Yu Zhang

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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

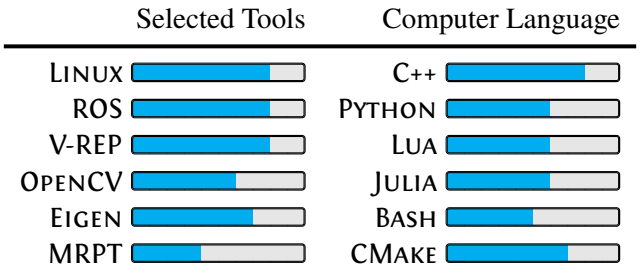
Advisors: Prof. Yu Tan

Achievements

- Leads 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.



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 Lead

- 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
- Implemented an efficient grid map module 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 Lead and Core Developer in Motion Planning Team

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

Team Lead 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 Lead 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 Scholorship 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
- Lead 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

ℹ 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, to appear. [Online]. Available: https://ieeexplore.ieee.org/document/8375948/

[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, under review. [Online]. Available: http://www.preprints.org/manuscript/201805.0164/v2

[3] **Y. Zhang**, H. Chen, S. L. Waslander, T. Yang, S. Zhang, G. Xiong, and K. Liu, "Speed planning for autonomous driving via convex optimization," in *IEEE International Conference on Intelligent Transportation Systems (ITSC)*, 2018, pp. 1– 8, under review.

[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*, vol. 8, no. 5, p. 822, 2018.

[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. 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.