Estimation for control – Practical Assignment 5
Discrete-time nonlinear model, control and estimation

Logistics

Same as previous

Prerequisite:

- A nonlinear model, with state vector $x = [x_1,\, x_2, ...x_n]^T$, and input vector $u = [u_1,\, u_2, ...u_m]^T$ where $n \geq 3$, is the number of state variables, $m \geq 1$, is the number of inputs, and the dynamic equation has the form:
$$\dot{x} = f(x, u).$$
- A linear model in classical state space form, linearized around an equilibrium point
- A state feedback control law, which brings the system to 0 from a non-zero initial condition
- An observer, designed for the linear model, implemented in Simulink
- A discrete-time linear model implemented in a Matlab script
- A discrete-time linear state-feedback controller
- A discrete-time linear observer

Assignment description

As it was done in the previous lab for the linear model, at this lab your task is to discretize the nonlinear model.

The nonlinear model can be converted using the Euler discretization:

$$\begin{aligned} \dot{x}(t) = f(x(t), u(t)) \quad &\Rightarrow \quad \frac{x(k+1) - x(k)}{T_s} = f(x(k), u(k)) \\ &\Rightarrow x(k+1) = x(k) + T_s\, f(x(k), u(k)) \end{aligned} \tag{1}$$

Requirements:

- Find the discrete-time nonlinear model
- Implement the nonlinear model in Matlab, not in Simulink!
- Apply the previously computed state-feedback gain to your nonlinear model, start with initial conditions close to the equilibrium point, then try others further away from that point. Is the controller working for far initial conditions? Why? Why not?
- Compare the results obtained for the linear case with the nonlinear case. Are they the same?
- Apply the observer from the linear model to your nonlinear model. Is it working properly? Is the error converging to 0?