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Parameter estimation for nonlinear dynamical adjustment models ☆

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ABSTRACT

A recursive generalized least squares algorithm and a filtering based least squares algorithm are developed for input nonlinear dynamical adjustment models with memoryless nonlinear blocks followed by linear dynamical blocks. The basic idea is to use the filtering technique and to replace the unknown terms in the information vectors with their estimates. The simulation results show the performance of the proposed algorithms.

1. Introduction

Recursive algorithms or iterative algorithms are important for identifying system parameters, estimating system states and finding the solutions of matrix equations [1–6]. For example, Dehghan and Hajarian presented a finite iterative algorithm for the reflexive and anti-reflexive solutions of the matrix equation $A_1X_1B_1 + A_2X_2B_2 = C$ [1], an efficient algorithm for solving general coupled matrix equations [2] and two algorithms for finding the Hermitian reflexive and skew-Hermitian solutions of Sylvester matrix equations [3], and studied the iterative solutions of matrix equations over (R, S)-symmetric and (R, S)-skew symmetric matrices [4]. Fang et al. presented a genetic adaptive state estimation algorithm with missing input/output data [5]. Shi and Chen studied optimal design problems of multi-channel transmultiplexers with stopband energy and passband magnitude constraints [6]. This paper explores recursive estimation methods for nonlinear system modelling.

Least squares methods are fundamental for parameter estimation in the area of system modelling [7–13]. Many estimation/identification algorithms were reported for different systems, e.g., the hierarchical estimation algorithms for multivariable systems [14,15], the multi-innovation estimation algorithms for linear systems [16–25]. Moreover, Shi and Fang presented a Kalman filter based identification method to estimate parameters for systems with randomly missing measurements in a network environment [26] and Shi et al. discussed Kalman filter based adaptive control for networked systems with unknown parameters and randomly missing outputs [27].

A nonlinear system can be commonly modelled by a Hammerstein model (linear time-invariant (LTI) block following a static nonlinear block), or Wiener model (LTI block preceding a static nonlinear block), or Hammerstein–Wiener model (LTI block sandwiched by two static nonlinear blocks). The Hammerstein model is a class of input nonlinear systems and the Wiener model is a class of output nonlinear systems. For input nonlinear systems, Ding et al. studied identification problems of Hammerstein systems [28–31]; Wang et al. presented an extended stochastic gradient identification algorithm

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