Yulun Tian

Massachusetts Institute of Technology
Cambridge, MA, USA
✉ *yulun@mit.edu*
🖱 *tianyulun.com*

Research Interests

I am passionate about developing **scalable and trustworthy multi-agent systems** that operate robustly over long periods of time without human intervention. My current research applies tools from nonlinear and distributed optimization, graph theory, and machine learning to develop principled **algorithms with theoretical guarantees** and **real-world systems** for multi-agent perception and navigation.

Education

2019 – 2023 **Ph.D. Aeronautics and Astronautics**, *Massachusetts Institute of Technology*.
- Thesis: *Algorithms and Systems for Scalable Multi-Agent Geometric Estimation.*
- Minor concentration: Optimization Methods.
- Cumulative GPA: 5.0/5.0.

2017 – 2019 **S.M. Aeronautics and Astronautics**, *Massachusetts Institute of Technology*.
- Cumulative GPA: 5.0/5.0.

2013 – 2017 **B.A. Computer Science**, *University of California, Berkeley*.
- Cumulative GPA: 3.94/4.0 (*High Distinction*).

Awards and Recognitions

2022 **Best Paper Award**, *IEEE Transactions on Robotics (T-RO)*

2023 **Outstanding Reviewer**, *IEEE Robotics and Automation Letter (RA-L)*

2021 **Honorable Mention for Best Paper**, *IEEE Transactions on Robotics (T-RO)*

2020 **Honorable Mention for Best Paper**, *IEEE Robotics and Automation Letter (RA-L)*

2019 **AUVSI XCELLENCE Humanitarian Award**, *Association for Uncrewed Vehicle Systems International (AUVSI)*

Experience

Sep 2023–Present **Postdoctoral Associate**, *Massachusetts Institute of Technology*.
My current work focuses on developing *algorithms with performance guarantees* and *real-world systems* to enable scalable and trustworthy multi-agent perception.

Sep 2017–Aug 2023 **Graduate Research Assistant**, *Massachusetts Institute of Technology*.
- Developed fully distributed algorithms for multi-agent SLAM with guaranteed convergence under asynchronous communication and global optimality certificates.
- Developed distributed and outlier-robust system for multi-agent metric-semantic SLAM.

Summer 2020 **Research Intern**, *Meta Reality Labs*.
- Researched rotation/translation averaging algorithms for global structure-from-motion.
- Benchmarked algorithm performance using large-scale internet photo datasets.

Teaching

Fall 2023 **16.485: Visual Navigation for Autonomous Vehicles**, *MIT*.
As a **guest lecturer and teaching assistant**, I teach a cohort of about 50 graduate and undergraduate students on the mathematical foundations, state-of-the-art algorithms, and software packages for visual navigation. My duties include giving selected lectures on nonlinear optimization for state estimation, leading labs and recitations, and holding office hours.

Fall 2023 **Kaufman Teaching Certification**, *MIT*.
As a **participant** of MIT's Kaufman Teaching Certificate Program (KTCP), I receive systematic training on effective evidence-based teaching. Through a series of interactive workshops, I practice skills that include course development, lesson planning, designing learning and assessment activities, and creating an effective and welcoming classroom climate.

Spring 2017 **EE 122: Communication Networks**, *UC Berkeley*.
As an **undergraduate teaching assistant**, I helped teach the undergraduate-level course on communication networks with about 30 students. My main duties included holding regular office hours and helping with the design and grading of exams.

Invited Talks

Nov 2023 **"Resilient and Scalable Distributed SLAM: Algorithms and Systems"**, *Guest Lecture for CS 5970, University of Oklahoma*.

Aug 2023 **"Multi-Agent Geometric Estimation: Algorithms and Systems"**, *NEURAL Lab, Northeastern University*.

July 2023 **"Rotation Averaging via Fast Laplacian Solvers"**, *Spectral Graph Theoretic Methods (SGTM) Workshop, RSS 2023, <u>Video</u>*.

July 2022 **"Kimera-Multi: Robust, Distributed, Dense Metric-Semantic SLAM for Multi-Robot Systems"**, *UC Berkeley Semiautonomous Seminar*.

Publications

Journal Articles

[1] **Yulun Tian** and Jonathan P. How. "Spectral Sparsification for Communication-Efficient Collaborative Rotation and Translation Estimation". In: *IEEE Transactions on Robotics (T-RO)* (2023). To Appear.

[2] **Yulun Tian**, Yun Chang, Fernando Herrera Arias, Carlos Nieto-Granda, Jonathan P How, and Luca Carlone. "Kimera-Multi: Robust, Distributed, Dense Metric-Semantic SLAM for Multi-Robot Systems". In: *IEEE Transactions on Robotics (T-RO)* (2022). King-Sun Fu Memorial Best Paper Award.

[3] **Yulun Tian**, Kasra Khosoussi, David M Rosen, and Jonathan P How. "Distributed Certifiably Correct Pose-Graph Optimization". In: *IEEE Transactions on Robotics (T-RO)* (2021). Honorable Mention for King-Sun Fu Memorial Best Paper Award.

[4] **Yulun Tian**, Kasra Khosoussi, and Jonathan P How. "A Resource-Aware Approach to Collaborative Loop-Closure Detection with Provable Performance Guarantees". In: *International Journal of Robotics Research (IJRR)* (2021). Invited paper.

[5] **Yulun Tian**, Alec Koppel, Amrit Singh Bedi, and Jonathan P How. "Asynchronous and Parallel Distributed Pose Graph Optimization". In: *IEEE Robotics and Automation Letters (RA-L)* (2020). Honorable Mention for Best Paper Award.

[6] **Yulun Tian**, Katherine Liu, Kyel Ok, Loc Tran, Danette Allen, Nicholas Roy, and Jonathan P. How. "Search and Rescue under the Forest Canopy using Multiple UAVs". In: *International Journal of Robotics Research (IJRR)* (2020). Invited paper.

[7] Kaveh Fathian, Kasra Khosoussi, **Yulun Tian**, Parker Lusk, and Jonathan P How. "CLEAR: A Consistent Lifting, Embedding, and Alignment Rectification Algorithm for Multiview Data Association". In: *IEEE Transactions on Robotics (T-RO)* (2020).

Conference Proceedings

[8] **Yulun Tian**, Yun Chang, Long Quang, Arthur Schang, Carlos Nieto-Granda, Jonathan P How, and Luca Carlone. "Resilient and Distributed Multi-Robot Visual SLAM: Datasets, Experiments, and Lessons Learned". In: *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*. Honorable Mention for MIT Open Data Prize. 2023.

[9] **Yulun Tian**, Amrit Singh Bedi, Alec Koppel, Miguel Calvo-Fullana, David M Rosen, and Jonathan P How. "Distributed Riemannian Optimization with Lazy Communication for Collaborative Geometric Estimation". In: *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*. 2022.

[10] Yun Chang, **Yulun Tian**, Jonathan P. How, and Luca Carlone. "Kimera-Multi: a System for Distributed Multi-Robot Metric-Semantic Simultaneous Localization and Mapping". In: *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. 2021.

[11] **Yulun Tian**, Katherine Liu, Kyel Ok, Loc Tran, Danette Allen, Nicholas Roy, and Jonathan P. How. "Search and Rescue Under the Forest Canopy Using Multiple UAS". In: *Intl. Sym. on Experimental Robotics (ISER)*. 2018.

[12] **Yulun Tian**, Kasra Khosoussi, and Jonathan P How. "Resource-Aware Algorithms for Distributed Loop Closure Detection with Provable Performance Guarantees". In: *Intl. Workshop on the Algorithmic Foundations of Robotics (WAFR)*. 2018.

[13] **Yulun Tian**, Kasra Khosoussi, Matthew Giamou, Jonathan P How, and Jonathan Kelly. "Near-Optimal Budgeted Data Exchange for Distributed Loop Closure Detection". In: *Robotics: Science and Systems (RSS)*. 2018.

[14] Ming Jin, Shichao Liu, **Yulun Tian**, Mingjian Lu, Stefano Schiavon, and Costas Spanos. "Indoor Environmental Quality Monitoring by Autonomous Mobile Sensing". In: *4th ACM International Conference on Systems for Energy-Efficient Built Environments*. 2017.

Preprints

[15] **Yulun Tian**, Kasra Khosoussi, and Jonathan P. How. *Block-Coordinate Minimization for Large SDPs with Block-Diagonal Constraints*. `https://arxiv.org/pdf/1903.00597.pdf`. 2019.

Theses

[16] **Yulun Tian**. "Algorithms and Systems for Scalable Multi-Agent Geometric Estimation". PhD thesis. Massachusetts Institute of Technology, 2023.

[17] **Yulun Tian**. "Reliable and resource-aware collaborative slam for multi-robot search and rescue". S.M. thesis. Massachusetts Institute of Technology, 2019.

Professional Activities

Journal Reviewer	**T-RO**: IEEE Transactions on Robotics (2020–2023)
	IJRR: International Journal of Robotics Research (2023)
	RA-L: IEEE Robotics and Automation Letters (2018–2023)
	Field Robotics (2021–2022)
	AIJ: Artificial Intelligence Journal (2022)
	AURO: Autonomous Robots (2022)
Conference Reviewer	**ICRA**: IEEE International Conf. on Robotics and Automation (2020–2023)
	IROS: IEEE/RSJ International Conf. on Intelligent Robots and Systems (2020–2023)

Membership IEEE: Institute of Electrical and Electronics Engineers (2020–2023)

Skills

Software **Languages**: C/C++, Python, MATLAB.
Robotics: ROS, Eigen, OpenCV, OpenGV, PCL.
Optimization: GTSAM, Ceres Solver, g2o, Manopt, ROPTLIB, cvx, YALMIP.
Machine Learning: PyTorch.

Hardware **Sensors**: RealSense, Velodyne, Ouster.
Platforms: Intel NUC, Jetson Xavier.

Software

Kimera-Multi A complete system for *distributed* and *robust* multi-robot metric-semantic SLAM, featuring distributed loop closure, pose graph optimization, and onboard metric-semantic mapping. Implemented in C++ and ROS (code).

dpgo A suite of distributed pose graph optimization (PGO) algorithms based on Riemannian optimization. Additional features include asynchronous communication and outlier-robust optimization. Implemented in C++ with ROS wrapper (code).

References available upon request.