converter Penetration"
- Webinar for the IEEE Tulsa Section — 03/2022
  "Large-Scale Power System Simulation Using Open-Source Software Through Code Generation"
- Pacific Northwest National Laboratory — 01/2022
  "ANDES for Hybrid Symbolic-Numeric Power System Simulation through Code Generation"
- Panel Session Presentation at 2021 PES GM, Online — 07/2021
  "Application of Electric Grid Simulators for Education"
- Panel Session Presentation at 2019 PES GM, Atlanta — 08/2019
  "HVDC Overlays in Testbeds"
- NIST Workshop on Smart Grid Testbeds and Collaborations — 04/2019
  Presentation: "Cyber-Physical Large-Scale Testbed"
- FUTA-USAID Workshop, Nigeria — 08/2018
  Presentation: "LTB for Closed-Loop Cyber-Physical Simulation"

Conference Presentations
- Presentation of Best Paper at the 2022 IEEE PESGM, Denver — 06/2022
  Cui, H., Zhang, Y., "Andes_gym: A Versatile Environment for Deep Reinforcement Learning in Power Systems"
- Transactions Paper Presentation at the 2019 IEEE PESGM, Atlanta — 08/2019
- Transactions Paper Presentation at the 2017 IEEE PESGM, Chicago — 07/2017

Outreach and Professional Development

• Faculty mentor for OSU CEAT Summer Bridge	07/2023
• Organizer, Student visit to Central Rural Electric Coop, Stillwater	11/2022
• Co-Chaired Panel Session at 2022 IEEE PESGM	08/2022

Title: "Combining physics-based and data-driven modeling and simulation for power systems"

• Faculty mentor for OSU CEAT Summer Bridge	07/2022
• Faculty mentor for OSU Discovery Day	04/2022
• Participant, CURENT Diversity & Inclusion Workshop	04/2018

Professional Services

Editorial Boards

- Associate Editor, *IET Energy Conversion and Economics*   05/2012 - Present
- Associate Editor, *Protection and Control of Modern Power Systems*   02/2012 - Present
- Associate Editor, *Journal of Modern Power Systems and Clean Energy*   01/2019 - Present
- Guest Editor, *Frontiers in Energy Research*   02/2022
  Special Issue: *"Advances in Distributed Energy Resources Aggregation for the Low Carbon Future"*
- Guest Editor, *IET Generation, Transmission and Distribution*   07/2021

Undergraduate Student Mentoring and Outreach

- Mentor, Research Experiences for Undergraduates Program   2014 - Present
- Faculty Mentor, OSU Summer Bridge   08/2022
- Faculty Volunteer, OSU CEAT Discovery Days   06/2022
- Mentor for Freshmen Research Scholar   11/2021 - 04/2022

Service to Professional Society

- Program Session Chair, 2024 North American Power Symposium   10/2024
- Organizing Committee Member, NSF CyberTraining PI Meeting   04/2024
- Judge, Student Poster Contest, IEEE PES   08/2022
- Chair, Transactions Paper Forum on Microgrid, IEEE PESGM   08/2019

Service to the ECE Department

- Member, Publicity Committee   09/2021 - Present
- Member, Awards Committee   09/2022 - Present

Professional Society Membership

- Vice Chair and TCPC, *Computer and Analytical Methods Subcommittee* (CAMS), IEEE Power and Energy Society   01/2023 - Present
- Secretary, *Ultra-Wide-Area HVDC Overlay Studies* Task Force, IEEE Power and Energy Society   08/2018 - Present
- Member, Power System Stability Control Subcommittee   2022 - Present
- Senior Member, IEEE   2020 - Present
- Member, IEEE Power and Energy Society   2013 - Present
- Member, IEEE   2018 - 2020
- Student Member, IEEE   2013 - 2018

Proposal Review Services

- Reviewer for three panels, *National Science Foundation*   2024

- Panel Reviewer, *Department of Energy*   Late 2023
- Panel Reviewer, *Department of Energy*   Early 2023

Peer Review Services
- Reviewer, *IEEE Transactions on Power Systems*
- Reviewer, *IEEE Transactions on Smart Grid*
- Reviewer, *IEEE Transactions on Sustainable Energy*
- Reviewer, *IEEE Transactions on Power Delivery*
- Reviewer, *IEEE Transactions on Power Engineering Letters*
- Reviewer, *IEEE Open Access Journal of Power and Energy (OAJPE)*
- Reviewer, *Applied Energy*
- Reviewer, *IET Generation, Transmission & Distribution*
- Book Reviewer, *Elsevier*