CONTENTS

VOLUME X

Adaptive Control Kumpati S. Narendra, Yale University, New Haven, CT, USA

- 1. Introduction
- 2. Basic Concepts and Definitions
- 3. Historical Background
 - 3.1. Gradient Based Adaptive Methods
 - 3.2. The MIT Rule and Park's Proof of Instability
- 4. Stable Adaptive Systems
- 5. Lyapunov Theory Based Design
- 6. Identification and Adaptive Control of Higher Order Systems
 - 6.1. Identification
 - 6.2. Control
- 7. Adaptive Observers
 - 7.1. Non-minimal Representation
 - 7.2. Minimal Representation
 - 7.3. Error Models
- 8. The Adaptive Control Problem (Relative Degree n*=1)
- 9. The Adaptive Control Problem (Relative Degree $n^* \ge 2$)
- 10. Persistent Excitation
- 11. Robust Adaptive Control 11.1. Time-Varying Systems
 - 11.2. Unmodeled Plant Dynamics
- 12. Hybrid Adaptive Control
- 13. Relaxation of Assumptions
- 14. Multivariable Adaptive Control
- 15. Nonlinear Adaptive Control
- 16. Recent Contributions16.1. Decentralized Adaptive Control16.2. Adaptive Control Using Multiple Models

Relay Autotuning of PID Controllers

D. P. Atherton, University of Sussex, UK

- 1. Introduction
- 2. Relay Autotuning
- 3. Analysis of Relay Autotuning using the DF method
- 4. Controller Design Based on the Critical Point
- 5. Further Considerations
- 6. Conclusions

Self-Tuning Control

P.J. Gawthrop, Centre for Systems and Control and Department of Mechanical Engineering, University of Glasgow, GLASGOW. G12 8 QQ Scotland, UK

- 1. Introduction
- 2. Categorization of Self-Tuning Controllers.
 - 2.1. Explicit or implicit
 - 2.2. Continuous-time or discrete-time
 - 2.3. Choice of controller design method
 - 2.4. Choice of identification method

31

1

42

- 3. Implicit generalized minimum variance control
- 4. Practical issues
 - 4.1. Choice of design parameters
 - 4.2. Integral action
 - 4.3. Initial conditions
- 5. Examples
 - 5.1. Example 1: Implicit Model-Reference Control
 - 5.2. Example 2: Explicit Model-Reference Control
 - 5.3. Example 3: Explicit Pole-placement Control of non-minimum phase system
 - 5.4. Examples 4 and 5 : Under-modeled systems
- 6. Future prospects

Model Reference Adaptive Control

Anuradha M. Annaswamy, Massachusetts Institute of Technology, Cambridge, MA, USA

- 1. Introduction
- 2. Dynamic Models
 - 2.1. Identification Model
 - 2.2. Reference Model
 - 2.2.1. Explicit and Implicit Model Following
 - 2.3. Reference Model with Inputs
- 3. Model Reference Adaptive Control
 - 3.1. Algebraic Part and Analytic Part
 - 3.2. The MRAC Problem
- 4. Parameter Identification

Adaptive Predictive Control

D.W. Clarke, Department of Engineering Science, Park Road, Oxford OXI 3 PJ, UK U.R. Halldorsson, Control Engineering Laboratory, Ruhr-University Bochum, D-44780, Germany

- 1. Introduction
- 2. System models and long-range prediction
 - 2.1. General long-range prediction models
 - 2.2. Dynamic matrix control prediction model
 - 2.3. Generalized predictive control prediction model
- 3. The GPC control law
- 4. Robustness analysis
- 5. Self-tuning aspects
- 6. Conclusions

Stochastic Adaptive Control

T. E. Duncan, Department of Mathematics, University of Kansas, Lawrence, KS 66045, USA

- 1. Introduction
- 2. Adaptive Control of Markov Chains
- 3. Adaptive Control of ARMAX models
- 4. Adaptive Control of Continuous Time Linear Stochastic Systems
- 5. Some Generalizations of Adaptive Control
- 6. Conclusions

Adaptive Dual Control

Björn Wittenmark, Lund Institute of Technology, Sweden.

- 1. Introduction
- 2. Stochastic Adaptive Control
- 3. Optimal Dual Controllers

122

ii

100

76

63

- 4. Suboptimal Dual Controllers
 - 4.1. Perturbation Signals
 - 4.2. Constrained One-Step-Ahead Minimization
 - 4.3. Approximations of the Loss Function
 - 4.4. Modifications of the Loss Function
 - 4.5. Finite Parameter Sets
- 5. When To Use Dual Control?

Adaptive Nonlinear Control

133

Petar Kokotovic, Department of Electrical and Computer Engineering, University of California at Santa Barbara, USA Miroslav Krstic, Department of Mechanical and Aerospace Engineering, University of California at San Diego, USA

- 1. Introduction
- 2. Backstepping
- 3. Tuning Functions Design: Examples
- 4. General Recursive Design: Procedure
- 5. Modular Design
 - 5.1. Controller design
 - 5.2. Identifier Design
- 6. Conclusions

Control of Intermittent Processes

Madhukar Pandit, Control Systems and Signal Theory Group, University of Kaiserslautern, Germany Heiko Hengen, Control Systems and Signal Theory Group, University of Kaiserslautern, Germany

- 1. Introduction
- 2. Definitions, physical and mathematical models
 - 2.1. Classes of Cyclic Processes
 - 2.2. System Models
 - 2.2.1. Transfer Function Models
 - 2.2.2. Finite Horizon Operator Models
- 3. Repetitive and iterative learning control schemes
- 4. Designing ILC for real world applications
 - 4.1. ILC as an Inverse Problem
 - 4.2. Delays and Degree of Difference
 - 4.3. Derivation of the Design Equation of ILC
 - 4.4. Optimizing ILC
 - 4.5. Design Aspects
 - 4.6. Signal Conditioning
- 5. Robustness issues and focus of research
 - 5.1. Robustness Against Model Inaccuracies
 - 5.2. Robustness Against Measurement Noise
 - 5.3. Robustness Against Initial State Variations
 - 5.4. Focus of Research
- 6. Industrial application examples
 - 6.1. Iterative Learning Control of the Aluminium Extrusion Process
 - 6.2. Controlling Multiple Input/Multiple Output Systems using ILC
 - 6.3. Repetitive Control of a Scanner Mirror
- 7. Conclusion

Index

About EOLSS

181 185

151