Dr. Cai Panpan

✉ cppmayontu@gmail.com

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. For more details, please visit me at `comp.nus.edu.sg/~caipp`.

Education

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

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

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).

Professional 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. These models have been plugged into planning algorithms to improve the safety and efficiency of driving.
- Urban traffic simulation. Simulators provide a rich source of interactive driving data to facilitate developing, training, and testing of driving algorithms. I developed an open-source driving simulator that simulates massive traffic crowds in real-world urban maps. Our aim is to boost up research and development in the challenging crowd-driving domain.

School of Mechanical and Aerospace Engineering, Nanyang Technological University **Singapore**
PhD student *2011–2016*

- 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. I addressed real-time collision detection in complex industrial environments consisting of millions of polygons using pixel-level massive parallelization.
- 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.

Professional Services

- Program committee member, Robotics: Science & Systems (RSS), 2020.
- Program committee member, Conference on Robot Learning (CORL), 2019.
- Program committee member, CS research week 2019, School of Computing, NUS.
- Reviewers for top robotics conferences (ICRA, ACC, IROS, RSS) and top-tier journals (TRO, IJRR, RAL).
- Speaker, NUS SOC research Workshop in Vietnam, 2019.

Awards

Best paper award in 2013 Symposium on GPU Computing and Applications co-organized by NVIDIA held on Oct 2013 with the paper "A GPU-enabled parallel genetic algorithm for path planning".

Teaching

- Lecturing, Module CS6244 "Robot Motion Planning & Control", Semester 1, 2017/2018, Lecture 3, NUS.
- Teaching assistance, Project P3.6 "Vibration Testing of Multiple DOF Systems" for AY 2015/16, S1 & S2, NTU.

Publications

Conference papers:

- P Cai, Y Lee, Y Luo, D Hsu. SUMMIT: A Simulator for Urban Driving in Massive Mixed Traffic. ICRA 2020.
- Y Luo, P Cai, D Hsu, WS Lee. GAMMA: A General Agent Motion Prediction Model for Autonomous Driving. arXiv:1906.01566.
- 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.
- 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.
- P. Cai, Y. Luo, D. Hsu, and W.S. Lee. HyP-DESPOT: A Hybrid Parallel Algorithm for Online Planning under Uncertainty. Robotics: Science & Systems (RSS), 2018.
- P. Cai, Y. Cai, I. Chandrasekaran, and J. Zheng, "A GPU-enabled parallel genetic algorithm for path planning", 2013 Symposium on GPU Computing and Applications, Oct 2013, Singapore. (Best Paper Award)

Journal papers::

- P. Cai, Y. Luo, D. Hsu, and W.S. Lee, 2018. HyP-DESPOT: A Hybrid Parallel Algorithm for Online Planning under Uncertainty. Accepted 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, 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.
- 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.

Book chapters::

- 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.
- 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.