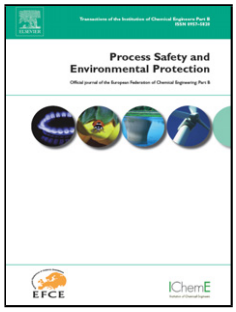

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Dynamic risk assessment of complex process operations based on a novel synthesis of soft-sensing and loss function

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Abstract

Applications of soft-sensing techniques in modern complex process systems can significantly reduce the monitoring cost and minimize the chance of false alarm. However, the potential of soft-sensing techniques have yet to be adequately exploited in the realm of dynamic risk assessment. This paper attempts to close such a gap by proposing a novel synthesis of soft-sensing and loss function for dynamic risk assessment of complex process operations. The soft-sensing technique adopted in this work is based on a Bayesian formulation of the kernel regression which takes into account both the model uncertainty and data uncertainty. Such a probabilistic regression model is able to predict the probability of an undesired event in real-time. On the other hand, the potential economical losses associated with the undesired event is also quantified through loss function. Subsequently, the dynamic risk of an undesired event can be determined as the product of its occurrence probability and its associated potential economical losses. The effectiveness of the proposed dynamic risk assessment is demonstrated through an industrial case study.

Keywords: Bayesian method, Dynamic risk assessment, Kernel function, Loss function, Nonlinear relationship modeling.

Highlights

- A soft-sensing technique for dynamic risk assessment of complex process operation;
- Kernel function is used to model nonlinear relationship;
- Model parameters are updated using Bayesian method;
- The probability of an undesirable event is calculated in real-time;
- Loss function is used for loss quantification.

1 Introduction

Modern process systems comprise of a large number of components. The operating conditions of these components are monitored in real-time to ensure the safe operation of the system as a whole. This process monitoring strategy often requires the deployment of a large amount of sophisticated sensors, which may be susceptible to errors and failures. The malfunctions of these sensors can lead to false alarms and flooding of alarms. Soft-sensing techniques are developed to overcome this drawback of the traditional process monitoring strategy, by reducing the required

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