

ABSTRACT

This document reviews and develop fault tolerant control (FTC) approaches for large-scale hierarchical nonlinear systems. Chapter one provides the motivation of the need for an FTC, then an overview of the FTC systems and basic terminologies are provided defining faults, fault detection and fault tolerant control systems, then faults are categorized into actuator, sensor, plant, and control input faults. It also discusses the types of faults in the structural point of view, which is additive and multiplicative faults. In chapter 2, the fault diagnosis problem is illustrated. It discusses the design procedure of fault diagnosis including three fault detection, localization, and estimation. The former just checks if a fault happens, while the second step finds the place where a fault occurs, and finally the magnitude of the fault is estimated. Different kinds of methods are discussed depending on having access to the model of the system, system's signal pattern, or knowledge about the system, or exciting the system using an input, and then the idea of fault detection is given for model-based fault diagnosis approach. In chapter 3, the controller part of an FTC is discussed in more details by categorizing it into the passive FTC and active FTC. While the former is designed offline using robust control theory, the latter uses a fault diagnosis along with the controller and it is online. The required terminology for large-scaled system is reviewed in chapter 4 by discussing distributed FTC (model based) and then providing formal definitions for graph theory concepts, and finally two kinds of communication schemes are illustrated for distributed FTC. Then, open problems are discussed in chapter 5. Chapter 6, and 7, provides case studies for an aero-electro-mechanical system, and pure electrical system, respectively. In chapter 6, multiple FTCs are designed for the wind turbine application so that the FTCs mitigate the pitch actuator faults. In chapter 7, FTCs are designed for the application of inverter-based resources. In this chapter, the controller deals with abrupt grid voltage disturbance, and also uncertainty in the transmission line parameters. Finally, chapter 8, provides conclusion and future works.