



SUPERVISION, FAULT-DETECTION AND FAULT-DIAGNOSIS METHODS - AN INTRODUCTION

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Abstract: The operation of technical processes requires increasingly advanced supervision and fault diagnosis to improve reliability, safety and economy. This paper gives an introduction to the field of fault detection and diagnosis. It begins with a consideration of a knowledge-based procedure that is based on analytical and heuristic information. Then different methods of fault detection are considered, which extract features from measured signals and use process and signal models. These methods are based on parameter estimation, state estimation and parity equations. By comparison with the normal behaviour, analytic symptoms are generated. Human operators are another source of information, and support the generation of heuristic symptoms. For fault diagnosis, all symptoms have to be processed in order to determine possible faults. This can be performed by classification methods or approximate reasoning, using probabilistic or possibilistic (fuzzy) approaches based on if-then-rules.

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Keywords: Fault detection, supervision, monitoring, parameter estimation, state estimation, parity equations, technical processes, actuators, sensors, fault diagnosis, diagnostic reasoning, fuzzy reasoning.

1. INTRODUCTION

Within the automatic control of technical systems, supervisory functions serve to indicate undesired or unpermitted process states, and to take appropriate actions in order to maintain the operation and to avoid damage or accidents. The following functions can be distinguished:

- (a) *monitoring:* measurable variables are checked with regard to tolerances, and alarms are generated for the operator.
- (b) *automatic protection:* in the case of a dangerous process state, the monitoring function automatically initiates an appropriate counteraction.
- (c) *supervision with fault diagnosis:* based on measured variables, features are calculated, symptoms are generated via change detection, a fault diagnosis is performed and decisions for counteractions are made.

The classical methods (a) and (b) are suitable for the overall supervision of the processes. To set the tolerances, compromises have to be made between the detection size of abnormal deviations and unnecessary alarms because of normal fluctuations of the variables. Most frequently, simple limit value checking is applied, which works especially well if the process operates approximately in a steady state. However, the situation becomes more involved if the process operating point changes rapidly. In the case of closed loops, changes in the process are covered by control actions and cannot be detected from the output signals, as long as the manipulated process inputs remain in the normal range. Therefore, feedback systems hinder the early detection of process faults.

The big advantage of the classical limit-value-based supervision methods is their simplicity and reliability. However, they are only able to react after a relatively large change of a feature, i.e. after either a large sudden fault or a long-lasting gradually increasing fault.

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