MPC for Spacecraft Rendezvous and Docking

Overview

This project investigates the use of Model Predictive Control (MPC) for autonomous spacecraft rendezvous and docking (RVD), a maneuver requiring precise six-degree-of-freedom (6-DOF) control of both translation and rotation. Traditional controllers such as PD or LQR perform well in simplified cases but degrade in coupled dynamics or when explicit constraints must be enforced.

A nonlinear 6-DOF plant model was developed, and both MPC and a baseline LQR controller were implemented and compared. Results show that MPC achieves stable convergence in coupled and uncoupled cases, with positional errors under 0.05 m and attitude errors within 0.024 rad RMS, highlighting its advantages for high-precision spacecraft control.

Documentation

A detailed technical report describing the problem formulation, methodology, results, and discussion is included in this repository:

Results (Highlights)

- Stable convergence achieved with MPC under 6-DOF nonlinear dynamics.
- MPC outperforms LQR in coupled scenarios.
- Positional error: < 0.05 m
- Attitude error: ~0.024 rad RMS

(Figures available in the report.)

Future Work

Planned extensions include incorporating **delay-tolerant strategies** and running Monte Carlo simulations to evaluate robustness under uncertainties.