

Robust identification of multivariable regression models

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In this paper robust (in the statistical sense) identification of multivariable systems with finite impulse response (FIR) is considered. The disturbance has non-Gaussian distribution. Using Huber's concept of min-max estimation we determined nonlinear transformation of prediction error. That introduces nonlinearity in identification algorithm. Also, the identification algorithm carries a priori information about the class of distributions to which belongs the real noise. The analysis of convergence uses the martingale theory and concept of stochastic Lyapunov function. It is shown that strong consistency holds under assumption, representing a special case of the general form of the strictly positive-real condition.

1. Introduction

Estimation algorithms based on Gaussian model have been found to be inefficient when the real distribution belongs to the heavy-tailed probabilities [1].

Considerable efforts have been oriented towards the design of robust estimation algorithm possessing a low sensitivity to distribution changes. The fundamental contribution has been given by Huber [2, 3]. The application of Huber's methodology in different fields is given in [4, 5].

Analysis of robust recursive algorithms is considered in the next author's papers. The paper [6] considers the strong consistency for robust AML algorithm. In that paper the new general form of strictly positive-real condition using passive operator theory has been introduced. The papers [7, 8] consider the adaptive minimum variance controllers for SISO and MIMO systems respectively. In those papers the global stability of adaptive controllers is shown. In the reference [9] the global convergence for a robust adaptive one-step ahead predictor is proved. In this paper the robust identification of multivariable FIR models is considered. First we propose robust identification algorithms and then prove the strong consistency of estimated parameters.

2. The robust recursive algorithm

Let the system under consideration be described by a linear multi-input, multi-output FIR model with p -dimensional output and r -dimensional input

$$y_k = B(q^{-1})u_k + w_k \quad (1)$$

$$y_k = w_k = 0, \quad u_k = 0, \quad k < 0$$

where $B(q^{-1})$ is matrix polynomial in the shift-back operator $q^{-1}y_k = y_{k-1}$. The order of polynomial $B(q^{-1})$ is m .

$$B(q^{-1}) = B_1q^{-1} + \dots + B_mq^{-m} \quad (2)$$

The noise $\{w_k\}$ is assumed to be a martingale-difference sequence with respect to a nondecreasing family of σ -algebras $\{F_k\}$.

The unknown matrix coefficients are

$$\theta^M = [B_1 \dots B_m]^T \quad (3)$$

Model (1) can be rewritten in the form

$$y_k = (\theta^M)^T X_k + w_k \quad (4)$$

