Dynamics of Continuous, Discrete and Impulsive Systems
Series **B:** *Applications & Algorithms* **11 (2004)** 101-121

PARAMETER ESTIMATION FOR DUAL-RATE SYSTEMS WITH FINITE MEASUREMENT DATA [1]

Feng Ding[2] and Tongwen Chen[3]

Department of Electrical and Computer Engineering
University of Alberta, Edmonton, Alberta, Canada T6G 2V4

Abstract. This paper on parameter estimation is motivated by practical consideration that the output sampling rate is often limited and that the data length is finite. In particular, for dual-rate systems in which the output sampling period is an integer multiple of the input updating period, we obtain frequency-domain models, study the properties of the least squares type algorithms in detail in the stochastic framework, and derive convergence rates and upper bounds of parameter estimation errors (PEE) for the least-squares (LS) algorithm, instrumental variable least squares (IVLS) algorithm, and forgetting-factor least squares (FFLS) algorithm, using directly the finite dual-rate input-output data. The analysis indicates that the mean square PEE upper bounds of LS and IVLS algorithms are proportional to $1/k$ and converge to zero as the data length k increases, and the PEE upper bound of the FFLS algorithm approaches a finite constant. Finally, we illustrate and verify the theoretical findings with example systems, including an experimental water-level system.
Keywords. System identification, parameter estimation, multirate systems, convergence properties, least squares optimization.

1 Introduction

It is well-known that the least squares type identification methods (including the standard least squares, instrumental variable least squares and forgetting-factor least squares algorithms) are important in the field of identification; and thus performance analysis of these algorithms has received much attention. However, most reported work considers only the asymptotic convergence properties of the parameter estimates, see, e.g., Goodwin and Sin (1984), Söderström and Stoica (1988), Ljung (1999). The limiting behavior of the parameter estimation errors (PEE) assumes that the number of data points tends to infinity. For example, Lai and Wei (1982) and Chen (1984) studied the convergence rates of least squares algorithm and modified least squares algorithms, respectively, and showed that the PEE vector

[1]This research was supported by the Natural Sciences and Engineering Research Council of Canada and the National Natural Science Foundation of China.

[2]Feng Ding's permanent address is Department of Automation,Tsinghua University, Beijing 100084, P. R. China.

[3]Corresponding author: Telephone: (780)492-3940; Fax: (780)492-1811; Email: tchen@ee.ualberta.ca.