Homework 04 - 2021

Due 09/06/2021 for those who will take the exam in the first session.
Due 3 days before the start of the July or September session.
If you want to take the exam later, the last deadline is still 3 days before the September session.

Problem 1
Go back to the motor example you have been using in the first homework and solve a robust performance control problem. Explore as much as possible the different ways to formulate (in Matlab) the problem and explore it as much as possible.

Problem 2
When you studied the performance limitations for SISO systems, you applied the results seen during the lectures on the inverted pendulum on a cart system. It became quite evident that choosing as input the force applied to the cart and as output the position of the cart, the performance could not be satisfactory. Now you will explore the potential benefit deriving from the introduction of an extra sensor which makes the angular position ϑ of the pendulum available. You obtain a 2×1 SIMO system (Single Input, Multiple Outputs) $G(s)$ with $y = (p, \vartheta)$. You can therefore represent the original system using the interconnection in Fig. 1 with $G_{u\vartheta}(s)$ the transfer function from the control input to the angular position ϑ and $G_{\vartheta p}$ the transfer function from ϑ to the cart position p.

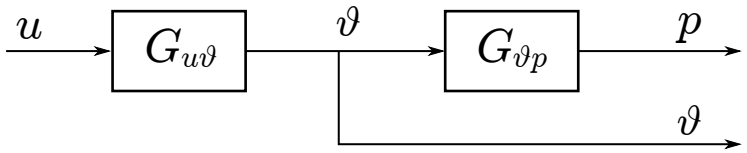

Figure 1: Inverted pendulum on a cart: adding an extra measurement – SIMO (2×1) system

1. Find, from the Cart Pendulum Notes sent in a previous homework, the SIMO transfer function
$$G(s) = \begin{pmatrix} G_{up}(s) \\ G_{u\vartheta}(s) \end{pmatrix}$$
2. Find the poles and zeros of the SIMO system.
3. Find a stabilizing (1×2) controller
$$C(s) = \begin{pmatrix} C_{up}(s) & C_{u\vartheta}(s) \end{pmatrix}$$
4. Compare the performance w.r.t. the case where ϑ was not available. How do you interpret the result?

Problem 3
Reproduce, and understand, as much as possible Example 4.1 of the paper:

J. Garrido, F. Vázquez and F. Morilla, "An extended approach of inverted decoupling", J. of Process Control, 2011