Introduction

The final lab report tests your understanding of all EECS 16B Labs, with an emphasis on conceptual and analytical understanding. It also allows you to look at these labs from a bigger picture and reflect on your design process and choices. You may use your homeworks, pre-labs, labs, lab notes, presentation slides, and any other resources we provided throughout the semester to help you. **However, all of your answers and explanations must be in your own words; you are not allowed to directly copy from those resources.**

This final lab report is an abridged version of the lab report from last semester, so the style of this lab report is quite different than the midterm lab report. Due to a lack of standard checkoffs, **Section 4 (Classification) will not be graded**.

Requirements

Format

The report is to be done with your lab group using LaTeX or Google Docs/Microsoft Word. **At the top of the report, please include the names and emails of all your group members, as well as the group ID you use for checkoffs.**

Contributions

Under Section 7, please detail each group member's contributions to the lab report. **If we find a highly disproportionate amount of work distribution among the group, we will adjust grades accordingly to penalize non-contributors.** Please cite any sources outside of course materials, if used.

Submission

The final lab report is (tentatively) due on Friday, December 9. **Only one group member should submit the lab report to Gradescope and the rest of the group members should be added to the same submission.**

1 System ID

1. How did you choose the region to collect finer data on *data_fine.txt*? Why is it important to choose such a region to run least-squares regression on?
2. What do θ and β represent physically, not mathematically?
3. Why do we have separate θ and β values for the left and right wheels?
4. Why do we set v^* to the midpoint of our overlapping wheel velocity range, instead of closer to the boundaries? What would happen if we operated our car at a velocity outside of the overlapping velocity range?

2 Controls Part 1

1. What are the open-loop model equations for our PWM input, $u[i]$?
2. What is the purpose of the jolts? Why might the left and right jolts be different?
3. Why does open-loop control fail? Why do we need to implement closed-loop control in order to have the car travel straight?
4. What are the closed-loop model equations for our PWM input, $u[i]$? Explain the purpose of each term.
5. When testing out different f-values in practice, how do you know if the system eigenvalue has gone from positive to negative based on the car's behavior?

6. What effect does setting both f-values to 0 have on the car's control scheme? How is this different from non-zero f-values? Why are non-zero f-values necessary?
7. Why can't we use negative f-values for both wheels? If we wanted to use negative f-values for both wheels, how should we change our closed-loop model equations such that our car goes straight and corrects any errors in its trajectory?
8. What does a zero `delta_ss` value tell you about your car's trajectory? What about a non-zero `delta_ss` value? What kind of error is it supposed to correct when we add it to our control scheme? (**Hint**: Think about the difference between the trajectories for a zero versus a non-zero `delta_ss` value.)

3 Controls Part 2

1. How did you change the closed-loop model equations to allow the car to turn? Write the equations below and explain how they change for turning left, turning right, and going straight.
2. Why do we divide v^* by $m = 5$ for the turning expressions?
3. How is using `STRAIGHT_CORRECTION` different from `delta_ss` in Controls Part 1?

4 Classification

1. What are some characteristics of a good set of four words for classification? Provide at least two features.
2. What are length, prelength, and threshold for our data processing? Include both the definitions and the values you chose.
3. Why do we process our data so that the words are aligned before we run SVD/PCA on it?
4. Why do we need to use SVD/PCA to represent our data set?
5. Why do we use the V^T vectors for our lab instead of the vectors inside of the U matrix returned by SVD?
6. Why can we simply take the dot product when projecting our recorded data vector onto the principal component vectors?
7. If we keep increasing the number of PCA vectors, how does the increase in accuracy with each subsequent PCA vector change?
8. What is `EUCLIDEAN_THRESHOLD`? What is `LOUDNESS_THRESHOLD`?

5 Integration/Final Demo

1. Briefly discuss what you learned throughout the S1XT33N car project and in the labs. What was your favorite part? Least favorite part? Please answer this question individually.
2. What was the most difficult bug you encountered this semester? How did you resolve the bug? What did you learn from the debugging experience?

6 Feedback

Please provide any feedback you have about 16B lab or anything we can do to better support you.

7 Collaborators and Sources

Please detail each group member's contributions to the lab report. Also, cite any sources you used that were not provided with the course materials.