CAREER: Re-Thinking the Perception-Action Paradigm for Agile Autonomous Robots

Giuseppe Loianno, New York University

Problem

- Design models and algorithms that enable simultaneous and concurrent perception–action for agile navigation of mobile robots equipped with cameras and IMUs

Challenges

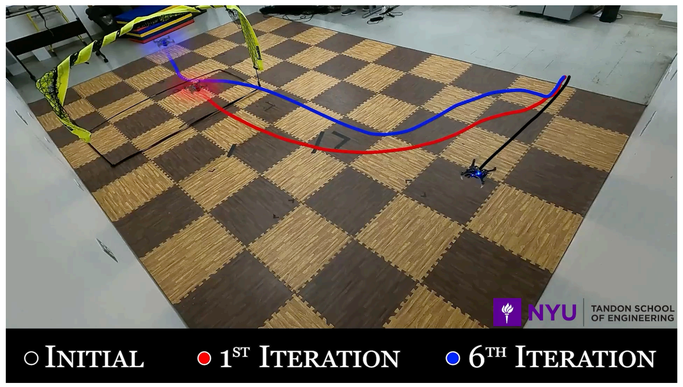
- Unify action and perception representations for fast decision-making
- Action-aware perception and estimation for accurate and robust inference
- Perception-aware planning and control to optimally couple perception and action

Scientific

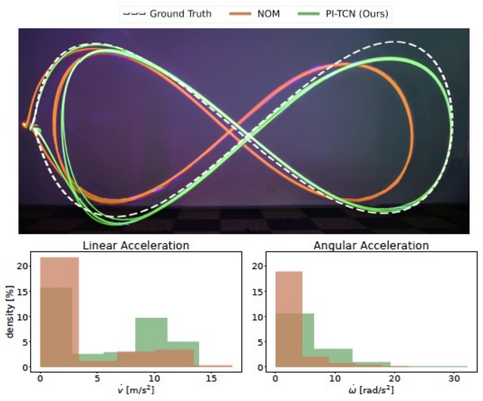
- Novel models and representation for fast decision-making
- Study principled combination of physics-based and data-driven techniques for autonomy
- AI/ML solutions for real-time navigation of autonomous vehicles

Proposed Solutions

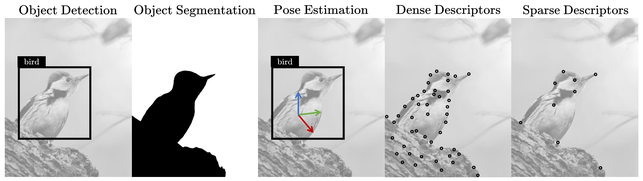
Learning MPC (ICRA 2022 **Outstanding Best Deployed Systems Paper finalist**)



PI-TCN Learning Dynamics and MPC (RA-L and IROS 2022)



Learning Dynamics and Representations (Annual Review of Control 2023)



Active Visual Planning for Agile Navigation (IEEE Transactions on Robotics 2023)

Broader Impacts (Society)

- Reduced working costs and human effort
- Increase society acceptance of autonomous machines
- Faster and safer execution of complex time-sensitive tasks with small and agile autonomous robots

Broader Impacts (Education and Outreach)

- Dissemination in three workshops at ICRA 2022 and one at IROS 2022
- K-12 and UG mentorship
- The Robot Code: An Interactive and Accessible Platform for Ethically using Autonomous Robots
- Open-source code

Broader Impacts (Impact)

- Reduced human risk to solve complex, time sensitive, and dangerous tasks
- Educate new researchers on autonomy
- Promote the use of autonomous robots in real-world tasks

Publications

- G. Li, A. Tunchez, and G. Loianno, "Learning Model Predictive Control for Quadrotors", IEEE/ICRA International Conference on Robotics and Automation, pp. 5872-5878, 2022, **Outstanding Best Deployed Systems Paper finalist**, doi: https://doi.org/10.1109/ICRA46639.2022.9812077
- A. Saviolo, G. Li, and G. Loianno, "Physics-Inspired Temporal Learning of Quadrotor Dynamics for Accurate Model Predictive Trajectory Tracking," in IEEE Robotics and Automation Letters, vol. 7, no. 4, pp. 10256-10263, Oct. 2022, and presented at IROS 2022, doi: https://doi.org/10.1109/LRA.2022.3192609
- J. Mao, S. Nogar, C. M. Kroninger and G. Loianno, "Robust Active Visual Perching With Quadrotors on Inclined Surfaces," in IEEE Transactions on Robotics, 2023, doi: https://doi.org/10.1109/TRO.2023.3238911
- A. Saviolo and G. Loianno, "Learning Quadrotor Dynamics for Precise, Safe, and Agile Flight Control", Annual Reviews in Control, 2023, doi: https://doi.org/10.1016/j.arcontrol.2023.03.009
- R. Ge, M. Lee, V. Radhakrishan, Y. Zhou, G. Li, and G. Loianno, "Vision-based Relative Detection and Tracking for Teams of Micro Aerial Vehicles", IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2022, doi: https://doi.org/10.1109/IROS47612.2022.9981115

2023 FRR & NRI Principal Investigators' Meeting
May 2-3, 2023

Award ID#: 2145277