Laboratory report 2: Challenge

Group 2, Tuesday Shift

Baron Davide, Bonetto Alessio, Mustacchi Marco, Piron Luca Vittorio

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1 Introduction

1.1 Activity Goal

The goal of the challenge of this laboratory is to design a control system for QUANSER SRV-02 MOTOR such that:

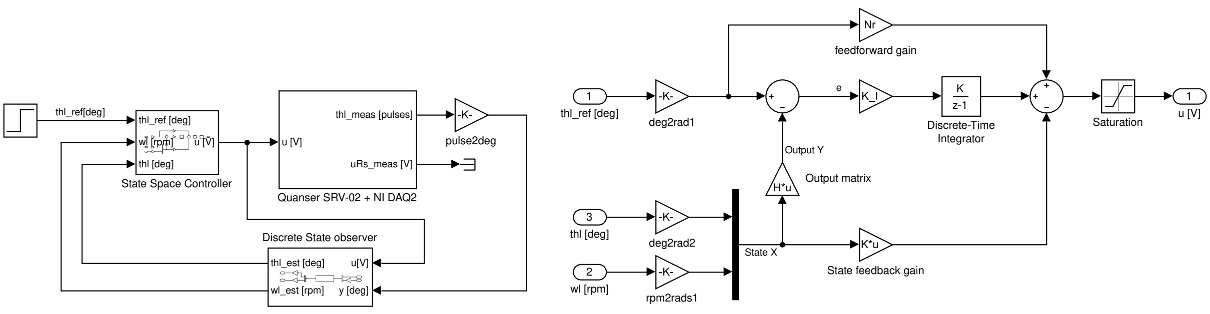
- It ensures asymptotic tracking of step references;
- It ensures an overshoot $M_p \leq 10\%$ for a 60deg step reference;
- It attains a settling time $t_{s,5\%} \leq 0.2s$ for the same reference;
- It employs the longest possible sampling time T_S.

1.2 Model used

The black box *Quanser_SRV02_block* has been used in order to replace the DC motors physically present in the laboratory and faithfully reproduce the behaviour of the real one.

2 Choice of control technique

Among the possible solutions a control in state space has been chosen. The state space controller has been chosen instead of a PID controller because through a feedback it is possible to allocate more precisely the poles' location.
The direct design method has been choosen instead of emulation method because the first one is more robust with respect to the choiche of T_S. Clearly, to ensures asymptotic tracking an integral control has been added in order to reduce the error modelling and the friction of the motor.



(a) (b)

Figure 1: Simulink model used: full system with discrete-time observer (a); Discrete time controller with integrator and feedforward compensation (b).

In the controller is also included a reduced order observer directly designed in discrete time as shown in Sec. 5.2 of the Handout, using the parameters evaluated in the next section.

3 Choice of Parameters

Through a trial-and-error approach the best sampling period T_S has been obtained:

$$T_S = 100\,ms \tag{1}$$

Then, the following matrices has been used for the reduced order observer::

$$\Phi_o = \begin{bmatrix} 1.3007 \cdot 10^{-5} \end{bmatrix}, \qquad \Gamma_o = \begin{bmatrix} 4.6916 & -1.0100 \end{bmatrix} \tag{2}$$

$$H_o = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, \qquad J_o = \begin{bmatrix} 0 & 1 \\ 0 & L \end{bmatrix} \tag{3}$$

The feedback control gains, K and K_I, and the reduced observer gain L, are obtained by poles' location,as:

$$K = [4.6162 \quad 0.0674] \quad K_I = 2.1307 \quad L = 1.01 \tag{4}$$

The feedforward gain has been obtained by trial-and-error:

$$N_r = 2.3 \tag{5}$$

4 Results

The best performances that the system is able to achieve with the chosen controller are:

$$T_S = 100\,ms \quad t_{s,5\%} = 0.19999\,ms \quad M_p = 0.2\% \tag{6}$$

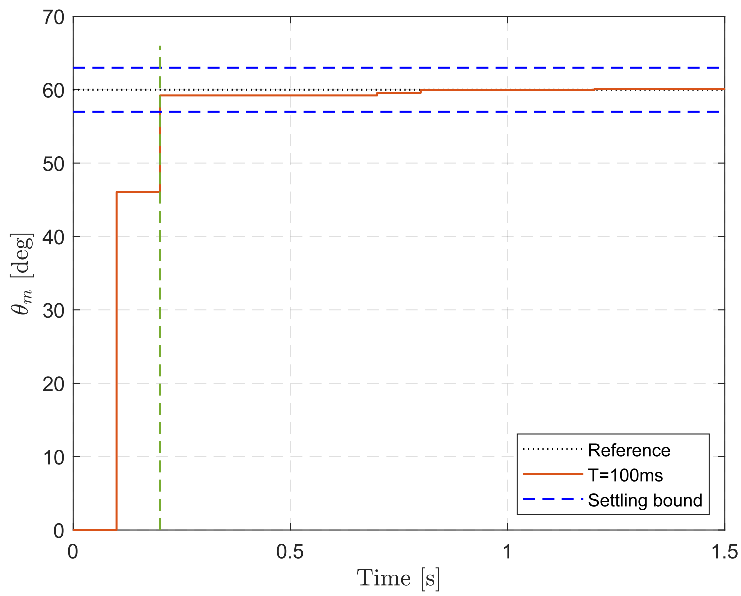


Figure 2: Step response to 60deg reference.