

FRTN15 Predictive Control—Home Work 1

Signals and Systems

In this homework exercise we recapitulate theory for discrete time signals and systems in assignments 1-3. Recursive Least square estimation (RLS) is treated in assignment 4. The exercise also gives the opportunity to practice Matlab/Simulink.

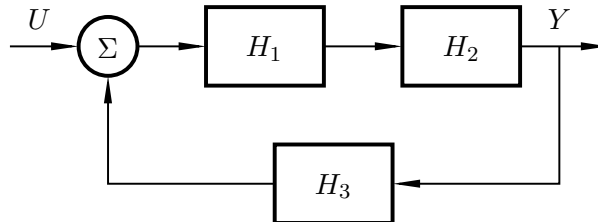
E-mail your detailed and motivated solutions in pdf-format to fredrikb@control.lth.se. Attach any Matlab code or Simulink models you might have used.

1. Sample the (continuous time) system

$$G_{y,u}(s) = \frac{s+1}{s^2}.$$

Provide the transfer function and a state space representation. Conduct the calculations

- a. by hand, with a parametrized sample period h .
 - b. using matlab, with sample period $h = 0.1$.
 - c. How does the sampling period affect the result?
2. Give the transfer function $H(z)$ from r to y of the interconnection below, where $H_1(z) = z + 2$, $H_2(z) = \frac{1}{z^2+2z+1}$ and $H_3(z) = \frac{z}{z+2}$. Also plot the response y when r is a step function.



- 3.

- a. Show that the system H given by

$$x(kh + h) = \begin{pmatrix} 1 & h \\ 0 & 1 \end{pmatrix} x + \begin{pmatrix} \frac{h^2}{2} \\ h \end{pmatrix} u(kh)$$

$$y(kh) = \begin{pmatrix} 1 & 0 \end{pmatrix} x(kh)$$

is not asymptotically stable. Here $h > 0$ denotes the sampling period.

- b. Stabilize H by means of linear state feedback. The resulting system should have all eigenvalues placed in the origin; use $h = 0.1$. (Hint: The command `acker` in the matlab control system toolbox can be useful.)
- c. Placing all eigenvalues in the origin is referred to as deadbeat control. Give an interpretation, motivating this nomenclature. What potential drawbacks are there, compared to less aggressive eigenvalue placements? Hint: Study how the feedback gain changes when h approaches zero.

4.

- a. Use Simulink to demonstrate RLS identification of $\Theta = [a \ b]^T$ for $y_k = ay_{k-1} + bu_{k-1} + w_k$, where w_k is a normal white noise process.

Hint: If you use Simulink, the the block 'Matlab function' might be useful.
Also type `'help persistent.'` at the Matlab prompt.

- b. Comment on the choice of input signal and how it affects the result.
- c. Assume a is time varying, how can the method be modified to identify a ?
How do you use information about typical speed of change of a to tune the algorithm?