Problem Set 6

AA279D: Dyn, Nav, Ctrl of DSS
Spring Quarter 2022/2023
Due: May 17, 2023, Wed, 11:59AM PT
Prof. Simone D'Amico

Submission Instructions

Please briefly document all tasks outlined below in a report which will grow during the course. You should include a table with change logs since the last submission, and an index for sections at the beginning. Please submit your report as a single PDF file to the course Canvas website. It should include narrative, plots, tables, code, and interpretations. You should use typesetting software like LaTeX or Microsoft Word to produce your document. Do not submit extra files.

Topics

Week 6. Continuation of project. Implement continuous control law.

Problem 1: Continuous Control Law

Now that you have set up the necessary framework and know your objectives, you will design and implement your first continuous control law for your mission. The details of this implementation will be left to you, however a base set of tasks is provided below:

1. Consider implementing a continuous control law for formation keeping or formation reconfiguration. The specifics of the control law are left entirely up to you (e.g. the tracked state, in-plane vs out-of-plane control, control windows, constraints etc.). You may choose from the formulations discussed in class or even look at other literature within the field. If you are involved in relevant research, this is an opportunity to apply your work.
2. If you decide to follow more closely the class material and what's done in practice, you could do the following:
    a. Define and setup the formation reconfigurations you want to solve (i.e., chief's orbit OE, initial ROE, final ROE, duration).
    b. Apply Lyapunov control theory with or without constraints, or
    c. Apply Convex optimization using CVX with or without constraints.
    d. Compare with impulsive control and delta-v lower bounds.
3. Justify your choices and describe the implementation in detail, including:
    a. Dynamics model implemented for ground truth simulation
    b. Selection of dynamics model and state representation for controller/maneuver planner
    c. Actuator implementation
    d. Inclusion of uncertainties (e.g. noisy sensors and actuators)
4. Discuss the performance of the control system with visualizations and interpretations of results:

a. Include plots of control tracking error, maneuver scheduling, and delta-v over time.
b. Comment on the strengths and weaknesses of your implementation(s)
c. Compare the performance against your expectations regarding parameters like delta-v budget, delta-v lower bound, frequency of maneuvers, maneuver directions
d. If the controller does not work for the application of interest, explain why

Note: This is a challenging problem as you face several choices and bugs in implementation are likely. It will be evaluated with a focus on methodology at this stage rather than accuracy. You will have a chance to improve this for the final project.

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