

# Peide Cai

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## EDUCATION

- **Hong Kong University of Science and Technology** Hong Kong SAR, China  
PhD in Electronic and Computer Engineering Sept. 2018 - Present  
[Robotics and Multi-perception Lab](#) Advisor: [Prof. Ming Liu](#)
- **Zhejiang University** Hangzhou, China  
Bachelor in Automation Engineering Sept. 2014 - June 2018  
College of Control Science and Engineering GPA: 3.91/4 (ranking: 8/116) Advisor: [Prof. Tao Zhang](#)

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## RESEARCH EXPERIENCE

- **Deep Reinforcement Learning for Urban Autonomous Driving** Apr. 2021 - Present  
◦ *Safe and Efficient Autonomous Driving* *under review*  
Complex and various traffic scenarios are hard to model manually, therefore, *learning to drive from data* is a promising solution. The control policies trained with supervised learning suffer from the distribution mismatch problem. In this work, we use deep reinforcement learning and graph neural networks to train agents interactively for safe and efficient autonomous driving.
- **High-speed Autonomous Car Drifting and Racing** July. 2019 - Apr. 2021  
◦ *Vision-based RC-Car Racing* RA-L & IROS  
We present a general deep imitative reinforcement learning approach (DIRL) which successfully achieves agile autonomous racing using visual inputs. *The driving knowledge is acquired from both imitation learning and model-based reinforcement learning*, where the agent can learn from human teachers as well as self-improve by safely interacting with an offline world model.  
◦ *High-speed Autonomous Drifting* RA-L & ICRA  
We propose a robust drift controller without explicit motion equations, which is based on the latest *model-free deep reinforcement learning* algorithm soft actor-critic. After being trained on tracks with different levels of difficulty, our controller is capable of making the vehicle drift through various sharp corners quickly and stably in the unseen map. The proposed controller is further shown to have excellent generalization ability, which can directly handle unseen vehicle types with different physical properties, such as mass, tire friction, etc.
- **End-to-End Learning of Planning and Control for Self-Driving** Mar. 2019 - Oct. 2020  
◦ *Multi-modal End-to-End Vehicle Navigation* RA-L & IROS  
All-day and all-weather navigation is a critical capability for autonomous driving, which requires proper reaction to varied environmental conditions and complex agent behaviors. In this paper, based on imitation learning, we propose a probabilistic driving model with multiperception capability utilizing the information from the camera, lidar and radar. The results suggest that our proposed model outperforms baselines and achieves excellent generalization performance in unseen environments with heavy traffic and extreme weather.  
◦ *Vision-based Trajectory Generation Network* T-IV & ITSC  
In this paper, we develop an uncertainty-aware end-to-end trajectory generation method based on imitation learning. It can extract spatiotemporal features from the front-view camera images for scene understanding, and then generate collision-free trajectories several seconds into the future. The experimental results suggest that under various weather and lighting conditions, our network can reliably generate trajectories in different urban environments, such as turning at intersections and slowing down for collision avoidance.

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## SELECTED PUBLICATIONS

\* indicates equal contribution

- **First authored**
  1. (*under review*) **Peide Cai**, Hengli Wang, Yuxiang Sun, and Ming Liu, "DQ-GAT: Towards Safe and Efficient Autonomous Driving with Deep Q-Learning and Graph Attention Networks," submitted to *IEEE Transactions on Intelligent Transportation Systems*, 2021.
  2. **Peide Cai**, Hengli Wang, Yuxiang Sun, and Ming Liu, "DiGNet: Learning Scalable Self-driving Policies for Generic Traffic Scenarios with Graph Neural Networks," accepted by *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2021*.

3. **Peide Cai**, Hengli Wang, Huaiyang Huang, Yuxuan Liu, and Ming Liu, "Vision-based Autonomous Car Racing Using Deep Imitative Reinforcement learning," accepted by *IEEE Robotics and Automation Letters (RA-L)* & *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* 2021.
  4. **Peide Cai**, Sukai Wang, Yuxiang Sun, and Ming Liu, "Probabilistic End-to-End Vehicle Navigation in Complex Dynamic Environments with Multimodal Sensor Fusion," in *IEEE Robotics and Automation Letters (RA-L)* & *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* 2020.
  5. **Peide Cai**, Yuxiang Sun, Hengli Wang, and Ming Liu, "VTGNet: A Vision-based Trajectory Generation Network for Autonomous Vehicles in Urban Environments," in *IEEE Transactions on Intelligent Vehicles*, 2020.
  6. **Peide Cai\***, Xiaodong Mei\*, Lei Tai, Yuxiang Sun, and Ming Liu, "High-speed Autonomous Drifting with Deep Reinforcement Learning," in *IEEE Robotics and Automation Letters (RA-L)* & *IEEE International Conference on Robotics and Automation (ICRA)* 2020.
  7. **Peide Cai**, Yuxiang Sun, Yuying Chen, and Ming Liu, "Vision-based Trajectory Planning via Imitation Learning for Autonomous Vehicles," in *IEEE Intelligent Transportation Systems Conference (ITSC)*, 2019.
- **Others**
    1. Hengli Wang\*, Rui Fan\*, **Peide Cai**, and Ming Liu, "SNE-RoadSeg+: Rethinking Depth-Normal Translation and Deep Supervision for Freespace Detection," In *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* 2021.
    2. Hengli Wang, **Peide Cai**, Rui Fan, Yuxiang Sun, and Ming Liu, "End-to-End Interactive Prediction and Planning with Optical Flow Distillation for Autonomous Driving," in *IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops*, 2021.
    3. Sukai Wang, **Peide Cai**, Lujia Wang, and Ming Liu, "DiTNet: End-to-End 3d Object Detection and Track ID Assignment in Spatio-temporal world," in *IEEE Robotics and Automation Letters (RA-L)* & *IEEE International Conference on Robotics and Automation (ICRA)* 2021.
    4. Hengli Wang, **Peide Cai**, Yuxiang Sun, Lujia Wang, and Ming Liu, "Learning Interpretable End-to-End Vision-based Motion Planning for Autonomous Driving with Optical Flow Distillation," in *IEEE International Conference on Robotics and Automation (ICRA)*, 2021.
    5. Hengli Wang\*, Rui Fan\*, **Peide Cai**, and Ming Liu, "PVStereo: Pyramid Voting Module for End-to-End Self-supervised Stereo Matching," in *IEEE Robotics and Automation Letters* & *IEEE International Conference on Robotics and Automation (ICRA)*, 2021.
    6. Tianyu Liu, Qinghai Liao, Lu Gan, etc., **Peide Cai**, Yuxiang Sun, Yandong Liu, Lujia Wang, and Ming Liu, "The Role of the Hercules Autonomous Vehicle During the Covid-19 Pandemic: An Autonomous Logistic Vehicle for Contactless Goods Transportation," in *IEEE Robotics Automation Magazine*, 2021.
    7. Rui Fan\*, Hengli Wang\*, **Peide Cai**, Jin Wu, Junaid Bocus, Lei Qiao, and Ming Liu. "Learning Collision-free Space Detection from Stereo Images: Homography Matrix Brings Better Data Augmentation," in *IEEE/ASME Transactions on Mechatronics*, 2021.
    8. Yuxiang Sun, Weixun Zuo, Huaiyang Huang, **Peide Cai**, and Ming Liu. "PointMoSeg: Sparse Tensor-based End-to-End Moving-obstacle Segmentation in 3-D Lidar Point Clouds for Autonomous Driving," in *IEEE Robotics and Automation Letters* & *IEEE International Conference on Robotics and Automation (ICRA)*, 2021.
    9. Rui Fan\*, Hengli Wang\*, **Peide Cai**, and Ming Liu, "SNE-RoadSeg: Incorporating Surface Normal Information into Semantic Segmentation for Accurate Freespace Detection," In *European Conference on Computer Vision (ECCV)*, 2020.

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## EXPERIENCE

### • Project in Charge

- 1<sup>st</sup> HKUST-Kaisa Autonomous RC Car Racing Competition (25 teams with 90+ participants)  
[\[News\]](#) [\[Code\]](#) [\[Workshops\]](#) [\[Video\]](#) July 2020 - Apr. 2021

### • Internship

- Unity-Drive Innovation Technology Co., Ltd. (Shenzhen, China) June 2018 - Aug. 2018
- City University of Hong Kong Shenzhen Research Institute July 2017 - Sept. 2017

- **Summer Session Study**

- University of California (UCLA)

Aug. 2016 - Sept. 2016

TEACHING

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Teaching Assistant: ELEC3200 - System Modeling, Analysis and Control, HKUST

Spring 2019

Teaching Assistant: ELEC3300 - Introduction to Embedded Systems, HKUST

Fall 2019

PROFESSIONAL SKILLS

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Programming Languages: Python, Matlab, C++

Deep Learning Framework: PyTorch.

Autonomous Driving Simulation: [CARLA](#).

AWARDS

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Postgraduate Student Scholarship

2018-Present, HKUST

Honorable Prize in Mathematical Contest In Modeling, America

2017

China Instrument and Control Society Scholarship

2017

International Exchange Scholarship

2017, ZJU

Research and Innovation Scholarship

2017, ZJU

Second-class Academic Scholarship

2015, 2016, ZJU

Second-class Scholarship of Outstanding Students (Top 10%)

2015, 2016, ZJU

ACADEMIC ACTIVITIES

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- **Review Services**

- Journal

- IEEE Robotics and Automation Letters (RA-L).

- IEEE Transactions on Industrial Electronics (TIE).

- IEEE Transactions on Neural Networks and Learning Systems (TNNLS).

- IEEE Transactions on Vehicular Technology (TVT).

- Conference

- International Conference on Intelligent Robots and Systems (IROS), 2019-2021.

- International Conference on Robotics and Automation (ICRA), 2020-2021.

- IEEE International Conference on Intelligent Transportation Systems (ITSC), 2019-2021.

- IEEE International Conference on Image Processing (ICIP), 2021.

- IEEE International Conference on Autonomous Systems (ICAS), 2021.

- **Conference Presentations**

- [IROS 2020](#), Las Vegas, USA.

- [ICRA 2020](#), Paris, France.

- [ITSC 2019](#), Auckland, New Zealand.

- **Conference Services**

- Committee Member of [Autonomous Vehicle Vision \(AVVision\) Community](#), with workshops in ICCV 2021, WACV 2021, and special sessions in ICIP 2021, ICAS 2021 and IROS 2021.