Hindawi Publishing Corporation
Journal of Applied Mathematics
Volume 2013, Article ID 863659, 2 pages
http://dx.doi.org/10.1155/2013/863659

Editorial

Recent Advances in Hybrid Dynamical Systems

Xinzhi Liu,[1] Piyapong Niamsup,[2] Qiru Wang,[3] and Yi Zhang[4]

[1] *Department of Applied Mathematics, University of Waterloo, Waterloo, Canada N2L 3G1*
[2] *Department of Mathematics, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand*
[3] *School of Mathematics and Computational Science, Sun Yat-Sen University, Guangzhou 510275, China*
[4] *School of Science, China University of Petroleum, Beijing 102249, China*

Correspondence should be addressed to Xinzhi Liu; xzliu@uwaterloo.ca

Received 29 October 2013; Accepted 29 October 2013

There has been extensive research in hybrid dynamical systems in recent years due to their important applications in various industrial and technological areas such as communication, complex networks, biotechnology, artificial intelligence, switching circuits in power electronics, spacecrafts control, and ecosystems management. This special issue consists of eight excellent papers that represent new and important developments in the field of hybrid dynamical systems. Hopefully, this special issue will stimulate further research on this topic and collaboration to the world of scientific community.

The paper "*A new series of three-dimensional chaotic systems with cross-product nonlinearities and their switching*" by X. Zhao, F. Jiang, Z. Zhang, and J. Hu introduces a new series of three-dimensional chaotic systems. Based on some conditions, it analyzes the globally (conditional) exponentially attractive set and positive invariant set of these chaotic systems. Moreover, it gives some examples to show that the results and the exponential estimate are explicitly derived. It also constructs some three-dimensional chaotic systems with cross product nonlinearities and studies the switching system between them.

In the paper "*Exponential stabilizability of switched systems with polytopic uncertainties*" by X. Zhang, Z.-Q. Xia, and Y. Gao, the exponential stabilizability of switched nonlinear systems with polytopic uncertainties are explored by employing the methods of nonsmooth analysis and the minimum quadratic Lyapunov function. The switchings among subsystems are dependent on the directional derivative along the vertex directions of subsystems. Especially, a sufficient condition for exponential stabilizability of the switched linear systems is established considering the sliding modes and the directional derivatives along sliding modes. Furthermore, the matrix conditions of exponential stabilizability are derived for the case of switched linear system and some numerical examples are given to show the validity of the synthesis results.

The paper "*Stability in terms of two measures for nonlinear impulsive systems on time scales*" by K. Zhang and X. Liu investigates the stability problems of nonlinear impulsive systems with fixed moments of impulses in terms of two measures on time scales. Sufficient conditions for (uniform) stability, (uniform) asymptotic stability, and instability in terms of two measures are derived by using the method of Lyapunov functions. The obtained results include the existing results as the time scale reduces to the set of real numbers. Particularly, the results provide stability criteria for impulsive discrete systems in terms of two measures, which have not been investigated extensively. Two examples are presented to illustrate the efficiency of the proposed results.

In the paper "*p-Stability and p-stabilizability of stochastic nonlinear and bilinear hybrid systems under stabilizing switching rules*" by E. Seroka and L. Socha, the problem of pth mean exponential stability and stabilizability of a class of stochastic nonlinear and bilinear hybrid systems with unstable and stable subsystems is considered. Sufficient conditions for the pth mean exponential stability and stabilizability under a feedback control and stabilizing switching rules are derived. A method for the construction of stabilizing switching rules based on the Lyapunov technique and the knowledge of the regions of decreasing of Lyapunov functions for subsystems is given. Two cases, including a single Lyapunov function and a single Lyapunov-like function, are discussed. The obtained results are illustrated by examples.

The paper "*Computational techniques for model predictive control of large-scale systems with continuous-valued and discrete-valued inputs*" by K. Kobayashi, and K. Hiraishi proposes some computational techniques for model predictive control of large-scale systems with both continuous-valued control inputs and discrete-valued control inputs, which are a class of hybrid systems. In the proposed method, it introduces the notion of virtual control inputs, which are obtained by relaxing discrete-valued control inputs to continuous variables. In online computation, first, it finds continuous-valued control inputs and virtual control inputs minimizing a cost function. Next, using the obtained virtual control inputs, only discrete-valued control inputs at the current time are computed in each subsystem. In addition, it also discusses the effect of quantization errors. Finally, the effectiveness of the proposed method is shown by a numerical example. The proposed method enables us to reduce and decentralize the computation load.

In the paper "*Necessary optimality conditions for a class of impulsive and switching systems*" by L. Li, Y. Gao, and G. Wang, an optimal control problem for a class of hybrid impulsive and switching systems is considered. By defining switching times as part of extended state, it gets the necessary optimality conditions for this problem. It is shown that the adjoint variables satisfy certain jump conditions and the Hamiltonian is continuous at switching instants. In addition, necessary optimality conditions of Fréchet subdifferential form are presented.

The paper "*Delay-dependent synchronization for complex dynamical networks with interval time-varying and switched coupling delays*" by T. Botmart, and P. Niamsup investigates the problem of synchronization for complex dynamical networks with interval time-varying delays in the dynamical nodes and the switched coupling term simultaneously. The constraint on the derivative of the time-varying delay is not required which allows the time delay to be a fast time-varying function. It uses common unitary matrix; the problem of synchronization is transformed into the stability analysis of some linear switched delay systems. Then, when subnetworks are synchronizable and nonsynchronizable, a delay-dependent sufficient conditions are derived and formulated in the form of a linear matrix inequalities (LMI) by average dwell time approach and piecewise Lyapunov-Krasovskii functionals which are constructed based on the descriptor model of the system and the method of decomposition. The new stability condition is much less conservative and is more general than some existing results. A numerical example is also given to illustrate the effectiveness of the proposed method.

The paper "*LMI-based sliding mode observers for incipient faults detection in nonlinear system*" by C.-F. Zhang, M. Yan, J. He, and C. Luo presents a diagnosis scheme based on a linear matrix inequality (LMI) algorithm for incipient faults in a nonlinear system class with unknown input disturbances. First, the nonlinear system is transformed into two subsystems, one of which is unrelated to the disturbances. Second, for the subsystem that is free from disturbances, a Luenberger observer is constructed; a sliding mode observer is then constructed for the subsystem which is subjected to disturbances, so that the effect of the unknown input disturbances is eliminated. Together, the entire system achieves both robustness to disturbances and sensitivity to incipient faults. Finally, the effectiveness and feasibility of the proposed method is verified through an experiment using a single-link robotic arm.

Xinzhi Liu
Piyapong Niamsup
Qiru Wang
Yi Zhang