Tong Zhou

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EDUCATION

The Chinese University of Hong Kong *Hong Kong, China*
Electronic Engineering – Ph.D 08/2017-Present
Research Interest: Autonomous Driving; Decision Intelligence ; Reinforcement Learning; Motion Planning;Monte Carlo Tree Search
Relevant Coursework: Advance Theory of Probability; Pattern Recognition; Advanced Robotics; Matrix Analysis and Computation; Advanced Topics in Game Theory; Optimization Theory

Harbin Institute of Technology, China(HIT) *Heilongjinag, China*
Measurement, Control Technique and Instruments - Bachelor of Engineering 08/2013-05/2017

- GPA: 90.99/100;
- Rank：3/114；
- Relevant Coursework: Advanced Mathematics; Physical Electronics Control
- Honors: The Third-class of People's scholarship for Academic Year 2013-2014;
  The Second-class of People's scholarship for Academic Years 2014-2015 & 2015-2016;
  National Scholarship for Academic Year 2014-2015

AWARDS

- T.J. Tran Best Paper in Robotics Award in 2021 International Conference on Robotics and Biomimetics
- Student Creativity Awards in 2019, issued by The Chinese University of Hong Kong – First Runner-up
- Obtained invention patent certificate for Airport Baggage Cart Automatic Recycling System in 2019
- NI LabVIEW Certified Associate Developer (CLAD) from 05/2016 to 05/2018
- 2014 China Undergraduate Mathematical Contest in Modeling in Heilongjiang Province - First Prize
- Bionic Robot Goal Seeking Contest of "HIT Cup" 16th National Robot Championship Contest and "Bosiweilong Cup" 5th International Humanoid Robot Olympic Games – First Prize

INTERNSHIP

Beijing SenseTime Technology Co.Ltd 05/2021-07/2023
Primarily Involved in the development of the following projects under OpenDILab in Sensetime and Shanghai AI Lab 35 hours/week

- DI-drive: a platform under OpenDIlab specifically designed for driving tasks. My main development tasks primarily focus on algorithm development based on the Carla and MetaDrive simulators.
- DI-engine: an open-source decision intelligence platform developed based on PyTorch and JAX. It provides support for reinforcement learning tasks in various environments. My primary responsibility is to replicate and implement exploration-related reinforcement learning algorithms, such as Intrinsic Curiosity Module and Soft Q-Learning.
- LightZero: a lightweight, efficient, and user-friendly open-source algorithm library that combines Monte Carlo Tree Search with reinforcement learning. My main responsibility lies in the development of MuZero, Sampled MuZero, and Stochastic MuZero algorithms within the LightZero library.

Neusoft Corporation
Intern of Training Department

- Join in a 5-member team, collect 32 references on Google website, learn the operation scheme and implementation method of elevator monitoring system; Lean the function of microcontroller language program in Keil and the function of policy circuit diagram drawing in Protues;
- Use simulation and C programming to realize the basic functions of elevator monitoring such as "door opening and closing", "floor call", and "emergency processor";
- Use Protues to produce circuit diagrams and find the best solution; Successfully completed the elevator monitoring system project

RESEARCH EXPEROENCE

Minimally-Intrusive Navigation in Densely-Populated Pedestrian Flow 09/2020-Present

- Proposed the concept of Minimal Intrusive Navigation, which is composed of two levels of disturbances in pedestrian flow. From the macroscopic perspective, we quantify the disturbance as the overall impact, such as density and direction, on pedestrian flow caused by the robot's presence. On the microscopic level, the disturbance is defined as the discrepancy between the future trajectory distributions of individual pedestrians with and without the robot, which quantifies how much additional displacement a pedestrian must make to avoid the robot, compared to the scenario where

no robot is present.

- Proposed a triangle-based sampling strategy, which divided the spatial space surrounding the robot into topologically defined “inserting areas” suitable for sampling with motion primitive method.
- Developed a complete navigation workflow, which takes into consideration the level of intrusiveness in both macro and micro-level modeling. Specifically, we utilize pedestrians' eye gaze information to assess their likelihood of noticing the robot, allowing us to make adjustments to the micro-level modeling of pedestrians.

Task Agnostic and Ego-Centric Reinforcement Learning in Autonomous Driving

- Designing a task-agnostic and ego-centric motion skill library, which is general-purpose to cover diverse motion skills and can be reused across tasks.
- Distilling motion skills into a latent skill space and modifying the RL algorithm to explore in the latent skill space to encourage efficient and effective learning
- Demonstrating that our method achieves efficient and effective learning for autonomous driving in three challenging dense-traffic scenarios

Expert-Guided Motion-Encoding Tree Search in Autonomous Driving

- Incorporated motion primitive methods into Monte Carlo Tree Search (MCTS), which allows searching complexity for long-duration MCTS tasks by decreasing the depth of the tree
- Leveraged multiple styles of expert policies to maintain a multi-modal policy distribution, ensuring that even under the same observation, there are multiple potential policies to be chosen from
- MCTS search with expert policy involvement and skill-based execution, which fully utilizes the most suitable style expert strategies while maintaining diversity intensions in policy output to avoid local opima.

LightZero

- Participated in the development of LightZero, an open-source algorithm tookit that combines Monte Carlo Tree Search and Deep Reinforcement Learning
- Replicated MuZero method, an algorithm that extends the application scenario of Alphago, allowing tree search where the transition dynamics of the environment are unkown
- Replicated Sampled MuZero method, an extension of MuZero that is able to learn in domains with arbitray complex action spaces by planning over sampled actions.
- Replicated Stochastic Muzero method, which allows for thorough consideration of the stochastic nature of the environment during the tree search.

DI-drive

- Participated in the development of an open-source Decision Intelligence Platform for Autonomous Driving simulation.
- Incorporated the Model Predicted Control algorithm into CARLA simulator, integrating both trajectory tracking and path following modes
- Implemented macro functionality in highway environment in MetaDrive Simulator, and utilized DQN algorithm to devise lane-changing strategies
- Reproducing the Disturbance-based Reward Extrapolation (D-REX) algorithm in the Drive environment, even with suboptimal demonstrations, enables the vehicle to learn effective strategies and surpass the provided demonstrations.

Online State-Time Trajectory Planning in Highly Dynamic Crowd Environments

- Propose a gradient-based planner over the state-time space for online trajectory generation in highly dynamic environments
- Propose timed ESDT arguments that support distance and gradient queries with state-time keys to optimize motion trajectory; define smooth prior and obstacle likelihood functions compatible with the state-time space, transform the trajectory planning problem into a mapping problem, solve it with the numerical optimizer
- Validate the method with simulated and benchmark datasets, and the experiment results show that planner can outperform the state-of-the-art methods, demonstrating its significant advantages over the traditional ones.

Human Trajectory Prediction 05/2019-05/2020

- Obtain and evaluate the ETH and UCY pedestrian datasets; collect naturally crowded pedestrian datasets from metro stations and plazas in Hong Kong by calibrated lidar and camera system.
- Based on the data analysis result, conclude the result that people pay more attention to the pedestrians in the front and less attention to the pedestrians behind, propose a new attention-based social pooling method
- Generate encoders that could predict the future trajectory of pedestrians; By comparing with the existing LSTM and GAN methods, it is improved in terms of average displacement error and final displacement error

Airport Baggage Cart Automatic Recycling System 05/2018-05/2019

- Learn the process and route of airport self-collection baggage system, determine the location and direction of the target baggage trolley; use multi-sensor fusion methods such as wheel odometer, 3D dimensional lidar, camera and ultrasonic sensor to achieve three-perimeter detection of trolley car
- Evaluate the fine attitude estimation on the trolley, obtain better maneuvering performance; use proximity vision waiting

method to enable the robot obtaining the best proximity action trajectory and guide the luggage trolley to the target location
- Successfully save labor costs, especially in developed regions where aging is severe or labor costs are relatively high;

An Autonomous Eye-in-Hand robotic System for Elevator Button Operation 10/2017-04/2018
- Read and study for the references related to elevator button operation system; propose an autonomous robot system with Eye-in-Hand structure to solve the button operation problem
- Use pytorch to develop deep neutral networks, apply them to button detection and character recognition functions to provide accurate perceptual input; propose a button pose estimation algorithm and accurately estimate the button pose by fitting a minimum uncertainly model
- Propose a coarse to precise control scheme to drive the manipulator compete the button operation task though the perception and pose estimation algorithm, which was successfully published in IEEE Transactions on Instrumentation and Measurement in 2020

ACTIVITIES

- Multivariate Calculus For Engineers (ENGG 1130E) 09/2020-04/2021
  Tutor 10 hours/week
- Intelligent Interactive Robot Practice (ELEG 4701) 09/2019-08/2020
  Tutor 10 hours/week
- Introduction to Embedded System (ELEG 2401) 09/2018-08/2019
  Tutor 10 hours/week
- Engineering Physics: Electromagnetics, Optics and Modern Physics (ENGG 1301) 09/2017-08/2018
  Tutor 10 hours/week
- HIT Virtual Instrument Technology Association – Training Department 09/2015-08/2016
  Director 5 hours/week
- Student Union from EE and Automation College – Learning Department 09/2013-08/2014
  Staff 4 hours/week

PUBLICATIONS

- **T Zhou**, E Lyu, J Wang, G Cen, Z Zha, S Qi, MQH Meng. Towards High Efficient Long-horizon Planning with Expert-guided Motion Encoding Tree Search. (arXiv preprint arXiv: 2309.15079) – Published in 2023
- **T Zhou**, L Wang, R Chen, W Wang, Y Liu. Accelerating Reinforcement Learning for Autonomous Driving using Task-Agnostic and Ego-Centric Motion Skills (2023 IEEE/RSJ International Conference on Intelligent Robots and Systems) – Published in 2023
- **T Zhou**, S Qi, E Lyu, G Cen, J Wang, MQH Meng. Towards Minimally-Intrusive Navigation in Densely-Populated Pedestrian Flow. (2021 IEEE International Conference on Robotics and Biomimetics) – Published in 2021
- D Zhu, **T Zhou**, J Lin, Y Fang, MQH Meng. Online State-Time Trajectory Planning Using Timed-ESDF in Highly Dynamic Environments. (2022 International Conference on Robotics and Automation) – Published in 2022
- J Lin, **T Zhou**, D Zhu, J Liu, MQH Meng. Search-Based Online Trajectory Planning for Car-Like Robots in High Dynamic Environments. (2021 IEEE International Conference on Robotics and Automation) – published in 2021
- D Zhu, Z Min, **T Zhou**, T Li, MQH Meng. An Autonomous Eye-in-Hand Robotic System for Elevator Button Operation Based on Deep Recognition Network. (IEEE Transactions on Instrumentation and Measurement 70, 1-13) – Published in 2020
- D Zhu, T Li, D Ho, **T Zhou**, MQH Meng. A novel OCR-RCNN for elevator button recognition. (2018 IEEE/RSJ International Conference on Intelligent Robots and Systems) – Published in 2018

ADDITIONAL INFORMATION

Programming: C++(Expertise), Python (Expertise), Pytorch (Expertise) , ROS(expertise), MATLAB (Experience), LabVIEW(Experience), Lua(Experience), CAD(Experience)
Language: Chinese (native); English (fluent)
Interests: Tennis (4 years); Reading (especially in history and Philosophy); Swimming (3 years)
IELTS: Overall 6.5 (Reading: 8.0)