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Editorial

Finite-Time Control and Estimation for Complex and Practical Dynamical Systems

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If a stable system is actuated by energy (Lyapunov function), the energy will be automatically attenuated in infinite time. The state will finally converge to the equilibrium point. But the trajectory of the state is not constrained. However, in the finite-time stability, the system state would be bounded in finite-time interval. The bounds of the state are prescribed. Thus, the finite-time stability has a great application potential for systems in which large values of the state are not acceptable. In spite of the extensive and successful applications of finite-time stability in automatic control and estimation areas, the capability to handle complex systems such as delayed systems, fuzzy systems, and singularly perturbed systems needs to be further expanded.

The aim of this special issue is to document the up-to-date status of work on control systems design by finite-time techniques via a collection of original high-quality papers. Of particular interest is the fact that the papers in this special issue are devoted to the new concept development of the finite-time technique and the applications of these new concepts to control and estimation problems of complex systems. Topics include, but are not limited to, (1) finite-time boundedness (theoretical and mathematical development); (2) finite-time approaches to networked control and estimation (limited communication capacity, distributed control and filtering, and priority scheduling); (3) finite-time delayed systems, stability, stabilization, control, and filtering; (4) finite-time modeling, analysis, and design of fuzzy systems and switched systems; (5) finite-time stochastic systems; and (6) practical applications of finite-time systems.

We have solicited a lot of submissions to our special issue from different institutes and countries. Based on the peer-review results, 18 submissions have been selected to appear in the final publication, which cover finite-time control theory for different kinds of setups, adaptive and nonlinear control, and control applications.

Though there are considerable results on the finite-time theory, the finite-time control theory needs to be further developed to incorporate the requirements of new applications. In the work entitled "*Resilient finite-time controller design of a class of stochastic nonlinear systems*" by Z. Yan, the definition of finite-time annular domain stability for stochastic nonlinear systems is introduced. An algorithm named double-parameters search is proposed to solve matrix inequalities and obtain the controller gain. In another work entitled "*Finite-time observer based cooperative tracking control of networked Lagrange systems*" by G. Chen and Q. Lin, with a leader-follower structure, the cooperative tracking control problem is investigated. A distributed adaptive fuzzy tracking control protocol is developed based on estimated velocity information of the leader. Numerical simulation results are provided to show both the stability and the robustness to external disturbances. X. Zhou et al. study the finite-time chaos control of a permanent magnet synchronous motor system in the work "*Finite-time chaos control of*

a complex permanent magnet synchronous motor system." Two control strategies are introduced to stabilize the motor system in a finite time. The finite-time stabilization problem of a four-tank system is investigated in "*Finite time stabilization of the four tanks system: extensions to the uncertain systems*" by C. B. Njima et al. For positive switched systems, the problem of l_1-gain control via delta operator approach is investigated in "*Finite-time l_1-gain control for positive switched systems with time-varying delay via delta operator approach*" by S. Li et al. A state-feedback controller design method is proposed to ensure both the finite-time boundedness and the l_1-gain performance. In the work entitled "*A new finite-time bounded control of stochastic Itô systems with (x,u,v)-dependent noise: different quadratic function approach*" by Z. Yan and Z. Lin, the existence of both state and output feedback controllers is presented by nonlinear matrix inequalities which are finally solved by a novel algorithm. For Itô-type stochastic singular systems, Z. Yan and W. Zhang in the paper entitled "*Finite-time stability and stabilization of Itô-type stochastic singular systems*" study the finite-time stability and the controller design problem. As the systems are stochastic, the definition of finite-time stochastic stability is used.

Beside the theory development in the finite-time systems, there are also some works on the adaptive and nonlinear control. In the work entitled "*Adaptive fault-tolerant tracking control of nonaffine nonlinear systems with actuator failure*" by H. Zhou et al, a model approximation approach which can bridge the gap between the affine and nonaffine systems are developed. The faults and states are estimated simultaneously by using unscented Kalman filter. With the estimated faults and states, the adaptive fault-tolerant control scheme is proposed. J. W. Jeong et al. investigate the control problem for second-order nonlinear systems in "*Extended nonsingular terminal sliding surface for second-order nonlinear systems*." An extended nonsingular terminal sliding surface which is a superset of a conventional nonsingular terminal sliding surface is proposed for the studied setups. When the transition rates are uncertain, Y. Li et al. deal with the stabilization problem for delayed Markovian jump linear systems in "*Quantized state-feedback stabilization for delayed Markovian jump linear systems with generally incomplete transition rates*." The quantization problem on the controller is also considered in the design. The control problem of nonlinear singular systems is investigated by L. Li and Y. Kang in the work "*Reliable l_2–l_∞ and H_∞ control for nonlinear singular systems via dynamic output feedback*." The nonlinearities considered are Lipschitz and the designed controller is a generalized nonlinear one.

On the application side, there are also some good works. In the paper entitled "*Control allocation design of reaction control system for reusable launch vehicle*" by R. Mu and X. Zhang, the reaction control system with an indexed control method is investigated. Flight mission simulation and comparisons are provided. The fault detection of Tennessee Eastman process is studied in the work "*Study on support vector machine-based fault detection in Tennessee Eastman process*" by S. Yin et al. The support vector machine algorithm is used in the investigation. In another work named "*Adaptive backstepping control based on floating offshore high temperature superconductor generator for wind turbines*" by F. Yang et al., the superconductor generator for offshore wind turbines is considered. The adaptive backstepping control is used in the wind power system consisting of a wind turbine and a high temperature superconductor generator. For bioreactor systems, S. S.-D. Xu deals with the control problem by using super-twisting-algorithm-based terminal sliding mode control in the work "*Super-twisting-algorithm-based terminal sliding mode control for a bioreactor system*." It infers from the comparison results that the proposed method can achieve better results than the existing method. The high speed trains are considered in the work "*Observer based traction/braking control design for high speed trains considering adhesion nonlinearity*" by W. Cai et al. Force observers are designed to estimate the adhesion force and the resistance. In the work entitled "*Wind and wave disturbances compensation to floating offshore wind turbine using improved individual pitch control based on fuzzy control strategy*" by F. Yang et al., a compensator is designed to reduce the effects of the disturbances including the wave and the wind. The robustness of the designed controller is good from the simulation results. The rigid satellite control is considered in the work "*Finite-time control for attitude tracking maneuver of rigid satellite*" by M. Huo et al. The lumped uncertainty arising from the model development is estimated in the work.

Disclosure

This special issue offers an up-to-date research progress in the area of finite-time control and applications.

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