Fault Detection and Diagnosis for a Three-Tank System

Background and Problem

Three-tank system has been proposed as a benchmark system for system modeling, identification, control, fault detection and diagnosis, as well as for fault-tolerant control. The system exhibits typical characteristics of a constrained hybrid system and has been proven useful to serve as a test environment for algorithms concerning state estimation, parameter identification, and control of hybrid systems. Two lab-scaled experimental systems can be viewed in the Fig.1 as below. Such a system can be viewed as a prototype of many industrial applications in process industry, such as chemical and petrochemical plants, oil and gas systems.

The three-tank liquid level control system is a multi-input-multi-output (MIMO) system, but with the valves (actuators) between the tanks closed, each tank can be treated as a single-input-single-output system (SISO). The typical control issue involved in the system is how to keep the desired liquid level in each tank in the presence of disturbances and even actuator, sensor or leakage faults in the tank system.

Fig. 1. Two experimental setup examples of three-tank system

Objective

The objective of this project is to develop certain fault detection and diagnosis (FDD) techniques with application to a three-tank system benchmark under the Matlab/Simulink environment, or if the students are interested, to an experimental three-tank system that can be set up during the project, as one of the objectives.

Following tasks need to be investigated in the project:

- Study on the three-tank benchmark as well as its Matlab/Simulink implementation environment
- Reliability-oriented analysis for the purpose of fault diagnosis, including failure modes and effects analysis and fault tree analysis of the benchmark
- Investigation and development of observer-based or other FDD techniques to the benchmark
- Investigation and development to neural network or fuzzy logic based FDD techniques to the benchmark (if interested)

References: (References and a Matlab/Simulink benchmark are available once the topic is selected)

Key words: Three-tank systems, observer-based, parameter estimation-based fault detection and diagnosis methods.

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