International Journal of Innovative Computing, Information and Control
Volume **5**, Number **10(B)**, October **2009**

ICIC International ©2009 ISSN 1349-4198
pp. **3287–3294**

TWO-DEGREE-OF-FREEDOM GENERALIZED PREDICTIVE CONTROL FOR INTEGRAL COMPENSATION IN A MULTIRATE SYSTEM

Takao Sato[1], Hiroyuki Yanai[1], Akira Yanou[2] and Shiro Masuda[3]

[1]University of Hyogo
2167 Shosha, Himeji, Hyogo, 671-2201, Japan
tsato@eng.u-hyogo.ac.jp

[2]Okayama University
3-1-1, Tsushima-naka, Okayama 700-8530, Japan
yanou@suri.sys.okayama-u.ac.jp

[3]Tokyo Metropolitan University
6-6 Asahigaoka, Hino, Tokyo, 191-0065 Japan
smasuda@cc.tmit.ac.jp

Received September 2008; revised February 2009

Abstract. *This paper proposes a new method for designing a multirate control system, in which a sampling interval of plant output is an integer multiple of a hold interval of a control input. To employ the effect of integral compensation in the multirate system, two-degree-of-freedom (2DOF) Generalized Predictive Control (GPC) is proposed only when there is a modeling error or disturbance. In this paper, a one-degree-of-freedom (1DOF) multirate GPC without integral compensation is first derived, and next the 1DOF multirate GPC is extended into 2DOF control using integral compensation. Numerical examples demonstrate the effectiveness of the proposed method.*
Keywords: Two-degree-of-freedom system, Multirate system, Generalized Predictive Control, Intersample ripple, Integral compensation

1. **Introduction.** This paper discusses a sample-data control system, in which a continuous-time plant is controlled using a discrete-time controller. In this sampled-data control system, a discrete-time control input is transformed into a continuous-time signal using a digital-analog (D/A) converter, and a continuous-time plant output is sampled using an analog-digital (A/D) converter. If the intervals of both the A/D and D/A converters are the same, one can easily design a single-rate control system, in which the sampling interval is the same as the hold interval. However, these intervals are not always equivalent due to constraints such as sensor performance, control structure, and so on. Therefore, a sampled-data control system can be considered as a multirate control system [1], in which the sampling interval of plant output is an integer multiple of a hold interval of a control input. Although the design of a multirate control system is clearly more complex than that of a single-rate system, a multirate system can be designed as a single-rate system by changing the hold interval to equal the sampling interval. However, the designed single-rate system is a slow-rate single-rate system, and its performance deteriorates more than the multirate system.

By lifting [2], the multirate system can be transformed into a multi-input, single-output, slow-rate and single-rate control system, in which the holding interval is changed to be equal to the sampling interval, and then the multirate system can be designed to be the same as the well-known single-rate system. However, in such a multirate system, the