Delft University of Technology

Fault Diagnosis and Fault Tolerant Control
SC42130

Homework Assignment 4
Group 14

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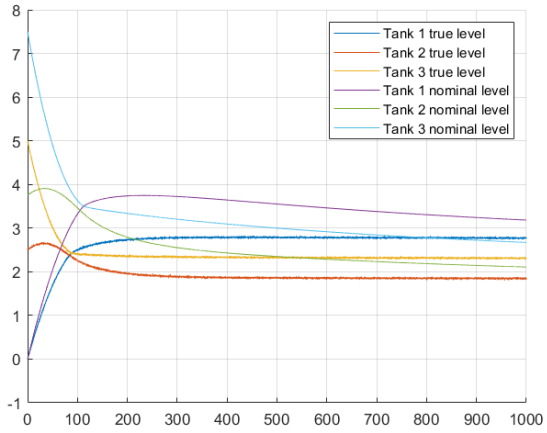
1 Introduction

This report is part of the course SC42130 Fault Diagnosis and Fault Tolerant Control given to master students at the TU Delft. The report contains the fault detection and fault diagnosis of a continuous time model of a three tank system. The Matlab code and Simulink model ate also uploaded to Brightspace along with this document.

2 Task 1: Fault detection in three tank model

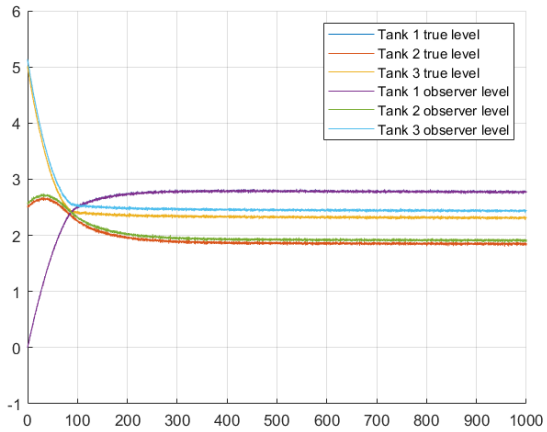
We used the provided three tank Simulink model. Then we added a random number generator block to simulate the measurement uncertainty on the level. The values for the level are around 3 m, so we scaled the blocks to generate zero mean numbers with variance 0.05 m. To ensure we always get a new independent noise signal, the blocks generate numbers dependent on a seed variable that changes every time the Matlab code is run.
Then we created a discrete time copy of the provided model, by changing the tank plants to include a discrete time integrator block. This discrete model now assumes some uncertainty on the model parameters, these variables are assigned in the Matlab code.
If we then simulate both the true continuous time model and the discrete time model for the same constant pump-flow input we get the following result.



The plot shows that the uncertainty of the model parameters result in an slight offset in the final equilibrium state. The uncertainty in the output value is not present for the discrete time model, because you calculate those values directly instead of measuring which is subject to noise.

Next we implemented a fault detection observer, that creates an estimate of the state from the nominal dynamics and an output error feedback term with a feedback gain lambda equals 1. The observer estimated the following state

trajectories for the tank levels.



From this plot it can be seen that the converges to the real model, except for some noise term since the observer nominal dynamics are based on noisy output measurements. Also since the initial conditions for the observer are different, there is a relatively large error in the first time instants, which reduces quickly due to the feedback term in the observer.

Next we created a threshold generator in Matlab, that is based on the residual and some constant value delta. We then used this to detect three different simulated faults. Our matlab code produces a zero vector with a 1 at time instant k, if a fault is detected a time instant k. For illustration we now plot the detection of a leakage in tank 1.