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# Modeling in the Observable or Latent Space? A Comparison of Dynamic Latent Variable based Monitoring for Sensor Fault Detection

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The latent variable framework is the base for the most widespread methods for monitoring large-scale industrial processes. Their prevalence arises from the robustness and stability of their algorithms and a well-established and mature body of knowledge. A critical aspect of these methods lies in the modeling of the dynamics of the system, which can be incorporated in two distinct ways: explicitly, in terms of the observed variables, or implicitly, in the latent variable's domain. However, there is a lack of conceptual and evidence-based information to support an informed decision about which modeling approach to adopt.
To assess the impact of these opposing modeling approaches in monitoring performance, we test and compare two state-of-the-art methods representative of each class: Dynamic Principal Component Analysis with Decorrelated Residuals (DPCA-DR; explicit modeling) [1] and Dynamic-Inner Canonical Correlation Analysis (DiCCA; implicit modeling) [2]. For completeness, the standard Principal Component Analysis (PCA) and Dynamic Principal Component Analysis (DPCA) monitoring methods were also considered.
These monitoring methods were compared on a realistic simulator of a Biodiesel production unit [3] over several sensor faults. Our results highlight limitations of state-of-the-art methods, such as reduced sensitivity due to fault adaptation and inability to handle integrating systems. The results also point to an advantage of using DPCA-DR for detecting sensor faults.

References:
1. Rato, et al., Chemometrics and Intelligent Laboratory Systems, 2013. 125(15): p. 101-108.
2. Dong, et al., IFAC-PapersOnLine, 2018. 51(18): p. 476-481.
3. Fernandes, et al., Industrial & Engineering Chemistry Research, 2019. 58(38): p. 17871-17884.

## Keywords

Dynamic Principal Component Analysis; Dynamic Canonical Correlation Analysis; Process monitoring; Fault detection; Process Analytics

## Classification

Mainly methodology

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