

Contents

Part I Robust Bifurcation and Control

1	Dynamic Robust Bifurcation Analysis	3
	Masaki Inoue, Jun-ichi Imura, Kenji Kashima and Kazuyuki Aihara	
1.1	Introduction	3
1.2	Problem Formulation: Dynamic Robust Bifurcation Analysis	5
1.3	Equilibrium, Stability/Instability, and Robustness Analysis	7
1.3.1	Equilibrium Analysis	8
1.3.2	Robust Hyperbolicity Analysis	11
1.3.3	Robust Bifurcation Analysis	14
1.4	Examples of Robust Bifurcation Analysis	15
1.4.1	Robustness Analysis of Saddle-Node Bifurcation	15
1.4.2	Robustness Analysis of Hopf Bifurcation	16
1.5	Conclusion	17
	References	17
2	Robust Bifurcation Analysis Based on Degree of Stability	21
	Hiroyuki Kitajima, Tetsuya Yoshinaga, Jun-ichi Imura and Kazuyuki Aihara	
2.1	Introduction	21
2.2	System Description and Robust Bifurcation Analysis	22
2.2.1	Continuous-Time Systems	22
2.2.2	Discrete-time Systems	23
2.2.3	Robust Bifurcation Analysis	24
2.3	Method of Robust Bifurcation Analysis	25
2.4	Numerical Examples	27
2.4.1	Equilibrium Point	27

2.4.2	Periodic Solution	29
2.5	Conclusion.	30
	References.	31
3	Use of a Matrix Inequality Technique for Avoiding Undesirable Bifurcation	33
	Yasuaki Oishi, Mio Kobayashi and Tetsuya Yoshinaga	
3.1	Introduction	33
3.2	Considered Problem	34
3.3	Proposed Method	35
3.4	Extension.	36
3.5	Example	37
3.6	Avoidance of Chaos	38
3.6.1	Method for Chaos Avoidance.	38
3.6.2	Experimental Result	39
3.7	Conclusion.	40
	References.	40
4	A Method for Constructing a Robust System Against Unexpected Parameter Variation	41
	Hiroyuki Kitajima and Tetsuya Yoshinaga	
4.1	Introduction	41
4.2	Method	42
4.2.1	Dynamical System	42
4.2.2	Search for Optimal Parameter Values	43
4.3	Results	45
4.3.1	Discrete-Time System	45
4.3.2	Continuous-Time System.	46
4.4	Conclusion.	47
	References.	48
5	Parametric Control to Avoid Bifurcation Based on Maximum Local Lyapunov Exponent	49
	Ken'ichi Fujimoto, Tetsuya Yoshinaga, Tetsushi Ueta and Kazuyuki Aihara	
5.1	Introduction	49
5.2	Problem Statement	50
5.3	Proposed Method	51
5.4	Experimental Results.	52
5.5	Conclusion.	54
	References.	55

6	Threshold Control for Stabilization of Unstable Periodic Orbits in Chaotic Hybrid Systems	57
	Daisuke Ito, Tetsushi Ueta, Takuji Kousaka, Jun-ichi Imura and Kazuyuki Aihara	
6.1	Introduction	57
6.2	Design of Controller with Perturbation of the Threshold Value	59
6.3	A Simple Chaotic System	63
6.3.1	Numerical Simulation	65
6.3.2	Circuit Implementation	67
6.4	Izhikevich Model	68
6.4.1	Controller	69
6.4.2	Numerical Simulation	70
6.5	Conclusion.	71
	References.	72

Part II Dynamic Attractor and Control

7	Chaotic Behavior of Orthogonally Projective Triangle Folding Map	77
	Jun Nishimura and Tomohisa Hayakawa	
7.1	Introduction	77
7.2	Orthogonally Projective Triangle Folding Map	78
7.3	Tetrahedron Map	81
7.3.1	Fixed Point and Periodic Point Analysis on the Boundary of \mathcal{D}	82
7.4	Extended Fixed Point and Periodic Point Analysis for Tetrahedron Map	83
7.4.1	Geometric Interpretation of the Triangle Folding Map	83
7.4.2	Periodic Points of the Tetrahedron Map.	87
7.4.3	Chaos by the Tetrahedron Map.	88
7.5	Conclusion.	90
	References.	90
8	Stabilization Control of Quasi-periodic Orbits	91
	Natushiro Ichinose and Motomassa Komuro	
8.1	Introduction	91
8.2	Properties of Quasi-periodic Orbit on Invariant Closed Curve	92
8.3	Unstable Quasi-periodic Orbit.	94
8.4	External Force Control	96
8.5	Delayed Feedback Control	98

8.6	Pole Assignment Method	103
8.7	Conclusions	105
	References.	106
9	Feedback Control Method Based on Predicted Future States for Controlling Chaos	109
	Miki U. Kobayashi, Tetsushi Ueta and Kazuyuki Aihara	
9.1	Introduction	109
9.2	Method	111
9.3	Application	112
	9.3.1 Logistic Map	112
	9.3.2 Hénon Map	116
9.4	Conclusions	118
	References.	119
10	Ultra-discretization of Nonlinear Control Systems with Spatial Symmetry	121
	Masato Ishikawa and Takuto Kita	
10.1	Introduction	121
10.2	Basic Properties on the Hexagonal Cellular Space.	123
	10.2.1 Coordinate Settings	123
	10.2.2 Basics of Difference Calculus in Concern	124
10.3	Locomotion Under Nonholonomic Constraints	125
	10.3.1 Derivation of the Continuous Single-Cart Model.	125
	10.3.2 Derivation of the Discrete Version	126
	10.3.3 Holonomy and the Lie Bracket Motion	128
10.4	Connected Rigid Bodies: Locomotion Under both Nonholonomic and Holonomic Constraints	129
	10.4.1 Cart-Trailer Systems	129
	10.4.2 Derivation of the Discrete Version	131
10.5	Reachability Issues	134
	10.5.1 Definitions.	135
	10.5.2 Application	135
10.6	Other Possibilities of Cellular Tessellation	137
10.7	Conclusion.	139
	References.	140
11	Feedback Control of Spatial Patterns in Reaction-Diffusion Systems	141
	Kenji Kashima and Toshiyuki Ogawa	
11.1	Introduction	141
11.2	Pattern Formation by Global Feedback	143
	11.2.1 Turing Instability	143

11.2.2	Interpretation of Turing Instability by Global Feedback	144
11.2.3	0:1:2-Mode Interaction	148
11.2.4	Wave Instability	150
11.2.5	Summary	153
11.3	Selective Stabilization of Turing Patterns	153
11.3.1	Reaction-Diffusion Systems	153
11.3.2	Problem Formulation	155
11.3.3	Feedback Control of Center Manifold Dynamics	156
11.3.4	Numerical Example	158
11.3.5	Summary	159
	References	159
12	Control of Unstabilizable Switched Systems	161
	Shun-ichi Azuma, Tomomi Takegami and Yoshito Hirata	
12.1	Introduction	161
12.2	Problem Formulation	162
12.2.1	Unstabilizable Switched Systems	162
12.2.2	Divergence Delay Problem	163
12.3	Discrete Abstraction of Switched Systems	163
12.4	Divergence Delay Control Based on Discrete Abstraction	164
12.5	Application to Optimal Scheduling Intermittent Androgen Suppression for Treatment of Prostate Cancer	166
12.5.1	Mathematical Model of ISA	166
12.5.2	Sub-optimal Scheduling Based on Discrete Abstraction	167
12.6	Conclusion	168
	References	169
 Part III Complex Networks and Modeling for Control		
13	Clustered Model Reduction of Large-Scale Bidirectional Networks	173
	Takayuki Ishizaki, Kenji Kashima, Jun-ichi Imura and Kazuyuki Aihara	
13.1	Introduction	173
13.2	Preliminaries	175
13.3	Clustered Model Reduction	177
13.3.1	Problem Formulation	177
13.3.2	Exact Clustered Model Reduction	178
13.3.3	Approximation Error Evaluation for Clustered Model Reduction	181

13.4	Numerical Example: Application to Complex Networks.	185
13.5	Conclusion.	188
	References.	188
14	Network Structure Identification from a Small Number of Inputs/Outputs	191
	Masayasu Suzuki, Jun-ichi Imura and Kazuyuki Aihara	
14.1	Introduction	191
14.2	Characteristic-Polynomial-Based NW Structure Identification using Knock-Out	193
14.2.1	Problem Formulation.	193
14.2.2	Representation Using the Generalized Frequency Variable	194
14.2.3	Identification Method	195
14.3	Identification of a Transfer Characteristic Among Measurable Nodes.	200
14.3.1	Network System and Its Dynamical Structure Function.	200
14.3.2	Reconstruction of Dynamical Structure Function from the Transfer Function of the NW System	204
14.4	Conclusions and Discussions	207
	References.	207
Index	209

Analysis and Control of Complex Dynamical Systems
Robust Bifurcation, Dynamic Attractors, and Network
Complexity

Aihara, K.; Imura, J.-i.; Ueta, T. (Eds.)

2015, XIV, 211 p. 103 illus., 45 illus. in color., Hardcover

ISBN: 978-4-431-55012-9