

# YUMENG XIU

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## RESEARCH INTERESTS

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- Safety Robot Navigation, especially real-world applications in multi-agent system.
- Reliable learning in control algorithms with formal guarantees.
- Trustworthy AI and optimization

To that end, my recent researches focus on:(1) Perception and social navigation on robots.(2) Developing reliable algorithms for stabilizing large-scale networked systems(see a few projects in my [homepage](#)).

## EDUCATION

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### Carnegie Mellon University

Pittsburgh, PA

*Master of Science in Mechanical Engineering (Robotics Track)* **GPA:3.94/4.0**

Aug. 2020 - May. 2023

**Relevant Coursework:** *Computer Vision, Machine Learning, Deep Learning, Optimization, Linear Control, Robot Localization and Mapping*

### Beijing Institute of Technology

Beijing, China

*Bachelor of Science in Mechanical Engineering* **GPA:3.5/4.0 Major GPA:3.86/4.0**

Aug. 2016 - May. 2020

### RWTH Aachen University

Aachen, Germany

*Summer School, Major in Automation and simulation*

Jul. 2017

**Relevant Coursework:** *Numerical Differentiation, Modeling of ODE, Discretization Methods, Nonlinear Equations*

## PUBLICATIONS

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1. Linxiaoyi Wan, Yumeng Xiu, Jingyang Liu, Joshua Bard and Dana Cupkova. Towards Adaptive Additive Manufacturing with Semi-autonomous Robotic Binder Jet 3D Printing of Concrete. Submitted to *ROB|ARCH 2024 - Robotic Fabrication in Architecture, Art, and Design*
2. Zhefan Xu\*, Xiaoyang Zhan\*, Yumeng Xiu, Christopher Suzuki, Kenji Shimada. Onboard dynamic-object detection and tracking for autonomous robot navigation with RGB-D camera. Accepted by *IEEE Robotics and Automation Letters (RA-L)*. [[arxiv](#)]
3. Zhefan Xu, Baihan Chen, Xiaoyang Zhan, Yumeng Xiu, Christopher Suzuki, Kenji Shimada. A vision-based autonomous UAV inspection framework for unknown tunnel construction sites with dynamic obstacles. Accepted by *IEEE Robotics and Automation Letters (RA-L)*. [[arxiv](#)]
4. Songyuan Zhang, Yumeng Xiu, Guannan Qu, Chuchu Fan. Compositional Neural Certificates for Networked Dynamical Systems. Accepted by *2023 Learning for Dynamics and Control (L4DC oral)*. [[paper](#)]
5. Zhefan Xu, Yumeng Xiu, Xiaoyang Zhan, Baihan Chen, and Kenji Shimada. Vision-aided UAV Navigation and Dynamic Obstacle Avoidance using Gradient-based B-spline Trajectory Optimization. Accepted by *IEEE International Conference on Robotics and Automation (ICRA)*, 2023. [[paper](#)]
6. Zhefan Xu\*, Xiaoyang Zhan\*, Baihan Chen, Yumeng Xiu, Chenhao Yang, and Kenji Shimada. A real-time dynamic obstacle tracking and mapping system for UAV navigation and collision avoidance with an RGB-D camera. Accepted by *IEEE International Conference on Robotics and Automation (ICRA)*, 2023. [[paper](#)]

## RESEARCH EXPERIENCE

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### Learning Multi-Robot Social Navigation in Pedestrian-rich Environments via Cooperative Perception

Sep. 2023 - Now

Advisor: Prof. Jiachen Li, Trustworthy Autonomous Systems Laboratory, University of California, Riverside

- Presented a deep reinforcement learning (DRL) based social navigation approach for multiple intelligent robots to safely move in pedestrian-rich environments via cooperative perception.
- Developed multiple Gazebo simulation scenarios rich in social behaviors of pedestrians using social force model.
- Applied end to end multi-object tracking algorithms for Cooperative Perception using 3D Lidar sensor data.

## Onboard dynamic-object detection and tracking for autonomous robot navigation with RGB-D camera

Dec. 2022 - Mar. 2023

Advisor: Prof. Kenji Shimada, Computational Engineering and Robotics Lab, Carnegie Mellon University

- Adopted a novel ensemble detection strategy combining multiple computationally efficient but low-accuracy detectors to achieve real-time and high-accuracy detection.
- Introduced a new feature-based data association to prevent mismatches utilizing point clouds' statistical features.
- Implemented constant-acceleration based Kalman filter for better obstacle state estimation and tracking.

## Compositional Neural Certificates for Networked Dynamical Systems

Jul. 2022 - Dec. 2022

Advisor: Prof. Guannan Qu, Carnegie Mellon University

- Proposed methods for stabilizing power systems based on ISS Lyapunov neural certificate, by collecting certificates of small subsystems to constitute a compositional certificate of the entire dynamical system.
- Developed Centralized neural controllers and Lyapunov functions to verify the global stability in power systems, designed decentralized neural controllers and Lyapunov functions that could be used across different subsystems.
- Utilized the Pandapower tool for modeling and simulation of multiple power system cases.

## A vision-based autonomous UAV inspection framework for unknown tunnel construction sites with dynamic obstacles

May. 2022 - Sep. 2022

Advisor: Prof. Kenji Shimada, Computational Engineering and Robotics Lab, Carnegie Mellon University

- Designed a vision-based UAV inspection framework for dynamic tunnel environments without using a prior map.
- Developed a novel dynamic map module that can simultaneously track dynamic obstacles and represent static obstacles based on an RGB-D camera. Introduced a trajectory prediction module using Markov Chain rule.
- Proposed a gradient-based B-spline path planner that utilizes the robot's onboard vision to find waypoint paths. Applied receding horizon distance field and iterative re-guide strategy to generate collision-free trajectories.
- Set up a real aerial robot platform. Conducted multiple physical experiments to verify the great performance of the inspection scheme in different scenarios.

## Design of a 3D Crossed hole Position degree Error Measurement Instrument

Juan. 2020 - Jul. 2020

Advisor: Prof. Muzheng Xiao, Beijing Institute of Technology

- Constructed a 3D instrument for cross-hole inspection, with a method for position degree accuracy measurement.
- Applied NX UG for device modeling. Analyzed finite element analysis of the instrument using ABAQUS.

## SELECTED COURSE PROJECTS

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### 3D Reconstruction For Tunnel Inspection Based On RGB-D Data

Sep. 2022 - Dec. 2022

Instructor: Prof. Michael Kaess, Robotics Institute, Carnegie Mellon University

- Conducted physical experiments in real tunnels for RGB-D image dataset collection using a real aerial robot.
- Experimented with SFM, NeRF, Open3d methods for 3D tunnel reconstruction.

### Variance reduction in stochastic gradient descent

Mar. 2022 - May. 2022

Instructor: Prof. Guannan Qu, Electrical and Computer Engineering, Carnegie Mellon University

- Implemented SAGA algorithm in strongly convex cases compared to GD, SGD, SAG and SVRG. SAGA achieves better convergence rates than SGD, SAG and SVRG, with less computation cost than GD.
- Outperformed SGD in non-convex neural network cases, with a convergence rate 10 times faster than SGD

## TECHNICAL SKILLS

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**Programming Languages** Python (Numpy, Pandas, Scipy), C/C++, Matlab

**Framework/Tools** Pytorch, OpenCV, ROS, AutoCAD, SolidWorks, Git, ABAQUS, NXUG, CloudCompare

## HONORS & AWARDS

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- 2020 Beijing Institute of Technology FastGear Third Prize Scholarship 03/2020
- Third Prize, Century Cup Creative Competition, BIT 05/2018
- Beijing Institute of Technology the Second Prize Scholarship 09/2018,09/2019
- Member of Student Science Association, BIT 2016-2017