Nom L0 : Erina PACCIARELLI
Nom L1 : Morjane SAIDANI
Titre : Artificial intelligence for monitoring and supervisory control of process systems

This text addresses the challenges faced by operators in monitoring and controlling large-scale processes with computerized control systems. It highlights the need for intelligent decision support systems using a variety of Al and non-Al techniques to effectively analyze process data. The book highlights three approaches to solutions for monitoring, control and diagnostic tasks: data-driven, analytical and knowledge-based approaches. The study highlights techniques such as Principal Component Analysis (PCA) and Partial Least Squares (PLS) analysis for early and reliable detection of faults in industrial processes. These techniques help to reduce data dimensionality, visualize variability and identify significant trends, thus improving the monitoring and control of industrial processes. PLS, in particular, is an essential dimensionality reduction method for monitoring, controlling and predicting product quality processes in process control engineering.
PLS has been successfully applied in various industries for process monitoring, fault detection and the design of statistical monitoring systems.
To detect and isolate problems in a process, a method is used in which the process equations are identified, the parameters of the physical model are gathered, these parameters are estimated, the estimated physical values are calculated, and then these values are compared with the expected values to spot problems.
Finally, the study discusses the knowledge-based approach, which uses intelligent computer systems employing artificial intelligence technologies such as expert systems, fuzzy logic, machine learning and pattern recognition to supervise, control and diagnose industrial processes.
Expert systems are like intelligent computer programs that store the knowledge of human experts to help make decisions. They are useful for solving problems that have missing information or require in-depth understanding.
A common application of expert system technology in process control is fault diagnosis. The basic components of an expert system include a knowledge base, an inference engine and a user interface.
The knowledge base can contain simple information based on practical rules, or more advanced knowledge based on structured, behavioral or mathematical models.

Although expert systems are used to control processes, they have limitations, such as the fact that the application of inference is implicit in the knowledge base, which can limit efficiency, especially as the knowledge base grows larger.
To overcome these limitations, combining expert systems with other methods such as fuzzy logic, machine learning and pattern recognition techniques helps to improve system performance and accuracy.
Fuzzy logic is an approximation mechanism for expressing ideas.
However, finding the right rules and parameters for a complex system can be complicated. To resolve some of these weaknesses, neural networks are often adopted Pattern recognition is useful for monitoring processes, as it looks for patterns in the data that may indicate problems.
One widely adopted approach to pattern recognition is that of artificial neural networks (ANNs). Artificial neural networks learn from examples and use connections between "neurons" to process information in a non-linear way, based on the structure and weights of the connections between neurons.

In the process industries, ANNs have been applied to fault detection and diagnosis. In addition, ANNs have also been used for estimating and controlling non-linear processes, detecting impending faults, improving control strategies and identifying the sensitivity of non-linear process systems. ANNs have been integrated into predictive control and fault diagnosis architectures to improve plant performance, reduce operating costs and facilitate informed decision-making by operators.