ELECENG 3CL4 Lab 1

Aaron Pinto Raeed Hassan

pintoa9   hassam41

L02   L02

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Member Contributions

Both group members contributed an even amount to both the exercises and the report. Both members went through the exercises together and contributed to all sections of the report.

Simulation Environment

The software used for our simulation environment consisted of Microsoft Windows 10 Education (Version 20H2, OS Build 19042.746), MATLAB R2020b Update 3, and Quanser Interactive Labs Version 2.9. This software was run on a Dell laptop with an Intel Core i7-8550U processor, 8GB of DDR4-2400MHz RAM, Intel UHD Graphics 620 (integrated), and a 256GB SSD.

Familiarization Exercises

Initial setup

The initial exercise had the proportional gain set to 1 and the derivative gain set to 0. The motor voltage quickly increased to just under 2 V and quickly shot back down, but required some time to settle back to 0 V. Figure 1a shows a plot of the motor voltage. The servo angle shoots past the 45 degrees to almost 80 degrees, before beginning to settle towards 45 degrees. The servo angle settles a bit under the targeted 45 degrees. Figure 1b shows a plot of the servo angle.
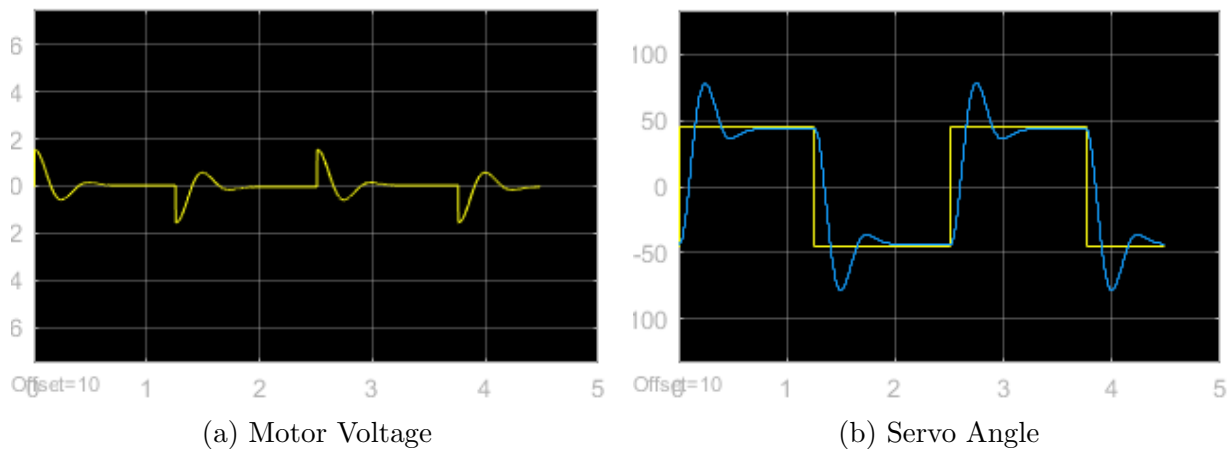

|(a) Motor Voltage | (b) Servo Angle|

Figure 1: Proportional gain: 1, Derivative gain = 0

Investigating the Effects of Increasing Proportional Gain

In the following familiarization exercise, the proportional gain is increased to 2. We observe even greater overshoot, with more oscillations before the motor voltage and servo angle settle. The motor voltage spikes to to approximately 3 V now, as a result of it being driven harder

by the bigger proportional gain, but requires longer to settle down to 0 V. Figure 2a shows a plot of the motor voltage. Similarly, the servo angle jumps to almost 100 degrees this time, before requiring a longer amount of time to settle to 45 degrees. However, the servo angle does eventually settle down to 45 degrees. Figure 2b shows a plot of the servo angle.
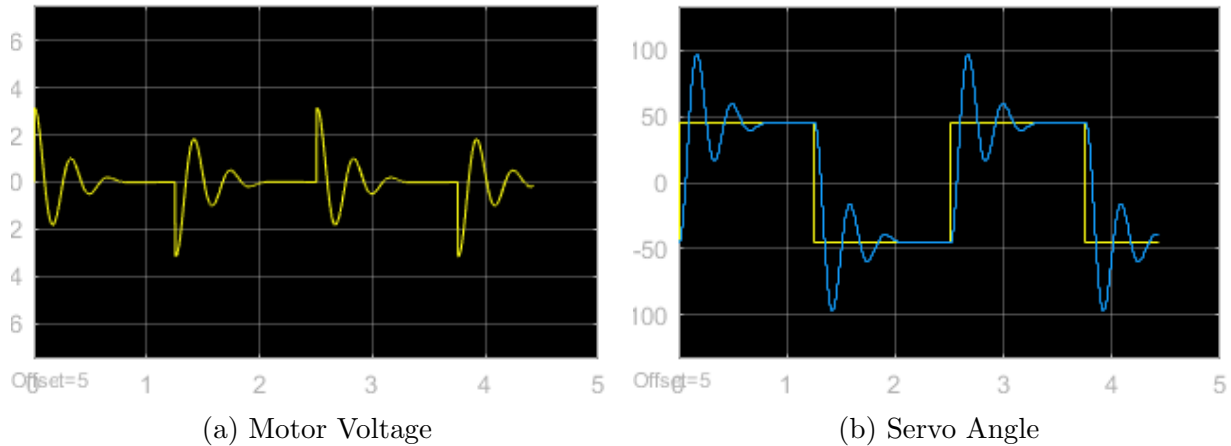

(a) Motor Voltage

(b) Servo Angle

Figure 2: Proportional gain: 2, Derivative gain = 0

Increasing the proportional gain further to 4 caused even greater overshoot, and even more oscillations as the settling time increased significantly. The motor voltage spikes all the way up to 6 V and oscillates for the entire period. The motor is driven in the other direction before it even has a chance to settle. Figure 3a shows a plot of the motor voltage. Similarly, the servo angle overshoots the targeted angle even farther, and does not even have enough time to settle at 45 degrees before it is driven the other way. Figure 3b shows a plot of the servo angle.
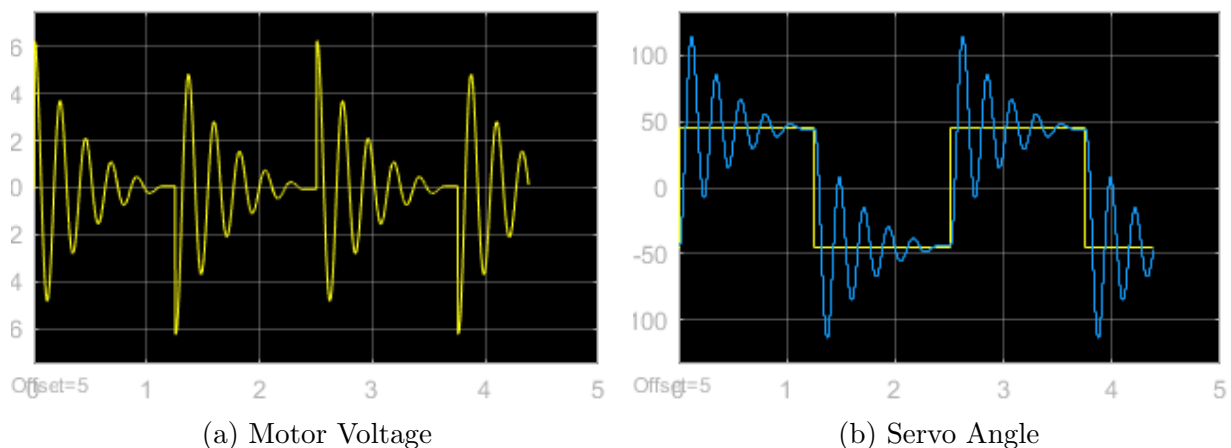

(a) Motor Voltage

(b) Servo Angle

Figure 3: Proportional gain: 4, Derivative gain = 0

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Introducing Derivative Gain

In the next familiarization exercise, we add a derivative gain by increasing it from 0 to 0.15 while keeping the proportional gain at 4. The motion of the disk was much smoother with little overshoot and a very short period of oscillations. The motor voltage still peaked at around 6 V but the subsequent peak was much smaller at 2 V, with oscillations stopping very quickly and the motor remaining settled for the majority of the period. Figure 4a shows a plot of the motor voltage. The servo angle only shoots a bit over the desired angle, but settles down near the desired angle very quickly. The angle remains slightly 45 degrees for most of the period. Figure 4b shows a plot of the servo angle.
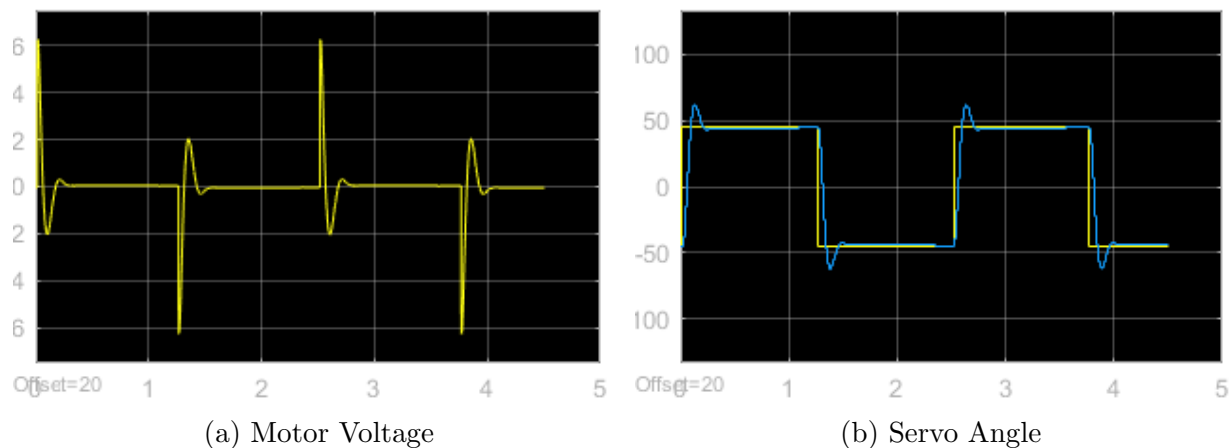

(a) Motor Voltage   (b) Servo Angle

Figure 4: Proportional gain: 4, Derivative gain = 0.1

Investigating the Effects of Increasing Derivative Gain

Increasing the derivative gain further to 0.15 cause the motion to be even smoother. The desired angle was hit with even less overshoot than previously, with a much shorter settling time. The motor voltage peak was slightly higher but the subsequent peak was smaller, with the duration of the peaks appearing to be slightly tighter, causing an even shorter settling time. Figure 5a shows a plot of the motor voltage. The servo angle only shoots a bit over the desired angle, but settles down near the desired angle very quickly and arrives at 45 degrees much quicker than previously. Figure 5b shows a plot of the servo angle.
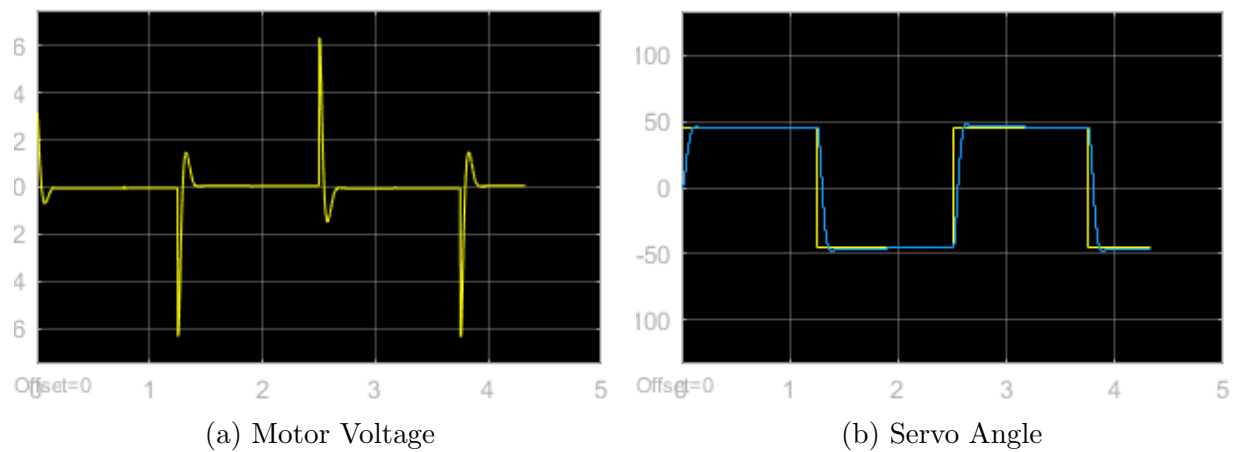
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(a) Motor Voltage

(b) Servo Angle

Figure 5: Proportional gain: 4, Derivative gain = 0.15