Preface

With the increasing demands on product quality and process operating safety, process monitoring and fault detection (PM-FD) has become an important area of research in recent decades. Numerous methods were developed in this area for different types of processes and applied to various industrial sectors. However, there is little work focusing on comparing and assessing their performance using a unified framework, and thus few suggestions and guidance for choosing an appropriate method can be provided to the practitioners. Therefore, the performance assessment study for PM-FD methods has become an area of interest in both academia and industry.

The first objective of this thesis is to assess the performance of basic FD statistics. The commonly used two statistics, namely, T^2 and Q are first examined. With the aid of χ^2 distribution, their differences to detect additive and multiplicative faults are revealed and compared under the statistical framework. Due to their low detectability to multiplicative faults, some alternative statistics are investigated.

Based on the basic FD statistics, different PM-FD methods have been proposed to monitor the key performance indicators (KPIs) of static processes, steady-state dynamic processes and dynamic processes including transient states. Thus, the second objective of this thesis is to assess the three classes of KPI-based PM-FD methods. Firstly, existing static methods are sorted into three categories based on the way to partition the KPI-correlated part from the KPI-uncorrelated part. A new EDD index is proposed to assess their performance to detect offsetting, drift and multiplicative faults. Secondly, two dynamic partial least squares (DPLS)-based methods for steady-state dynamic processes are compared, and their performance is assessed using EDD. Furthermore, the KPI-based PM-FD methods for general dynamic processes are introduced, some new developments are given.

Finally, to validate the theoretical developments, a case study on the Tennessee Eastman benchmark process that can be considered as a

steady-state dynamic process is performed to assess the two DPLS-based methods. In addition, a real large-scale hot strip rolling mill process is applied to assess the dynamic KPI-based PM-FD methods.

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