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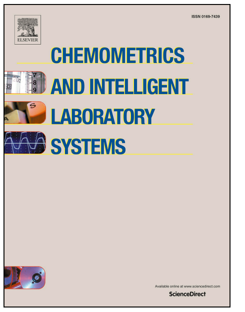

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Kernel dynamic latent variable model for process monitoring with application to hot strip mill process

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Abstract

Dynamic models are preferred rather than static models in the process monitoring of modern manufacturing. Compared with static models, dynamic models can reflect not only correlations but also causality among measurements and manipulated variables. Linear dynamic models are very common due to the simplicity of representation and parameter estimation. However, because of natural nonlinearity of a dynamic process, it is ineffective to apply linear models within a long term and varying condition. Nonlinear dynamic models are hence desired under such a circumstance. In this paper, a kernel dynamic latent variable (KDLV) model is proposed to describe the nonlinearity between original measurements and dynamic latent variables. This model is an extension of dynamic latent variable model in the aspect of nonlinearity, and keeps all merits of it. In order to build such a model, a KDLV search algorithm is proposed to acquire key model parameters from data, then a KDLV modeling procedure is derived to complete the whole model. After the KDLV model is trained from data, corresponding detection strategy is also developed to perform fault detection. The KDLV based fault detection is applied to the monitoring of hot strip mill process and comparison study is also conducted on both DLV and DKPCA models.

Keywords: kernel dynamic latent variable, nonlinear process monitoring, dynamic process, hot strip mill process

1. Introduction

Dynamic models are widely used in the modeling of industrial processes. Generally, dynamic models are described by a group of differential equations (continuous) or difference equations (discrete) while static models have only a group of algebra equations. There are many types of dynamic models for linear time invariant (LTI) systems in the control area, such as transfer function, frequency domain method, and state space models. If there is only weak nonlinearity in a system under fixed point, the system behavior can be

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