Heng Yang

(Incoming) **Assistant Professor**
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Research Interests

Robotics; Computer Vision; Optimization; Statistics; Machine Learning

I am broadly interested in the *algorithmic foundations* of robot perception, action, and learning. My vision is to enable *safe and trustworthy autonomy* for a broad range of high-integrity robotics applications, by (i) designing *tractable and provably correct algorithms* that enjoy rigorous performance guarantees, (ii) developing *fast implementations*, and (iii) validating them on *real robotic systems*.

Education

Massachusetts Institute of Technology, Cambridge, MA
Doctor of Philosophy in Mechanical Engineering 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 Principal Scholarship (9/3000+)

Appointments

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

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

Honors and Awards

MIT LIDS/ALL Magazine: Honing Robot Perception, 2022

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

Best Paper Award Finalist, Robotics: Science and Systems (RSS), 2021

Robotics: Science and Systems (RSS) Pioneer, 2021

Graduated Non-Convexity (GNC) algorithm included in Matlab Navigation Toolbox and appeared in MathWorks News and Stories, 2020

Best Paper Award Honorable Mention, Robotics and Automation Letters (RAL), 2020

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

MIT Spotlight: Spotting objects amid clutter, 2019

Tsinghua Principal Scholarship (Tsinghua News Spotlight), 2015

Selected Publications

Preprint

[P1] Shi, Jingnan, Yang, Heng, and Carlone, Luca. Optimal and Robust Category-level Perception: Object Pose and Shape Estimation from 2D and 3D Semantic Keypoints. *arXiv preprint arXiv:2206.12498*. 2022

Journal

[J1] Yang, Heng, Liang, Ling, Carlone, Luca, and Toh, Kim-Chuan. An Inexact Projected Gradient Method with Rounding and Lifting by Nonlinear Programming for Solving Rank-One Semidefinite Relaxation of Polynomial Optimization. *Mathematical Programming*. 2022 (code) (news)

[J2] Yang, Heng, and Carlone, Luca. Certifiably Optimal Outlier-Robust Geometric Perception: Semidefinite Relaxations and Scalable Global Optimization. *IEEE Trans. Pattern Anal. Machine Intell.* 2022 (code)

[J3] Antonante, Pasquale, Tzoumas, Vasileios, Yang, Heng, and Carlone, Luca. Outlier-robust estimation: Hardness, minimally tuned algorithms, and applications. *IEEE Transactions on Robotics*. 2021 (code)

[J4] Yang, Heng, Antonante, Pasquale, Tzoumas, Vasileios, and Carlone, Luca. Graduated non-convexity for robust spatial perception: From non-minimal solvers to global outlier rejection. *IEEE Robotics and Automation Letters*. 2020 (code) (news)
Best Paper Award in Robot Vision at ICRA
Best Paper Award Honorable Mention from RAL

[J5] Yang, Heng, Shi, Jingnan, and Carlone, Luca. TEASER: Fast and certifiable point cloud registration. *IEEE Transactions on Robotics*. 2020 (code)

Conference

[C1] Shi, Jingnan, Yang, Heng, and Carlone, Luca. ROBIN: a graph-theoretic approach to reject outliers in robust estimation using invariants. In *IEEE Intl. Conf. on Robotics and Automation (ICRA)*. 2021

[C2] Yang, Heng, Doran, Chris, and Slotine, Jean-Jacques. Dynamical Pose Estimation. In *Intl. Conf. on Computer Vision (ICCV)*. 2021 (code)

[C3] Yang, Heng, Dong, Wei, Carlone, Luca, and Koltun, Vladlen. Self-supervised geometric perception. In *IEEE Conf. on Computer Vision and Pattern Recognition (CVPR)*. 2021 (code)

[C4] Shi, Jingnan, Yang, Heng, and Carlone, Luca. Optimal Pose and Shape Estimation for Category-level 3D Object Perception. In *Robotics: Science and Systems (RSS)*. 2021
Best Paper Award Finalist

[C5] Yang, Heng, and Carlone, Luca. One ring to rule them all: Certifiably robust geometric perception with outliers. In *Advances in neural information processing systems (NeurIPS)*. 2020 (code)

[C6] Yang, Heng, and Carlone, Luca. In Perfect Shape: Certifiably Optimal 3D Shape Reconstruction from 2D Landmarks. In *IEEE Conf. on Computer Vision and Pattern Recognition (CVPR)*. 2020

[C7] Yang, Heng, and Carlone, Luca. A quaternion-based certifiably optimal solution to the Wahba problem with outliers. In *IEEE/CVF International Conference on Computer Vision (ICCV)*. 2019 (code)

[C8] Yang, Heng, and Carlone, Luca. A Polynomial-time Solution for Robust Registration with Extreme Outlier Rates. In *Robotics: Science and Systems (RSS)*. 2019 (code) (news)

Workshop

[W1] Yang, Heng, and Pavone, Marco. Conformal Semantic Keypoint Detection with Statistical Guarantees. In *NeurIPS Workshop on Robot Learning: Trustworthy Robotics*. 2022 (pdf)

Teaching

Guest lecturer, Computer modeling and simulation of autonomous vehicles and robots, University of Wisconsin-Madison, 2022

Guest lecturer, Robotics: Science and Systems, MIT, 2021

Guest lecturer, Visual Navigation for Autonomous Aerial Vehicles, Univ. of Michigan, 2021

Teaching assistant, Visual Navigation for Autonomous Vehicles, MIT, 2020

Invited Talks

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

DASC Lab Controls Conversations, University of Michigan (video) 2023

Perception with Confidence: A Conformal Prediction Perspective (slides)

X-idea seminar, Tsinghua University 2022

ECCV Workshop on 3D Perception for Autonomous Driving 2022

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 (web), IEEE International Conference on Intelligent Transportation Systems (ITSC) 2022

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

International Conference on Continuous Optimization (ICCOPT) 2022

Certifiable Outlier-Robust Geometric Perception

Computing in Engineering Forum, University of Wisconsin–Madison (web) 2022

ICRA Workshop on Trustworthy Autonomy and Robotics 2022

AI and Robotics Seminar, University of Toronto (video)[1] 2022

Computer Science, Purdue University 2022

Electrical and Computer Engineering, Princeton University (video) (video) 2022

Aeronautics and Astronautics, University of Washington 2022

Electrical and Computer Engineering, University of Southern California 2022

Electrical Engineering, Harvard University 2022

[1] 1 I recommend watching this video if you are interested in my PhD research on certifiable perception.

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 (video) 2022

GRASP Lab, University of Pennsylvania (video) 2021

Robotics and Autonomous Systems Seminar, HKUST 2021

College of Computing and Informatics, UNC Charlotte 2021

Robotics Seminar, Cornell University (web) 2021

Driverless, Massachusetts Institute of Technology (video) 2020

Self-supervised Geometric Perception

MatchLab, Imperial College London 2021

Professional Activities

Associate Editor, International Journal of Robotics Research, 2023

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

Organization of International Workshops, Seminars, and Tutorials

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

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

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

Reviewer for Journals

IEEE Transactions on Pattern Analysis and Machine Intelligence

IEEE Robotics and Automation Letters

IEEE Transactions on Robotics

International Journal of Robotics Research

Journal of Mathematical Imaging and Vision

Autonomous Robots

Graphical Models

International Journal of Computer Vision

Computational Optimization and Applications

Journal of Field Robotics

Transactions on Visualization and Computer Graphics

Artificial Intelligence

Reviewer for Conferences

Robotics: Science and Systems

International Conference on Computer Vision

International Conference on Robotics and Automation

IEEE/RSJ International Conference on Intelligent Robots and Systems

Learning for Dynamics and Control

Conference on Computer Vision and Pattern Recognition

Conference on Neural Information Processing Systems

International Conference on Machine Learning

International Conference on Learning Representations

Conference on Robot Learning

International Symposium on Robotics Research

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