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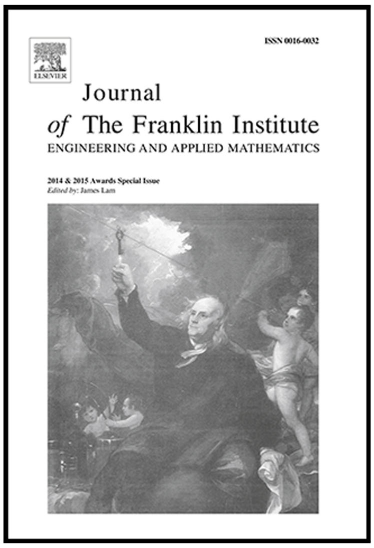

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Recursive parameter estimation algorithm for multivariate output-error systems☆

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Abstract

In this paper, we consider the parameter estimation issues of a class of multivariate output-error systems. A decomposition based recursive least squares identification method is proposed using the hierarchical identification principle and the auxiliary model idea, and its convergence is analyzed through the stochastic process theory. Compared with the existing results on parameter estimation of multivariate output-error systems, a distinct feature for the proposed algorithm is that the such a system is decomposed into several sub-systems with smaller dimensions so that parameters to be identified can be estimated interactively. The analysis shows that the estimation errors converge to zero in mean square under certain conditions. Finally, in order to show the effectiveness of the proposed approach, some numerical simulations are provided.

Keywords: Parameter estimation, Recursive identification, Auxiliary model, Multivariate system, Least squares

1. Introduction

Multivariable systems extensively exist in various industrial processes [1, 2] and some identification methods have been reported in many areas such as state filtering and signal processing [3, 4] and so on. The parameter estimation for multivariable systems is of great practical significance [5]. For the past decades, a number of identification methods have been proposed for multivariable systems [6]. In [7], a maximum-likelihood estimation method was derived for the possibly high dimension linear time-invariant state-space systems. In [8], a gradient-based search algorithm to deal with the estimation problem was derived for multivariable systems. A generalized instrumental variable estimator for solving the errors-in-variables identification issues of multi-input multi-output systems was provided in [9]. Furthermore, other related identification algorithms have been studied, including the subspace approaches (see some examples in [10, 11]), the coupled identification algorithms (see some examples in [12, 13]), and the iterative algorithms for bilinear systems with colored noise [14, 15, 16].

It is well-known that the recursive least squares (RLS) algorithm is popular in system identification owing to the fact that it exhibits fast convergence rate and high parameter estimation accuracy [17, 18]. However, it is accompanied with heavy computational burden. Specifically, the multivariable system involves more parameters to be identified than that in the single-variable system, which inevitably brings heavier computational effort in applying such a class of identification algorithms. This shortcoming motivates the identification researchers to explore more efficient algorithms for online estimation [19]. Interesting results have been reported for this challenging problem. An alternative way in the literature is to decompose such a large-scale system into smaller sub-systems by utilizing the hierarchical identification principle. In other words, in the corresponding least squares algorithm, the dimensions of sub-covariance matrices will be smaller after doing model decomposition [20,

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