Open Invited Session on

"Advanced Soft-Sensor Systems for Fault Diagnosis, Process Monitoring, Control, and Optimisation"

Registration Code: 9p7cw (to be used when submitting your papers)

Organized by

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Call for Papers

Abstract:

As process become more complicated and the regulatory constraints more strict, there is an increasing need to understand the processes. Unfortunately, accurate, online measurements of many of the required variables for control, monitoring, and optimisation may not be feasible at the sampling times required. Thus, there is a need to develop and implement advanced soft sensors that can provide forecasts

about the current state of the system using the available information. This invited session will provide the opportunity for both academic and industrial researchers to exchange their ideas and thoughts with the goals of finding common problems and solutions.

Detailed Description:

The increasing demands on industry that they be both economically profitable and environmentally safe has led to renewed interest in developing and implementing advanced methods for control, monitoring, and optimisation of complex industrial processes. Despite the development of advanced, online measurement sensors, it still remains difficult to accurately measure various critical variables, such as density and concentration, especially for multiphase fluids and laboratory analysis must be used to obtain reliable values. However, the laboratory analysis cannot provide sufficiently fast or frequent measurements in order to effectively monitor, control, or optimise the process. Therefore, there is an increasing need to consider other methods, namely soft sensors, which are mathematical models of the desired process values that can use the readily available measurements to provide more accurate forecasts of the desired values. Although the idea of soft sensors has been considered for some time now, the implementation of soft sensor into different areas brings its own challenges that require solution leading to new approaches and methods.

Firstly, soft sensors once developed are not often updated or changed as the underlying process changes due to such factors as aging and process or equipment changes. Thus, there is a need to update the soft sensors online and in real time to take into consideration the changing conditions. The worst-case scenario is, for example, to use a soft sensor with model predictive control, but the process has so changed that there is significant plant-model mismatch so that the controller performance degrades. Unless the models are updated, the whole control strategy may be turned off as being useless, despite the fact that a simple correction of the models would fix the problem. Therefore, the development of methods for the detection of plant-model mismatch and the re-identification of a new model is essential.

Secondly, with the increasing use of machine learning, artificial intelligence, and neural-network-based models, the resulting soft-sensor models are becoming more complex and less intuitive. This means that is not always obvious of the soft sensor is necessarily working as desired and truly making the correct prediction. Recently, the idea of explainable artificial intelligence has been developed that seeks to understand how a neural network makes its decisions, and hence, determine if the results are plausible. Therefore, there is a need to develop and implement methods that can understand how complex soft sensors are working and increase the confidence in their correctness.

Thirdly, although soft sensors have been developed and often used for process monitoring, control, and optimisation, the implications of them have not been considered. This means that such topics as the optimal configuration or situations where the use of a soft sensor may lead to unexpected or even undesired behaviour has not been considered. This means that even if the soft sensor itself is perfectly designed, the overall system may still provide poor results since the overall configuration has not been properly designed. Furthermore, properly incorporating slowly sampled, but accurate values into the overall soft-sensor system needs to be considered and a general framework developed. Therefore, the applications and uses of soft sensors need to be considered and a proper framework for the use of soft sensors developed.

Finally, there is a need to bring together industrial and academic researchers so that they can enrich each other's approaches to the problem. Firstly, the actual industrial problems need to be formulated and explained so that theoretical solutions can be found. Likewise, the theoretical approaches need to be properly formulated and tested so that the correct industrial application can be found. Therefore, there is a need to offer the opportunity for both sides to meet and discuss these issues.

For this open invited session, the topics of interest include, but are not limited to:

- Soft sensors for process monitoring;
- Soft sensors for control, including model predictive control and adaptive control;
- Soft sensors for process optimisation;
- Updating and maintaining soft sensors with changing conditions;
- Detecting plant-model mismatch;
- Dual control and how it can be used to develop a unified framework for sensor development and control;
- Applications of soft sensors in industry;
- Real-time model-free learning methods;
- Practical implementations of the above topics; and
- Survey papers discussing the impact and implications of the methods in industry.

Suggested IFAC TC: **TC 6.1**