SRV02 POSITION CONTROL: Lab 4 Report

Course: ENG 4550

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Lab#: 4

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Procedure:

Ramp Response with PV Controller

The goal of this lab was to measure the steady-state error of the simulated ramp response thru simulation. This was done by generating a triangle reference signal, and comparing it to the ramp-response(thru simulation). The steady-state error was found by looking at the difference between the setpoint and the simulation, and finding the error value at steady state. The theoretical steady state error can be found using eq.1, and the measured and theoretical steady-state errors were compared using percent error(eq. 2)

$$\text{theoretical } e_{ss} = \lim_{s\to 0} sE(s) = \frac{Ro(1+Kkv)}{Kkp} = 0.21375 \quad (1)$$

$$\%\text{error} = \left|\frac{experimental - theoretical}{theoretical}\right| \text{x} 100\% \quad (2)$$

Implementing Ramp Response Using PV

The goal of this lab was to measure the steady-state error of the experimental ramp response thru experimentation with the SRV02. This was done by creating a reference triangle signal and plotting the ramp-response. The steady-state error was found by looking at the difference between the setpoint and the simulation and finding the error value at steady state. The theoretical steady state error can be found using eq 1, and the measured and theoretical steady state errors were compared using percent error (eq. 2).

Results:

Ramp Response with PV Controller

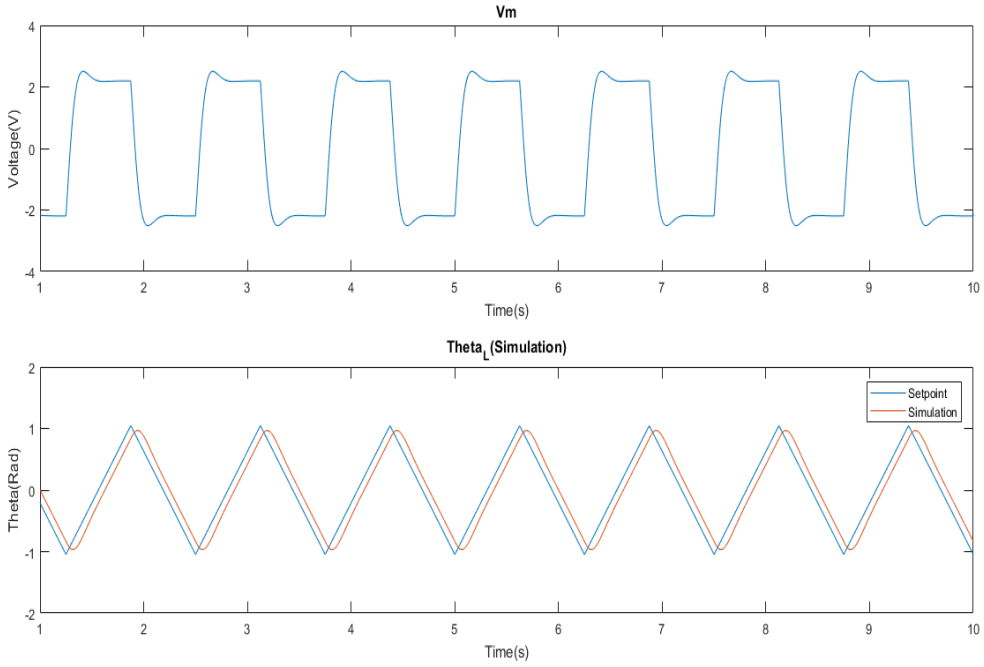

Figure 1: The ramp response (simulation) of the SRV02; plotted is the Vm (input) and the reference and simulated positions (output).

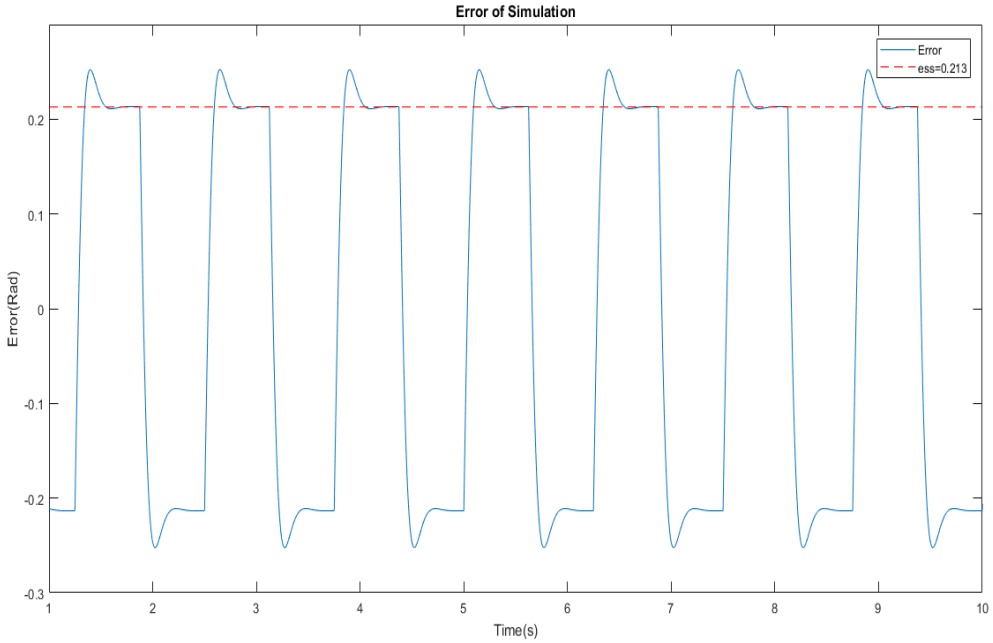

Figure 2: The ramp response error (simulation) of the SRV02. Steady state error is considered when the response has settled.

Implementing Ramp Response Using PV

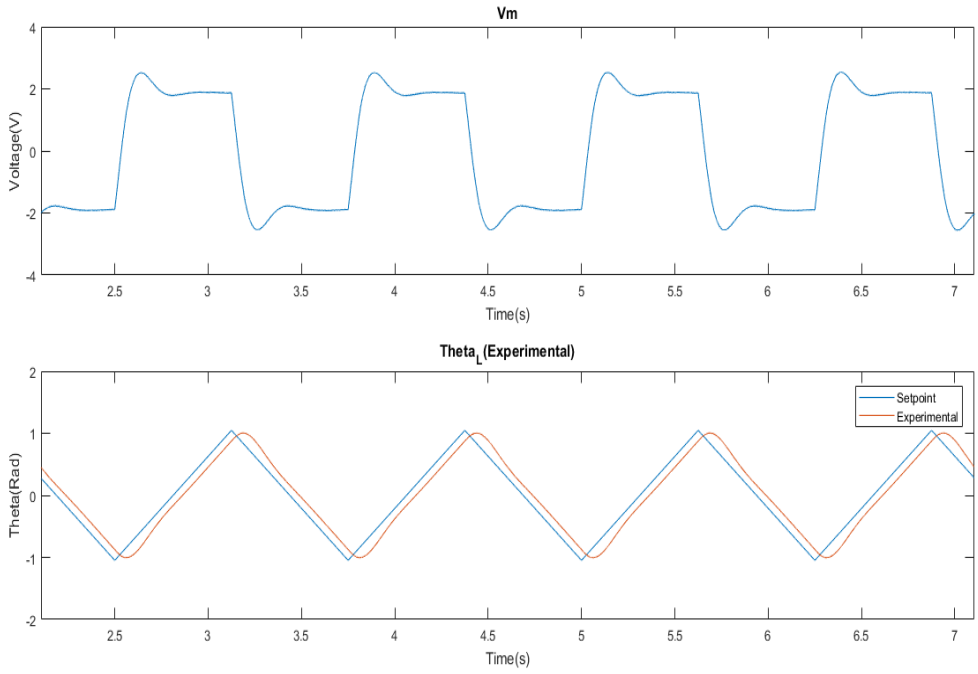

Figure 3: The ramp response (experimental) of the SRV02; plotted is the Vm (input) and the reference position and experimental position (output).

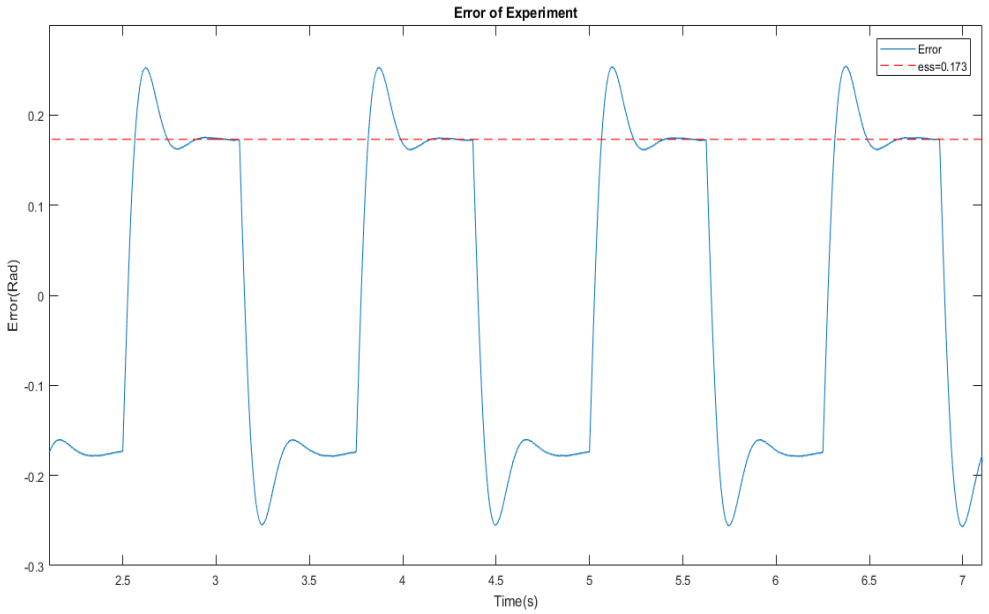

Figure 4: The ramp response error (experimental) of the SRV02. Steady state error is considered when the response has settled.

Section /Question	Description	Symbol	Value	Unit
Question 4	Pre-Lab: Model Parameters Open-loop Steady-state Gain Open-loop Time constant	K tau	1.53 0.0254	Rad/s/v s
Question 4	Pre-Lab: PV Gain Design Proportional gain Velocity gain	k_p k_v	7.8187 -0.1565	V/rad Vs/rad
Question 6	Pre-Lab: Ramp Steady-State Error	e_{ss}	0.214	rad
2.3.2.1	Ramp Response Simulation with PV Steady-state error	e_{ss}	0.213	rad
2.3.2.2	Ramp Response Implementation with PV Steady-state error	e_{ss}	0.173	rad

Table 1: Properties of the PV controller.

Analysis:

Ramp Response with PV Controller

The e_{ss} was found by looking at the difference between the simulation and the setpoint (Figure 2).

e_{ss}=0.213 rad

$$\%error=\left|\frac{experimental-theoretical}{theoretical}\right|x100\%=0.35\%$$

The value measured is approximately equal to the value found in the pre-lab (0.21375) and was only off by 0.35%.

Implementing Ramp Response Using PV

The e_{ss} was found by looking at the difference between the experimental and the setpoint (Figure 4).

$$\mathbf{e_{ss}=0.173\ rad}$$

$$\%error=\left|\frac{experimental-theoretical}{theoretical}\right|x100\%=19\%$$

The value slightly deviates from the value found in the pre-lab(0.21375) and was off by 19%.

Conclusion:

Ramp Response with PV Controller

The e_{ss} found in the simulation (0.213 rad) is close to the theoretical e_{ss} value of 0.214 rad. The simulation was very accurate in modeling the SRV02; percent error of only 19%.

Implementing Ramp Response Using PV

The e_{ss} found in the experiment (0.174 rad) deviates from the theoretical e_{ss} value of 0.214 rad. The discrepancy might be due to noise, instrument error or the dead zone of the motor. The instrument had caused the tachometer to incorrectly measure the position as shown by Figure 3. A controller with integral control can be used to eliminate the steady state error.

References

Apkarian, J., Lévis, M., & Gurocak, H. (Eds.). (n.d.). SRV02 Base Unit Experiment For Matlab/ Simulink. Retrieved October 20, 2018.