

FAST RATE ADAPTIVE OUTPUT FEEDBACK CONTROL OF MULTI-RATE SAMPLED SYSTEMS WITH AN ADAPTIVE OUTPUT ESTIMATOR

IKURO MIZUMOTO¹, YOTARO FUJIMOTO¹, NAO WATANABE¹ AND ZENTA IWAI²

¹Department of Intelligent Mechanical Systems
Kumamoto University
2-39-1 Kurokami, Kumamoto 860-8555, Japan
ikuro@gpo.kumamoto-u.ac.jp

²Kumamoto Prefectural College of Technology
4455-1 Haramizu, Kikuyou-mach, Kikuchi-gun, Kumamoto 869-1102, Japan
iwai@kumamoto-pct.ac.jp

Received April 2010; revised September 2010

ABSTRACT. *This paper deals with the problem of designing an adaptive controller for multi-rate sampled systems with slow output sampling and fast input updating rates. By using an adaptive output estimator based on a reduced first order model of the controlled system, an adaptive output feedback controller with a fast-rate input updating period will be proposed for uncertain multi-rate systems.*

Keywords: Multi-rate systems, Adaptive output feedback control, Adaptive output estimator

1. **Introduction.** There are many systems including several multi-rate sampled chemical and mechanical ones in which higher speed output sampling periods cannot be taken, even though the input actuating period can be taken at relatively high speeds [1,2,16]. Generally, in such systems, feedback controllers are designed according to a single rate based on the slow output sampling rate. In these cases, the control performance within the slow sampling period has not always been ensured. However, if the input can be updated at a faster rate by applying a multi-rate control strategy, one can expect an improvement in the control performance.

Recently, a novel adaptive output estimator that realizes output feedback at fast rates has been proposed [11,12]. In this method, the adaptive output estimator is designed for a reduced simple first order model of the controlled system and so has a relatively simple structure compared with common adaptive state observers. In order to observe the output response within the slow rate sampling periods, several kinds of output estimators and fast rate model identification methods have been proposed for multi-rate systems [3-7]. Most of them, however, are based on a full order model of the considered system. In practical systems, it might be difficult to determine the exact order of the considered systems and for higher order systems, the designed estimator may become complex. In [11,12], by using the proposed fast rate output estimator, a fast rate static output feedback control with a relatively simple controller structure has been proposed based on the system's almost strictly positive real (ASPR) properties [13,14,17]. However, as has been pointed out, it is difficult to determine an appropriate feedback gain for most practical unknown systems.

In this paper, an adaptive control system design method, which can achieve a fast rate adaptive output feedback using adaptively estimated outputs and adaptively adjusted