EN.530.626: Trajectory Generation for Space Systems
Homework 3
Due Oct 21st 11:59PM

The code for this assignment can once again be found on GitHub at this link and can be downloaded by running `git clone https://github.com/JHU-ACEL/trajdesign_hw.git` from a terminal window. You can either clone/download the repository out or simply `git pull` if you had cloned out the repository for the last homework. Homework submissions and grading will be managed through Canvas.

Introduction

This homework will focus on the following technical concepts:

1. Understanding the importance of convex optimization techniques as applied to trajectory generation problems and how they can be extended to solve non-convex problems using sequential convex programming approaches.
2. Understanding how manifold constraints arising for physical systems can be satisfied within an optimal control framework and with a particular emphasis on the rotational space of quaternions $\mathcal{S}^3$.

To accomplish this, the software development learning goals include,

- Implementing trajectory optimization problem using off-the-shelf trajectory optimization packages such as `cvxpy` and `acados`.

Problem 1: PDG

In this problem, we will be implementing the lossless convexification approach for rocket powered descent guidance presented in [1].

Problem 2: Quaternion Optimal Control

In this problem, we will be implementing a controller to execute slews for the Astrobee free-flying robot [2] and learn how to satisfy manifold constraints associated with the quaternion space $\mathcal{S}^3$.

Submission Instruction

- Download the marimo notebook for each problem and join them together into a single PDF or HTML file named `hw3.pdf`.

- Compress the `hw3` folder containing your python files. Name this file "hw3.zip".
- Upload both the PDF/HTML file and the zip folder into the canvas assignment "`Homework 3`".

References

[1] B. Açıkmeşe, J. M. Carson, and L. Blackmore, "Lossless convexification of nonconvex control bound and pointing constraints of the soft landing optimal control problem," *IEEE Transactions on Control Systems Technology*, vol. 21, no. 6, pp. 2104–2113.

[2] T. Smith, J. Barlow, M. Bualat, T. Fong, C. Provencher, H. Sanchez, and E. Smith, "Astrobee: A new platform for free-flying robotics on the International Space Station," in *Int. Symp. on Artificial Intelligence, Robotics and Automation in Space*, 2016.