



Recursive identification of multivariable ARX models in the presence of a priori information: Robustness and regularization

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ABSTRACT

This paper considers the nonlinear recursive algorithm for the identification of multivariable ARX models (autoregressive with exogenous input). It is assumed that the following a priori information is available:

- (a) a distribution class to which the stochastic disturbance belongs
- (b) a distribution class to which unknown parameters of ARX model belong

A priori information (a) allows a description of outliers (large realizations of the stochastic process which are inconsistent with the largest part of population of observations) and introduces the nonlinear transformation of the prediction error in the recursive algorithm. A priori information (b) defines the initial conditions of the algorithm (for the vector of unknown parameters and the matrix gain) which increases the convergence speed in initial iterations. This intervention in the algorithm represents its regularization. Regularization problems are recently actualized thanks to statistical learning theory. Thanks to a priori information, the considered recursive algorithm is robust with respect to the uncertainty of statistical characteristics of disturbances and has the increased convergence speed in initial iterations. It is formulated theorem for convergence of estimated parameters with probability one. Simulation results illustrate the practical behavior of the algorithm.

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1. Introduction

The task of identification is estimation of unknown dynamics based on measurement data. This is a key ingredient for areas of adaptive control and adaptive signal processing. The theory of identification covers a wide corpus of problems [1–6]. New impulse in the development of the theory is given by the area of statistical learning theory [7–9].

Multivariable systems represent an important class of systems in practice. Special attention is devoted to their identification [10–13]. References [14–16] represent an important contribution to the identification of multivariable systems and they are inspired by the hierarchical control theory based on the decomposition-coordination principle for large-scale systems. This kind of identification is called a hierarchical identification and it is based on the decomposition of the original multivariable system to the finite collection of lower dimension subsystems whose identification is less demanding in computational terms.

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