

# Xinjie (Richard) Liu

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## Education

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### Delft University of Technology

Sep 2021 - Jul 2023

M.Sc. in Robotics

Delft, Netherlands

- GPA : **9.2/ 10.0** (top 1%)
- Courses (grades): Model Predictive Control (10/10), Deep Reinforcement Learning (10/10), Planning & Decision Making (9/10), Robot Dynamics & Control (9.2/10), Deep Learning (9.4/10), Machine Learning for Robotics (9.1/10), Machine Perception (8.5/10), etc.

### Tongji University

Sep 2016 - Jul 2021

B.S. in Automotive Engineering

Shanghai, China

- GPA: 4.39/ 5.0 (89 on 95 basis)
- Major GPA: **4.90/5.0** (top 3%)

### Graz University of Technology

Jan 2020 - Jun 2020

Exchange Programme

Graz, Austria

## Research Interests & Software Skills

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**Research interests:** applicable interaction-aware motion planning & control methods for (multi-) robot systems in a shared environment, where uncontrolled agents like humans are present. Utilize frameworks like *dynamic games*, *optimal control*, *reinforcement learning*, etc.

**Programming language:** Julia, C++, Python, Matlab

**Version control:** Git

**Optimization toolbox:** FORCES Pro, OCS2, PATHSolver.jl (MCP solver), CasADi, OSQP, IPOPT, CVX, YALMIP, etc.

**Machine learning packages:** PyTorch, Flux.jl, TensorFlow, Keras, etc.

**Other:** Robot Operating System (ROS), Linux, LaTeX

## Research Experience

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### Autonomous Multi-Robots Lab, TU Delft

Apr 2022 - Present

Advisor: Javier Alonso-Mora

- **Game Theoretic Planning:** Development of game theoretic planning techniques for safe interaction of autonomous mobile robots with other agents, focusing on problems of unknown objectives and multi-modal behaviors of uncontrolled opponents, modeled as local equilibria of general-sum dynamic games

## Project Experience

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### Planning & Control:

#### Champion of Hackathon, European Robotics Forum 2022

Jun 2022 - Jul 2022

Rotterdam, Netherlands

[Hackathon - Battle of Institutions](#) is a competition that took place during [European Robotics Forum 2022](#). The [challenge](#) was manipulation tasks on a randomly positioned task board.

- The winner of the Franka Emika challenge and the final champion of the Hackathon ([Post](#) for the team TU Delft A)

- Used point cloud from the depth camera and iterative closest point method for localizing the task board. Executed touching trajectories for modifying the localization
- Employed interactive imitation learning method for task execution
- Transformed the pre-learned trajectories to new task frames

### **Autonomous Robotics Solution for Field Coverage**

Apr 2022 - Jun 2022

[video](#)

Delft University of Technology, Netherlands

Project provided by partner institution from industry, conducted in a team of five members. The objective is to design a robotic solution autonomously covering a field with minimizing the time usage and considering the battery level and the dynamic obstacle avoidance.

- Used a top-view camera for mapping and localization
- Solved traveling salesman problems combined with A\* for global path planning
- (My part) used MPC controller for motion control and obstacle avoidance
- Used state machine as a behavioral layer, including error handling mechanism and human-robot interaction
- The proposed solution was combined with ROS framework and tested on a real [Husky](#) robot

### **Safe MPC Approach for Non-holonomic Mobile Robots in Dynamic Scenarios**

Jan 2022 - Apr 2022

[video](#) | [paper](#) | [code](#)

Delft University of Technology, Netherlands

Development of model predictive control approach for navigating non-holonomic mobile robots in a dynamic environment, focusing on theoretical analysis and guarantees

- Designed time-varying MPC approach for linearized system dynamics, included terminal cost, terminal control invariant set, etc.
- Designed dynamic obstacle avoidance algorithm by defining and linearizing obstacles in velocity space
- Theoretically analyzed and proved closed-loop system stability, region of attraction, computed approximation of maximal control invariant set

### **Model-free Deep Reinforcement Learning Algorithms Implementation**

Jan 2022 - Apr 2022

Delft University of Technology, Netherlands

Multiple implementation projects along with course CS4400 Deep Reinforcement Learning (Deep RL)

- Implemented Deep Q-networks. Used tricks like n-step target, replay buffer, value semi-gradients (target network) and double DQN to speed up and stabilize the bootstrapping
- Implemented common on-policy gradient methods like REINFORCE, Actor-Critic and off-policy gradient methods like PPO, DDPG, TD3
- Used measures like pseudo-visitation counts, novelty measures, density measures for adding intrinsic rewards for exploration and propagation of epistemic uncertainty
- Implemented centralized training + decentralized execution algorithm MADDPG for solving multi-agent cooperative game

### **Autonomous Delivery Using Quadrotor Robots**

Oct 2021 - Jan 2022

[video](#) | [paper](#) | [code](#)

Delft University of Technology, Netherlands

Development of algorithm including global path planning, trajectory optimization and control, for realizing autonomous flight of quadrotor drone in unseen environment.

- Implemented sampling method RRT\* for global path planning
- Used minimum snap optimization to compute time-optimal and smooth trajectory, given the waypoints from RRT\*
- Implemented non-linear MPC controller for tracking and local obstacle avoidance, with providing collision avoidance guarantee w.r.t. the static obstacles

## **Robot Dynamics & Control**

Sep 2021 - Nov 2021

[video](#)

Delft University of Technology, Netherlands

Three projects along with the course Robot Dynamics & Control (RO47001).

- Performed control tasks of a 2 DoF robotic arm using force/impedance & position controllers in Python. Employed techniques including singularity-robust control, task-priority control, etc.
- Conducted lateral motion control of a vehicle in lane-changing scenario with PID controller in MATLAB
- Executed multiple trajectory-tracking tasks of quadrotor in both MATLAB and Python. Implemented both linear PD controller and nonlinear geometric controller to track trajectories including circle, diamond, and 'TUD'. Evaluation criteria consist of tracking error, tracking time, and consumed energy

## **Bachelor Thesis: Interactive Imitation Learning in Robotics (excellent bachelor thesis at TJU)**

Oct 2020 - Jul 2021

Tongji University, China

Advisor: Prof. Youling Yu | Institute of Intelligent Systems at TJU

[video](#) | [thesis](#)

- Developed interactive imitation learning algorithms for various simulation robotic tasks, including pendulum balancing, spaceship landing, robotic arm grasping (raw images as input)
- Agents learn to perform tasks from demonstrations of non-expert human in an online fashion and are compared with baselines using deep reinforcement learning (DRL) algorithms
- Compared deterministic and stochastic policy, learning in state-space and in action-space

## **Perception:**

### **Reproduction of Event Camera Data Processing Project**

Jan 2022 - Apr 2022

[blog](#)

Delft University of Technology, Netherlands

Reproduction of project '[High Speed and High Dynamic Range Video with an Event Camera](#)'.

- Defined training loop for recurrent neural network architecture and re-trained model on different event datasets for reconstructing intensity images from a stream of asynchronous event data. Compared results for different hyper-parameter settings

## **Multisensor Perception of Autonomous Driving Car**

Oct 2021 - Jan 2022

[video1](#) | [video2](#)

Delft University of Technology, Netherlands

Project of perception module for a self-driving car using real-world sensor data from binocular camera, LiDAR and Radar.

- Trained classifiers CNN & SVM+HOG features as visual pedestrian detector
- Processed LiDAR data by removing the ground plane, conducted DBSCAN clustering, used clusters as 3D prior for visual detector
- Used iterative closest point (ICP) algorithm for ego-motion compensation of the car
- Implemented ROS packages for perception module of autonomous driving car

## **Autonomous Car Racing by Learning from Pixels**

Sep 2021 - Nov 2021

[video](#)

Delft University of Technology, Netherlands

Learning driving policy for autonomous racing car from raw images as observation

- Designed image pre-processing pipeline for extracting edge information from pixels. Used PCA for dimensionality reduction of the feature vector
- Used multiple models like random forest, neural network for learning useful driving policy with being robust to irrelevant features like the background color. The learned policy was able to generalize to the unseen environment

## **Awards & Scholarships**

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- First Prize Scholarship for Outstanding Students at Tongji University (3% at TJU, 2019)
- CSC National Scholarship for Outstanding Undergraduate Exchange Program (3 students at School of Automotive Studies, 2020)
- Annual Excellent Student at Tongji University (5% at TJU, 2020)
- Outstanding Student Leader at Tongji University (3 students at School of Automotive Studies, 2019)
- Third Prize Scholarship for Outstanding Students at Tongji University (20% at TJU, 2018)
- Scholarship for Social Activities at Tongji University (2 times, 2017, 2019)
- Winning Prize for Outstanding Innovative Project at TJU (Autonomous Flight of UAV based on UWB Localization, 2019)

## Other Experience (TA/ Service/ Management)

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### Teaching Assistant of Deep Reinforcement Learning (CS4400) (incoming)

[CS4400](#) is an advanced, research-oriented course at TU Delft for PhD students and excellent master students. It mainly talks about modern model-free RL techniques.

### Consulting Intern at IQVIA (Shanghai)

Jul 2020 - Aug 2020

- Marketing project of drugs for rare diseases: conducted policy analysis, interviews with specialists and employees, business analysis for generating strategies for national negotiations and local breakthrough of orphan drugs

### Consulting Intern at Boston Consulting Group (BCG Shanghai)

Mar 2020 - May 2020

- Strategic digitalization project for a capital insurance enterprise: conducted qualitative and quantitative analysis of competitors, operation diagnosis, and customer journey survey for effective digitalization of business

### Tongji University Basketball Association (TJBA)

Oct 2016 - Jun 2019

- Served as president of TJBA, with over 200 club members involved
- Organized referee skills training sessions and 5 campus events with an audience over 500 each. TJBA was the biggest student organization at TJU and was rated as a five-star club many times

## Other Skills & Hobbies

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- **Languages:** Mandarin (native speaker), English (C1, IELTS 7.5), German (B2, DSH 2 at KIT)
- **Hobbies:** Workout training, Basketball (university team member, chief referee at TJU), Singing (third place in Tongji singing competition), Writing (part-time editor, reading quantity over 200,000)