Dr. Cai Panpan

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Personal Statement

I am a roboticist. I have been conducting active research in robotics, artificial intelligence, robot learning, and parallel computing. My vision is to develop robots that can seamlessly interact with human in crowded, chaotic environments and accomplish complex tasks.

Experience

Department of Computer Science, National University of Singapore **Singapore**
Postdoctoral research fellow *2017–now*

- Autonomous driving in dense urban traffics. How can a robot vehicle drive better than human in challenging environments where the traffic is dense and chaotic? My research aims to answer this question. The idea is to "think locally and learn globally". I proposed a crowd-driving algorithm, LeTS-Drive, that integrates planning and learning to tackle large-scale, highly dynamic and interactive urban scenes.
- Online planning under uncertainty. We have to hedge against uncertainty in real-world robotics tasks, but the corresponding planning problem can be computationally intractable. My solution is a parallel planner, HyP-DESPOT, that speedups planning under uncertainty by hundreds of times and successfully achieves real-time performance in large-scale problems.
- Modeling and predicting traffic agents. Modeling and predicting other agents are crucial capabilities of intelligent robots. I have developed two motion models, PORCA and GAMMA, for autonomous driving in challenging urban environments. I am also extending the motion models to an open-source driving simulator for dense, unregulated urban traffic.

School of Mechanical and Aerospace Engineering, Nanyang Technological University **Singapore**
PhD student *2011–2017*

- Real-time collision detection in complex environments. Collision detection is not only a computer graphic problem, but also an important subroutine of robot planning. Collision detection has to be fast in order to be useful. My PhD research addressed real-time collision detection in complex industrial environments consisting of millions of polygons.
- Parallel path planning for single- and cooperative-crane lifting. Path planning in complex environments is computationally hard, especially when it involves two cooperative robots. I have developed GPU-boosted path planners based on genetic algorithms to address the optimal planning problem in complex industrial environments.

Education

Nanyang Technological University **Singapore**
Doctor of Philosophy *2011.8–2016.7*
Research on robotic path planning, collision detection, and GPU computing.

Zhejiang University **Hangzhou, China**
Bachelor's Degree in Mathematics (specialized on Information and Computing Science)
Top student selected into the Chukochen Honors College *2007.8–2011.6*
Trained on Mathematics, scientific computing, and Computer Aided Geometric Design (CAGD).

PhD Thesis

Title: *Massively Parallelized GA Based Optimal Path Planning for Single and Dual Crane Lifting in Complex Industrial Environments*

Publications

Conference papers:

- P Cai, Y Lee, Y Luo, D Hsu. SUMMIT: A Simulator for Urban Driving in Massive Mixed Traffic. Submitted to ICRA 2020.
- Y Luo, P Cai, D Hsu, WS Lee. GAMMA: A General Agent Motion Prediction Model for Autonomous Driving. Submitted to ICRA 2020.
- P Cai, Y Luo, A Saxena, D Hsu, WS Lee. LeTS-Drive: Driving in a Crowd by Learning from Tree Search.

Robotics: Science Systems (RSS), 2019.

- P. Cai, Y. Luo, D. Hsu, and W.S. Lee. HyP-DESPOT: A Hybrid Parallel Algorithm for Online Planning under Uncertainty. Robotics: Science and Systems (RSS), 2018.
- Malika Meghjani*, Yuanfu Luo, Qi Heng Ho, Panpan Cai, Shashwat Verma, Daniela Rus, David Hsu. Context and Intention Aware Planning for Urban Driving. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2019.

Journal papers::

- P. Cai, Y. Luo, D. Hsu, and W.S. Lee, 2018. HyP-DESPOT: A Hybrid Parallel Algorithm for Online Planning under Uncertainty. Under review by the International Journal of Robotics Research.
- Y.F. Luo, P.P. Cai, A. Bera, D. Hsu, W.S. Lee, and D. Manocha. PORCA: Modeling and planning for autonomous driving among many pedestrians. In IEEE Robotics Automation Letters (RAL), vol. 3, no. 4, pp. 3418-3425, Oct. 2018.
- P. Cai, Y. Cai, I. Chandrasekaran, and J. Zheng, 2016. "Parallel GA based automatic crane lifting path planning in complex environments", Automation in Construction, Volume 62, Pages 133-147, ISSN 0926-5805.
- P. Cai, Y. Cai, I. Chandrasekaran, and J. Zheng, 2017 "Automatic Path Planning for Dual-Crane Lifting in Complex Environments Using a Prioritized Multi-objective PGA", IEEE Transactions on Industrial Informatics, 14(3), 829-845.

Book chapters::

- P. Cai, C. Indhumathi, Y. Cai, J. Zheng, Y. Gong, T. Lim, and P. Wong, "Collision detection using axis aligned bounding boxes", in Simulations, Serious Games and Their Applications (Y. Cai and S. L. Goei, eds.), Gaming, Media and Social Effects, pp. 1-14, Springer Singapore, 2014.
- P. Cai, Y. Cai, I. Chandrasekaran, and J. Zheng, "A GPU-enabled parallel genetic algorithm for path planning of robotic operators", in Y. Cai and Simon See (eds.), GPU Computing and Applications, pp. 1-13, Springer, 2015.