International Journal of Innovative
Computing, Information and Control
Volume **5**, Number **11(B)**, November **2009**

ICIC International ©2009 ISSN 1349-4198
pp. **4061–4074**

ALGORITHM AND IMPLEMENTATION OF DIRECT CLOSED-LOOP IDENTIFICATION VIA OUTPUT OVER-SAMPLING SCHEME

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Received October 2008; revised February 2009

Abstract. *Algorithm and its implementation are considered for direct closed-loop identification via the output over-sampling scheme. It is shown that the plant model can be identified from the input and output data obtained by output over-sampling even though the conventional identifiability conditions are not satisfied. Furthermore, its implementation is also investigated under the environment where the numerical representations in measurement device or controller only have finite wordlength. The new explicit expressions are presented to illustrate the property of quantization errors caused by finite wordlength effect and asymptotic variance of identification result. Some simulation examples illustrate the effectiveness of the proposed algorithm in the practical applications.*

1. **Introduction.** It is essential to construct an effective plant model through identification techniques for control system design [21], system analysis [5], signal processing [7], and model based fault detection [2, 11]. When the plant is operated by feedback controller, or the system has inherent feedback loop, closed-loop identification is necessary under output feedback situation, as illustrated in [9, 14]. Many closed-loop identification approaches have been developed, and they can be classified into direct, indirect and joint input-output groups. The direct approach identifies the plant model from the plant input and output data directly. It performs identification in the same way as open loop identification through the algorithms such as maximum likelihood (ML), or prediction error method (PEM) [3, 6], whereas the indirect or joint input-output one decomposes the closed-loop into several open loops whose inputs are external signals, then identifies these open loops from which one can retrieve the estimation of plant model [18, 21, 22].

Identifiability is one of the most fundamental problems in closed-loop identification [9]. An external exciting test signal is expected to guarantee the identifiability of plant model when performing identification. Nevertheless, external test signal is not allowed in many practical applications since it disturbs the normal technical operations. When no external test signal is available, it seems that the direct approach is the prime possible choice for closed-loop identification. Moreover, the direct approach has some advantages, for example, its computational efficiency is usually higher than that of the other two groups, neither the knowledge on the feedback controller nor the measurement of reference is required for identification. When using the direct approach without external test signal,