Adaptive Whole-Body Planning and Control for Aerial Manipulator Grasping

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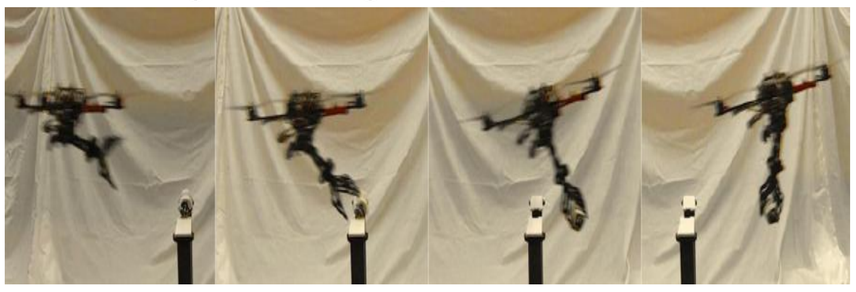
Introduction

- **Aerial manipulators**, combining quadrotors with robotic arms, have gained attention for tasks like inspection, manipulation, and transportation.
- Accurate trajectory tracking is important for aerial manipulator application; however, it is challenging due to the coupling between the quadrotor dynamics and the robotic arm, especially during object manipulation.

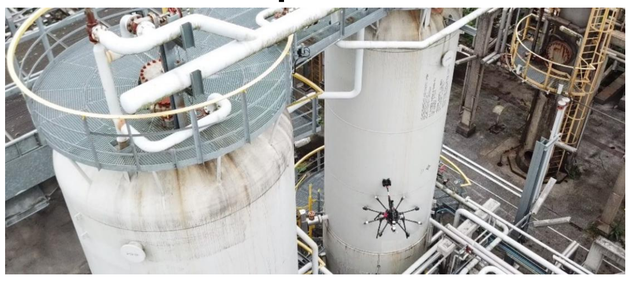
Objective: Develop an adaptive control framework to improve trajectory tracking accuracy under dynamic coupling and disturbances caused by heavy-object grasping.

High-speed grasp and transport



Construction

Inspection



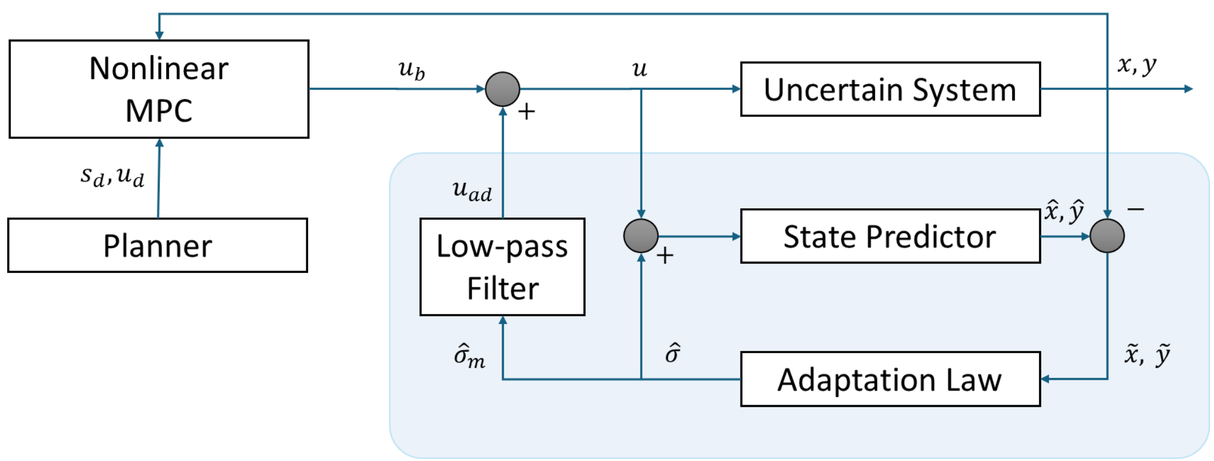
Methodology

Non-linear Whole-body Model Predictive Control (MPC)

- **Purpose:** Whole-body path planning and trajectory tracking.
- Limitation: Fixed model parameters fail to account for disturbances from dynamic coupling and heavy-object grasping.

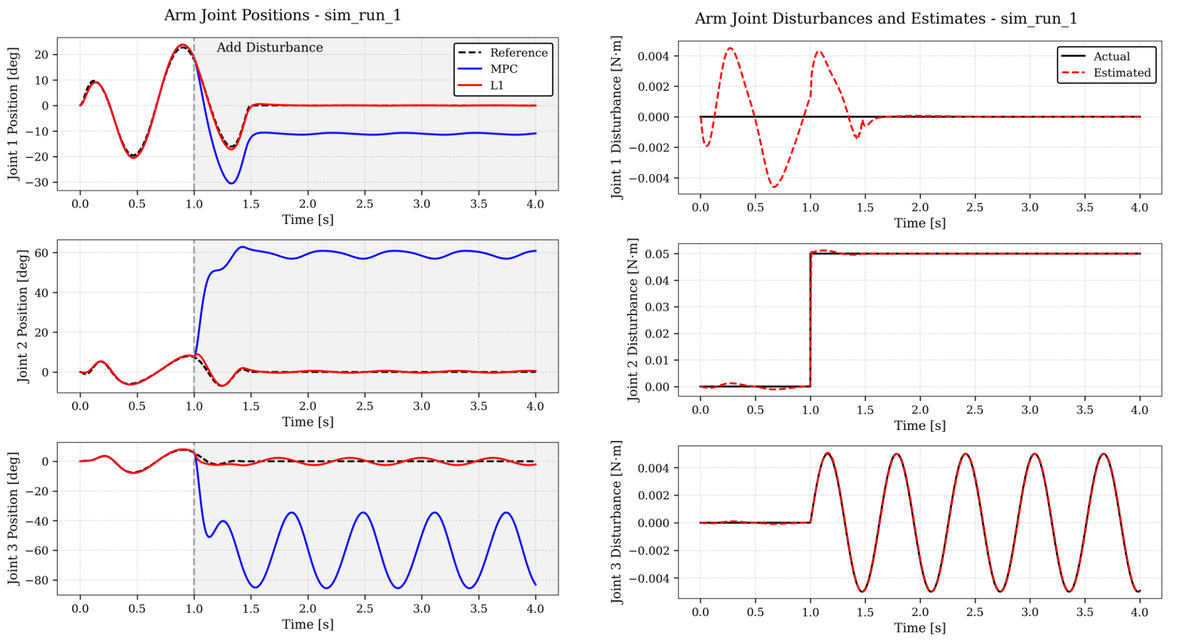
L1 Adaptive Control Augmentation

- Role: Estimate and compensate for disturbances in real time.
- Integration: Augmented with MPC to dynamically adjust control inputs.
- Key Features: Rapid disturbance estimation and compensation to enhance tracking performance.

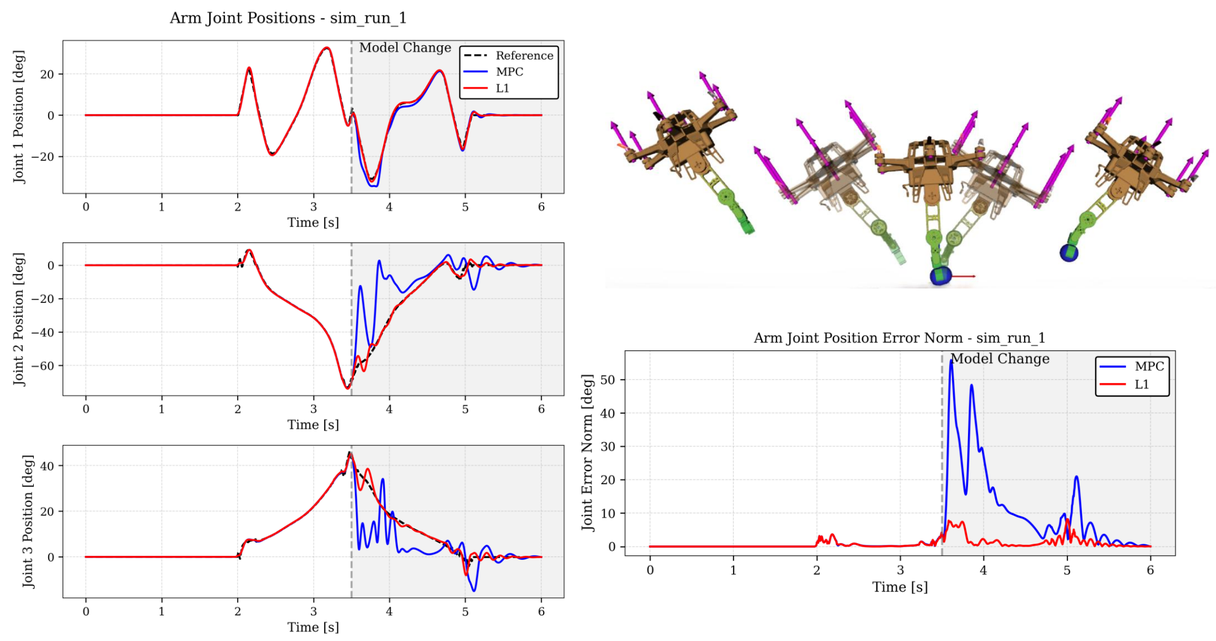


Simulation

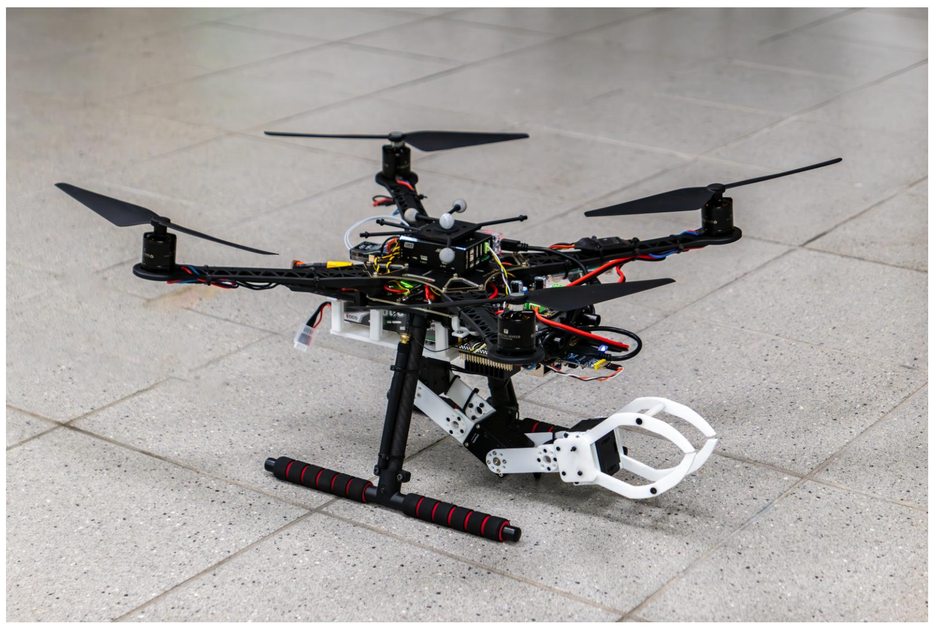
Hovering with disturbance

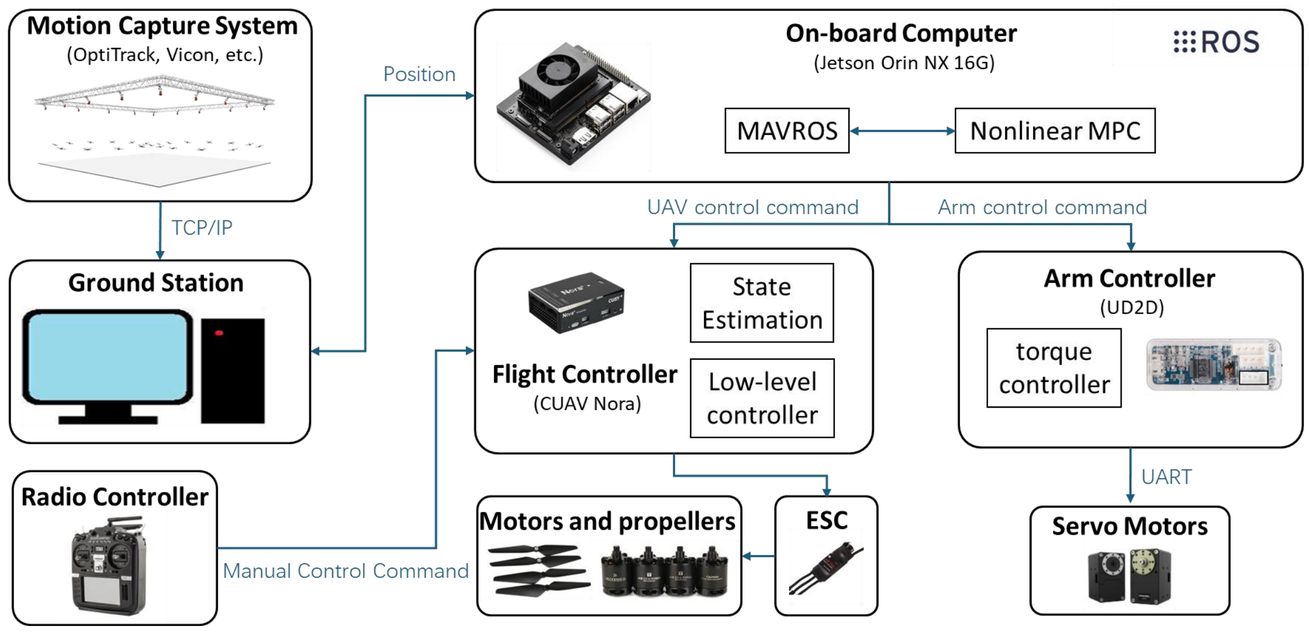


Grasping and transport



Hardware Prototype





Conclusion and Future work

- **Main Finding**: L1 adaptive control significantly improves trajectory tracking accuracy by compensating for unmodeled disturbances caused by heavy-object grasping.
- **Impact:** Enhanced control robustness makes aerial manipulators more viable for dynamic and uncertain environments.
- **Future Work:** Extending the framework for real-time vision-based object identification and grasp.

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