

Preface

Associated with increasing demands on system safety and reliability, fault detection (FD) and fault-tolerant control (FTC) have attracted considerable attention in both research and application fields. Due to the continuously increasing system automation, integration and complexity degrees, industrial processes are typically nonlinear. Therefore, developing FD and FTC approaches for nonlinear systems belong definitely to the most remarkable and challenging topics.

This work is devoted to address the analysis and design issues of observer-based FD and FTC for nonlinear systems. In the first part of the thesis, the configuration of nonlinear observer-based FD systems is formulated by parameterizing the residual generators. Based on the parameterization form, the nonlinear observer-based FD systems are parameterized as well as the threshold settings. Furthermore, the existence conditions of the nonlinear observer-based FD systems are studied to gain a deeper insight into the construction of the FD systems.

The second part of the work focuses on the developments of FD schemes by dealing with the proposed conditions with the aid of the Takagi-Sugeno (T-S) fuzzy dynamic modelling techniques. To further improve the FD performance, an alternative fuzzy observer-based approach is proposed by making use of the knowledge provided by the fuzzy models of each local region and weighting the local residual signal by means of different weighting factors. This is motivated by the fact that unlike linear systems with unified dynamics over the whole working range, the local behavior of nonlinear systems can be significantly different.

With the FD system at hand, it is important to re-configure the controller to maintain or recover the system operations after an alarm is given. For this purpose, the third part of the work is dedicated to two FTC configurations for a class of nonlinear systems. The proposed architectures provide an integrated solution that has advantages to make the plant maintenance, repair and operations easier to handle. Finally, the derived FD and FTC approaches are verified by two benchmark

processes. The application results demonstrate the effectiveness of the developed methods.

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