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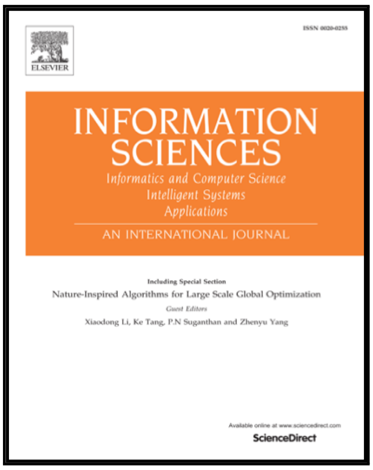

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Yong-Feng Gao, Xian Du, Yanhua Ma, Xi-Ming Sun

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Stabilization of Nonlinear Systems Using Event-triggered Controllers with Dwell Times☆

Yong-Feng Gao[a], Xian Du[a], Yanhua Ma[a,*], Xi-Ming Sun[a]

[a] *School of Control Science and Engineering, Dalian University of Technology, Dalian 116024, China*

Abstract

In this paper, the problem of event-triggered stabilization is investigated for a class of nonlinear systems. By adding different dwell times to static and dynamic event-triggering mechanisms, respectively, two event-triggered control strategies are proposed to ensure that the closed-loop system under study is asymptotically stable with the Zeno phenomenon being excluded. Barbalat's Lemma and sufficient Lyapunov stability conditions are used to compute different dwell times. Comparative study is made and illustrated for the static and dynamic event-triggering mechanisms by a numerical example.

Keywords: Nonlinear control systems, event-triggering mechanism, asymptotic stability, dwell time

1. Introduction

Nowadays, control systems are often run through communication networks due to many advantages in terms of cost reduction and structure flexibility [14, 30–32]. In this setup, controllers, actuators and sensors are connected over a communication network [2, 23, 25, 29]. One main concern in such control systems is how to determine the transmission and sampling instants so that the stability of the closed-loop systems can be guaranteed. Recalling the existing literature, two methods are commonly used, namely a time-triggered method and an event-triggered method [12, 33, 36]. The time-triggered method is often adopted in the traditional sampled-data control systems, by which, signal transmissions and samplings are determined via the elapse of a certain time interval. One of advantages is it can make the sampled-data control easy to be implemented. However, since the signal transmission and sampling is irrespective of the system state, it is possible to cause excessive usage of the central processing unit and the communication channel. Different from the time-triggered method, the event-triggered method paves a natural way as human behaves. With an event-triggered scheme, the transmission of sampled-data depends on the system state rather than the elapse of time [3, 13, 34, 35]. Besides, control signals will be updated once a state-dependent condition is violated [6–9]. Hence, in event-triggered control (ETC), a transmission occurs only when an event triggers, otherwise control signal will not be updated. In this way, the transmission and updating instants of control signals can be determined dynamically to ensure the stability and desired performance of the system under study.

ETC has attracted growing attention in the recent years, see e.g. [5, 11, 15, 16, 20, 28] and the references therein. Both static and dynamic event-triggering mechanisms (ETMs) are proposed to run a given stabilizing state-feedback controller. A static ETM often consists of a static law based on the system state (see, e.g., [26]), while with a dynamic ETM, some internal dynamic variable is introduced for the design of the ETM. Different kinds of interval dynamic variables are presented in several works. In [18, 24, 27], internal clocks are used for the presented ETMs. A monotonic clock, which can be regarded as an internal dynamic variable, is given to design some ETMs in [21] and [22]. In fact, the growth rate of the monotonic clock is up to the state of the plant. In [10], a filtered version of the signal is used to design some triggering law in [26].

*Corresponding author

Email addresses: gaoyongfeng@dlut.edu.cn (Yong-Feng Gao), duxian@dlut.edu.cn (Xian Du), mayanhua@dlut.edu.cn (Yanhua Ma), sunxm@dlut.edu.cn (Xi-Ming Sun)