Nonlinear Analysis 74 (2011) 3099–3111

Contents lists available at ScienceDirect

Nonlinear Analysis

journal homepage: www.elsevier.com/locate/na

Stability of impulsive stochastic differential delay systems and its application to impulsive stochastic neural networks

Chunxiang Li [a], Junping Shi [b], Jitao Sun [a,*]

[a] Department of Mathematics, Tongji University, Shanghai 200092, China
[b] Department of Mathematics, College of William and Mary, Williamsburg, VA, 23187-8795, USA

ARTICLE INFO

Article history:
Received 11 November 2010
Accepted 27 January 2011

MSC:
34K50
34K20
49N25

Keywords:
Stability
Stochastic system
Delay
Impulsive control
Neural networks

ABSTRACT

This paper is concerned with the stability of n-dimensional stochastic differential delay systems with nonlinear impulsive effects. First, the equivalent relation between the solution of the n-dimensional stochastic differential delay system with nonlinear impulsive effects and that of a corresponding n-dimensional stochastic differential delay system without impulsive effects is established. Then, some stability criteria for the n-dimensional stochastic differential delay systems with nonlinear impulsive effects are obtained. Finally, the stability criteria are applied to uncertain impulsive stochastic neural networks with time-varying delay. The results show that, this convenient and efficient method will provide a new approach to study the stability of impulsive stochastic neural networks. Some examples are also discussed to illustrate the effectiveness of our theoretical results.

1. Introduction

Impulsive systems arise naturally in a wide variety of evolutionary processes in which states are changed abruptly at certain moments of time. Such processes are often investigated in various fields, such as economics, physics, population dynamics, engineering, biology, etc. For instance, in implementation of electronic networks in which the state is subject to instantaneous perturbations and experiences abrupt change at certain moments, which may be caused by switching phenomenon, frequency change or other sudden noise, does exhibit impulsive effects. Besides the impulsive effects, time delays are frequently encountered in real world, which can cause instability and oscillations in the system. For example, time delays can be caused by the finite switching speed of amplifier circuits in neural networks or deliberately introduced to achieve tasks that deal with motion-related problems such as moving image processing. Recently, impulsive delay systems have been used with great success in a variety of applications, and a large number of important results have been reported (see [1–5] and the references therein).

Yan and Zhao [1] considered the following linear impulsive delay differential equation:

$$\begin{cases} y'(t) + \sum_{i=1}^{n} p_i(t) y(t - \tau_i(t)) = 0, \quad t \neq t_k \\ y(t_k^+) - y(t_k) = b_k y(t_k), \quad k = 1, 2, \ldots. \end{cases} \tag{1.1}$$

* Corresponding author. Tel.: +86 21 65983240x1307; fax: +86 21 65981985.
E-mail address: sunjt@sh163.net (J. Sun).

0362-546X/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.na.2011.01.026