
Contents

1	Introduction to Model-based Fault Diagnosis and Fault-tolerant Control	1
1.1	Fault Diagnosis	1
1.2	Fault-tolerant Control	2
2	Actuator and Sensor Fault-tolerant Control Design	7
2.1	Introduction	7
2.2	Plant Models	7
2.2.1	Nonlinear Model	7
2.2.2	Linear Model: Operating Point	8
2.2.3	Example: Linearization Around an Operating Point	9
2.3	Fault Description	13
2.3.1	Actuator Faults	14
2.3.2	Sensor Faults	15
2.4	Nominal Tracking Control Law	16
2.4.1	Linear Case	16
2.4.2	Nonlinear Case	18
2.5	Model-based Fault Diagnosis	23
2.5.1	Actuator/Sensor Fault Representation	24
2.5.2	Residual Generation	27
2.6	Actuator and Sensor Faults Estimation	31
2.6.1	Fault Estimation Based on Unknown Input Observer ..	31
2.6.2	Fault Estimation Based on Decoupled Filter	32
2.6.3	Fault Estimation Using Singular Value Decomposition .	32
2.7	Actuator and Sensor Fault-tolerance Principles	34
2.7.1	Compensation for Actuator Faults	34
2.7.2	Sensor Fault-tolerant Control Design	37
2.7.3	Fault-tolerant Control Architecture	38
2.8	General Fault-tolerant Control Scheme	39
2.9	Conclusion	39

3	Application to a Winding Machine	41
3.1	Introduction	41
3.2	System Description	43
3.2.1	Process Description	43
3.2.2	Connection to dSPACE®	44
3.3	Linear Case	46
3.3.1	System Modeling	46
3.3.2	Linear Nominal Control Law	48
3.3.3	Fault-tolerant Control for Actuator Faults	52
3.3.4	Fault-tolerant Control for Sensor Faults	60
3.4	Nonlinear Case	66
3.4.1	System Modeling	66
3.4.2	Controller Gain Synthesis	70
3.4.3	Fault-tolerant Control for Actuator Faults	79
3.4.4	Fault-tolerant Control for Sensor Faults	90
3.5	Major Fault	96
3.5.1	Actuator Failure in Linear Case	96
3.5.2	Complete Loss of a Sensor in Nonlinear Case	103
3.6	Conclusion	106
4	Application to a Three-tank System	109
4.1	Introduction	109
4.2	System Description	110
4.3	Linear Case	112
4.3.1	Linear Representation	112
4.3.2	Linear Nominal Control Law	113
4.3.3	Fault Detection and Isolation with Magnitude Estimation	114
4.3.4	Fault Accommodation	123
4.4	Nonlinear Case	129
4.4.1	Nonlinear Representation	129
4.4.2	Closed-loop Fault-free Case	129
4.4.3	Closed-loop in the Presence of Faults	134
4.4.4	Sensor Fault-tolerant Control Design	137
4.4.5	Actuator Fault-tolerant Control Design	142
4.4.6	Fault-tolerant Control Design Against Major Actuator Failures	149
4.5	Conclusion	153
5	Sensor Fault-tolerant Control Method for Active Suspension System	157
5.1	Introduction	157
5.2	Full Vehicle Active Suspension System	158
5.2.1	System Description	158
5.2.2	System Modeling	158

5.2.3	System's Model	162
5.2.4	System Breakdown	162
5.2.5	Subsystems Models and Vehicle Parameters	166
5.3	Controller Design	169
5.3.1	First Control Module: Chassis Module $C_{Chassis}$	169
5.3.2	Second Control Module: Cylinder Module C_{ϑ}^c	173
5.3.3	Third Control Module: Servo Valve Module C_{ϑ}^s	174
5.4	System Instrumentation	174
5.4.1	Required Measurements	174
5.4.2	Available Sensors	175
5.4.3	Unavailable Sensors	176
5.4.4	Sensors in Use	176
5.4.5	Optimal Sensor Network Design	177
5.5	Sensor Fault Diagnosis Strategy	177
5.5.1	Sliding Mode Observers-based Sensor Fault Diagnosis ..	178
5.5.2	Active Suspension Sensor Fault Detection and Isolation	180
5.5.3	Sensor Fault-tolerance	186
5.6	Simulation	187
5.6.1	Frequency Response	187
5.6.2	Performance of Controlled System	189
5.6.3	Sliding Mode Control with Model Mismatch	200
5.6.4	Sensor Fault Effect	202
5.6.5	Fault Diagnosis	203
5.6.6	Fault-tolerance	204
5.7	Conclusion	207
6	Conclusion	209
A	Three-tank System Simulation	213
A.1	Main Page	213
A.2	Modeling Part	215
A.3	Animation Part	216
A.4	Various Files	217
	References	219
	Index	229

Fault-tolerant Control Systems

Design and Practical Applications

Noura, H.; Theilliol, D.; Ponsart, J.-C.; Chamseddine, A.

2009, XXI, 233 p. With online files/update., Hardcover

ISBN: 978-1-84882-652-6