Yu Zhang

✉ yu.zhang.bit@gmail.com · ☎ (+86) 152-1087-9455 · 🔗 Zhang Yu · 🐙 yuzhangbit

🎓 Education

Beijing Institute of Technology (BIT), Beijing, China   2012 – Present

PhD, Mechanical Engineering, School of Mechanical Engineering, expected 2018
Advisors: Prof. Huiyan Chen

University of Waterloo (UW), Waterloo, Canada   2015 – 2017

Visiting Student at Wavelab, Department of Mechanical and Mechatronics Engineering
Advisors: Prof. Steven L. Waslander

China Agricultural University (CAU), Beijing, China   2008 – 2012

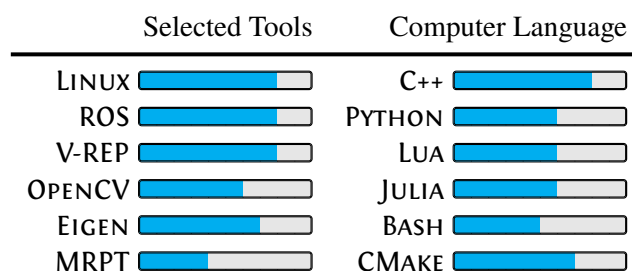*B.S.*, Automotive Engineering, College of Engineering
Advisors: Prof. Yu Tan

🏴 Achievements

- Leaders and team players in various projects related to autonomous driving with teams of different sizes.
- More than six years of relevant work experience in autonomous driving, including two-year close collaboration with researchers and engineers in academia and industry for autonomous driving in North America.
- Solid theoretical foundations in motion planning for autonomous driving, especially in mathematical optimization and graph search algorithms.
- A lot of experience with real-time implementation of motion planning algorithms in C++ and simulation developments for autonomous driving.
- Over 100,000 lines of C++ coding for autonomous systems over the past three years.

⚙ Skills

- Programming Languages: C++ > Python = Lua = Julia > Bash …
- Platform: Linux, Windows, QNX
- Tools: ROS, V-REP, MRPT, OpenCV, Eigen, Maple …
- Development: Perform the test-driven development work-flow with code reviews while following the Google C++ style guide and the typical git work-flow.

	Selected Tools		Computer Language
Linux	▮▮▮▮▯	C++	▮▮▮▮▯
ROS	▮▮▮▮▯	Python	▮▮▮▯▯
V-REP	▮▮▮▮▯	Lua	▮▮▯▯▯
OpenCV	▮▮▮▯▯	Julia	▮▮▮▯▯
Eigen	▮▮▮▮▯	Bash	▮▮▯▯▯
MRPT	▮▮▯▯▯	CMake	▮▮▮▯▯

▤ Theoretical foundations

- ◔ Motion Planning Algorithms
- ◔ Curve Fitting & Interpolation
- ◔ Vehicle Dynamics
- ◔ Mathematical Optimization
- ◔ Graph Search Algorithms
- ◔ Nonlinear System
- ◔ Differential Geometry
- ◔ Robotics
- ◔ Optimal Control

👥 Experience (selected)

Hybrid Motion Planning Library (HMPL) Development 🚗 at BIT-IVRC

September 2017 – Present

Brief introduction: HMPL is a real-time C++ motion planning library for autonomous driving that is able to handle task constraints, geometry constraints, nonholonomic constraints and dynamics constraints of cars in a human-like and layered fasion. Please see [1] for details of the state of HMPL in 2017.

👤 *Team Leader*

◉ built a github research organization – bit-ivrc – with around 9 developers specially for motion planning and control algorithms developments for autonomous driving and many other users.

👤 *Core Developer*

◉ conceived, designed and implemented the HMPL framework;

◉ created simulation tools and HD map interfaces for testing and developments of motion planning algorithms.

Details:

- Realized a fast search-based space explore path planning algorithm
- Developed an derivative-free semi-global path deformation algorithms
- Implemented efficient and robust optimization-based path generation algorithms with different solver interfaces (IPOPT, Ceres, SNOPT, Gradient Descent)
- Developed multiple phase state space sampling motion planning algorithms
- Developed efficient grid map implementations that can leverage built-in functions both in Eigen and OpenCV to operate on maps without copying map data
- Developed a fast collision checking algorithm
- Proposed and implemented a more general, flexible and complete convex-optimization-based speed planning approach that addresses limitations of the state-of-the-art speed planning methods, which is able to provide globally-optimal, smooth, safety-guaranteed, dynamic-feasible, and time-efficient speed profiles along the fixed path in both static and dynamic environments. Please see [2, 3] for details.

Autonomoose Project 🚗

May 2016 – July 2017

Brief introduction: Autonomous driving towards the ultimately level 4 autonomy with the ***Autonomoose*** platform in all-weather conditions that are specific to Canada in University of Waterloo. This project has attracted several industrial partners such as RENESAS, DENSO and QNX.

👤 *Team Leader and Core Developer* in Motion Planning Team

◉ developed real-time trajectory planning algorithms for autonomous driving systems.

& *Team Leader and Core Developer*   in Simulation Team
    ❯ created simulation toolkits specially for autonomous driving based on the general V-REP simulator

Details:

- Implemented the robust and efficient nonlinear-programming-based path generation algorithms with the IPOPT solvers interface
- Developed the single phase state space sampling trajectory planning algorithms for autonomous driving
- Created a modular simulation model library for autonomous driving that includes cars, lidars, GPS, IMU, road elements, cameras, sky-box, buildings, high-fidelity trees, the drive-by-wire module with ros interfaces for V-REP.
- Created the Waterloo Test Track V-REP scenario based on the real GPS data.

Skyline CES 2017 Project 🚗 June 2016 – January 2017

Brief introduction: This Skyline CES 2017 project is a demo project to show the functional safety of our autonomous driving system running on low power consumption RENESAS R-Car H3 SoC in CES (Consumer Electronics Show) 2017. It is a big project with collaboration of RENESAS, Autonomoose team in UW, QNX, POLYSYNC, AutonomouStuff, and eTRANS.

& *Team Leader and Core Developer*   in Motion Planning Team
    ❯ developed trajectory planning algorithms of autonomous driving systems to handle various traffic participants in restricted environments.

& *Core Developer*   in Simulation Team
    ❯ created demo-realated simulation models and scenarios for integration, testing and validation of motion planning and control algorithms.

Details:

- Adapted the optimization-based path generation algorithm to run on the Renesas R-Car H3 (arm chips) SoC with the Ceres solver interface in real-time.
- Developed a real-time state-space-sampling-based trajectory planning algorithm that is able to handle moving vehicles, traffic lights and traffic signs through V2X infrastructures.
- Created the traffic light, traffic sign, moving vehicles models with HMI graphic interfaces and ROS interfaces and visualization tool models for planning results in V-REP.

Competitions 🚗

"Kua Yue Xian Zu" Unmanned Ground Vehicle Challenge 2014
China Intelligent Vehicle Future Challenge 2013

& *Core Member*
    ❯ developed a forward-simulation-based path planning algorithm using a nonlinear feedback control rule;
    ❯ implemented a fast sprial path generation algorithm via the gradient descent;

⦻ created waypoints generation tools for user-defined tasks and developed drivers for the Integrated Navigation System;

⦻ created the modular vehicle model with customized drive-by-wire interfaces in V-REP;

⦻ tweaked the system and conducted various field tests.

♡ HONORS AND AWARDS

- Scholarship for Joint PhD Programs from China Scholarship Council   2015-2017
- Part of BIT team that won the second place in Unmanned Groud Vehicle Challenge 2014   2014
- Part of BIT team that won the championship in China Intelligent Vehicle Future Challenge 2013   2013
- First-class Doctoral Scholarship for PhD Students, BIT   2012
- National Scholarship for Encouragement, CAU   2011
- Technological Innovation Award, CAU   2011
- Leader of CAU team that won the second place in the RoboCup China Open   2011
- Prize of Pioneer of College Student's Holiday Social Pratice, CAU   2010
- Major Award, CAU   2009
- Outstanding Reporter, CAU   2009
- Anlifang Individual Scholarship, CAU   2009

ⓘ MISCELLANEOUS

- Homepage: http://yuzhangbit.github.io/

- Blog: https://yuzhangbit.github.io/blogs/

- GitHub: https://github.com/yuzhangbit

- Languages: English - Fluent, Mandarin - Native speaker

🕮 PUBLICATIONS

[1] Y. **Zhang**, H. Chen, S. L. Waslander, J. Gong, G. Xiong, T. Yang, and K. Liu, "Hybrid Trajectory Planning for Autonomous Driving in Highly Constrained Environments," *IEEE Access*, pp. 1 – 21, 2018, under review.

[2] Y. **Zhang**, H. Chen, S. L. Waslander, T. Yang, S. Zhang, G. Xiong, and K. Liu, "Toward a More Complete, Flexible, and Safer Speed Planning for Autonomous Driving via Convex Optimization," *Sensors (Switzerland)*, pp. 1 – 29, 2018, submitted.

[3] ——, "Speed planning for autonomous driving via convex optimization," in *IEEE International Conference on Intelligent Transportation Systems (ITSC)*, 2018, pp. 1– 8, submitted.

[4] K. Liu, J. Gong, S. Chen, Y. **Zhang**, and H. Chen, "Model Predictive Stabilization Control of High-speed Autonomous Ground Vehicles Considering the Effect of Road Topography," *Applied Sciences*, pp. 1 – 15, 2018, under review.

[5] K. Liu, J. Gong, Y. **Zhang**, and H. Chen, "Model predictive stabilization control for high-speed autonomous ground vehicles with roll dynamics," in *IEEE International Conference on Intelligent Transportation Systems (ITSC)*, 2018, submitted.

[6] K. Liu, J. Gong, S. Chen, Y. **Zhang**, and H. Chen, "Dynamic modeling analysis of optimal motion planning and control for high-speed self-driving vehicles," *Jixie Gongcheng Xuebao/Journal of Mechanical Engineering*, pp. 1 – 11, 2018, under review.

[7] H. Y. Chen and Y. **Zhang**, "An overview of research on military unmanned ground vehicles," *Acta Armamentarii*, vol. 35, no. 10, pp. 1696 – 1706, 2014.

[8] H. Zhang, G. Xiong, P. Liu, Y. **Zhang**, and H. Chen, "A hierarchical navigation framework for mobile robots," *Journal of Computational Information Systems*, vol. 9, no. 7, pp. 2683 – 2690, 2013.