

Open Invited Track proposal on

Diagnosis and Diagnosability of Hybrid Dynamic Systems: Challenges, Methods and Applications

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Abstract

In Hybrid Dynamic Systems (HDS), the dynamical behaviors evolve continuously with time according to the discrete mode in which the system is. Consequently, model based diagnosis approaches must take into account both discrete and continuous dynamics as well as the interactions between them in order to achieve correct fault diagnosis. In addition, in HDS, two types of faults may occur: parametric and discrete faults. Parametric faults occur as abnormal changes in the value of parameters describing the continuous dynamics while discrete faults are defined as unexpected, abnormal, changes in the system discrete mode. Discrete event systems approaches deal with discrete faults; while continuous systems approaches deal with parametric faults. HDS approaches need to deal with both parametric and discrete faults, and this significantly increases the task of monitoring and diagnosing faults in the system. This open

invited track aims at bringing together researchers working on the fault diagnosis of HDS. The track will provide the researchers with a forum for exchanging ideas, presenting recent advances and discussing challenges related to fault diagnosis of HDS.

IFAC technical committee for evaluation

TC 1.3 on Discrete Event and Hybrid Systems

Detailed description

Online fault diagnosis is crucial to ensure safe operation of complex dynamic systems in spite of faults impacting the system behaviors. Consequences of the occurrence of faults can be severe and result in human casualties, environmentally harmful emissions, high repair costs, and economical losses caused by unexpected stops in production lines. Therefore, early detection and isolation of faults is the key to maintaining system performance, ensuring system safety, and increasing system life.

The general principal of model based diagnosis approaches is based on the use of a model of the system's normal and/or fault behaviors. Generally, they can be divided into discrete-event and continuous system approaches. Discrete-event model based diagnosis approaches describe the system's behavior as a dynamic sequence discrete mode changes in response to the occurrence of discrete events, which may be nominal or represent faulty situations. The fault diagnosis task involves analyzing observed event sequences. These approaches assume that the dynamic behavior of a system can be characterized by a sequence of discrete events; therefore, they ignore the continuous dynamics of the system. Model based diagnosis approaches of continuous systems represent the system dynamics as a continuous time evolution using differential or difference equations. Detection and isolation of faults is achieved by tracking the dynamic behavior of the system, and characterizing and analyzing deviations as a set of non-zero residuals that are linked to possible faults. However, they do not take into account the discrete changes in behavior of the system that may occur due to mode or configuration changes.

Therefore, neither approach by itself applies to the fault diagnosis of hybrid dynamic systems (HDS), since in the latter continuous behavior evolution is interspersed with discrete dynamics and the interactions between the two must be taken into account for fault detection and isolation. In addition, faults may impact both the continuous and discrete dynamics of the system. Hence, fault diagnosis approaches for HDS must deal with the evolution of continuous dynamics in each discrete mode. Consequently, diagnoser approaches that combine continuous and event-based behaviors as well as their interactions, are the most adequate to perform the fault diagnosis of HDS. This makes the traditional approaches to diagnosis computationally intractable, and, therefore, requires new approaches for designing online diagnosers.

The approaches performing fault diagnosis of HDS can be classified into three main categories:

1. Approaches for the diagnosis of parametric faults,
2. Approaches for the diagnosis of discrete faults,
3. Approaches for the diagnosis of both parametric and discrete faults.

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This open invited track aims at bringing together researchers working on the fault diagnosis of HDS. The track will provide the researchers with a forum for exchanging ideas, presenting recent advances and discussing challenges related to fault diagnosis of HDS in different applications.