Project: Towards the Formulation and Implementation of the New Generation of Tools for Process Monitoring

In a highly integrated and automated process within a typical industrial environment, a Distributed Control System (DCS) mainly handles the normal operations and some of the disturbances and the operator acts as a supervisor. However, many complex abnormal situations and faulty conditions cannot be controlled by the DCS. In these conditions, the operator is required to rapidly assess the situation, determine the appropriate cause(s) and take necessary and appropriate corrective actions. Failure to act under these circumstances can have tremendous economic, safety and environmental impacts.

All the proposed methods to date can be broadly classified into three general categories: quantitative model based methods, qualitative model based methods and process history based approaches. The first two categories of approaches require process models and also a priori knowledge about the process is needed whereas the methods based on process history data do not assume any form of model information and rely only on the history data related to the process. Generally, for large complex industrial plants, development of a detailed process model is a tedious task. Even if it is available, due to the complexity of the solution, it loses its real-time applicability. Hence, in the recent past, process history based approaches have gained popularity for real-time process monitoring since they need only the availability of a large amount of historical process data.
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Description

The aim of this research is to create the theoretical framework, development and implementation of a Real-Time Integrated Automated Support System (RIASS) for process monitoring, data analysis, event detection and diagnosis based on artificial intelligence techniques for a process or manufacturing plant. This aim will be achieved specifically as follows:

Development of state of the art techniques to accomplish the different subtasks of process monitoring and supervision:

- The reliability of the information provided by a monitoring and diagnostic system highly depends on the quality of the measurement data. Since measurements from a sensor inherently are corrupted by errors, it is essential that we look at the data driven techniques, which can refine these data to be used further.

- Feature extraction/dimensionality reduction is one of the key issues, which needs to be considered since the historical data of a large-scale plant is high dimensional. We shall develop a novel technique for feature extraction considering the nonlinear correlation between the process variables.

- Fault diagnosis closely resembles pattern recognition in which input/feature vectors are assigned to a pre-determined class. In intelligent systems, the location of these classes in the class space is learnt from the history data. If a priori information about the fault classes is known, a supervised pattern classification technique is required. We shall look at the existing techniques of supervised pattern classification and their limitations and propose an improved strategy to accomplish this task.

- It is also possible that a priori information about the fault classes is not known in advance; rather only historical data are available. Under these circumstances, data of different operating conditions should cluster themselves in the class space. Although many techniques are available for unsupervised pattern classification, we shall address the limitations of these techniques by suggesting a new methodology. Another important issue is to consider the incipient faults and both of these techniques (supervised/unsupervised) should be able to identify the abnormality in its initial stage. It should also be noted that a primary consideration while developing these techniques will be the real-time applicability of the techniques i.e. less computational complexity and well defined structure/architecture with less designer influence.

Development towards a fully integrated framework for intelligent process monitoring and supervision:

- In a fully integrated framework, it is imperative that we consider the issues of seamless functioning and communication between different modules. Therefore, issues like process initiation, communication and relational structure need to be considered. Furthermore, this framework should consider issues such as reliability, collaboration and communication of different software components.

Project Personnel

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Publications

- "Nonlinear principal component analysis using radial basis function network and polygonal lines", Bhushan B., J A Romagnoli, *7th International Conference on Cognitive Systems*, Delhi, India (2005)
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