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STABILIZATION OF NETWORKED CONTROL SYSTEMS WITH PACKET LOSS AND TRANSMISSION DELAY

Ya Zhang and Yu-Ping Tian

School of Automation
Southeast University, Nanjing 210096, China

Abstract. This paper discusses the stability of discrete-time networked control systems (NCSs) in which transmission delay is a constant, packet-loss process is described by a Bernoulli model and packet dropping probability is varying and driven by a finite Markov chain. We treat the NCS as a jump linear system. By using the stochastic control theory, a necessary and sufficient condition for mean square stability is obtained. The feedback controller is constructed via solving linear matrix inequalities. Finally, a numerical example is given to show the effectiveness of the proposed approach.

Keywords. networked control systems, packet loss, delay, stability, finite Markov chain, linear matrix inequalities.

1 Introduction

Feedback control systems with control loops that are closed through a real-time network are usually called networked control systems (NCSs). Nowadays NCSs are widely used in many industrial areas, including manufacturing plants, chemical processes and so on.

The insertion of communication networks in feedback loops makes the analysis and design of NCSs more complex. Since every device connected to the communication intermediate is an information source and the communication intermediate is time division multiplexing, the information can only be sent out when the network is idle. This results in transmission delays unavoidably. Recently, various results on the stability of NCSs with transmission delays are proposed [4,9,10,12]. Because of limited bandwidth, there are node failures or message collisions in networks, which may result in data packet dropout. In [10], a NCS with packet loss was modeled as an asynchronous dynamical system with rate constraints on events. Based on this model a sufficient condition on packet dropping probability was obtained, which guarantees the stability of the NCS. Supposing that all the components in the system were connected through a communication network, Azimi-Sadjadi [1] obtained a condition on the packet dropping probability, under which the NCS was mean square stable. Hadjicostis and Touri [2] modeled a packet dropping network as an erasure channel and obtained a