ASEN 5014 Linear Control Systems, Spring 2024

Final Project

Assigned: Friday, April 19, 2024

Due: 5 PM Monday, May 6, 2024

Note: This assignemnt is due after the scheduled final exam time

The purpose of this project is to exercise the analysis and design tools discussed in class on a system of your interest. Please be concise in discussing your work in each of the parts below, but describe your work in enough detail so that your reasoning, assumptions, key developments, and results can be understood. Be sure to properly label and reference figures explicitly in the text.

Students will work in **groups of three or four** to complete the assignment. Students may select their own group. Email me (`eric.frew@colorado.edu`) your group and the model you choose by Friday, April 26, 2024. If a student is not able to find a group let me know as soon as possible.

The assignment will be submitted electronically to Gradescope as a single pdf document. A written assignment should be submitted that addresses the questions given below. It is recommended that you include any computer code you used as an appendix to the report.

1. (10 pts) Students are to select a state space system for this assignment from the set of provided models. These models can be found on the course web page under the submodule "Final Project". For the purpose of completeness, describe the specific model chosen. Discuss the purpose of the physical system, what behavior is desired from it, and what aspects of the system were most important to model. Describe the physical meaning of the state variables and the inputs and outputs of the system. List the specific matrices of the state space model with their numerical values.

2. (15 pts) Establish control system objectives in terms of desired closed loop poles and reference tracking accuracy. Appropriateobjectives depend on the system you have chosen, and should be determined by your group. Determine the system poles. Simulate the system response to an appropriate reference input with no controller in place, and verify that this makes sense considering the system poles.

3. (15 pts) Determine the controllability and observability of your system. If the system fails to be (completely) controllable and observable, discuss how you determined which system poles can be moved with state observation/state variable feedback.

4. (20 pts) Design a state feedback controller to place poles in desired locations. Simulate the closed loop system under the same reference input used in Part 2. Discuss whether the closed loop response corresponds with what is expected considering the desired closed loop pole locations.

5. (20 pts) Design an observer to reconstruct the state. Discuss how you determined the desired observer poles. Simulate the closed loop system consisting of observer and state variable feedback. Verify that the state observation error goes to zero at the desired rate. Compare the closed loop response with that obtained in Part 4.

6. (10 pts) Develop an infinite-horizon cost function, and solve for the corresponding optimal state feedback law. Where are the closed loop poles located? Implement this (with an observer for the state) in simulation, and compare the response to that obtained in Part 5.

The assignment is graded out of 100 points. 90 points are allocated to the parts listed above. The final 10 points are for technical writing and report organization. Reports should be well organized and professionally written. All figures should be properly formatted, labeled, and referenced in the body of the text. Proper formating includes font sizes that can be read and color or marker patterns that are distinguishable.