Mandatory exercise 3

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Native matlab implementation of a level control of an equalization tank.

The code for the process control without time delay is in the file *mandatory3_part1.m.*

In this file all the parameters are defined, and some are available for the user to change via a prompt.

The sensor has a noise parameter, and this is filtered using the following filter formula

$$y_{mf} = (1 - a) \cdot y_{mf(k-1)} + a \cdot y_m$$

Where y_{mf} is the filtered measured value, y_m is the current measured value and a is the filter constant.

The error e is calculated from the difference between y_{mf} and the setpoint. The error is then used in the PID control formula as show below

$$u = u_0 + K_c \cdot e + \frac{K_c}{T_i} \int_0^t e \, \delta\tau + K_c \cdot T_d \cdot \delta e$$

Where K_c, T_i and T_d are Controller gain, integral time and derivative time respectively.

These parameters are calculated with the Skogestad method without time delay

$$T_c = 500$$

$$K = \frac{1}{A}$$

$$K_c = \frac{1}{K \cdot T_c}$$

$$T_i = 2 \cdot T_c$$

Where T_c is the time constant of the process and A is the cross area of the water tank.

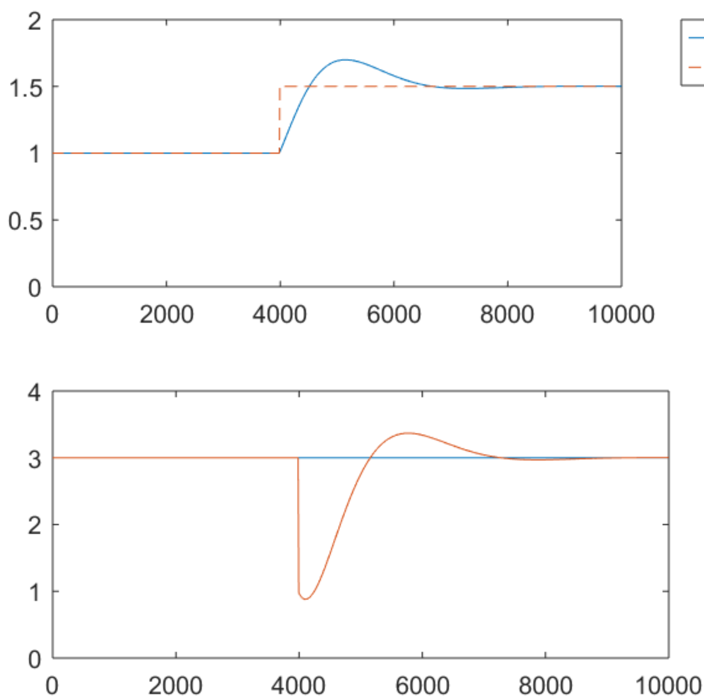
As the process is reversed the control signal is negative.

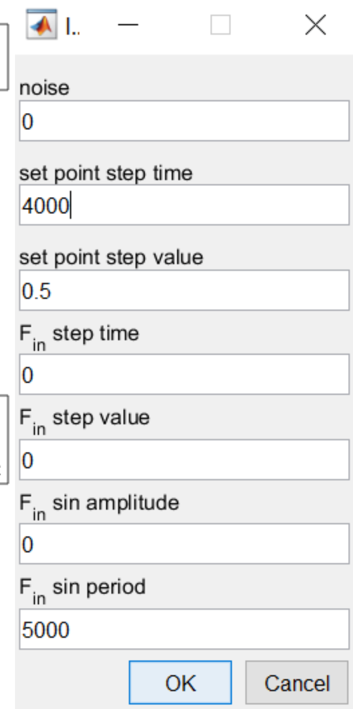
$$F_{out} = -u$$

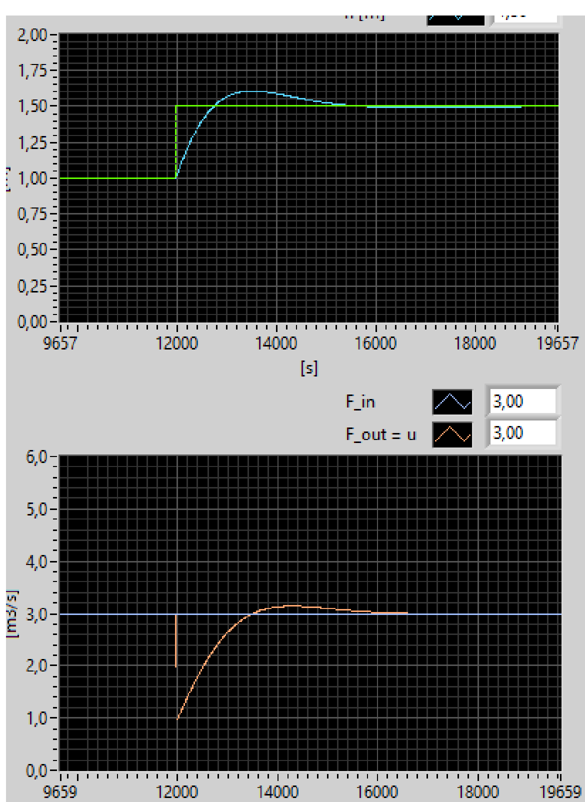
Finally, the results are plotted.

Below follows some results and comparisons to the labview simulation for the same process parameters.

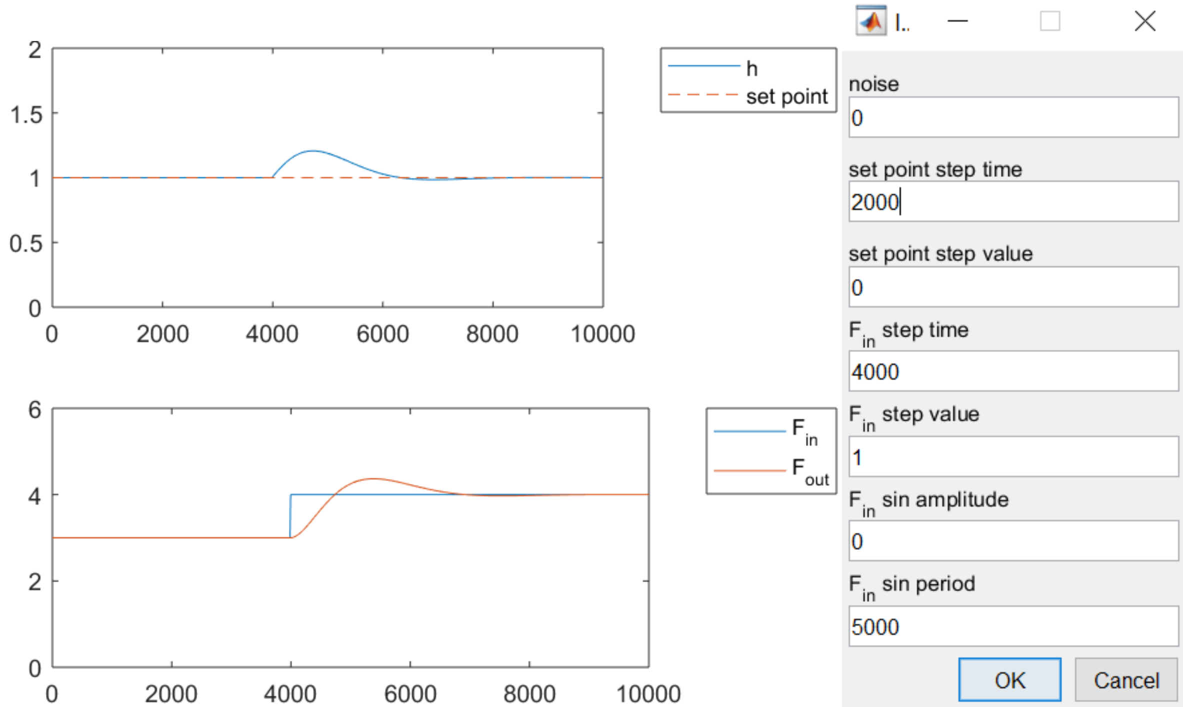
1. set point step response

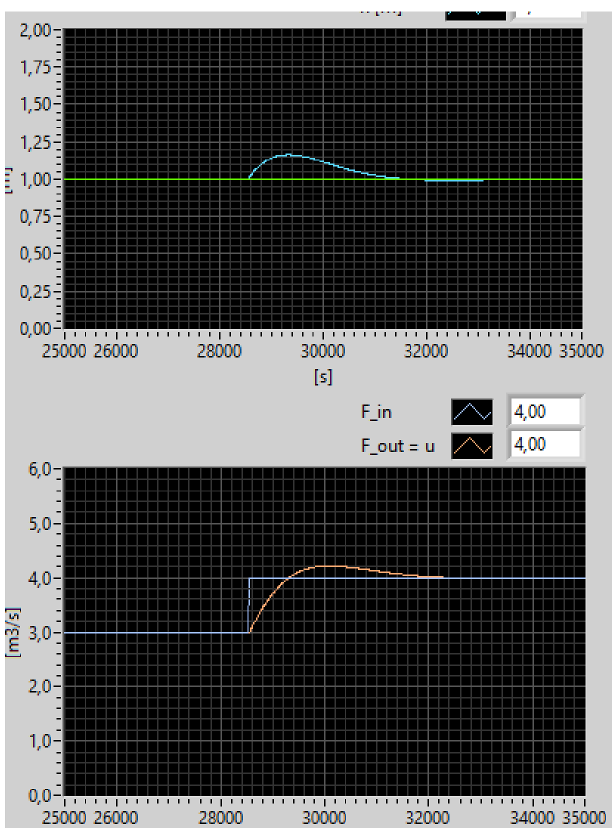




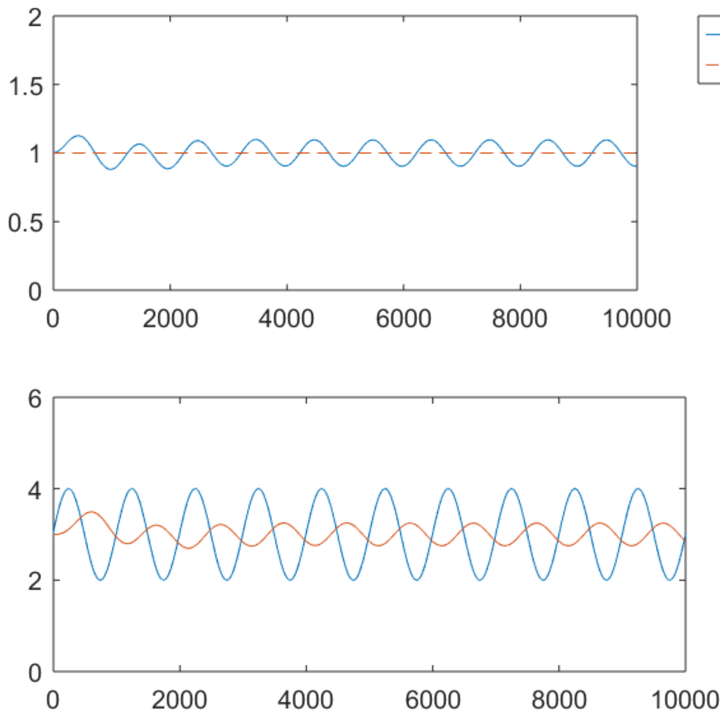


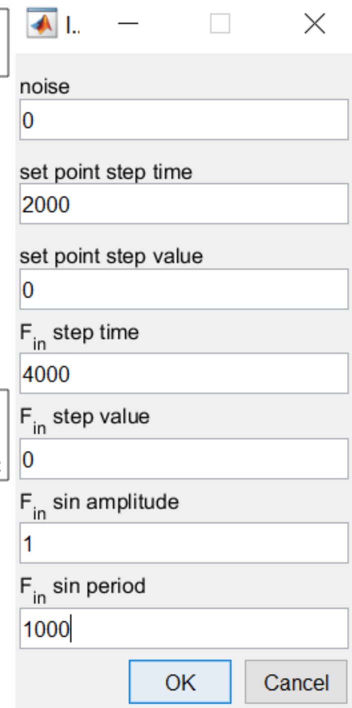
2. F_{in} step response

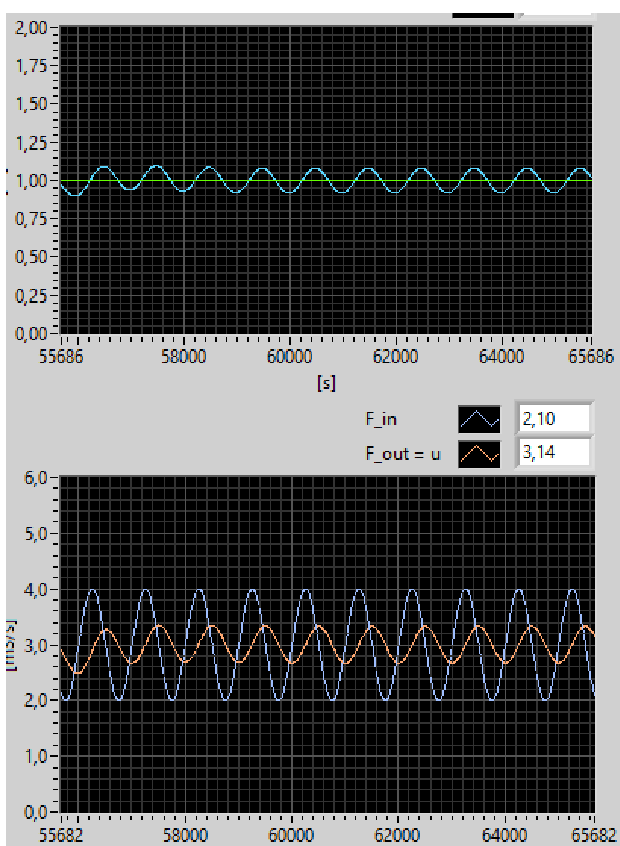




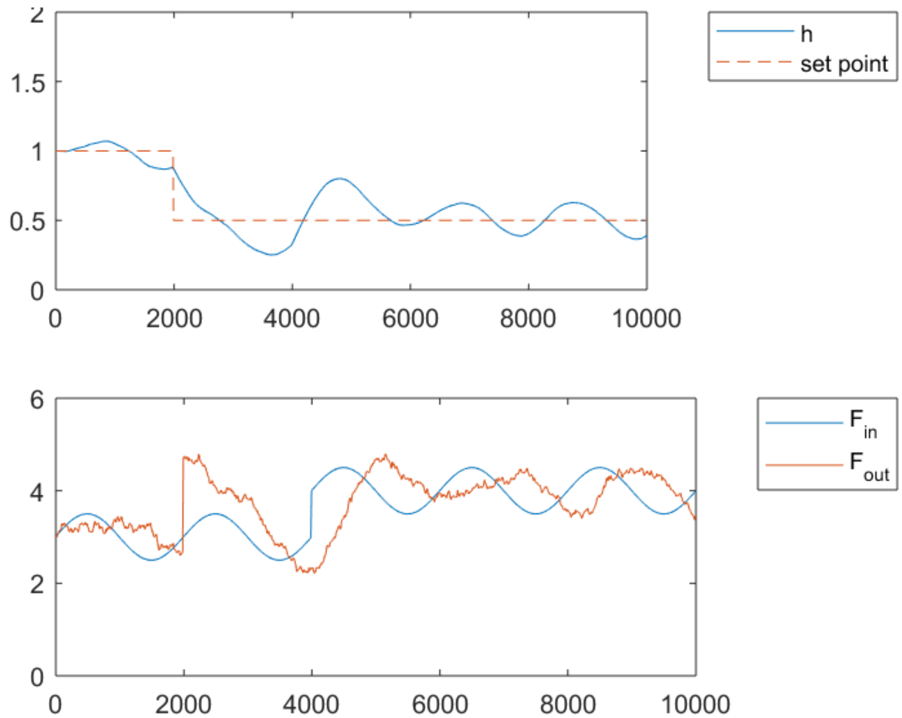
3. Variable F_{in} response

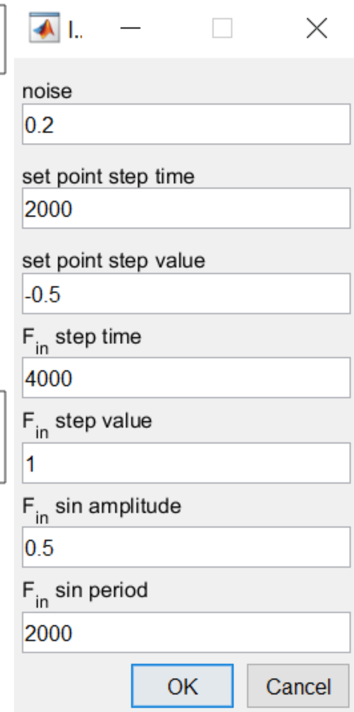






4. Setpoint step, F_{in} step, noise and variable F_{in}.





Process with time delay

The process with time delay τ is set up the same way as the one without, but the sensor collects values at a displaced time equal to the time delay. The skogestad tuning formula also changes to the following

$$T_c = \tau$$

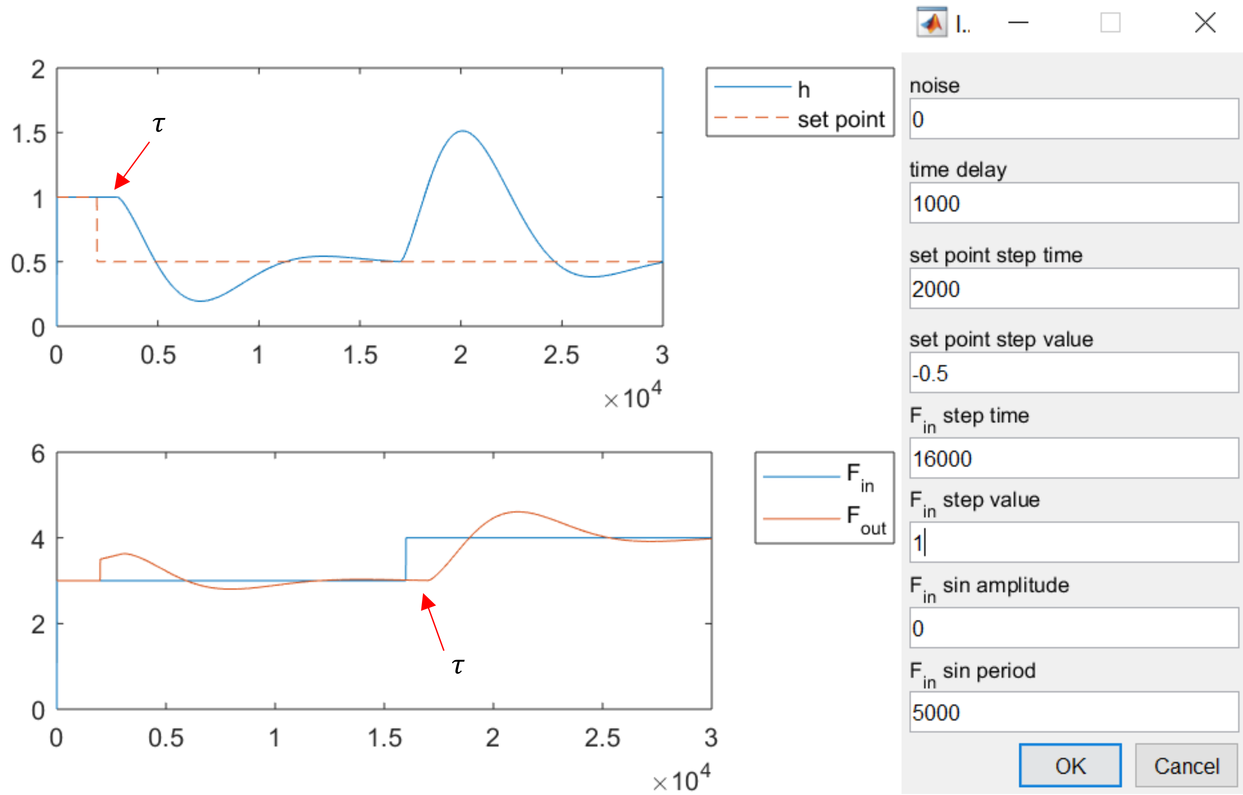
$$K = \frac{1}{A}$$

$$K_c = \frac{1}{K \cdot (T_c + \tau)}$$

$$T_i = 2 \cdot (T_c + \tau)$$

The script file is called *mandatory3_part2.m*.

A simulation done with a set point response and a F_{in} response is shown below.



The dead time right after the set point change and F_{in} step shows the time delay of the process.

Remarks and conclusions

The results of the matlab implementation are comparable to the labview implementation. The skogestad tuning gives satisfactory results for this process.

There are however several checks that would be nice to implemented in the script, like float comparison fixes, better array handling and optimization.