Xingyu Li

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Education

Northeastern University China
Master in Control Science and Engineering *09/2023 - Present (expected 06/2026)*
- College Of Information Science and Engineering (GPA 89.42/100)

Shenyang University of Chemical Technology China
Bachelor in Process Equipment and Control Engineering *09/2019 - 06/2023*
- School of Mechanical and Power Engineering (GPA 89.01/100)

Publications

- **Xingyu Li**, Hongyu Nie, Haoxuan Xu, Xingrui Liu, Zhaotong Tan, Chunyu Jiang, Yang Feng and Sen Mei, ”GeoSafe: A Unified Unconstrained Multi-DOF Optimization Framework for Multi-UAV Cooperative Hoisting and Obstacle Avoidance”. (Accepted by **2025-IROS**)
- **Xingyu Li**, Haoxuan Xu, Xingrui Liu and Zhaotong Tan, ”Real-Time Occupancy Grid Mapping Using RMM on Large-scale and Unstructured Environments”. (Accepted by **2025-IROS**)
- Hongyu Nie†, **Xingyu Li**†, Xu Liu, Decai Li, Yuqing He, ”FELP:Fast and Effective Autonomous Flight on Large-scale and Cluttered Environments Based on Unified Linear Parametric Map”.(Accepted by **2025-RAL**) (†: equal contribution)
- Hongyu Nie†, **Xingyu Li**†, Xu Liu, Zhaotong Tan, Sen Mei, Wenbo Su, ”Unified Linear Parametric Map Modeling and Perception-aware Trajectory Planning for Mobile Robotics”. (**Available on arXiv**, V1) (†: equal contribution)

Research Experience

Multi-UAV Cooperative Hoisting and Trajectory Planning in Constrained Environments *2023 - 2024*
- Proposed a unified optimization framework (GeoSafe) that introduces a rotational degree of freedom to the standard 4-DOF model, expanding the solution space for navigating narrow passages.
- Utilized the MINCO transformation to reformulate the constrained formation adjustment and obstacle avoidance problem into a single unconstrained optimization, enabling efficient, real-time trajectory generation.
- Validated with scalable formations (2-4 UAVs) in extensive simulations and real-world experiments, demonstrating superior success rates and computational efficiency compared to IF-based and sampling-based methods.

Lightweight and Efficient Occupancy Mapping for UAV Autonomous Exploration *2024 - 2025*
- Proposed a linear parametric model using the Random Mapping Method (RMM) to generate complete and coherent world models, overcoming the limitations of traditional probabilistic methods like **Bayesian filtering** that produce fragmented maps due to occlusions.
- Implemented an online learning framework for the model on a resource-constrained UAV platform with Livox Lidar, demonstrating its efficiency for real-time map updates and inference during autonomous flight.
- Validated the method in extensive simulations and real-world tests, demonstrating that it surpasses traditional methods in storage efficiency, access time, and prediction accuracy.

Fast and Efficient Autonomous Flight in Large-Scale Environments *2024 - 2025*
- Proposing a novel **knowledge representation** framework using a unified linear parametric model to symbolically represent both occupancy grids and ESDF maps for autonomous flight.
- Enabling efficient **symbolic reasoning** by deriving a closed-form, resolution-invariant ESDF from the parametric model, which allows for direct computation of distance and gradients without traditional interpolation.
- Validating the complete flight system (FELP), demonstrating that the symbolic representation and reasoning approach yields superior performance in mapping and planning efficiency against state-of-the-art methods in diverse, large-scale environments.

Unified Parametric Mapping and Perception-Aware Planning for Mobile Robots *2024 - 2025*

- Proposed a unified mapping framework (RMRP) for environmental **knowledge representation** using random mapping and sparse random projection to create a lightweight, continuous linear parametric map, supported by a novel Residual Energy Preservation Theorem for theoretical guarantees.
- Developed a perception-aware planning framework (RPATR) for UAVs that uses the map's analytical gradient to refine initial paths and a closed-form ESDF model for back-end optimization, enabling proactive navigation through **symbolic inference** of unobserved structures from learned geometric priors.
- Extended the framework to UGVs for terrain-aware navigation by modeling terrain and its analytical gradient to avoid hazards, and validated the entire system in diverse scenarios, demonstrating superior performance in mapping and planning.

Research Interest

- Enabling autonomous robots to make common-sense decisions in real, open environments by integrating symbolic planning, probabilistic reasoning, world modeling, and learning-based methods.

Skills

- **Programming:** C/C++ & Python for Linux (ROS), CUDA, ROS, Gazebo, V-REP, Git, CMake, LaTeX
- **Machine Learning & Algorithms:** Machine Learning fundamentals, Algorithm optimization and deployment on embedded platforms(Intel NUC, NVIDIA Orin NX)
- **Mathematics & Modeling:** Linear Algebra, Optimization, Probability Theory, 3D Modeling (SolidWorks)
- **Development Tools:** WSL2, System integration and testing, Adobe Illustrator, Adobe After Effects
- **Soft Skills:** Independent Research, Team Collaboration, Problem-solving, Analytical Thinking, Technical Communication
- **Miscellaneous:** NumPy, Matplotlib, CAD, Markdown, NodeJs, Ansys Fluent

Awards & Honors

- First-Class Academic Scholarship, Northeastern University (2024, 2025, University-level)
- National University Mechanical Engineering Innovation and Creativity Competition Zhuoran-Dushun Cup (2022, National Second Prize, Team Leader)
- Wenyu Scholarship for the year 2021 (2022, University-level)