International Journal of Innovative
Computing, Information and Control
Volume **6**, Number **6**, June **2010**

ICIC International ©2010 ISSN 1349-4198
pp. 2737–2747

ESTIMATOR-BASED CONTROL OF NETWORKED SYSTEMS WITH PACKET-DROPOUTS

Shu Yin, Li Yu and Wenan Zhang

Department of Automation
Zhejiang University of Technology
Zhejiang Provincial United Key Laboratory of Embedded Systems
Hangzhou 310014, P. R. China
yinshu8@yahoo.com.cn; lyu@zjut.edu.cn; wazhg@hotmail.com

Received January 2009; revised May 2009

Abstract. *This paper is concerned with the stabilization problem for networked control systems (NCSs) with packet-dropouts and delays. A state estimator is incorporated into the controller node, and the controller uses the estimated states when packet-dropouts occur. By using such a estimator-based controller, the closed-loop NCS is modelled as a discrete-time switched systems with both stable and unstable subsystems. Then, a sufficient condition for the exponential stability of the closed-loop NCS is derived by using the average dwell-time method. The obtained stability condition establishes the quantitative relation between the packet-dropout rate and the stability of the closed-loop NCS. Furthermore, design procedures are also presented for the packet-dropout-dependent stabilizing controllers and estimators. Finally, an illustrative example is given to demonstrate the effectiveness of the proposed results.*
Keywords: Networked control systems, Packet-dropouts, Switched systems, Average dwell-time, Exponential stability

1. **Introduction.** Control systems in which control loops are closed through a serial network are called networked control systems (NCSs). NCSs has became a hot research topic in both the control and communication society [1-5]. Packet-dropout is one of the important problems in NCSs [6]. During the last decade, much research effort has been devoted to the NCSs with packet-dropouts. Some effective approaches, such as the stochastic system approach [7,8], the time-delay system approach [9,10] and the switched system approach [11-14], have been presented in the literature. In stochastic system approach, Markov chain and independent Bernoulli random process are commonly used to describe the packet-dropout processes. Prior known information on the stochastic characteristics of the packet-dropout process, which may not be available in practice, is required in applying the stochastic system approach. Time-delay system approach may be conservative when the number of consecutive packet-dropouts is very small or may be unapplicable when the number exceeds the allowable upper bound. Switched system approach usually applies the arbitrary switching scheme or the average dwell-time method. The arbitrary switching scheme is restrictive for the NCS with unstable subsystems.

In the design of NCSs with packet-dropouts, it is of great significance to establish the quantitative relation between the stability of the NCS and the packet-dropout rate. Such a relation reveals the robustness of the NCS against the packet-dropouts, and may provide an useful guideline for the NCS designers. Note that in all the aforementioned results, it is assumed that the control input holds its previous value or is set to zero when packet-dropout occurs. Such assumption is either conservative or not applicable when a memory unite in the actuator (or controller) is not available. An useful way to overcome these