(Last Update: 12-25-2021)

CHANGLIU LIU

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ACADEMIC APPOINTMENTS:

2019.1- Assistant Professor, Robotics Institute, School of Computer Science, **Carnegie Mellon University**
- With courtesy appointments in Electrical and Computer Engineering, Mechanical Engineering

2018.1-12 Postdoctoral Fellow, Department of Aeronautics and Astronautics, **Stanford University**

2017.9-12 Postdoctoral Scholar, Department of Mechanical Engineering, **University of California, Berkeley**

EDUCATION:

2017.9 **Ph.D.**, Department of Mechanical Engineering, University of California, Berkeley
- Major: Control; Minor: Mathematics, Computer Science
- Dissertation: Designing Robot Behavior in Human-Robot Interactions

2016.5 **M.A. (Math)**, Department of Mathematics, University of California, Berkeley

2014.5 **M.S. (ME),** Department of Mechanical Engineering, University of California, Berkeley

2012.7 **B.Eng**, Department of Precision Instruments and Mechanology, Tsinghua University

2012.7 **B.Econ**, School of Economics and Management, Tsinghua University

2010 **Exchange student**, Department of Mechanical Engineering, the University of Hong Kong

INVITED TALKS:

- "How Good are Current Neural Network Formal Verification Methods?" **SAE G-34 AI in Aviation**, December 2021.
- "Safe Control and Learning for Effective Human-Robot Collaboration," ICON's Fall Seminar Series on Human-Autonomy Teaming, **Purdue University**, November, 2021.
- "Learning and Coordination for Autonomous Driving," **CCTA Workshop on Motion Planning, Control, and Learning for Autonomous Driving Systems**, Aug 2021.
- "Safety-critical learning and control for collaborative robots," **RSS Workshop on Robotics for People (R4P): Perspectives on Interaction, Learning and Safety**, July 2021. [Video]
- "Safe AI for Effective Human-Robot Collaboration," Department of Automation, **Central South University**, July 2021.
- "Toward provably safe co-robots: safe control and robust prediction," NSF-REU site, **University of Texas at San Antonio**, June 2021.
- "Design and verification of safe co-robots: safe control and robust prediction," **ACC Workshop on Recent Advances in Human-Autonomy Interactions**, May 2021.
- "Hierarchical Long Short Term Safety under Uncertainty," **Amazon Robotics Research Symposium**, May 2021.
- "Towards Provably Safe Robotics," **Google Machine Learning and Robotics Safety Workshop**, March 2021.
- "Algorithms for verifying deep neural networks and their applications," **Bytedance Tech Talk**, January 2021.
- "Verification and adaptation of deep neural networks," **Lorentz Workshop on Robust Artificial Intelligence**, January 2021. [Video]
- "Algorithms for verifying deep neural networks and their applications," seminar series in **SAE G-34 AI in Aviation**, January 2021.
- "Prediction and Planning for Safe and Interactive Autonomous Driving," **IV Workshop on Behavior Generation and Decision Making for Socially Compatible Autonomous Vehicles**, November 2020.
- "Design and Verification of Safe AI", AI-enabled mobility summer school, September 2020.
- "Safe Autonomous Driving: Prediction, Planning, and Coordination," **RSS Workshop on Interaction and Decision-Making in Autonomous-Driving**, July, 2020.
- "Safe Intelligent Vehicles: Planning and Prediction," **AutoBrain Tech Talk**, June, 2020.
- "Run-time verification of deep neural networks," **NASA Formal Methods (NFM) Workshop on AI Safety**, May 2020.

- "Toward Safe Co-Robots: Design and Verification," **National Robotics Engineering Center (NREC)**, July 2019.
- "Toward Safe Co-Robots: Design and Verification," Robotics Seminar in **National Institute for Occupational Safety and Health (NIOSH)**, Morgantown, WV, June 2019.
- "NeuralVerification.jl: Algorithms for Verifying Deep Neural Networks," **Center of Automotive Research at Stanford (CARS)**, Stanford, CA, June 2019. [CARS Workshop]
- "Real-Time Motion Planning with Collision Avoidance and Temporal Optimization for Collaborative Robot Arms," Plenary talk in **MathWorks Research Summit**, Boston, MA, June 2019.
- "Toward Safe Co-Robots: Behavior Design and Verification", Department of Mechanical and Aerospace Engineering, **University of California, Davis**, October 2018.
- "Designing Robot Behavior in Human-Robot Interactions", CITRIS People and Robotics Initiative, **University of California, Berkeley**, March 2018.
- "Designing Robot Behavior in Human-Robot Interactions", Department of Mechanical Engineering, **University of Texas at Austin**, February 2018.
- "Designing Robot Behavior in Human-Robot Interactions", Department of Mechanical Engineering, **Texas A&M University**, February 2018.
- "Designing Robot Behavior in Human-Robot Interactions", Robotics Institute, **Carnegie Mellon University**, January 2018.
- "Designing Robot Behavior in Human-Robot Interactions", School of Electrical and Computer Engineering, **Georgia Institute of Technology**, December 2017.
- "Designing Robot Behavior in Human Robot Interactions with Application to Intelligent Industrial Co-Robots", Department of Mechanical Engineering, **University of California, Los Angeles**, April 2017.
- "Designing Robot Behavior in Human Robot Interactions with Application to Intelligent Industrial Co-Robots", Department of Mechanical Engineering, **Carnegie Mellon University**, March 2017.
- "Designing Robot Behavior in Human Robot Interactions with Application to Intelligent Industrial Co-Robots", Department of Mechanical Engineering, **University of California, San Diego**, February 2017.
- "Designing Robot Behavior in Human Robot Interactions with Application to Intelligent Industrial Co-Robots", Department of Computer Engineering, **University of California, Santa Cruz**, February 2017.

PUBLICATIONS:

Journal Publications

[J11] J. Grover, **C. Liu**, and K. Sycara, "The Before, During and After of Multi-Robot Deadlock," in the *International Journal of Robotics Research*.

[J10] H. Chen, and **C. Liu**, "Safe and Sample-efficient Reinforcement Learning for Clustered Dynamic Environments," in *IEEE Control System Letters*. Early access.

[J9] **C. Liu**, T. Arnon, C. Lazarus, C. Strong, C. Barrett, and M. Kochenderfer, "Algorithms for verifying deep neural networks," Foundations and Trends in Optimization: Vol. 4, No. 3-4, pp. 244–404, 2021.

[J8] R. Liu, and **C. Liu**, "Human Motion Prediction Using Adaptable Recurrent Neural Networks and Inverse Kinematics," in *IEEE Control System Letters,* vol. 5, no. 5, pp. 1651-1656, Nov. 2021

[J7] A. Abuduweili, and **C. Liu**, "Robust Nonlinear Adaptation Algorithms for Multi-Task Prediction Networks," in *International Journal of Adaptive Control and Signal Processing,* vol. 35, no. 3, pp. 314-341, Mar. 2021.

[J6] Y. Cheng, L. Sun, **C. Liu**, M. Tomizuka, "Towards Efficient Human-Robot Collaboration with Robust Plan Recognition and Trajectory Prediction," in *IEEE Robotics and Automation Letters,* vol. 5, no. 2, pp. 2602-2609, Apr. 2020.

[J5] Y.-T. Lin, H. Hsu, S.-C. Lin, C.-W. Lin, H.-R. Jiang, and **C. Liu**, "Graph-Based Modeling, Scheduling, and Verification for Intersection Management of Intelligent Vehicles," in *ACM Transactions on Embedded Computing Systems (TECS),* vol. 18, no. 5s, article 95, Oct. 2019.

[J4] **C. Liu**, C.-W. Lin, S. Shiraishi, and M. Tomizuka, "Distributed conflict resolution for connected autonomous vehicles", in *IEEE Transactions on Intelligent Vehicles*, vol. 3, no. 1, Mar. 2018.

[J3] **C. Liu**, C. Lin, and M. Tomizuka, "The convex feasible set algorithm for real time optimization in motion planning", in *SIAM Journal on Control and Optimization*, vol. 56, no. 4, pp. 2712-2733, Jul. 2018.

[J2] **C. Liu**, and M. Tomizuka, "Real time trajectory optimization for nonlinear robotic systems: Relaxation and convexification", in *Systems & Control Letters*, vol. 108, pp. 56-63, Oct. 2017.

[J1] **C. Liu**, "Safe robot navigation among moving and steady obstacles [Bookshelf]," in *IEEE Control Systems*, vol. 37,

no. 1, pp. 123-125, Feb, 2017.

Book

[B2] **C. Liu**, T. Tang, H. Lin, and M. Tomizuka, "Designing robot behavior in human-robot interactions." CRC Press, 2019.

Book Chapters

[B1] **C. Liu**, and M. Tomizuka, "Designing the robot behavior for safe human robot interactions", in *Trends in Control and Decision-Making for Human-Robot Collaboration Systems* (Y. Wang and F. Zhang (Eds.)). Springer, 2017.

Refereed Conference Publications

[C39] J. Grover, **C. Liu**, K. Sycara, "Parameter Identification for Optimization-based Controllers in Multirobot Systems," in *IEEE International Symposium on Multi-Robot and Multi-Agent Systems*, 2021.

[C38] W. Zhao, T. He, **C. Liu**, "Model free safe control for zero-violation reinforcement learning," in *Conference on Robot Learning*, 2021.

[C37] C. Noren, W. Zhao, **C. Liu**, "Safe Adaptation with Multiplicative Uncertainties Using Robust Safe Set Algorithm," in *Modeling, Estimation, and Control Conference*, 2021.

[C36] J. Grover, **C. Liu**, K. Sycara, "System Identification for Safe Controllers using Inverse Optimization," in *Modeling, Estimation, and Control Conference*, 2021.

[C35] H. Zhou, **C. Liu**, "Distributed motion coordination using convex feasible set based model predictive control," in *IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2021.

[C34] J. Grover, **C. Liu**, K. Sycara, "Feasible Region-Based Identification Using Duality," in *European Control Conference*, 2021.

[C33] J. An, G. Giordano, **C. Liu**, "Flexible MPC-based Conflict Resolution Using Online Adaptive ADMM," in *European Control Conference*, 2021.

[C32] R. Jena, **C. Liu**, K. Sycara, "Augmenting GAIL with BC for sample efficient imitation learning**,**" in *Conference on Robot Learning,* 2020.

[C31] B. Niu*, C. Wang*, **C. Liu**, "Tolerance-guided Policy Learning for Adaptable and Transferrable Delicate Industrial Insertion," in *Conference on Robot Learning,* 2020.

[C30] W. Zhao, S. He, C. Wen, and **C. Liu**. "Contact-Rich Trajectory Generation in Confined Environments Using Iterative Convex Optimization," in *ASME Dynamic Systems and Control Conference,* 2020. **Best Student Paper Finalist**.

[C29] J. Huang, and **C. Liu**. "Multi-car convex feasible set algorithm in trajectory planning," in *ASME Dynamic Systems and Control Conference,* 2020.

[C28] J. Grover, **C. Liu**, K. Sycara, "Deadlock Analysis and Resolution in Multi-Robot Systems: The Two Robot Case," in *International Workshop on the Algorithmic Foundations of Robotics (WAFR),* 2020.

[C27] S.C. Lin, H. Hsu, Y.T. Lin, C.W. Lin, H.R. Jiang, and **C. Liu**, "A Dynamic Programming Approach to Lane Merging of Connected and Autonomous Vehicles," in *IEEE Intelligent Vehicle Symposium*. IEEE, 2020.

[C26] A. Abuduweili, and **C. Liu**, "Robust online model adaptation by extended kalman filter with exponential moving average and dynamic multi-epoch strategy," in Learning for Dynamics and Control (L4DC) Conference, 2020.

[C25] J. Grover, **C. Liu**, and K. Sycara, "Why Does Symmetry Cause Deadlocks?" in 2020 IFAC World Congress.

[C24] W. Zhao, L. Sun, **C. Liu**, and M. Tomizuka, "Experimental Evaluation of Human Motion Prediction Toward Safe and Efficient Human Robot Collaboration," in *American Control Conference*. IEEE, 2020.

[C23] T. Wei, and **C. Liu**, "Safe control using energy functions: A unified framework, benchmark, and new directions," in *IEEE Conference on Decision and Control*. IEEE, 2019.

[C22] Z. Xu, H. Chang, C. Tang, **C. Liu**, and M. Tomizuka, "Toward modularization of neural networks autonomous driving policy using parallel attribute networks," in *IEEE Intelligent Vehicle Symposium*. IEEE, 2019.

[C21] W. Si, T. Wei, and **C. Liu**, "AGen: Adaptable generative prediction networks for autonomous driving," in *IEEE Intelligent Vehicle Symposium*. IEEE, 2019.

[C20] Y. Cheng, W. Zhao, **C. Liu**, and M. Tomizuka, "Human motion prediction using semi-adaptable neural networks," in *American Control Conference*. IEEE, 2019.

[C19] R. Bhattacharyya, D. Phillips, **C. Liu**, J. Gupta, K. Driggs-Campbell, and M. Kochenderfer, "Simulating emergent properties of human driving behavior using multi-agent RAIL," in *IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2019.

[C18] H. Lin*, **C. Liu***, and M. Tomizuka, "Fast robot motion planning with collision avoidance and temporal

optimization", in *IEEE International Conference on Control, Automation, Robotics and Vision*. IEEE, 2018, pp. 29 – 35. **Best Paper Award.**

[C17] **C. Liu**, and M. Kochenderfer, "Analytically modeling unmanaged intersections with microscopic vehicle interactions", in *IEEE Intelligent Transportation Systems Conference*. IEEE, 2018, pp. 2352 - 2357.

[C16] **C. Liu**, C.-W. Lin, S. Shiraishi, and M. Tomizuka, "Improving efficiency of autonomous vehicle via V2V communication", in *American Control Conference*. IEEE, 2018, pp. 4778 – 4783.

[C15] J. Chen, **C. Liu**, and M. Tomizuka, "FOAD: Fast optimization-based autonomous driving motion planner", in *American Control Conference*. IEEE, 2018, pp. 4725 – 4732.

[C14] H. Lin, **C. Liu**, Y. Fan, and M. Tomizuka, "Real-time collision avoidance algorithm on industrial manipulators", in *IEEE Conference on Control Technology and Applications (CCTA)*. IEEE, 2017, pp. 1294-1299.

[C13] **C. Liu**, Y. Wang, and M. Tomizuka, "Boundary layer heuristic for search-based nonholonomic path planning in maze-like environments", in *IEEE Intelligent Vehicle Symposium*. IEEE, 2017, pp. 831-836.

[C12] **C. Liu**, W. Zhan, and M. Tomizuka, "Speed profile planning in dynamic environments via temporal optimization", in *IEEE Intelligent Vehicle Symposium*. IEEE, 2017, pp. 154-159.

[C11] W. Zhan, J. Chen, C-Y. Chan, **C. Liu**, and M. Tomizuka, "Spatially-partitioned environmental representation and planning architecture for on-road autonomous driving", in *IEEE Intelligent Vehicle Symposium*. IEEE, 2017, pp. 632-639.

[C10] **C. Liu**, C. Lin, Y. Wang, and M. Tomizuka, "Convex feasible set algorithm for constrained trajectory smoothing", in *American Control Conference*. IEEE, 2017, pp. 4177-4182.

[C9] **C. Liu**, J. Chen, T. Nguyen, and M. Tomizuka, "The robustly-safe automated driving system for enhanced active safety", in *SAE World Congress*, SAE Technical Paper 2017-01-1406, 2017.

[C8] W. Zhan, **C. Liu**, C-Y. Chan, and M. Tomizuka, "A non-conservatively defensive strategy for urban autonomous driving", in *Intelligent Transportation Systems Conference (ITSC)*. IEEE, 2016, pp. 459 – 464.

[C7] T. Tang, **C. Liu**, W. Chen, and M. Tomizuka, "Robotic manipulation of deformable objects by tangent space mapping and non-rigid registration," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2016, pp. 2689 – 2696.

[C6] **C. Liu**, and M. Tomizuka, "Enabling safe freeway driving for automated vehicles", in *American Control Conference*. IEEE, 2016, pp. 3461 – 3467.

[C5] **C. Liu**, W. Zhang and M. Tomizuka, "Who to blame? Learning and control strategies with information asymmetry", in *American Control Conference*. IEEE, 2016, pp. 4859 – 4864.

[C4] **C. Liu**, and M. Tomizuka, "Algorithmic safety measures for intelligent industrial co-robots", in *IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2016, pp. 3095 – 3102.

[C3] **C. Liu**, and M. Tomizuka, "Safe exploration: addressing various uncertainty levels in human robot interactions", in *American Control Conference*. IEEE, 2015, pp. 465 – 470.

[C2] **C. Liu**, and M. Tomizuka, "Control in a safe set: addressing safety in human-robot interactions", in *Dynamic Systems and Control Conference*. ASME, 2014, p. V003T42A003. **Best Student Paper Finalist**.

[C1] **C. Liu**, and M. Tomizuka, "Modeling and controller design of cooperative robots in workspace sharing human-robot assembly teams", in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. IEEE, 2014, pp. 1386 – 1391.

Workshop Publications

[W10] L. Wang, Y. Hu, C. Liu, "Online Adaptation of Neural Network Models by Modified Extended Kalman Filter for Customizable and Transferable Driving Behavior Prediction," in *AAAI Workshop on Human-Centric Self-Supervised Learning*, 2021.

[W9] L. Wang, Y. Hu, L. Sun, W. Zhan, M. Tomizuka, C. Liu, "Hierarchical Adaptable and Transferable Networks (HATN) for Driving Behavior Prediction," in *NeurIPS workshop on Machine Learning for Autonomous Driving*, 2021.

[W8] S. He, W. Zhao, C. Hu, Y. Zhu, C. Liu, "A hierarchical long short term safety framework for efficient robot manipulation under uncertainty" in *MECC Workshop on Safe Control and Learning under Uncertainty*, 2021.

[W7] H. Ma, C. Liu, S. Li, S. Zheng, J. Chen, "Joint Synthesis of Safety Certificate and Safe Control Policy using Constrained Reinforcement Learning," in *MECC Workshop on Safe Control and Learning under Uncertainty*, 2021.

[W6] T. Wei, **C. Liu**, "Safe control with neural network dynamic models" in *RSS Workshop on Robotics for People: Perspectives on Interaction, Learning and Safety*, 2021.

[W5] R. Liu, **C. Liu**, "IADA: Iterative Adversarial Data Augmentation using Formal Verification and Expert Guidance" in *ICML Workshop on Human In the Loop Learning*, 2021.

[W4] J. Grover, **C. Liu**, K. Sycara, "Simultaneously learning safety margins and task parameters of multirobot systems," in *RSS Workshop on Behavioral Inference of Remotely Sensed Multi-agent Systems*, 2021.

[W3] C. Ho*, K. Shih*, J. Grover, **C. Liu**, S. Scherer, "'Provably Safe in the Wild: Testing Control Barrier Functions on a Vision-Based Quadrotor in an Outdoor Environment," in *RSS Workshop on Robust Autonomy*, 2020.

[W2] A. Abuduweili*, S. Li*, and **C. Liu**, "Adaptable Human Intention and Trajectory Prediction for Human-Robot Collaboration", *AAAI Fall Symposium Series, AI for HRI*, 2019.

[W1] **C. Liu**, T. Arnon, C. Lazarus, and M. Kochenderfer, "NeuralVerificaiton.jl: Algorithms for verifying deep neural networks," in *ICLR 2019 Debugging Machine Learning Models Workshop*. **Best Applied Paper Award**.

Preprints

[5] T. Wei, **C. Liu**, "Online Verification of Deep Neural Networks under Domain or Weight Shift," arXiv: 2106.12732.

[4] **C. Liu,** "A Microscopic Epidemic Model and Pandemic Prediction Using Multi-Agent Reinforcement Learning," arXiv: 2004.12959.

[3] **C. Liu**, T. Tang, H. Lin, Y. Cheng, and M. Tomizuka, "SERoCS: Safe and efficient robot collaborative systems for next generation intelligent industrial co-robots". arXiv: 1809.08215.

[2] **C. Liu**, and M. Kochenderfer, "Analyzing traffic delay at unmanaged intersections". arXiv: 1806.02660.

[1] **C. Liu**, and M. Tomizuka, "Robot safe interaction system for intelligent industrial co-robots". arXiv: 1808.03983.

TEACHING:

Fall 2021	16-899 Adaptive Control and Reinforcement Learning
Spring 2021	16-883 Special Topics: Provably Safe Robotics
Fall 2020	16-899 Adaptive Control and Reinforcement Learning
Spring 2020	16-899 Adaptive Control and Reinforcement Learning
Fall 2019	16-883 Special Topics: Provably Safe Robotics

OTHERS:

Automated Polishing and Grinding: Advanced Robotic Manufacturing
YouTube video

The Cobot Experience: Changliu Liu & The Difference Between Technology and Fantasy.
By Emmet Cole on the Robotiq Blog.

NeuralVerification.jl online course.
By Center of Automobile Research at Stanford.

Grit Ventures Interview
By Jennifer Roberts

Robotic Weld Bead Removal with ATI's Force/Torque Sensors
By ATI