Haoran Song

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Robotics Institute, HKUST
Clear Water Bay, Kowloon, Hong Kong

EDUCATION

Hong Kong University of Science and Technology, *Hong Kong SAR, China*
Ph.D. in Robotics Institute — *Sep. 2016 – Jun. 2021 (expected)*
Advisors: 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*
Advisors: Prof. Danica Kragic

Harbin Institute of Technology, *Harbin, China*
B.Eng. in Flight Vehicle Design and Engineering, School of Astronautics — *Sep. 2012 – Aug. 2016*
GPA: 88.96 / 100.00

RESEARCH

Prediction and Planning for Autonomous Driving — *May. 2019 – Present*

- *Multi-modal prediction for urban driving*: *Ongoing*
  A reasonable result for trajectory prediction should be accord with the vehicle's dynamic constraints, compatible with the road structure and traffic rules, and socially-compliant with the surrounding vehicles' motion. Most prediction works so far take these factors in a learning-based framework and directly output the future spatial-temporal trajectories. However, some of such predictions are kinematically, environmentally, or socially infeasible, especially in urban scenarios. It brings burdens to the downstream planning module. Given these, my current work is to develop a robust and interpretable framework to make the multi-modal prediction for urban driving more reasonable.
- *Planning-informed trajectory prediction*: *ECCV 2020*
  Different future plans of the ego agent will largely affect the future behaviors of surrounding agents, which leads to a significant difference in future predictions. We propose planning-informed prediction (PiP) to tackle the multi-agent trajectory prediction task. By incorporating the future planning of ego vehicle with the historical tracking of others, PiP architecture achieves the state-of-the-art performance of multi-agent forecasting on highway datasets. Moreover, PiP enables a novel planning-prediction-coupled pipeline that produces future predictions one-to-one corresponding to ego's candidate plans which is especially suitable for planning in dense and highly interactive traffic.

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 to address the interesting "herding" task. We propose an RRT-based path planning algorithm for herding by caging, 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 traditional point contact modeling. We learn the representative contact geometries from grasping demonstrations to optimize the robotic fingertip. Thereafter, we propose an efficient grasp planning algorithm that significantly improves the grasp stability and tolerance to positioning error.

PUBLICATIONS

First-authored

[1] **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.

[2] **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.

[3] **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.

[4] 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**).

[5] **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 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

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

HONORS & AWARDS

- 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 (MCM), USA *Feb. 2015*
- Renmin Scholarship, Harbin Institute of Technology *2012 – 2015*