



University of Southern Queensland

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**Analysis and Development of Iterative Fast
Model Control Strategies for Systems with
Constraints**

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Abstract

In this research, new fast model control strategies are developed and analysed. To avoid confusion with the competing directions taken by Predictive Control they have been named ‘Iterative Fast Model Control (IFMC) Strategies’. It has been shown that new IFMC strategies deliver near time optimal performance and have finite settling time. IFMC strategies that include various state constraints are also developed. The system responses and the Lyapunov stability have been analysed.

The possibility of extending IFMC strategies for systems up to an n^{th} order is supported by development of IFMC strategies for 6th to 11th order systems. Application of IFMC in a real life situation of Aircraft Lateral Control has been studied. Successful implementation of IFMC in a third order ball and beam experiment demonstrates its effectiveness practice. A performance comparison with other contemporary strategies showed that IFMC delivers performance with almost 45% improvement.

The purpose of any real time controller is to determine the drive that should be applied to the plant at each instant. In IFMC, this is performed with the aid of a fast model of the system that can run at a speed that may be a thousand or more times that of the system. Then a decision on plant input is made, based on the fast model behaviour. The input is constrained at both extremes, full positive and full negative.

Fast Model Control strategies were developed from the mid 1950s, initially termed “Predictive control” although subsequently this term has been taken up by a different research thread. There have been hardly any publications extending the original theme since 1990. It is possible that the slow and expensive computing resources of that time may have led to the methods being regarded as purely academic. However the more recent proliferation of high speed, yet small affordable microcontrollers may have renewed the relevance of fast model control strategies.

Certification of Dissertation

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

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Contents

Abstract	i
Acknowledgments	iii
List of Figures	ix
Notations and Definitions	xviii
Chapter 1 Introduction	1
1.1 Background	2
1.2 Motivation and Hypothesis	3
1.3 Research Objectives	4
1.4 Structure of the Thesis	4
Chapter 2 Literature Review	7
2.1 Introduction	7
2.2 Existing control Strategies	8
2.2.1 Control methods: Unconstrained design philosophies	9
2.2.2 Control methods with input/state constraints	10
2.3 Control of Cascaded Integrator Systems	12
2.4 Lyapunov Stability	16
2.5 Evolution of Fast Model Control Strategies	17
2.6 Conclusion	20

CONTENTS	v
<hr/>	
Chapter 3 Iterative Fast Model Control	21
3.1 Introduction	21
3.2 Previous Fast Model Control Strategies	22
3.2.1 1968 Fast Model Control Strategy	22
3.2.2 1987 Fast Model Control Strategy	23
3.3 New Iterative Fast Model Control Strategy	24
3.4 Time Optimality Test	25
3.5 Simulation Results and Analysis	29
3.6 Accuracy in achieving target	31
3.7 Important Points	37
3.8 Conclusion	39
Chapter 4 Sliding Model Analysis and Slugging	40
4.1 Introduction	40
4.2 Analysis of a Second Order System Response	41
4.3 Analysis of a Third Order System Response	49
4.4 IFMC For Higher ($> 3^{rd}$) Order Systems	55
4.4.1 Slugging and its effects	55
4.4.2 IFMC for 4^{th} and 5^{th} order systems	56
4.4.3 IFMC for a 6^{th} order system	60
4.5 Important Points	63
4.6 Conclusion	64
Chapter 5 Iterative Fast Model Control with State Constraints	65
5.1 Introduction	65
5.2 Developing IFMC with State Constraints for various systems	66
5.2.1 A third order system	66

5.2.2	IFMC with state constraints for a third order system . . .	72
5.2.3	A fourth order system	72
5.2.4	IFMC with state constraints for a fourth order system . .	76
5.2.5	A fifth order system	76
5.3	Generalised IFMC strategy with state constraints	79
5.4	Important Points	79
5.5	Conclusion	80
Chapter 6 Iterative Fast Model Control of Higher Order Systems		81
6.1	Introduction	81
6.2	IFMC for a 6 th Order system	82
6.2.1	Why limit of ± 0.01	84
6.2.2	IFMC with a new approach	85
6.3	IFMC for a 7 th Order system	86
6.4	IFMC for 8 th to 11 th Order systems	87
6.5	IFMC for an n^{th} Order system	90
6.6	Important Points	91
6.7	Conclusion	92
Chapter 7 Lyapunov Stability Analysis		93
7.1	Introduction	93
7.2	Lyapunov stability of IFMC for a second order system	94
7.3	Lyapunov stability of IFMC for a third order system	97
7.4	Lyapunov stability of IFMC for Higher Order Systems	102
7.5	Important Points	103
7.6	Conclusion	104

Chapter 8 Iterative Fast Model Control: Applications	105
8.1 Introduction	105
8.2 IFMC for Aircraft Lateral Control	106
8.2.1 State Constraint - Wind-Gust	109
8.2.2 Disturbance - Turbulence	112
8.2.3 IFMC with State Constraints for Aircraft Control	113
8.2.4 Important points	114
8.3 The Ball and Beam Experiment	114
8.3.1 Experiment Components and Setup	115
8.3.2 System Identification and Modeling	116
8.3.3 Methodology	118
8.3.4 Results	122
8.3.5 Important Points	126
8.4 Conclusions	127
Chapter 9 Conclusions	128
9.1 New IFMC Strategies	128
9.1.1 IFMC for a third order system	128
9.1.2 IFMC for fourth and fifth order systems	129
9.1.3 IFMC for higher (6^{th} to n^{th}) order systems	130
9.1.4 IFMC with state constraints	130
9.2 Analysis of IFMC Strategies	131
9.2.1 Settling time efficiency and settling point accuracy	131
9.2.2 Working of IFMC and Mathematical Analysis	131
9.2.3 Lyapunov stability analysis	132
9.3 Applications of IFMC	132
9.3.1 Aircraft Lateral Control	133

9.3.2	Ball and Beam Experiment	133
9.4	Suggestions for Future Work	133
	References	135
	Appendix A Performance comparisons with recent strategies	142
	Appendix B 1981 & 1968 Fast Model Control Strategies Results	146

List of Figures

3.1	1968 Fast Model Predictive Control Strategy Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a)	23
3.2	1987 Fast Model Predictive Control Strategy Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a)	24
3.3	Iterative Fast Model Control Strategy Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a)	25
3.4	Time optimality test result of Iterative Fast Model Control with Third Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a), 5: 10^* Backward journey of acceleration (a) from $x = 0, v = 0$ and $a = 0$	26
3.5	Iterative Fast Model Control with Third Order System, termination using error condition. Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a), 5: 10^* Backward journey of acceleration (a) from $x = 0, v = 0$ and $a = 0$	28
3.6	Color Plots of Time Optimality Ratios	29

3.7	Fast Model Control Strategy 1987 - Fourth Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: $10*\text{Jerk } (j)$	30
3.8	Iterative Fast Model Control - Fourth Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full nega- tive drive, 3: Position x , 4: $10*\text{Jerk } (j)$	31
3.9	Final values of State (position) for different strategies	32
3.10	Color Plots IFMC Strategy with Smaller Steplength	33
3.11	Color Plots of Final Variable Values	34
3.12	Color Plots of Final Variable Values with new error for 2008 Strategy	35
3.13	Color Plots for time optimal performance of Iterative Fast Model Control Strategy	37
4.1	Iterative Fast Model Control of a Second Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: $2*\text{Velocity } (v)$	42
4.2	IFMC traces after time T when $t_- > t_+$ Curves:- 1: Prediction of position with full negative drive, 2: Prediction of position with full positive drive, 3: Prediction of velocity with full positive drive, 4: Prediction of velocity with full negative drive	43
4.3	IFMC traces after time T when $t_- \text{almost} = t_+$ Curves:- 1: Predic- tion of position with full negative drive, 2: Prediction of position with full positive drive, 3: Prediction of velocity with full positive drive, 4: Prediction of velocity with full negative drive	44
4.4	IFMC curves after times $t_+ = t_-$ Curves:- 1: Predictions of position with full positive drive, 2: Predictions of position with full negative drive, 3: Plant Position, 4: Plant Velocity	45
4.5	The graph of variable x and input u	49

4.6	Iterative Fast Model Control of a Third Order System 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a)	49
4.7	3^{rd} order IFMC traces after time T when $t_{-almost} = t_{+}$ Curves:- 1: Prediction of position with full negative drive, 2: Prediction of position with full positive drive, 3: Prediction of velocity with full positive drive, 4: Prediction of velocity with full negative drive, 5: Prediction of acceleration with full positive drive, 6: Prediction of acceleration with full negative drive	50
4.8	The graph of variable x , variable a and input u	53
4.9	Simulation of Iterative Fast Model Control when $t_{-}=t_{+}$ second time	54
4.10	Simulation of Iterative Fast Model Control with a Fourth Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Jerk (j)	56
4.11	Simulation of Iterative Fast Model Control with a Fifth Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 5: 10^* Rate of jerk k	57
4.12	Simulation of Iterative Fast Model Control with Slugging for a Fourth Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Jerk j	58
4.13	Simulation of Iterative Fast Model Control with Slugging for a Fifth Order System Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Rate of jerk	58
4.14	Individual variable curves of Fifth Order System without slugging	59
4.15	Individual variable curves of Fifth Order System with Slugging	60
4.16	Simulation of Iterative Fast Model Control Strategy for a Sixth Order System without slugging	61

4.17 Individual variable curves of a Sixth Order System without slugging	61
4.18 Simulation of Iterative Fast Model Control Strategy for a Sixth Order System with Slugging	62
4.19 Individual variable curves of a Sixth Order System with slugging .	62
5.1 Individual variable performance of third Order system: Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10*acceleration (a)	66
5.2 Individual variable performance of third Order system: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 10*Acceleration (a)	67
5.3 Performance of third Order system with constrained acceleration: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 10*Acceleration a , 4: 10*Upper acceleration limit (0.35), 5: 10*Lower acceleration limit (-0.35)	68
5.4 Performance of third Order system with constrained velocity: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 10*Acceleration (a), 4: 5*Up- per velocity limit (1.2), 5: 5*Lower velocity limit (-1.2)	70
5.5 Performance of third Order system with constrained acceleration and velocity: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 10*Ac- celeration (a)	71
5.6 Performance of fourth Order system variables: Curves:- 1: Pre- dictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10*Jerk (j)	73
5.7 Performance of fourth Order system variables: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 5*Acceleration (a), 4: 10*Jerk (j)	73
5.8 Performance of fourth Order system variables: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 5*Acceleration (a), 4: 10*Jerk (j), 5: 10*Upper limit of j (0.45), 6: 10*Lower limit of j (-0.45)	74

5.9	Performance of fourth Order system variables with constraints 1: Curves:- 1: Position x , 2: 5*Velocity (v), 3: 5*Acceleration (a), 4: 10*Jerk (j), 5: 10*Upper limit of j (0.45), 6: 10*Lower limit of j (-0.45)	75
5.10	Performance of fourth Order system variables with constraints 2: Curves:- 1: Position x , 2: 5*Velocity v , 3: 5*Acceleration (a), 4: 10*Jerk (j), 5: 10*Upper limit of j (0.45), 6: 10*Lower limit of j (-0.45)	75
5.11	Performance of fifth Order system variables: Curves:- 1: Predic- tions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 5: 10*Rate of Jerk (k)	77
5.12	Performance of fifth Order system variables: Curves:- 1: Posi- tion x , 2: 5*Velocity (v), 3: 5*Acceleration (a), 4: 5*Jerk (j), 5: 10*Rate of Jerk (k)	77
5.13	Performance of fifth Order system variables v and a with con- straints and x : Curves:- 1: Position x , 2: 8*Velocity (v), 3: 8*Ac- celeration (a)	78
5.14	Performance of fifth Order system variables j and k with con- straints and x : Curves:- 1: Position x , 2: 8 * j , 3: 12 * k	78
6.1	Sixth Order System Response with Slugging Curves:- 1: Predic- tions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10*Primary variable (p)	82
6.2	Sixth Order System Response with new approach Curves:- 1- 10*Pri- mary variable (p), 2- Position x	83
6.3	Sixth Order System Response with new approach Curves:- 1: 10*third variable (j), 2: 10*fourth variable (a), 3- 10*fifth variable (v)	84
6.4	Sixth Order System Response with limit ± 1 Curves:- 1: 10*Pri- mary variable (p), 2: Position x	85

6.5	Sixth Order System Response with limit ± 0.1 Curves:- 1: 10*Primary variable (p), 2- Position x	85
6.6	Seventh Order System Response with new approach Curves:- 1: 10*Primary Variable, 2: System response x	86
6.7	Eighth Order System Response with new approach Curves:- 1: 10*Primary Variable, 2: System response x	87
6.8	Ninth Order System Response with new approach Curves:- 1: 10*Primary Variable, 2: System response x	88
6.9	Tenth Order System Response with new approach Curves:- 1: 10*Primary Variable, 2: System response x	88
6.10	Eleventh Order System Response with new approach Curves:- 1: 10*Primary Variable, 2: System response x	89
6.11	Eleventh Order System Response with new approach and slugging	89
7.1	Second Order Response Reproduced for convenience	94
7.2	IFMC traces after time T when $t_{almost} = t_+$	96
7.3	3rd Order Response Reproduced for convenience Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: System Response x , 4(a,b,c): Primary Variable Curve . .	98
7.4	Simulation of Iterative Fast Model Control with Third Order System Variables	100
7.5	Simulation of Iterative Fast Model Control when $t_- = t_+$ second time	101
7.6	Response of a Fifth order system for 70 seconds	103
8.1	The landing of the Aircraft	106

8.2	The Aircraft Rollangle (Bank-angle) Control using IFMC Strategy Curves: 1: Distance x , 2: 3000* Heading (ψ), 3: 3000*Rollangle (ϕ) and 4: 8000*Rollrate (α)	108
8.3	The performance of variable ϕ that is bank angle with limits Curves: 1: Distance x , 2: 3000*Bank angle (ϕ), 3: 3000*Upper limit of ϕ (0.2792), 4: 3000*Lower Limit of ϕ (-0.2792)	109
8.4	The performance of variables with wind-gust Curves:- 1: Distance x , 2: 3000*Heading (ψ), 3: 3000*Bank Angle (ϕ), 4: 8000*rollrate (α), 5: 3000*Upper limit of ϕ (0.2792), 6: 3000*Lower Limit of ϕ (-0.2792), 7: Bank Angle curve crosses the limit	109
8.5	IFMC with bank angle limits incorporated Curves: 1: Distance x , 2: 3000*Heading (ψ), 3: 3000*Bank Angle (ϕ), 4: 8000*rollrate (α), 5: 3000*Upper limit of ϕ (0.2792), 6: 3000*Lower Limit of ϕ (-0.2792), 7: Check for overshoot	111
8.6	Scaled Variable axis with distance x . Curves:- 1: Distance x , 2: Overshoot	111
8.7	Distance x curve improvement with Slugging. Curves:- 1: Distance x , 2: No overshoot	112
8.8	Performance of other variables with slugging. Curves:- 1: Distance x , 2: 3000*Heading (ψ), 3: 3000*Bank Angle (ϕ), 4: 8000*rollrate (α)	112
8.9	Iterative Fast Model Control in presence of disturbance/turbulence. Curves:- 1: Distance x , 2: 3000*Heading (ψ), 3: 3000*Bank Angle (ϕ), 4: 8000*rollrate (α)	113
8.10	The experiment setup	116
8.11	GUI - for the experiment	118
8.12	Ball and Beam Experiment: Initial Starting Position	122

8.13	Ball and Beam Experiment: Beam leveling process - Get Ready Curves:- 1: Path taken by the ball 2: tilt multiplied by 2 for better visibility	123
8.14	Ball and Beam Experiment: Beam leveled reasonably	124
8.15	Ball and Beam Experiment: Ball balanced at the center of the beam Plot Curves:- 1: Path taken by the ball 2: 2*tilt	125
8.16	Ball and Beam Experiment: Ball balanced at the center of the beam	125
8.17	Ball and Beam Experiment: Recovery from External Disturbance. Curves:- 1- Path taken by the ball 2- tilt multiplied by 2, 3- Distur- bance ball pushed to left, 4 and 5 - Recovery curves, 6- Disturbance ball pushed to right, 7- Recovery curve	126
A.1	Response of 1968 fast model control strategy with same initial con- ditions as (Gayaka & Yao 2011) Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: Acceleration a	143
A.2	Response of 1987 fast model control strategy with same initial conditions as (Gayaka & Yao 2011)Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: Acceleration a	143
A.3	Response of new Iterative fast model control strategy with same initial conditions as (Gayaka & Yao 2011)Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: Acceleration a	144
A.4	Performance of Gayaka and Yao strategy reproduced from (Gayaka & Yao 2011, pp. 3789)	144
B.1	1968 Fast Model Predictive Control Strategy Curves:- 1: Predic- tions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10*Acceleration (a)	147

B.2 Dodds's Fast Model Control Strategy Curves:- 1: Predictions with full positive drive, 2: Predictions with full negative drive, 3: Position x , 4: 10^* Acceleration (a) 147

Notations and Definitions

T	Plant time
t	Model time
t_+	Predicted model time, to have all model variables positive with full positive drive applied
t_-	Predicted model time, to have all model variables negative with full negative drive applied
dt_p	Plant steplength
dt_f	Model steplength
onside	A stage where variables have the sign, same as the input
offside	A stage where variables have the sign, opposite to the input
primary variable	First variable (integral) in the cascade
subsequent variable	Remaining variables (integrals) in the cascade