Course overview

This 2 credit course consisting of 25 lecture hours, over a period of 2 weeks, by Professor Sridh Shast (University of Alberta, Canada) will present a new set of smart analytic tools and techniques that collectively analyze alarm data, process data and process connectivity information to provide a holistic view of the process. Such data-based tools and methodologies enable engineers to systematically carry out process and performance monitoring, system identification, fault detection plus isolation and alarm design, monitoring and rationalization.

Who should attend this course?

The course is suitable for graduate students in engineering and science, engineers working in industry and faculty members.

Objectives

Process data analytic methods rely on the notion of sensor fusion whereby data from many sensors or units are combined with process information, such as physical connectivity of process units, to give a holistic picture of health of an integrated plant. Typical analytic methods require the execution of following steps: i) understanding the process and the purpose of the analytics exercise; ii) data collection and quality assessment; iii) outlier detection, noise filtering and data reconciliation; iv) data segmentation followed by process and performance monitoring including root cause detection of faults or development of an intrinsic soft-sensor or system identification for model building. The entire process is iterative and may require revisiting earlier steps again and again.

For efficient and informative analytics, data analysis is ideally carried out in the temporal as well as spectral domains on a multi-rate and NOT singular sensor signals to detect process abnormality. Such multi-domain process data analytics involves information extraction from routine process data, that is typically non-categorical, plus alarm data which is mainly in binary form and process connectivity information that can be inferred from the data through causal analysis or obtained from piping and instrumentation diagrams of a process.

The following topics will be discussed in this course:

6/12/2016 - Monday Day-1
10.00 AM - 10:30 AM: Inaugural Function
10.30 AM - 11.00 AM: Course Overview
11.15 AM - 12.30 PM: Lectures and Discussion (3 hours)
Overview of Process data analytics. Data quality assessment: Use of the Fisher Information Matrix as a metric for data quality; Data distributions and methods for visualizing process data.
12.30 PM - 01.30 PM: Lunch Break
01.30 PM - 02.30 PM: Lectures and Discussion (1 hour)
Big data versus good data quality, outlier detection and filtering.
02.30 PM - 03.00 PM: Discussion
03.00 PM - 03.30 PM: Tutorial Sessions
03.30 PM - 04.15 PM: Tutorial Sessions
04.15 PM - 05.30 PM: Tutorial Sessions

6/12/2016 - Tuesday Day-2
10.00 AM - 11.00 AM: Lecture
11.15 AM - 12.30 PM: Lecture
12.30 PM - 01.15 PM: Tutorial Sessions
01.15 PM - 02.30 PM: Tutorial Sessions
02.30 PM - 03.00 PM: Tutorial Sessions
03.00 PM - 03.30 PM: Tutorial Sessions
03.30 PM - 04.15 PM: Tutorial Sessions
04.15 PM - 05.30 PM: Tutorial Sessions
05.30 PM - 06.45 PM: Tutorial Sessions

6/12/2016 - Wednesday Day-3
10.00 AM - 10.30 AM: Lecture
10.30 AM - 11.15 AM: Lecture
11.15 AM - 12.30 PM: Lecture
12.30 PM - 01.00 PM: Tutorial Sessions
01.00 PM - 01.30 PM: Tutorial Sessions
01.30 PM - 02.00 PM: Tutorial Sessions
02.00 PM - 03.00 PM: Tutorial Sessions
03.00 PM - 03.15 PM: Tutorial Sessions
03.15 PM - 04.15 PM: Tutorial Sessions

6/12/2016 - Thursday Day-4
10.00 AM - 11.00 AM: Tutorial Sessions
11.15 AM - 12.30 PM: Tutorial Sessions
12.30 PM - 01.00 PM: Tutorial Sessions
01.00 PM - 01.30 PM: Tutorial Sessions
01.30 PM - 02.00 PM: Tutorial Sessions
02.00 PM - 03.00 PM: Tutorial Sessions
03.00 PM - 03.15 PM: Tutorial Sessions
03.15 PM - 04.15 PM: Tutorial Sessions

6/12/2016 - Friday Day-5
10.00 AM - 11.00 AM: Tutorial Sessions
11.15 AM - 12.30 PM: Tutorial Sessions
12.30 PM - 01.00 PM: Tutorial Sessions
01.00 PM - 01.30 PM: Tutorial Sessions
01.30 PM - 02.00 PM: Tutorial Sessions
02.00 PM - 03.00 PM: Tutorial Sessions
03.00 PM - 03.45 PM: Tutorial Sessions

6/12/2016 - Monday Day-6
10.00 AM - 11.00 AM: Lecture
11.15 AM - 12.30 PM: Lecture
12.30 PM - 01.00 PM: Lecture
01.00 PM - 01.30 PM: Lecture
01.30 PM - 02.00 PM: Lecture
02.00 PM - 03.00 PM: Lecture
03.00 PM - 03.15 PM: Lecture
03.15 PM - 04.15 PM: Lecture

Principal components analysis (PCA) for process monitoring and Partial Least Squares (PLS) for soft-sensor design.

Data-based causality analysis for identification of process topologies. This would be useful for detection and diagnosis of plant-wide oscillations or disturbances.

Alarm data analytics: Methods for visualizing alarm data and how to minimize false and missed alarms; dealing with clattering alarms, alarm configuration and rationalization.

Simulated as well as industrial case studies will be presented to demonstrate the power and utility of new analytic methods.

Faculty

Sridh Shast has been with the University of Alberta since 1978, where he held the NSERC-CRIF Postgraduate and Research Chair position. He is the recipient of the Alberta Business and Technology Award of the Canadian Society for Chemical Engineering (CSSCE) in recognition of distinguished contributions to chemical engineering in 1989, the Killam Professor in 2003, the L.G. Fisher Award of the CSSCE for significant contributions in the field of systems and control, the ASTECH award in 2011 and the IEEE Transition to Practice award in 2016. He has held visiting appointments at Oxford University and Balliol College as a SERC fellow, Kumamoto University (Japan) as a senior research fellow of the Japan Society for the Promotion of Science (JSPS), the University of Newcastle, Australia, BT-Mudunis India and the National University of Singapore. The main area of his current research is the application of data analytic tools for process and performance monitoring, system identification - and analysis and rationalization of alarm systems. He has co-authored three books, the Performance Assessment of Control Loops: Theory and Applications, a second titled "Diagnosis of Process Failure and Vibration Stiction: Data Driven Approaches", and a more recent monograph on "Capturing connectivity and causality in complex industrial processes". He is a fellow of the Canadian Academy of Engineers.