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A PARTICLE FILTERING-BASED FRAMEWORK FOR ON-LINE FAULT DIAGNOSIS IN HYBRID SYSTEMS

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Abstract. *Hybrid system consists of discrete and continuous state. Fault diagnosis and prediction of hybrid system is a new and critical issue in hybrid system study. Utilizing the advantage of particle filter, which can estimate the discrete and continuous states simultaneously, Rao-Blackwellized particle filtering method for fault diagnosing and predicting of hybrid system is proposed. After giving the design steps of particle filter based fault diagnosis and prediction, we discuss the application of the method to the continuous stirred tank reactor fault diagnosis and prediction system. The simulation results show the effectiveness of the proposed approach.*
Keywords: State estimation, Fault diagnosis, Hybrid systems, Particle filtering, JMLG model

1. **Introduction.** The increasing requirements to achieve more reliable performance on complex systems such as air traffic management systems, automated highway systems, petrochemical industries, and power systems, have necessitated the development of fault diagnosis schemes for accurate diagnosis of system failures. Such systems can be viewed as hybrid systems and therefore fault diagnosis is a challenging task in the control of hybrid systems. Hybrid systems are systems including both continuous and discrete dynamics influencing each other, and therefore the global dynamics. The issues of safe operation for such systems are of major importance and require their supervision in order to timely handle the occurrence of faults or failures. In fault detection, we have to answer whether a transition from the normal to a faulty state has occurred.

The task can be particularly difficult when the system under study is operating in real-time. More importantly, the obtained results do not necessarily include knowledge about the physics of the system and there is little room left for on-line updates in the predicted model when the system is behaving differently from what is expected.

In that sense, the research work proposed here intends to establish a general framework to deal with the problems of real-time fault detection and identification via the utilization of particle filtering (PF) techniques, an emerging methodology for sequential signal processing that is very suitable in the case when the system is nonlinear or in the presence of non-Gaussian process or observation noise.

The diagnosis problem is to determine the current state of a system given a stream of observations of that system. In traditional model-based diagnosis systems such as [1,2], diagnosis is performed by maintaining a set of candidate hypotheses about the current