

## Table of Contents

<b>Preface . . . . .</b>	<b>ix</b>
<b>Introduction . . . . .</b>	<b>xi</b>
<b>Chapter 1. State of the Art in Fault-tolerant Control . . . . .</b>	<b>1</b>
1.1. Fault detection and isolation . . . . .	4
1.2. Control reconfiguration . . . . .	6
1.3. Sets in control . . . . .	9
1.3.1. Set generalities . . . . .	11
1.3.2. Set operations . . . . .	14
1.3.3. Dynamic systems and sets . . . . .	16
1.3.4. Other set-theoretic issues . . . . .	18
1.4. Existing set-theoretic methods in FTC . . . . .	22
<b>Chapter 2. Fault Detection and Isolation in Multisensor Systems . . . . .</b>	<b>27</b>
2.1. Problem statement . . . . .	28
2.1.1. Multisensor scheme . . . . .	29
2.1.2. Fault scenarios . . . . .	32
2.2. Fault detection and isolation . . . . .	35
2.2.1. Partition of the sensor indices . . . . .	36
2.2.2. Residual sets for FDI . . . . .	40

2.3. Recovery mechanism . . . . .	45
2.3.1. Necessary and sufficient conditions . . . . .	46
2.3.2. Construction of set $S_j^R$ . . . . .	48
2.3.3. Inclusion time computation . . . . .	51
<b>Chapter 3. Residual Generation and Reference Governor Design</b> . . . . .	55
3.1. Residual signals . . . . .	56
3.1.1. Measurement equations residual . . . . .	57
3.1.2. Observer-based residual . . . . .	58
3.1.3. Receding observation window-based residual	62
3.2. Reference governor synthesis . . . . .	68
<b>Chapter 4. Reconfiguration of the Control Mechanism for Fault-tolerant Control</b> . . . . .	73
4.1. Active FTC with fix gain feedback . . . . .	76
4.1.1. Fix gain feedback synthesis . . . . .	81
4.1.2. Reference governor synthesis . . . . .	86
4.2. Active FTC with MPC control . . . . .	89
4.2.1. A classic MPC design . . . . .	89
4.2.2. Toward a cooperative view of FTC-MPC . .	93
4.3. Passive FTC control . . . . .	96
4.3.1. Quadratic cost function . . . . .	98
4.3.2. Penalty function using the gauge function of the healthy invariant set . . . . .	99
<b>Chapter 5. Related Problems and Applications</b> . .	103
5.1. Set-theoretic issues . . . . .	103
5.1.1. Over-approximation methods . . . . .	104
5.1.2. Convergence time issues . . . . .	105
5.1.3. Cyclic invariance for dwell-time systems . .	110
5.2. Illustrative examples . . . . .	113
5.2.1. Fault detection and isolation . . . . .	114
5.2.2. Recovery mechanism . . . . .	115

Table of Contents vii

5.2.3. Feasible reference generation . . . . .	124
5.2.4. Fault-tolerant control results . . . . .	126
<b>Conclusions</b> . . . . .	133
<b>Bibliography</b> . . . . .	139
<b>Index</b> . . . . .	151