YUMENG XIU

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RESEARCH INTERESTS

- Intersection of machine learning and robotics, with real-world applications in multi-agent autonomous systems.
- Learning-based control on large-scale systems with formal guarantees.
- Trustworthy AI and optimization

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

EDUCATION

Carnegie Mellon University — Pittsburgh, PA
Master of Computational Design and Manufacturing **GPA:3.96/4.0** — Aug. 2023 -May. 2025
Relevant Coursework: *Talking to Robotics, Models and Algorithms for Interactive Robotics*

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

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. Accepted by *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

Multimodal large language model for 2D engineering drawing understanding — Jan. 2024 - June. 2024
Advisors: Prof. Kenji Shimada and Prof. Levent Burak Kara, Carnegie Mellon University

- Applied contrastive learning to analyze dissimilar engineering drawings by computing their similarity metrics.
- Fine tuned a CLIP model on SVG-PNG engineering drawing datasets, showing promising potential to interpret masked elements in engineering drawings.

Learning Multi-Robot Social Navigation in Pedestrian-rich Environments via Cooperative Perception
Sep. 2023 - Mar. 2024

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.

SELECTED COURSE PROJECTS

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

Programming Languages Python (Numpy, Pandas, Scipy), C/C++, Matlab
Framework/Tools Pytorch, OpenCV, ROS, AutoCAD, SolidWorks, Git, ABAQUS, NXUG, CloudCompare

HONORS & AWARDS

- CMU MechE Summer Research Fellowship — 05-08/2022
- 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