## Contents

List of Symbols							
Abstract							
1	Intr	oduction  Motivations	1 1				
	1.2 1.3	Objectives	4 5				
2	Rev	riew of fault detection techniques	7				
	2.1	Description of dynamic systems	7				
		2.1.2 Dynamic systems with model uncertainties	8				
	2.2	Observer-based FD	11 11				
		2.2.2 Requirements of FD performance	12 13 15				
	2.3	2.2.4 Observer-based FD for stochastic systems	20				
		2.3.1 Multiple-model adaptive estimation	21 23				
		2.3.4 Parity space approach	25 26				
	2.4	Summary	27				
3	the state of the s						
	3.1	Preliminaries for LMJS	28 28 30				
	3.2		30 32 36 38				
	3.3		38				

4	Moa	le-dependent FD scheme for LMJS	40		
	4.1	KF design for mode-dependent FD scheme	41		
		4.1.1 State estimation error covariance in the fault-free case	42		
		4.1.2 State estimation error covariance in the faulty case	43		
	4.2	Residual evaluation and threshold setting	46		
		4.2.1 Residual evaluation function variance and threshold set-			
		ting in the fault-free case	46		
		4.2.2 Residual evaluation function variance and threshold set-			
		ting in the faulty case	49		
	4.3	Numerical examples	53		
	4.4	Summary	60		
5	Mod	de-independent FD scheme for LMJS	61		
	5.1	KF design for mode-independent FD scheme	62		
		5.1.1 Corresponding covariances in the fault-free case	62		
		5.1.2 Corresponding covariances in the faulty case	64		
	5.2	Residual evaluation and threshold setting	69		
	•	5.2.1 Residual evaluation function variance and threshold set-			
		ting in the fault-free case	69		
		5.2.2 Residual evaluation function variance and threshold set-			
		ting in the faulty case	72		
	5.3	Numerical examples	77		
	5.4	Summary	82		
6	FD schemes design for LMJS with a trade-off between FAR				
	and	FDR	83		
	6.1	Maximization of FDR for a given FAR	83		
		6.1.1 Inversion of residual covariance approach			
		6.1.2 Trace ratio optimization approach			
	6.2	Minimization of FAR for a given FDR			
	6.3	Solutions of the trace ratio optimization problem	89		
		6.3.1 Trace difference approach	90		
		6.3.2 Ratio trace approach			
		6.3.3 Geometric approach	90		
		6.3.4 Eigenvalue decomposition approach	91		
	6.4	Numerical examples			
	6.5	Summary	97		
7	A b	enchmark example: Vehicle lateral dynamics control sys-			
	tem		99		
	7.1	Modeling of vehicle lateral dynamics			
		7.1.1 Single-track model			
		7.1.2 LMJS model			
	7.2	Simulation results			
	7.3	Summary	109		

CONTENTS	

8 Conclusions and future directions	110
Bibliography	112