

Haoran Song

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EDUCATION

Hong Kong University of Science and Technology, Hong Kong SAR, China

Ph.D. in Robotics Institute

Sep. 2016 – May. 2021

Advisor: Prof. Michael Yu Wang and Prof. Qifeng Chen

KTH Royal Institute of Technology, Stockholm, Sweden

Visiting scholar in Robotics, Perception and Learning Lab

Mar. 2018 – Sep. 2018

Advisor: Prof. Danica Kragic

Harbin Institute of Technology, Harbin, China

B.Eng. in Flight Vehicle Design and Engineering

Sep. 2012 – Aug. 2016

Graduated with Excellent Thesis Award

WORKING

Huawei ADS - Prediction / PnC AI, Beijing, China

Tech Lead & Principal Engineer

Jul. 2021 – Present

- Implemented a comprehensive data-driven prediction solution that covers various dynamic objects (vehicles, cyclists and pedestrians) and traffic scenarios (urban and highway), which is widely deployed on Huawei ADS products.
 - Optimized trajectory accuracy, temporal consistency and kinematic feasibility of prediction module by a large margin.
 - Developed a fast trajectory re-planner to enable long-term prediction with obstacle-avoidance ability.
 - Constructed a unified training framework that is capable of decoupling model branches, data flow and optimization flow, handling frame-based and stream-based data, and thus improves the efficiency of model development and iteration.
 - Initiated the FSD project by implementing the PRIME framework and defined the data-driven PnC architecture
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RESEARCH

Prediction and Planning for Autonomous Driving

May. 2019 – Mar. 2021

- *Predicting trajectories with model-based planning:*

CoRL 2021

Unlike most prediction works that produce unconstrained trajectories, we propose a feasibility-guaranteed and robust prediction architecture called PRIME, which learns to predict vehicle trajectories with model-based trajectory generation, thereby outperforming the other state-of-the-art works in prediction accuracy, trajectory feasibility, robustness against imperfect tracking. Until March 2021, we kept **ranking 1st** on the Argoverse Motion Forecasting Leaderboard.

- *Planning-informed trajectory prediction:*

ECCV 2020

By incorporating the future planning of ego vehicle with the historical tracking of others, we propose planning-informed prediction (PiP) to tackle the multi-agent trajectory prediction task. The PiP architecture achieves state-of-the-art prediction performance on interactive scenarios and pioneers a novel prediction-planning-coupled pipeline.

Motion Planning Under Physical Interaction

Mar. 2017 – Sep. 2019

- *Planar objects sorting:*

IROS 2020

To address the challenging sorting tasks under multi-contact physics, we propose an MCTS-based planner with a heuristic reward. A rollout policy is learned from its successful sorting experience and finally employed to further reinforce the Monte Carlo Tree Search. We validate the planner's effectiveness from large-scale experiments.

- *Formation-based motion planning:*

Autonomous Robots

Apply computational geometry and topology in planning a set of mobile robots. We propose an RRT-based path planning algorithm, demonstrate its probabilistic completeness, and validate it in simulations and real robots.

- *UAV maneuver planning:*

Science Robotics (cover article)

Enable UAVs with the capability of making and stabilizing contacts with the environment. We propose an actuated landing gear framework for performing UAV perching and resting on different structures, which is effective in reducing power consumption, promoting pose stability, and preserving large vision ranges while maneuvering at heights.

- *Robust grasp planning:*

ICRA 2018 & RA-L

Rethink grasp planning from geometry matching rather than contact modeling. We learn the representative contact geometries and propose an efficient planning algorithm that significantly improves the grasp stability and error tolerance.

PUBLICATIONS

First-authored

- [1] **Haoran Song**, Di Luan, Wenchao Ding, Michael Yu Wang, and Qifeng Chen, "Learning to Predict Vehicle Trajectories with Model-based Planning," in *Conference on Robot Learning (CoRL)*, 2021.
- [2] **Haoran Song**, Wenchao Ding, Yuxuan Chen, Shaojie Shen, Michael Yu Wang, and Qifeng Chen, "PiP: Planning-informed Trajectory Prediction for Autonomous Driving," in *European Conference on Computer Vision (ECCV)*, 2020.

- [3] **Haoran Song***, Joshua A. Haustein*, Weihao Yuan, Kaiyu Hang, Michael Yu Wang, Danica Kragic, and Johannes A. Stork, "Multi-Object Rearrangement with Monte Carlo Tree Search: A Case Study on Planar Nonprehensile Sorting," in *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2020.
- [4] **Haoran Song***, Anastasiia Varava*, Oleksandr Kravchenko, Danica Kragic, Michael Yu Wang, Florian T. Pokorny, and Kaiyu Hang, "Herding by Caging: A Formation-based Motion Planning Framework for Guiding Mobile Agents," in *Autonomous Robots (AURO)*, 2021.
- [5] Kaiyu Hang*, Ximin Lyu*, **Haoran Song***, Johannes A Stork*, Aaron M Dollar, Danica Kragic, and Fu Zhang, "Perching and resting - A paradigm for UAV maneuvering with modularized landing gears," in *Science Robotics*, 2019. (* **denotes equal contribution**).
- [6] **Haoran Song**, Michael Yu Wang, and Kaiyu Hang, "Fingertip surface optimization for robust grasping on contact primitives," in *IEEE International Conference on Robotics and Automation (ICRA) & IEEE Robotics and Automation Letters (RA-L)*, 2018.

Others

- [1] Weihao Yuan, Kaiyu Hang, **Haoran Song**, Danica Kragic, Michael Y. Wang, and Johannes A. Stork, "Reinforcement Learning in Topology-based Representation for Human Body Movement with Whole Arm Manipulation," in *IEEE International Conference on Robotics and Automation (ICRA)*, 2019.
- [2] Kaiyu Hang, and **Haoran Song**, "Robotic fingertip design and grasping on contact primitives," *US Patent App*, 2019.

ACADEMIC ACTIVITIES

Services

- Reviewer for The Conference on Robot Learning (CoRL)
- Reviewer for IEEE / CVF Computer Vision and Pattern Recognition Conference (CVPR)
- Reviewer for The European Conference on Computer Vision (ECCV)
- Reviewer for IEEE Transactions on Robotics (T-RO)
- Reviewer for IEEE Robotics and Automation Letters (RA-L)
- Reviewer for IEEE International Conference on Robotics and Automation (ICRA)
- Reviewer for IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

Presentations

- CoRL 2021, London, UK
- IROS 2020, Las Vegas, USA
- ECCV 2020, Glasgow, Scotland, UK
- ICRA 2018, Brisbane, Australia
- IROS 2017, Vancouver, Canada

HONORS & AWARDS

- Beijing Research Institute Director's Award - Advanced R&D Individual, Huawei (1 place in ADS Beijing) Mar. 2023
- Excellent Delivery Team Award, Huawei ADS 2022, 2023
- Outstanding Undergraduate Thesis Award, Harbin Institute of Technology (top 2%) Jun. 2016
- Outstanding Graduate Award, Harbin Institute of Technology (top 10%) May. 2016
- Meritorious Winner in Mathematical Contest in Modeling, USA Feb. 2015
- Renmin Scholarship, Harbin Institute of Technology 2013, 2014, 2015