Xudong Chen

CONTACT INFO

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ACADEMIC EXPERIENCE

Assistant Professor Aug. 2016 – present
Department of Electrical, Computer, and Energy Engineering
University of Colorado Boulder

Postdoctoral Research Associate Sept. 2014 – Aug. 2016
Coordinated Science Laboratory
University of Illinois at Urbana-Champaign
Advisors: Tamer Başar and Mohamed-Ali Belabbas

EDUCATION BACKGROUND

Harvard University, Cambridge, MA, U.S.
Division of Engineering and Applied Sciences
Ph.D. in Electrical Engineering May 2014
Dissertation: "Multi-agent systems with reciprocal interaction laws"
Advisor: Roger W. Brockett

Tsinghua University, Beijing, China
Bachelor of Science in Electronic Engineering June 2009

AWARDS

Donald P. Eckman Award, 2021
Citation: For contributions to control, estimation, and analysis of large-scale multi-agent systems, including ensemble control theory, ensemble estimation theory, ensemble system identification, and networked control theory

NSF CAREER Award, 2021

Air Force Young Investigator Program Awardee, 2020

TEACHING EXPERIENCE

ECEE Department, CU Boulder (*new course developed)

ECEN 3810: Intro to Probability	Fall 2019 and Spring 2020-2022
ECEN 5448/MCEN 5228: Advanced Linear Systems	Fall 2016-2021
*ECEN 5488: Geometric Control Theory	Spring 2017, 2020
*ECEN 5498: Stochastic Control Theory	Fall 2020 and Spring 2019

MENTORING EXPERIENCE

Primary advisor of Ph.D. students (all at ECEE Department)

Henry Titus	Aug. 2021 – present
Sara Kamali (co-advisor: Jorge Poveda)	Aug. 2021 – present
Thomas Dearing (co-advisor: Marco Nicotra)	Aug. 2018 – present
Muhammad Umar Javed (co-advisor: Jorge Poveda)	Aug. 2017 – present

Advisor of Master students with thesis

Vishal Shenoy, Mechanical Engineering, CU Boulder Sept. 2020 – July 2021

Thesis: "Structural Controllability Theory for Linear Time-invariant Ensemble Systems"

FUNDING SUPPORT

CAREER: Resilient and Scalable Framework for Control of Multi-agent Systems: Ensemble Control of Network Motifs

Source: NSF. Amount: $500,012. Role: PI. Period: 04/01/2021 – 03/31/2026

Foundations of Ensemble Estimation Theory

Source: AFOSR. Amount: $450,000. Role: PI. Period: 07/01/2020 – 06/30/2023

Collaborative Research: Foundations of secure multi-agent networked systems

Source: NSF. Amount: $440,000 (portion for CU Boulder: $220,000). Role: PI. Period: 09/01/2018–08/31/2022

PUBLICATIONS

Preprints

[**1**] *X. Chen*. Controllability Issues of Linear Ensemble Systems over Multi-dimensional Parameterization Spaces. Arxiv 2003.04529.

[**2**] M.-A. Belabbas, *X. Chen*, and D. Zelazo. On Structural Rank and Resilience of Sparsity Patterns. Arxiv 2107.11894.

[**3**] M. Javed, J. Poveda, and *X. Chen*. A Stochastic Binary Vertex-Triggering Resetting Algorithm for Global Synchronization of Pulse-Coupled Oscillators.

Journal publications

[**1**] *X. Chen*, M.-A. Belabbas, and J. Liu. Gossip over Holonomic Graphs. Automatica, appeared online.

[**2**] M.-A. Belabbas, *X. Chen*, and T. Başar. On the H-Property for Step-graphons and Edge Polytopes. IEEE Control Systems Letters, 6:1766-1771, 2022.

[**3**] T. Dearing, J. Hauser, *X. Chen*, M. Nicotra, and C. Petersen. Efficient Trajectory Optimization for Constrained Spacecraft Attitude Maneuvers. Journal of Guidance, Control, and Dynamics, appeared online.

[**4**] *X. Chen*. Sparse Linear Ensemble Systems and Structural Controllability. IEEE Transactions on Automatic Control, appeared online.

[**5**] *X. Chen*. Ensemble Observability of Bloch Equations with Unknown Population Density. Automatica, appeared online.

[**6**] M. Javed, J. Poveda, and *X. Chen*. Scalable Resetting Algorithms for Synchronization of Pulse-Coupled Oscillators over Rooted Directed Graphs. Automatica, appeared online.

[**7**] M.-A. Belabbas and *X. Chen*. On Integer Balancing of Directed Graphs. Systems & Control Letters, appeared online.

[**8**] Q. Ma, J. Huang, T. Başar, J. Liu, and *X. Chen*. Reputation and Pricing Dynamics in Online Markets. IEEE/ACM Transactions on Networking, 29(4):1745-1759, 2021.

[**9**] M. Javed, J. Poveda, and *X. Chen*. Excitation Conditions for Uniform Exponential

Stability of the Cooperative Gradient Algorithm over Weakly Connected Digraphs. IEEE Control Systems Letters, 6:67-72, 2022.

[**10**] M. Sinner, *X. Chen*, and L. Pao. Controllability of Formations Systems on Special Orthogonal Groups over Directed Graphs. IEEE Transactions on Control of Network Systems, 8(2):872-883, 2021.

[**11**] *X. Chen*. Controllability of Continuum Ensemble of Formation Systems over Directed Graphs. Automatica, appeared online.

[**12**] B. Gharesifard and *X. Chen*. Structural Averaged Controllability of Linear Ensemble Systems. IEEE Systems and Control Letter, 6:518-523, 2022.

[**13**] M.-A. Belabbas and *X. Chen*. Triangulated Laman Graphs, Local Stochastic Matrices, and Limits of Their Products. Linear Algebra and its Applications, 619:176-209, 2021.

[**14**] *X. Chen* and B. Gharesifard. Distinguished Sets of Semi-simple Lie Algebras. Journal of Algebraic Combinatorics, 54:879-891, 2021.

[**15**] T. Dearing, *X. Chen*, and M. Nicotra. Stabilizing Formation Systems with Nonholonomic Agents. IEEE Control Systems Letters, 5(2):403-408, 2021.

[**16**] E. Jenson, *X. Chen*, and D. Scheeres. Optimal Spacecraft Guidance with Asynchronous Measurements and Noisy Impulsive Controls. IEEE Control Systems Letters, 5(5):1813-1818, 2021.

[**17**] K. Alshehri, J. Liu, *X. Chen*, and T. Başar. *A Game-Theoretic Framework for Multi-Period-Multi-Company Demand Response Management in the Smart Grid*. IEEE Transactions on Control Systems Technology, 29(3):1019-1034, 2020.

[**18**] E. Jenson, *X. Chen*, and D. Scheeres. Optimal Control of Sampled Linear Systems with Control-Linear Noise. IEEE Control Systems Letters, 4(3):650-655, 2020.

[**19**] *X. Chen*, Z. Gao, and T. Başar. Asymptotic Behavior of Conjunctive Boolean Networks over Weakly Connected Digraphs. IEEE Transactions on Automatic Control, 65(6):2536-2549, 2019.

[**20**] *X. Chen*. Structure Theory for Ensemble Controllability, Observability, and Duality. Mathematics of Control, Signals, and Systems, 31(2):1-40, 2019.

[**21**] *X. Chen*, M.-A. Belabbas, and T. Başar. Controlling and Stabilizing a Rigid Formation Using a Few Agents. SIAM Journal on Control and Optimization, 57(1):104-128, 2019.

[**22**] M.-A. Belabbas and *X. Chen*. Sensor Placement for Optimal Estimation of Vector-valued Diffusion Processes. Systems & Control Letters, 121:24-30, 2018.

[**23**] Z. Gao, *X. Chen*, and T. Başar. Stability Structures of Conjunctive Boolean Networks. Automatica, 89:8-20, 2018.

[**24**] *X. Chen*, M.-A. Belabbas, and T. Başar. Controllability of Formations over Directed Time-varying Graphs. IEEE Transactions on Control of Network Systems, 4(3):407-416, 2017.

[**25**] *X. Chen*, J. Liu, M.-A. Belabbas, Z. Xu, and T. Başar. Distributed Evaluation and Convergence of Self-appraisals in Social Networks. IEEE Transactions on Automatic Control, 62(1):291-304, 2017.

[**26**] *X. Chen*. Swarm Aggregation with Fading Attractions. IEEE Transactions on

Automatic Control, 62(10):5198-5204, 2017.

[**27**] *X. Chen*, M.-A. Belabbas, and T. Başar. Global Stabilization of Triangulated Formations. SIAM Journal on Control and Optimization, 55(1):172-199, 2017.

[**28**] *X. Chen*, M.-A. Belabbas, and T. Başar. Cluster Consensus with Point Group Symmetries. SIAM Journal on Control and Optimization, 55(6):3869-3889, 2017.

[**29**] *X. Chen*, M.-A. Belabbas, and T. Başar. Optimal Capacity Allocation for Sampled Networked Systems. Automatica, 85:100-112, 2017.

[**30**] Z. Gao, *X. Chen*, and T. Başar. Controllability of Conjunctive Boolean Networks with Application to Gene Regulation. IEEE Transactions on Control of Network Systems, 5(2):770-781, 2018.

[**31**] J. Liu, *X. Chen*, T. Başar, and M.-A. Belabbas. Exponential Convergence of the Discrete- and Continuous-time Altafini Models. IEEE Transactions on Automatic Control, vol. 62(12):6168-6182, 2017.

[**32**] *X. Chen*, M.-A. Belabbas, and T. Başar. Distributed Averaging with Linear Objective Maps. Automatica, 70:179-188, 2016.

Conference publications

[**1**] E. Jenson, D. Scheeres, and *X. Chen*. Robust Spacecraft Guidance with Control-Dependent Noise: Analysis and Application. AIAA SCITECH 2022 Forum.

[**2**] B. Gharesifard and *X. Chen*. Structural Averaged Controllability of Linear Ensemble Systems. IEEE Conference on Decision and Control, 2021 (joint submission to IEEE Control Systems Letters).

[**3**] M. Javed, J. Poveda, and *X. Chen*. Excitation Conditions for Uniform Exponential Stability of the Cooperative Gradient Algorithm over Weakly Connected Digraphs. American Control Conference, 2021 (joint submission to IEEE Control Systems Letters)

[**4**] T. Dearing, *X. Chen*, and M. Nicotra. Stabilizing Formation Systems with Nonholonomic Agents. IEEE Conference on Decision and Control, 2020 (joint submission to IEEE Control Systems Letters).

[**5**] E. Jenson, *X. Chen*, and D. Scheeres. Optimal Control of Sampled Linear Systems with Control-Linear Noise. IEEE Conference on Decision and Control, 2020 (joint submission to IEEE Control Systems Letters).

[**6**] T. Dearing, C. Petersen, M. Nicotra, and *X. Chen*. Fuel-Balanced Formation Flight Control of Underactuated Satellites. American Control Conference, 2020, pp.4319-4324.

[**7**] M. Javed, J. Poveda, and *X. Chen*. Global Synchronization of Clocks in Directed Rooted Acyclic Graphs: A Hybrid Systems Approach. IEEE Conference on Decision and Control, 2019, pp.7352-7357.

[**8**] M.-A. Belabbas and *X. Chen*. Optimal Sensor Design for Secure Cyber-physical Systems. The 8th IFAC Workshop on Distributed Estimation and Control in Networked Systems, 2019, pp.387-390.

[**9**] *X. Chen*. Joint Actuator-sensor Design for Stochastic Linear Systems. IEEE Conference on Decision and Control, 2018, pp.6668-6673.

[**10**] *X. Chen* and B. Gharesifard. Distinguished Vector Fields over Smooth Manifolds with Applications to Ensemble Control. IEEE Conference on Decision and Control,

2017, pp.1963-1968.

[**11**] *X. Chen*, Z. Gao, and T. Başar. Asymptotic Behavior of a Reduced Conjunctive Boolean Network. IEEE Conference on Decision and Control, 2017, pp.4404-4409.

[**12**] *X. Chen* and M.-A. Belabbas. Optimal Actuator Placement for Minimizing the Worst-case Control Energy. 20th IFAC World Congress, 2017, pp.9991-9996.

[**13**] Z. Gao, *X. Chen*, and T. Başar. State-controlling Sets for Conjunctive Boolean Networks. 20th IFAC World Congress, 2017, pp.14290-14295.

[**14**] Z. Gao, *X. Chen*, and T. Başar. Orbit-controlling Sets for Conjunctive Boolean Networks. 2017 American Control Conference, 4989-4994.

[**15**] *X. Chen*, M.-A. Belabbas, and T. Başar. Controlling a Rigid Formation from a Triangle. IEEE Conference on Decision and Control, 2016, pp.57-62.

[**16**] Z. Gao, *X. Chen*, and T. Başar. Periodic Behavior of a Diffusion Model over Directed Graphs. IEEE Conference on Decision and Control, 2016, pp.37-42.

[**17**] *X. Chen*, M.-A. Belabbas, and T. Başar. Cluster Consensus over Strongly Connected Voltage Graphs. International Symposium on Mathematical Theory of Networks and Systems (MTNS), 2016.

[**18**] J. Liu, *X. Chen*, and T. Başar. Stability of the Continuous-time Altafini Model. American Control Conference, 2016, pp.1930-1935.

[**19**] J. Liu, *X. Chen*, T. Başar, and A. Nedić. A Continuous-time Distributed Algorithm for Solving Linear Equations. American Control Conference, 2016, pp.5551-5556.

[**20**] *X. Chen*, M.-A. Belabbas, and T. Başar. Controllability of Formations over Directed Graphs. IEEE Conference on Decision and Control, 2015, pp.4764-4769.

[**21**] *X. Chen*, M.-A. Belabbas, and T. Başar. Formation Control with Triangulated Laman Graphs. IEEE Conference on Decision and Control, 2015, pp.4115-4120.

[**22**] *X. Chen*, M.-A. Belabbas, and T. Başar. Consensus with Linear Objective Maps. IEEE Conference on Decision and Control, 2015, pp.2847-2852.

[**23**] *X. Chen*, J. Liu, Z. Xu, and T. Başar. Distributed Evaluation and Convergence of Self-appraisals in Social Networks. IEEE Conference on Decision and Control, 2015, pp.2895-2900.

[**24**] J. Liu, *X. Chen*, T. Başar, and M.-A. Belabbas. Stability of Discrete-time Altafini's Model: A Graphical Approach. IEEE Conference on Decision and Control, 2015, pp.2835-2840.

[**25**] K. Alshehri, J. Liu, *X. Chen*, and T. Başar. A Stackelberg Game for Multi-period Demand Response Management in the Smart Grid. IEEE Conference on Decision and Control, 2015, pp.5889-5894.

[**26**] *X. Chen*. Decentralized Formation Control with a Quadratic Lyapunov Function. American Control Conference, 2015, pp.4362-4367.

[**27**] *X. Chen*. Gradient Flows for Organizing Multi-agent System. American Control Conference, 2014, pp.5109-5114.

[**28**] *X. Chen* and R. W. Brockett. Centralized and Decentralized Formation Control with Controllable Interaction Laws. IEEE Conference on Decision and Control, 2014, pp.601-606.

SERVICE

Activities in the ECEE Department and the Engineering College

1. Member of the *Marketing and Outreach Committee* Aug. 2020 – present
2. Co-organizer of the *Rocky Mountain Workshop on Decisions, Autonomous Systems, and Controls* Aug. 2019 – present
3. Member of the faculty search committee in the *Robotics, Dynamics, and Control* area for the college (recruited Jorge Poveda) Aug. 2017 – May 2018
4. Representative of the *Systems and Controls* group for graduate student orientations Aug. 2017 and Aug. 2018
5. Member of the *Graduate Studies Committee* Aug. 2016 – May 2017

Activities in the systems and controls community

1. Committee member of 2022 *AACC O. Hugo Schuck Best Paper Award*
2. Co-organizer of a 5-day control workshop: "Geometry, Topology and Control System Design," at the Banff International Research Station (Alberta, Canada). The workshop will take place during 06/11/2023 – 06/16/2023
3. Co-organizer of an invited session: "Sensor and Actuator Placement for Large-Scale Systems," at the 2018 IEEE Conference on Decision and Control, Miami
4. NSF panelist, active reviewer of journals and conferences, chair of conference sessions

Member of comprehensive exam and thesis defense committees

1. *Muhammad Umar Javed*, ECEE Department. Thesis advisors: Xudong Chen and Jorge Poveda. Thesis topic: "Cooperative Estimation: Decentralized Gradient Flows, Acceleration and Synchronization." Comprehensive exam date: 11/10/2021
2. *Chandrakanth Venigalla*, Department of Aerospace Engineering Sciences. Thesis advisor: Daniel Scheeres. Thesis topic: "Multi-spacecraft Trajectory Optimization." Comprehensive exam date: 08/17/2020. Thesis defense date: 11/03/2021
3. *Erica L. Jenson*, Department of Aerospace Engineering Sciences. Thesis advisor: Daniel Scheeres. Thesis topic: "Stochastic Optimal Control to Minimize State Uncertainty." Comprehensive exam date: 04/19/2021
4. *Michael Sinner*, ECEE Department. Thesis advisor: Lucy Pao. Thesis topic: "Optimal Control of Wind Turbines." Comprehensive exam date: 07/08/2020. Thesis defense date: 05/13/2021
5. *Roger Arnold Braker*, ECEE Department. Thesis advisor: Prof. Lucy Pao. Thesis topic: "Control Methods for Compressive Sensing in Atomic Force Microscopy." Comprehensive exam date: 11/17/2017. Thesis defense date: 05/13/2019
6. *Farhad Pourkamali Anaraki*, Department of Applied Mathematics. Thesis advisor: Stephen Becker. Thesis topic: "Randomized Algorithms for Large-scale Data Analysis." Thesis defense date: 03/22/2017