Ruiqi Zhang

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EDUCATION

B.Eng. in Vehicle Engineering / Automobile Design, Tongji University, Shanghai, China Sep.2018 - Present
Research Interest: **Reinforcement Learning, Robotics, Autonomous Driving, Computer Vision**
Major GPA: 91.5/100, Overall GPA: 88.4/100 (ranking 4/60)
2 times of University Scholarship (only 10%)
Core courses: Python Programming (100), Mechanics of Materials (100), Probability Theory (100), Big Data & AI (95), Mechanical Design (95), CAD Mechanical Drawing (95), MATLAB Programming (95)

PUBLICATION AND MANUSCRIPTS

- **Ruiqi Zhang,** Jing Hou, Guang Chen*, Zhijun Li, Jianxiao Chen, Alois Knoll, Residual Policy Learning Facilitates Efficient Model-Free Autonomous Racing (2nd round revision for ***IEEE Robotics and Automation Letters***)
- **Ruiqi Zhang**, Guang Chen*, Jing Hou, Zhijun Li, Changjun Jiang, PIPO: Policy Optimization with Permutation-Invariant Graph Network for Decentralized Multi-Agent Navigation (Submitted to ***2022 IEEE International Conference on Multi-Sensor Fusion and Integration***)
- Jing Hou, Guang Chen*, **Ruiqi Zhang**, Zhijun Li, Changjun Jiang, SPREEZE: High-Throughput Parallel Framework for Reinforcement Learning (Submitted to ***IEEE Trans. on Parallel and Distributed Systems***)
- Zichen Liang, Haotian Liu, Yinlong Liu, Guang Chen*, **Ruiqi Zhang**, Alois Knoll, Globally-Optimal Inlier Maximization for Relative Pose Estimation under Planar Motion, ***Frotiers in NeuroRobotics***, 11, 2022

(The Pre-Print and code are available at http://ruiqizhang99.github.io)

RESEARCH EXPERIENCE

Model-free Autonomous Racing Framework with Residual DRL | Project Leader Jun.2021 –Oct.2021
Advisor: Guang Chen, professor @ EECS, Tongji University

- We develop an efficient residual policy learning algorithm with the modified artificial potential field for autonomous racing ResRace to solve the inefficient sampling and risk exploration problem of classical model-free RL.
- We propose a novel complementary property of MAPF and model-free policy optimization method. The sub-optimal MAPF policy provides a feasible initial policy to generate better behavior trajectories than that of random sampling, and DRL agent provides a supplementary action to maximize the total return.
- Compare with other baselines, our method has an advantage on the sample efficiency and real-time performance. We also compare the lap time on 5 tracks of the F1Tenth competition and our method outperforms the state-of-the-art method Dreamer and reaches the comparable level of professional human players.

Graph-based Policy Optimization for Decentralized Multi-Agent Navigation | Project Leader Nov.2021 –Feb.2022
Advisor: Guang Chen, professor @ EECS, Tongji University

- We extend our previous research ResRace to the multi-agent navigation task and propose a decentralized reinforcement learning method via graph convolutional network.
- Our method utilizes the permutation-invariant property in multi-agent system to enhance the representation and generalization ability of the classical actor-critic structure. By random shuffling the segmented observation, the GCN presents better than the shallow MLPs used in conventional decentralized methods
- We also illustrate our method is much safer than centralized MARL baselines and control barrier function-based methods and can be generalized to an arbitrary number of agents in different scenarios.

High-Throughput Parallel Reinforcement Learning Framework | Research Assistant Aug.2021-Dec.2021
Advisor: Guang Chen, professor @ EECS, Tongji University

- Classical RL frameworks like RLlib, rlpyt and ACME require high-performance CPU to sampling. In this paper, we propose a high-throughput RL framework SPREEZE.
- We asynchronously parallelize the experience sampling, network update, performance evaluation, and visualization operations, and adopt multiple queue and lock/unlock mechanism to transfer different types of data between processes. The framework can automatically adjust the parallelization hyperparameters according to the computing power of the hardware device to achieve efficient large-batch updates.
- The simulation results show that our framework can achieve up to 15,000Hz experience sampling and 370,000Hz network update frame rate with only a personal desktop computer, which is an order of magnitude higher than other mainstream parallel RL frameworks, making the training time efficiency significantly improved.

Active Robotic Lower Limb with Reinforcement Learning | Research Assistant Jan.2021 – May.2021
Advisor: Zhijun Li, professor @ EE, University of Science and Technology of China, IEEE Fellow

- In this project, we proposed an automatic robotic prosthesis framework, which is adaptive to different real-world situations with deep reinforcement learning.
- Through the multi-expert and curriculum learning method, we train the sub-agent for a single task independently, and the dominator policy integrates the actions provided by sub-policies to adapt to different scenarios and tasks.
- Our active prosthesis can cooperate with the motion of healthy joints of the disabled to realize walking on the different terrains like the plane, upstairs, downstairs, and slopes.

Learning Sparse Events Attention for Efficient Event-based Stereo Matching | Assistant Jun.2021 – Oct.2021
Advisor: Guang Chen, professor @ EECS, Tongji University

- Previous learning-based event stereo matching methods follow the pipeline of frame-based methods to construct and regularize dense cost volume and ignore the sparse nature of events data, thus leading to redundant computation and sacrificing efficiency. In this project, we present a different paradigm to achieve efficient and accurate event-based stereo matching.
- We start by extracting deep features of event data using the sparse convolutional network and then construct a sparse cost volume based on the sparse feature maps and construct a sparse cost volume based on the sparse feature maps.
- Besides, we design a novel attentive cost aggregation module to regularize the sparse cost volume. Extensive experiments demonstrate that our method achieves comparable performance to SOTA methods with higher efficiency on the leading event data sets.

Globally-Optimal Inlier Maximization for Relative Pose Estimation | Research Assistant Jan.2021 – Apr.2021
Advisor: Guang Chen, professor @ EECS, Tongji University

- We propose a globally-optimal Branch-and-Bound (BnB) solver for relative pose estimation under general planar motion, which aims to figure out the globally-optimal solution even under a quite noisy environment.
- Through reasonable modification of the motion equation, we decouple the relative pose into relative rotation and translation to apply the simplified bounding strategy.
- Experimental results support the global optimality and demonstrate that the proposed method outperforms the existing leading approaches.

EXTRACURRICULAR ACTIVITIES

The Formula Student Team at Tongji | Chassis-Steering Group Dec.2019 – Present

I am responsible for the assembly and adjustment of the chassis system and participated in the design of steering system in 2020. We participated in 4 international races and won **the title of FS China 2019**, **3rd of FS Japan 2019, 3rd of FSChina2020, and 2nd of FSChina2021.**

Obstacle Detection System for Formula Student Racing | Project Leader Mar.2020 –Mar.2021
Advisor: Liguang Li, professor and dean @ School of Automobile, Tongji University

We design a low-cost cone detection system for Formula and improve SOTA models with increased frame rate and higher accuracy by optimizing the network structure and training hyperparameters. Furthermore, we established a large-scale dataset by collecting over 3000 pictures from dynamic racing and labeled hundreds of static pictures.

SKILLS

- Research Experiences in Reinforcement Learning & Robotic Vision
- Programming Languages and Tools: Python (PyTorch, Tensorflow), PyBullet, LaTeX
- Engineering Software: Unigraphics NX, AutoCAD, Catia
- Natural Language: Chinese, English, German