Delft University of Technology

Fault Diagnosis and Fault Tolerant Control
SC42130

# Homework Assignment 5
# Group 14

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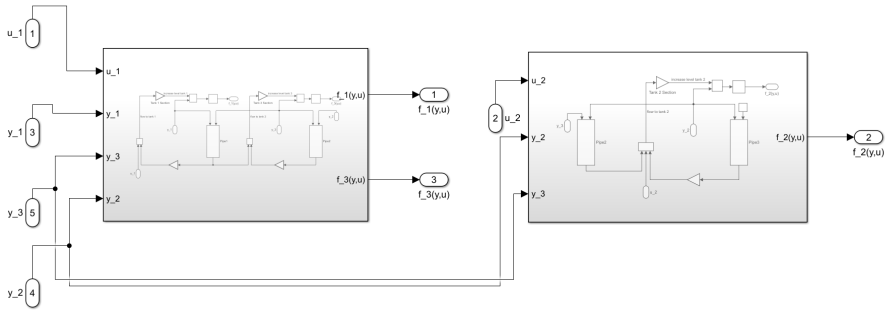
# 1 Introduction

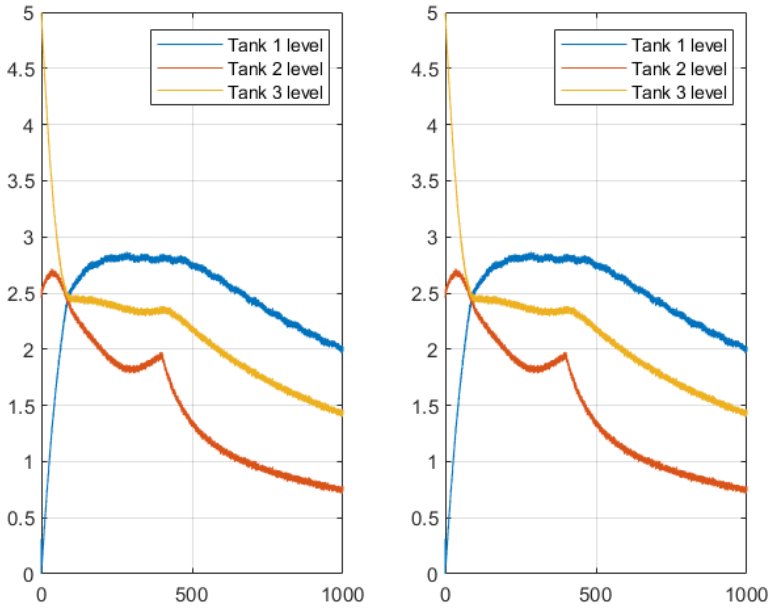
This assignment uses the same FDI architecture developed in the previous homework for the three tank system. Now, it is distributed into two Local Fault Diagnosis (LFD) systems. The effect of communication delays on performance and robustness will be investigated. The actual modelling has been done using Matlab and Simulink, these files will be uploaded along with this report on Brightspace.

# 2 Creating two Local Fault Diagnosers

Firstly, we need to divide the three tank systems into two smartly chosen subsystems. A logical choice is to consider tank 1 and tank 3 as one subsystem and tank 2 as a subsystem. The local states for subsystem 1 will then be the heights of tank 1 and tank 2, $x1 = [x1, x3]$, and for subsystem 2: x2 = [x2]. The interconnection variables are the heights of tank 2 and tank 3. How the observer model of the three tank system was divided into two subsystems can be found in the Simulink model and in the figure below.




To show that without communication delays the performances are the same, we implemented the original observer system in parallel to the interconnected subsystem observer system. By subtracting both outputs and showing that the residual is zero, we can verify data is the same for both observers, e.g. the performances are the same.
Then, we implemented another LFD observer system, but now we added communication delay to the transmission of the interconnection variables between both subsystems. In Simulink this has been modelled with an additional parallel LFD observer. Now delay blocks have been added in between the interconnection variables. It can now be shown that the residual between the model without communication delay oscillates around zero, with amplitude dependent on the duration of the delay. If we assume a time delay of 500 time instants, 5 s, and a leakage at t = 400s, we get the following observer results. In the figure below the observer with and without delay are plotted to the left and right, respectively.




From this plot it can be seen that there is almost no difference due to the time delay. This is to be expected because the connection between the subsystems is a pipe can only let through a limited amount of water per time unit. This amount is small in comparison to the volume of the tanks. So we conclude the LFD observer is robust against time delays.