Sunan Sun

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Education

University of Pennsylvania Philadelphia, PA
Masters of Science in Robotics Sep 2021 - May 2023
Courses: Learning in Robotics, Control and Optimization with Applications in Robotics, Advanced Robotics, Convex Optimization

Union College Schenectady, NY
Bachelor of Science in Mechanical Engineering Sep 2016 - May 2020
Honors: Dean's List 2016-2020, Pi Tau Sigma (International Honor Society for Mechanical Engineers), Tau Beta Pi (Engineering Honor Society)

Research

GRASP Lab at the University of Pennsylvania Philadelphia, PA
Research Assistant advised by Nadia Figueroa May 2022 - Present

Learning Stable Dynamical System-Based Motion Policy for Robotic Planning/Control

- Transcribed the robotic planning/control problem into designing autonomous *dynamical systems* with stability guarantees;
- Incorporated reactive orientation control for robotic manipulators to (i) preserve intrinsic behavior between position and orientation within tasks, and (ii) ensure robust response to temporospatial disturbances;
- Enabled online learning within a Learning from Demonstration (LfD) framework by advancing the training speed by orders of magnitudes over baseline methods while efficiently requiring as few as a single trajectory from human demonstrator;
- Proposing an *elastic* motion policy with a high degree of intratask generalization, enabling real-time adaptation to varying initial and goal locations, new via points, and dynamic object locations.

Verifiable and Reactive Long-horizon Skill Generalization

- Designing a *code-writing* Large Language Models (LLMs) that is capable of synthesizing task-parameterized Linear Temporal Logic (LTL) from language instructions and generating Python programs for safety checking and formal verification;
- Encoding safety guarantees into a closed-loop feedback system at both the task and motion levels, enabling robots to detect, interpret and recover from failures across varying granularities in long-horizon tasks.

Passivity-Based Impedance Control for Contact-Rich Force Regulation

- Developing a geometry-aware impedance controller with energy tank-based passivity to enable: (i) compliant control for dexterous manipulation, and (ii) consistent force/torque regulation for contact-rich tasks.

Embodiment-Aware Motion Policy Transfer with Manipulability Modulation

- Transferring motion policy from natural human demonstrations to robots with varying embodiments by learning, modulating and tracking the optimal manipulability field to ensure kinematic and dynamic feasibility.

Publication

[1] **S. Sun*** and N. Figueroa, "Se(3) linear parameter varying dynamical systems for globally asymptotically stable end-effector control," in *IEEE/RSJ IROS 2024*, Abu Dhabi, UAE.

[2] **S. Sun***, H. Gao, T. Li, and N. Figueroa, "Directionality-aware mixture model parallel sampling for efficient linear parameter varying dynamical system learning," *IEEE Robotics and Automation Letters (RA-L)*, May 2024.

Project

Autonomous Visual Inertial Odometry(VIO)-based Quadrotor

- Implemented the Quaternion-based Unscented Kalman Filter (UKF) to estimate the pose of the flying robotic platform by optimally combining the observations from the onboard inertial measurement unit (IMU) and the onboard stereo pair;
- Planned safe geometric paths using Rapidly-exploring Random Trees (RRT) and A^* search algorithms, and computed Minimum Snap trajectory satisfying dynamics constraints with smoothness up to the 4th order of kinematic state;
- Deployed both linear back-stepping and geometric nonlinear controllers for nano quadrotors, enabling swift navigation through tightly constrained terrains in simulation and indoors environments.

Skills

Languages: Python, MATLAB, C, C++, LaTeX
Frameworks: Linux, ROS, PyTorch, TensorFlow, GitHub