Ruirui Ma

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EDUCATION

University of Pennsylvania May 2025

Candidate for Master of Science in Engineering: Robotics. GPA: 3.95/4.00
- **Relevant Courses**: Control and Optimization in Robotics, Distributed Robotics, Learning for Dynamics and Control, Advanced Robotics, Graph Neural Network, Advanced Machine Perception

Georgia Institute of Technology May 2023

Bachelor of Science in Computer Engineering. GPA: 3.99/4.00
- **Relevant Courses**: Intro to Artificial Intelligence, Machine Learning, Intro to Automation and Robotics, Feedback Control System, Control System Design

Bachelor of Science in Mathematics. GPA: 3.99/4/00
- **Relevant Courses**: Advanced Linear Algebra, Real Analysis, Numerical Analysis, Stochastic Processes, Statistics and Applications, Science-based Data Science

SKILLS

Programming Languages: Python | MATLAB | C | C++ | Wolfram Language
Platforms/ Tools: Pytorch | Pytorch Geometric | GPytorch | OpenAI Gym | Issac Gym | Git | LaTex | Unity
Hardware: Oscilloscope | Logic analyzer | Microcontroller Unit | Pixhawk Flight Controller

PROJECTS

Online Learning of Kernel Kalman Filter Sept. 2024 – Present
Goal: Observation predictions of an unknown linear system with non-linear partial observer.
- Deriving Kalman filter update rule with a kernel observer.
- Developing online learning algorithm that predicts observation based on past observations.

Learning-Based Approach to Vehicle Routing Problem Feb. 2024 – Oct. 2024
Goal: Approximate solutions to large scale Multi-Vehicle Routing Problem (mVRP).
- Trained graph neural network (GNN) predicts optimal vehicle routing with ~80% accuracy.
- Trained GNN transferable to larger problem sizes with comparable accuracies.

Multi-Agent System Flocking Control Feb. 2024 – May 2024
Goal: Extended oscillator model for multi-robot flocking control in 3d space.
- Derived distributed control laws for multi-robot flocking along reference trajectories.

Deep Reinforcement Learning (Deep RL) for Multi-Rotor Aerial Vehicle Dec. 2023 – May 2024
Goal: Neural network controller for Multi-Rotor Aerial Vehicle (MAV) with dozens of rotors.
- Customized OpenAI Gym environment and GPU-accelerated parallel training.
- Deep RL trained tracking controller and online path planner for MAVs with up to 64 rotors.

Model Predictive Control for Unicycle Robot Aug. 2023 – Dec. 2023
Goal: Control algorithms for a novel robot with a double pendulum mounted on a unicycle.
- Model predicted control for robot balancing task around fixed points.

Bipedal Robot Walking Gait Sept. 2022 – Dec. 2022
Goal: Planar walking gait for bipedal robots.
- Planar walking gait design as solution to constrained optimization problems.
- Fine-tuned walking gait on bipedal robot in real world experiments.

Nonlinear Dimension Reduction Method Feb. 2022 – May. 2022
Goal: Compute mapping from high dimensional data to lower-dimensional embedding.
- Implemented diffusion map to find geometric structure in high dimensional data.
- Diffusion map reduced image data to interpretable lower-dimensional embedding.

EXPERIENCES

Master's Thesis: Multi-robot Coverage Control, *University of Pennsylvania* Sept. 2023 – Present
Goal: Multi-robot coverage in unknown environment with sparse signal distribution
- Online learning of signal distribution using mixture of gaussian process.
- Upper confidence bound to balance signal coverage and environment exploration.
- Developing informative path planning for better coverage performance and faster convergence.

Research Assistant, *PRECISE Lab at University of Pennsylvania* May 2023 – Aug. 2023
Goal: Neural network policy for hyper-performance quadcopter flight.

- Deep RL policy achieved near theoretical-limit flight time performance on trained racetracks.
- Deep RL trained high-speed turning maneuvers on unseen turns in racetracks.

Undergraduate Researcher, *Borg Lab at Georgia Institute of Technology*   May 2021 – May 2023
Goal: Oil paintings by robotic arms.
- Integrated computer vision algorithms into motion planning pipeline for robotic paintings.
- Automated painting data collection process.

Senior Design Lead, *Georgia Institute of Technology*   Sept. 2021 – May 2022
Goal: Autonomous aerial survey drone with wireless charging station.
- Organized senior design project timelines and work assignments.
- Programmed vision-based autonomous landing on a wireless charging station.
- Customized drone with an onboard computer and peripherals.

Teaching Assistant, *Georgia Institute of Technology*   Sept. 2021 – Dec. 2021
Summary: Teaching assistant for the embedded system programming course.
- Hosted office hours and review sessions. Graded student lab assignments.
- Helped students debug hardware/ software projects at lab sessions.

Undergraduate Researcher, *EPIC Lab at Georgia Institute of Technology*   May 2019 – Sept. 2019
Goal: Hip exoskeleton that aids human movements.
- Constructed VR environments in Unity for simulation experiments.
- Programmed Heads-up Display for incoming projectile path prediction and user evasion path indication.