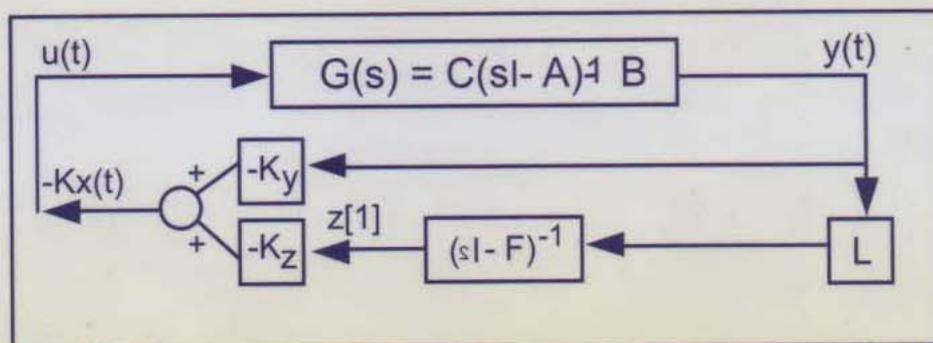


Control Engineering Series

Robust Control System Design

Advanced State Space Techniques

Second Edition, Revised and Expanded



Chia-Chi Tsui

Contents

<i>Series Introduction</i>	v
<i>Preface</i>	vii
1. System Mathematical Models and Basic Properties	1
1.1 Two Kinds of Mathematical Models	2
1.2 Eigenstructure Decomposition of a State Space Model	11
1.3 System Order, Controllability, and Observability	13
1.4 System Poles and Zeros	21
Exercises	23

Contents

2	Single-System Performance and Sensitivity	27
2.1	System Performance	28
2.2	System Sensitivity and Robustness	38
	Conclusion	53
	Exercises	53
3	Feedback System Sensitivity	55
3.1	Sensitivity and Loop Transfer Function of Feedback Systems	56
3.2	Sensitivity of Feedback Systems of Modern Control Theory	63
	Summary	76
4	A New Feedback Control Design Approach	79
4.1	Basic Design Concept of Observers—Direct Generation of State Feedback Control Signal Without Explicit System States	80
4.2	Performance of Observer Feedback Systems—Separation Property	85
4.3	The Current State of LTR Observer Design	88
4.4	A New Design Approach and New Feedback Structure—A Dynamic Output Feedback Compensator that Generates State/Generalized State Feedback Control Signal	93
	Exercises	99
5	Solution of Matrix Equation $TA - FT = LC$	105
5.1	Computation of a System's Observable Hessenberg Form	106
5.2	Solving Matrix Equation $TA - FT = LC$	115
	Exercises	126
6	Observer (Dynamic Part) Design for Robustness Realization	129
6.1	Solution of Matrix Equation $TB = 0$	130
6.2	Analysis and Examples of This Design Solution	132
6.3	Complete Unification of Two Existing Basic Modern Control System Structures	149
6.4	Observer Order Adjustment to Tradeoff Between Performance and Robustness	150
	Exercises	154

Contents

7	Observer Design for Minimized Order	157
7.1	Design Formulation	158
7.2	Design Algorithm and Its Analysis	160
7.3	Examples and Significance of This Design	164
	Exercises	174
8	Design of Feedback Control—Eigenstructure Assignment	177
8.1	Selection and Placement of Feedback System Poles	178
8.2	Eigenvector Assignment	196
	Summary	215
	Exercises	216
9	Design of Feedback Control—Quadratic Optimal Control	221
9.1	Design of Direct State Feedback Control	223
9.2	Design of Generalized State Feedback Control	226
9.3	Comparison and Conclusion of Feedback Control	
	Designs	230
	Exercises	233
10	Design of Failure Detection, Isolation, and Accommodation Compensators	235
10.1	Failure Detection and Isolation	236
10.2	Adaptive State Feedback Control for Failure Accommodation	246
10.3	The Treatment of Model Uncertainty and Measurement Noise	251
	Exercises	262
	<i>Appendix A: Relevant Linear Algebra and Numerical Linear Algebra</i>	263
	<i>Appendix B: Design Projects and Problems</i>	289
	<i>References</i>	299
	<i>Index</i>	315