Zentralblatt MATH

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Zbl pre02221302
Christofides, Panagiotis D.; El-Farra, Nael H.
Control of nonlinear and hybrid process systems. Design for uncertainty constraints and time-delays. (English)
[B] Lecture Notes in Control and Information Sciences 324. Berlin: Springer. xi, 444 p. EUR 199.95/net; sFr 338.50; \sterling 154.00; \$ 259.00 (2005). [ISBN 3-540-28456-7/pbk]

The monograph consisting of 9 Chapters, Proofs of Chapters 3-7, 9 in the appendix, and References presents a fundamental exposition and insight into the nature of nonlinear and hybrid control methods for dynamic systems with uncertainty, constraints, and time delays. Chapter 1 is an introduction. Chapter 2 reviews some basic results on the analysis and control of nonlinear systems. Chapter 3 presents robust inverse optimal control design for input/output linearizable nonlinear systems with time-varying bounded uncertainty. The state feedback controllers are designed by re-shaping the scalar nonlinear nonlinear gain of Sontag's formula guaranteeing different robustness and optimality objectives. Dynamic output feedback controller with high-gain observer and saturation filter eliminating observer peaking is designed. The controller enforces semi-global closed-loop stability and achieves near-optimal performance. Chapter 4 presents a unified control design of multivariable nonlinear systems with uncertainty and constraints. Explicit formulas for bounded robust nonlinear state feedback controllers with well-characterized stability and performance properties are given. The dynamic output control with high-gain observers is presented. A tuning technique for classical PID control using nonlinear control methods is supplied. Chapter 5 deals with hybrid predictive state and output control (HPC) of constrained linear system. Model predictive control and hybrid control are united into a hybrid structure for LTI systems with input constraints. Extensions to address the state estimation and output feedback stabilization are included. Chapter 6 generalizes the HPC structure to address the stabilization problem for nonlinear and uncertain systems. Chapter 7 presents hybrid nonlinear control methodologies for switched processes with constrained and uncertain dynamics, coordinating feedback and switching for robust hybrid control, and predictive control of switched nonlinear systems. Multiple Lyapunov functions are used. Lyapunov-based predictive controller guaranteeing the closed-loop system switching stability is designed for switching nonlinear systems. Chapter 8 focuses on an application of the results developed in Chap. 7 to fault-tolerant control design for systems with multiple, distributed interconnected processing units. Chapter 9 deals with a methodology for the synthesis of nonlinear output feedback controllers for nonlinear Differential Difference Equations systems which include time delays in the states, the actuator, and the sensor. Finally, the proofs of all assertions are given in the appendix. Each chapter is supplied with nontrivial real-world examples of control design for specific chemical processes including simulations. The book is a self-contained text assuming a basic knowledge of linear systems, linear and nonlinear control systems. It is an excellent up-to-date authoritative reference covering original results presented in a rigorous, unified framework with numerous practical examples. The monograph is intended for researchers, graduate students, and process control engineers

working in the areas of control engineering and applied mathematics interested in nonlinear and hybrid control systems as well as process control applications.
[**Lubomír Bakule (Praha)**]

MSC 2000:

*93-02 Research monographs (systems and control)
93B50 Synthesis problems
93B51 Design techniques in systems theory
93B52 Feedback control
93C10 Nonlinear control systems
93C65 Discrete event systems
93D15 Stabilization of systems by feedback

Keywords: Nonlinear and hybrid systems; feedback control; stabilization; predictive control; Lyapunov functions; uncertainty; constraints; time delay; fault-tolerant control; stability
Cited in Zbl. reviews...

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