PRONTO

PROcess NeTwork Optimization for efficient and sustainable operation of Europe's process industries taking machinery condition and process performance into account

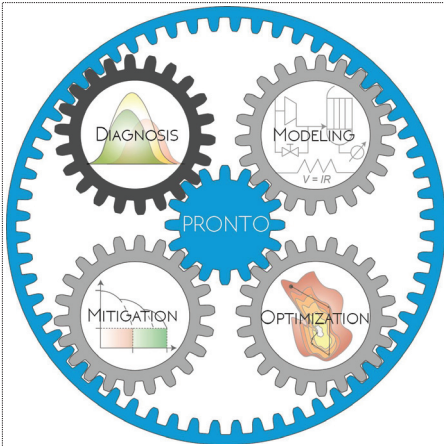PRONTO — PROcess NeTwork Optimization

Detection and diagnosis of change of condition

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Detection and diagnosis of change of condition

Tian Cong (AGH/ABB PL, ABB DE)
Bayesian reasoning analysis of fault occurrences using hybrid data in industrial applications

Ruomu Tan (Cranfield, Imperial/ABB PL)
Kernel based nonlinear condition monitoring for operation under varying production regimes

Anna Stief (ABB PL/AGH, Cranfield)
Combining data from disparate sources for condition monitoring purposes

Matthieu Lucke (ABB DE/Imperial)
Abnormal event management with heterogeneous data from disparate sources

A **change of condition** in a process or a piece of equipment may be a developing fault or variations in the production regimes.

Fault **detection and diagnosis** determines the occurrence, the type and the severity of the undesirable changes.

Heterogeneous Data

Flow rate, Acoustic, Composition, Operation log, Video clips, Temperature

Research Outcomes

Feature design

Multimode methods

Data fusion

PRONTO dataset

Improvements Achieved

Reduced false and missed alarm rates

More robust monitoring systems

Easier interpretation of monitoring results

Wider range of diagnosable faults

Impact

New analytics approaches which combine data from heterogeneous sources whilst accounting for varying production regimes improve the **detection, diagnosis and modelling** of change of condition.

Improving feature design

Better feature design can increase the robustness & industrial applicability of solutions. New methods were developed:

- Normalizing process measurements using alarm thresholds
- Extracting features in alarm logs or multimode process data
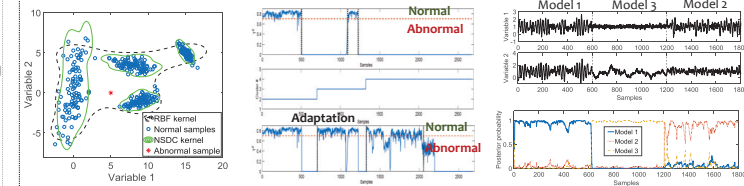- Ranking and selecting process measurements (using their alarms) or features from electromechanical measurements
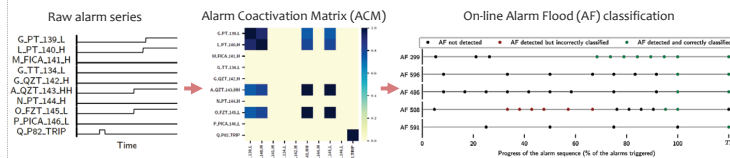
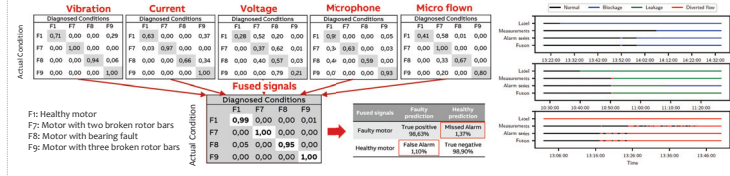The ACM is a condensed representation of the alarm activations. It can cope with uncertainty in the order and dates of the alarms.

Combining the heterogeneous data

Combining data from diverse sources improves the reliability & robustness of condition assessments. Methods created for:

- Fusing process measurements and alarm and event logs
- Fusing signals from multiple sensors and acquisition systems
- Fusing process measurements and statistical alarms

F1: Healthy motor
F7: Motor with two broken rotor bars
F8: Motor with bearing fault
F9: Motor with three broken rotor bars

By fusing results from different signal types, the developed Two-stage Bayesian Framework increases the reliability and robustness of fault detection

Fusing process measurements and statistical alarms to increase diagnosis accuracy

Accounting for varying production regimes

Varying production regimes should be distinguished from undesirable changes. This was achieved by:

- Characterizing multimode data using a new localized kernel
- Creating a framework with adaptive clustering & a new kernel
- Identifying varying dynamics using Bayesian Kalman filtering

The new kernel describes multimode data better than existing approaches

The on-line monitoring framework can account for new operating modes

Bayesian Kalman filtering allows different dynamic modes to be identified

Creating the PRONTO heterogeneous benchmark dataset

The PRONTO benchmark dataset was created to meet the need for a benchmark dataset to support development and validation of monitoring techniques with heterogenous data.

The dataset was used in PRONTO and is openly available to the scientific community at doi.org/10.5281/zenodo.1341583.

Health conditions	Data type	Sampling rate	Storage
Normal	Process data	1 Hz	Regularly sampled
Input air blockage via V11	Alarm and event log	Event-driven	Discrete events
Input air leakage via V10	Ultrasonic data	10 kHz	60s recordings
Diverted flow via U39	High-frequency pressure	5 kHz	60s recordings
Slugging	Videos	-	30-60s recordings

Various fault modes were simulated in the facility

The PRONTO Benchmark Dataset contains data from a number of heterogeneous sources

Fully-automated process facility used to generate the PRONTO Benchmark Dataset