Heng Yang

Assistant Professor
Harvard University

Research Scientist
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Research Interests

Robotics; Optimization; Computer Vision; Control; Machine Learning

My research focuses on developing structured optimization and learning algorithms to empower robots and autonomous systems to perform complex tasks in the physical world.

Education

Massachusetts Institute of Technology, Cambridge, MA
Doctor of Philosophy in Robotics 9/2017 – 6/2022
Thesis: Certifiable Outlier-Robust Geometric Perception; Advisor: Luca Carlone

Master of Science in Mechanical Engineering 9/2015 – 5/2017

Tsinghua University, Beijing, China
Bachelor of Engineering in Automotive Engineering 8/2011 – 7/2015
Graduated with highest honors: Tsinghua Presidential Scholarship (9/3000+)

Appointments

Assistant Professor of Electrical Engineering 8/2023 – present
John A. Paulson School of Engineering and Applied Sciences
Harvard University

Visiting Expert Scientist 5/2025 – 6/2025
Polynomial Optimization Team, Laboratory for Analysis and Architecture of Systems
French National Centre for Scientific Research

Research Scientist 7/2022 – present
Autonomous Vehicle Research Group
NVIDIA Corporation

Honors and Awards

Outstanding Systems Paper Award Finalist, Robotics: Science and Systems, 2025

Best Paper Award Finalist, RAS TC on Model-based Optimization for Robotics, 2025

MIT Spotlight: Making self-driving cars safer through keener robot perception, 2022

Best Paper Award Finalist, Robotics: Science and Systems, 2021

Robotics: Science and Systems (RSS) Pioneer, 2021

Best Paper Award Honorable Mention, Robotics and Automation Letters, 2020

Best Paper Award in Robot Vision, International Conference on Robotics and Automation, 2020

MIT Spotlight: Spotting objects amid clutter, 2019

Presidential Scholarship, Tsinghua University (News Spotlight), 2015

Selected Publications

Journal

[J1] Shucheng Kang, Xin Jiang, and **Heng Yang**. Local Linear Convergence of the Alternating Direction Method of Multipliers for Semidefinite Programming under Strict Complementarity. *Mathematical Programming* (Under Review), 2025

[J2] Lei Huang, Shucheng Kang, Jie Wang, and **Heng Yang**. Sparse Polynomial Optimization with Unbounded Sets. *SIAM Journal on Optimization*, 2025 (pdf)

[J3] Xihang Yu and **Heng Yang**. SIM-Sync: From Certifiably Optimal Synchronization over the 3D Similarity Group to Scene Reconstruction with Learned Depth. *IEEE Robotics and Automation Letters*, 2024 (pdf)

[J4] **Heng Yang**, Ling Liang, Luca Carlone, and Kim-Chuan Toh. An Inexact Projected Gradient Method with Rounding and Lifting by Nonlinear Programming for Solving Rank-One Semidefinite Relaxation of Polynomial Optimization. *Mathematical Programming*, 2023 (pdf) (code)

[J5] Jingnan Shi, **Heng Yang**, and Luca Carlone. Optimal and Robust Category-level Perception: Object Pose and Shape Estimation from 2D and 3D Semantic Keypoints. *IEEE Transactions on Robotics*, 2023 (pdf)

[J6] **Heng Yang** and Luca Carlone. Certifiably Optimal Outlier-Robust Geometric Perception: Semidefinite Relaxations and Scalable Global Optimization. *IEEE Trans. Pattern Anal. Machine Intell.* 2022 (pdf) (code)

[J7] Pasquale Antonante, Vasileios Tzoumas, **Heng Yang**, and Luca Carlone. Outlier-robust estimation: Hardness, minimally tuned algorithms, and applications. *IEEE Transactions on Robotics*. 2021 (pdf)

[J8] **Heng Yang**, Pasquale Antonante, Vasileios Tzoumas, and Luca Carlone. Graduated non-convexity for robust spatial perception: From non-minimal solvers to global outlier rejection. *IEEE Robotics and Automation Letters*. 2020 **(Best Paper Award) (Best Paper Award Honorable Mention)** (pdf)

[J9] **Heng Yang**, Jingnan Shi, and Luca Carlone. TEASER: Fast and certifiable point cloud registration. *IEEE Transactions on Robotics*. 2020 (pdf) (code)

Conference

[C1] Han Qi, Haocheng Yin, Yilun Du, and **Heng Yang**. Strengthening Generative Robot Policies through Predictive World Modeling. In *Conference on Robot Learning* (Under Review), 2025 (pdf) (web)

[C2] Zhiyu Zhang, Zhou Lu, and **Heng Yang**. The Benefit of Being Bayesian in Online Conformal Prediction. In *International Conference on Machine Learning* (Under Review), 2025 (pdf)

[C3] Shucheng Kang, Guorui Liu, and **Heng Yang**. Global Contact-Rich Planning with Sparsity-Rich Semidefinite Relaxations. In *Robotics: Science and Systems*, 2025 (pdf) (web)

[C4] Haoyu Han and **Heng Yang**. Building Rome with Convex Optimization. In *Robotics: Science and Systems*, 2025 **(Outstanding Systems Paper Award Finalist)** (pdf) (web)

[C5] Yulin Li, Haoyu Han, Shucheng Kang, Jun Ma, and **Heng Yang**. On the Surprising Robustness of Sequential Convex Optimization for Contact-Implicit Motion Planning. In *Robotics: Science and Systems*, 2025 (pdf) (web)

[C6] Han Qi, Haocheng Yin, and **Heng Yang**. Control-oriented Clustering of Visual Latent Representation. In *International Conference on Learning Representations*, 2025 **(Spotlight)** (pdf) (web)

[C7] Ziqi Lu, **Heng Yang**, Danfei Xu, Boyi Li, Boris Ivanovic, Marco Pavone, and Yue Wang. LoRA3D: Low-Rank Self-Calibration of 3D Geometric Foundation Models. In *International Conference on Learning Representations*, 2025 **(Spotlight)** (pdf)

[C8] Shucheng Kang, Xiaoyang Xu, Jay Sarva, Ling Liang, and **Heng Yang**. Fast and Certifiable Trajectory Optimization. In *International Workshop on the Algorithmic Foundations of Robotics*, 2024 **(Best Paper Award Finalist, Model-based Optimization for Robotics)** (pdf) (web)

[C9] Aneesh Muppidi, Zhiyu Zhang, and **Heng Yang**. Fast TRAC: A Parameter-Free Optimizer for Lifelong Reinforcement Learning. In *Conference on Neural Information Processing Systems*, 2024 (pdf) (web)

[C10] Zhiyu Zhang, David Bombara, and **Heng Yang**. Discounted Adaptive Online Learning: Towards Better Regularization. In *International Conference on Machine Learning*, 2024 (pdf)

[C11] Yihuai Gao, Yukai Tang, Han Qi, and **Heng Yang**. CLOSURE: Fast quantification of pose uncertainty sets. In *Robotics: Science and Systems*, 2024 (pdf)

[C12] Haoyu Han and **Heng Yang**. On the Nonsmooth Geometry and Neural Approximation of the Optimal Value Function of Infinite-Horizon Pendulum Swing-up. In *Annual Learning for Dynamics & Control Conference*, 2024 (pdf)

[C13] Yukai Tang, Jean-Bernard Lasserre, and **Heng Yang**. Uncertainty Quantification of Set-Membership Estimation in Control and Perception: Revisiting the Minimum Enclosing Ellipsoid. In *Annual Learning for Dynamics & Control Conference*, 2024 **(Oral)** (pdf)

[C14] Zhiyu Zhang, **Heng Yang**, Ashok Cutkosky, and Ioannis Paschalidis. Improving adaptive online learning using refined discretization. In *International Conference on Algorithmic Learning Theory*, 2024 (pdf)

[C15] Shucheng Kang, Yuxiao Chen, **Heng Yang**, Marco Pavone. Verification and Synthesis of Robust Control Barrier Functions: Multilevel Polynomial Optimization and Semidefinite Relaxation. In *IEEE Conference on Decision and Control*, 2023 (pdf)

[C16] **Heng Yang** and Marco Pavone. Object Pose Estimation with Statistical Guarantees: Conformal Keypoint Detection and Geometric Uncertainty Propagation. In *Conference on Computer Vision and Pattern Recognition*, 2023 **(Highlight)** (pdf)

[C17] Jingnan Shi, **Heng Yang**, and Luca Carlone. ROBIN: a graph-theoretic approach to reject outliers in robust estimation using invariants. In *IEEE Intl. Conf. on Robotics and Automation*, 2021 (pdf)

[C18] **Heng Yang**, Wei Dong, Luca Carlone, and Vladlen Koltun. Self-supervised geometric perception. In *Conference on Computer Vision and Pattern Recognition*, 2021 (pdf)

[C19] **Heng Yang**, Chris Doran, and Jean-Jacques Slotine. Dynamical Pose Estimation. In *Intl. Conf. on Computer Vision*, 2021 (pdf)

[C20] Jingnan Shi, **Heng Yang**, and Luca Carlone. Optimal Pose and Shape Estimation for Category-level 3D Object Perception. In *Robotics: Science and Systems*, 2021 **(Best Paper Award Finalist)** (pdf)

[C21] **Heng Yang** and Luca Carlone. One ring to rule them all: Certifiably robust geometric perception with outliers. In *Conference on Neural Information Processing Systems*, 2020 (pdf)

[C22] **Heng Yang** and Luca Carlone. In Perfect Shape: Certifiably Optimal 3D Shape Reconstruction from 2D Landmarks. In *Conference on Computer Vision and Pattern Recognition*, 2020 (pdf)

[C23] **Heng Yang** and Luca Carlone. A quaternion-based certifiably optimal solution to the Wahba problem with outliers. In *International Conference on Computer Vision*, 2019 **(Oral)** (pdf)

[C24] **Heng Yang** and Luca Carlone. A Polynomial-time Solution for Robust Registration with Extreme Outlier Rates. In *Robotics: Science and Systems*, 2019 (pdf) (code)

Teaching

Instructor, (ES 257) Semidefinite Optimization and Relaxation, School of Engineering and Applied Sciences, Harvard University, Spring 2024 (Online Textbook)

Instructor, (ES/AM 158) Introduction to Optimal Control and Estimation,[1] School of Engineering and Applied Sciences, Harvard University, Fall 2023 (Online Textbook)

Instructor, (ES 155) Systems and Control, School of Engineering and Applied Sciences, Harvard University, Fall 2024

Professional Activities

Area Chair, Robotics: Science and Systems, 2025

Expert Reviewer, Schmidt Sciences AI2050 Early Career Fellowship, 2025

Associate Editor, IEEE Robotics and Automation Letters, 2024 – present

Associate Editor, International Journal of Robotics Research, 2023 – present

Panelist, National Science Foundation, 2024

Associate Editor, International Conference on Intelligent Robots and Systems, 2023

Organization of International Workshops, Seminars, and Tutorials

Session "Moment-SOS Hierarchy: From Theory to Computation in the Real World", in conjunction with International Conference on Continuous Optimization (ICCOPT), 2025

Workshop "Frontiers of optimization for robotics", in conjunction with Robotics: Science and Systems (RSS), 2024 (web)

Workshop "Lifelong Robot Learning: Generalization, Adaptation, and Deployment with Large Models", in conjunction with Robotics: Science and Systems (RSS), 2024 (web)

Workshop "Safe and Robust Learning for Perception-based Planning and Control", in conjunction with American Control Conference (ACC), 2023

Tutorial "Global Optimization for Geometric Understanding with Provable Guarantees", in conjunction with International Conference on Computer Vision (ICCV), 2019 (web)

Tutorial "Certifiable Robot Perception: from Global Optimization to Safer Robots", in conjunction with Robotics: Science and Systems (RSS), 2020 (web)

Other Committee and Board Membership

SEAS Graduate Scholarships Subcommittee, Harvard University, 2025

Standing Committee, S.M. Degree in Data Science at Harvard University, 2024 – 2025

Program Committee, Robotics: Science and Systems (RSS) Pioneers, 2022

Program Committee, AAAI Student Abstract and Poster Program, 2022

LIDS & Stats Tea Talks Committee, Massachusetts Institute of Technology, 2021

[1] Will be updated to Introduction to Optimal Control and Reinforcement Learning starting Fall 2025.

Co-organizer and Co-chair of the 26th LIDS Student Conference, Massachusetts Institute of Technology, 2021 (web)

Invited Talks

Large-Scale Semidefinite Programming with GPU-accelerated ADMM

INFORMS Annual Meeting, Atlanta, GA 10/2025

Local Linear Convergence of ADMM for SDP under Strict Complementarity

Department of Mathematics, Hong Kong Baptist University 5/2025

Department of Mathematics, University of Maryland College Park 4/2025

Optimization-Driven Discovery of Contact-Rich Behaviors in Robotics

Robotics Department, LAAS-CNRS, Toulouse 6/2025

Robotics Research at Boston Dynamics 4/2025

Sparse Moment-SOS Relaxations for Direct Optimal Control

International Conference on Continuous Optimization, Los Angeles 7/2025

Oberwolfach Research Institute for Mathematics, Germany 8/2024

New Frontiers in Decision and Control at Harvard University 8/2024

Online Uncertainty Set Prediction and Set-Membership Estimation

Workshop on "Interplay Between Machine Learning and Set-Based Identification & Control", American Control Conference 7/2025

Learning-enabled Perception: From 3D Reconstruction to Physical Intelligence

Draper Laboratory 3/2025

Control-oriented Clustering of Visual Latent Representation

CSE DSI Machine Learning Seminar, University of Minnesota 10/2024

The Power of Modern Convex Optimization in Nonconvex Perception, Control, and Learning

MIT SPARK Lab 12/2024

Polynomial Optimization Team, LAAS-CNRS, Toulouse, France 10/2024

Department of Electrical Engineering, Northeastern University 10/2024

INRIA Paris 10/2024

Semidefinite Relaxation in the Large: Towards Fast and Certifiable Robot Perception and Control

Mathworks 5/2024

Fast and Certifiable Approximation of Pose Uncertainty Sets

INFORMS Optimization Society Conference 2024

Semidefinite Relaxations for Robot Perception and Control: Performance Certificates and Computational Challenges

Department of Mathematics, National University of Singapore 2023

Revisiting the Minimum Enclosing Ellipsoid of Set-Membership Estimation in Control and Perception

Autonomy Talks, Institute for Dynamic Systems and Control, ETH Zurich 2023

Object Pose Estimation with Statistical Guarantees: Conformal Keypoint Detection and Geometric Uncertainty Propagation

Multirobot Systems Lab, Stanford University 2023

DASC Lab Controls Conversations, University of Michigan 2023

Towards Trustworthy Geometric Perception: Certifiably Optimal Estimation and Probabilistically Correct Detection

Stanford Vision and Learning Lab, Stanford University 2022

Workshop on Safety Validation of Connected and Automated Vehicles, IEEE International Conference on Intelligent Transportation Systems (ITSC) 2022

Solving Rank-One Semidefinite Relaxation of Polynomial Optimization: From Certifiable Robot Perception to Beyond

International Conference on Continuous Optimization 2022

Certifiable Outlier-Robust Geometric Perception

Yau Mathematical Sciences Center, Tsinghua University 2023

Computing in Engineering Forum, University of Wisconsin-Madison 2022

ICRA Workshop on Trustworthy Autonomy and Robotics 2022

AI and Robotics Seminar, University of Toronto 2022

Computer Science, Purdue University 2022

Electrical and Computer Engineering, Princeton University 2022

Aeronautics and Astronautics, University of Washington 2022

Electrical and Computer Engineering, University of Southern California 2022

Electrical Engineering, Harvard University 2022

Electrical and Systems Engineering, University of Pennsylvania 2022

Robotics Institute, University of Michigan 2022

Mechanical Engineering, University of Wisconsin-Madison 2022

Robotics Colloquium, University of Washington 2022

GRASP Lab, University of Pennsylvania 2021

Robotics and Autonomous Systems Seminar, HKUST 2021

College of Computing and Informatics, UNC Charlotte 2021

Robotics Seminar, Cornell University 2021

MIT Driverless 2020

Advisees and Mentees

Postdoctoral Associates

Wenhui Huang 2025 – present

Zhiyu Zhang (Alumnus) 2023 – 2025
Next: Assistant Professor at Zhejiang University

PhD Students

Shucheng Kang (G2) Electrical Engineering, Harvard University
Thesis: Solving Large-Scale Structured Semidefinite Relaxations for Autonomy

Han Qi (G2) Computer Science, Harvard University
Thesis: Structured Representation and Architecture for Vision-based Robot Learning

Haoyu Han (G1) Applied Mathematics, Harvard University
Thesis (tentative): Contact-Rich Motion Planning

Jack Benarroch Jedlicki (incoming G1 Fall 2025) Computer Science, Harvard University
Supported by "la Caixa" Foundation Fellowship and SEAS Prize Fellowship

Visiting PhD Students

Yulin Li (Alumnus) 9/2024 – 1/2025
Hong Kong University of Science and Technology

PhD Qualifying Exam Committee

Jordan Feldman (PhD Advisor: Patrick Slade) Bioengineering, Harvard University

Haitong Ma (PhD Advisor: Na Li) Electrical Engineering, Harvard University

Christian Chan (PhD Advisor: Robert Wood) MSME, Harvard University

Undergraduate Student Mentees

Aneesh Muppidi (**US Rhodes Scholar**) Computer Science, Harvard University
Next: PhD student at Stanford University

Minseung (Ritta) Choi California Institute of Technology

Aris Zhu Physics and Computer Science, Harvard University

John Rho Statistics and Computer Science, Harvard University

Alex Tong Mathematics, UC Berkeley

Tim Nguyen Statistics and Computer Science, Boston University

Christy Jestin (Alumnus) Computer Science, Harvard University
Next: Boston Dynamics

Xihang Yu (Alumnus) Computer Science, University of Michigan
Next: PhD student at MIT AeroAstro

Yukai Tang (Alumnus) Electrical Engineering, Tsinghua University
Next: PhD student at Princeton Operations Research and Financial Engineering

Jiarui Li (Alumnus) Robotics, Peking University
Next: PhD student at MIT CEE and LIDS

Xiaoyang Xu (Alumnus) Computer Science, University of Science and Technology of China
Next: PhD student at UCSB Computer Science

Haoyu Han (Alumnus) Mathematics, University of Science and Technology of China
Next: PhD student at Harvard University (stayed in my group)

Jay Sarva (Alumnus) Computer Science, Brown University

Master Student Mentees

Antoine Groudiev École Normale Supérieure - PSL

Marguerite Benoist Swiss Federal Institute of Technology in Lausanne (EPFL)

Rajiv Swamy Computational Science and Engineering, Harvard University

Elijah Dabkowski (Harvard Draper Scholar) Data Science, Harvard University

David Bombara (Alumnus)
Next: Data Analyst at State Street Corporation

Stephen Yang (Alumnus) Computational Science and Engineering, Harvard University
Next: Researcher at Applied Intuition

Haocheng Yin (Alumnus) Computer Science, ETH Zurich
Next: PhD Student at Georgia Institute of Technology

Elior Benarous (Alumnus) Computer Science, ETH Zurich

Hugo Buurmeijer (Alumnus) Aeronautics and Astronautics, Stanford University
Next: PhD Student at Stanford University

Kevin Kasa (Alumnus) University of Guelph and Vector Institute
Next: ServiceNow Research

Zequn Chen (Alumnus) Tsinghua University

Undergraduate Student Advisees

Ike Ogbu; Moeen Razzaque; Ashley Redhead Electrical Engineering, Harvard University

High School Student Mentees

William Zhang Weston High School, MA
Next: Undergraduate at University of Pennsylvania

Tim Nguyen Boston Latin School, MA
Next: Undergraduate at Boston University and Undergraduate researcher at Harvard

Last update: January 6, 2026