

Contents

1	Introduction	1
1.1	What Is Nonlinear Model Predictive Control?	1
1.2	Where Did NMPC Come from?	3
1.3	How Is This Book Organized?	5
1.4	What Is Not Covered in This Book?	9
	References	10
2	Discrete Time and Sampled Data Systems	13
2.1	Discrete Time Systems	13
2.2	Sampled Data Systems	16
2.3	Stability of Discrete Time Systems	28
2.4	Stability of Sampled Data Systems	35
2.5	Notes and Extensions	39
2.6	Problems	39
	References	41
3	Nonlinear Model Predictive Control	43
3.1	The Basic NMPC Algorithm	43
3.2	Constraints	45
3.3	Variants of the Basic NMPC Algorithms	50
3.4	The Dynamic Programming Principle	56
3.5	Notes and Extensions	62
3.6	Problems	64
	References	65
4	Infinite Horizon Optimal Control	67
4.1	Definition and Well Posedness of the Problem	67
4.2	The Dynamic Programming Principle	70
4.3	Relaxed Dynamic Programming	75
4.4	Notes and Extensions	81
4.5	Problems	83
	References	84

5	Stability and Suboptimality Using Stabilizing Constraints	87
5.1	The Relaxed Dynamic Programming Approach	87
5.2	Equilibrium Endpoint Constraint	88
5.3	Lyapunov Function Terminal Cost	95
5.4	Suboptimality and Inverse Optimality	101
5.5	Notes and Extensions	109
5.6	Problems	110
	References	112
6	Stability and Suboptimality Without Stabilizing Constraints	113
6.1	Setting and Preliminaries	113
6.2	Asymptotic Controllability with Respect to ℓ	116
6.3	Implications of the Controllability Assumption	119
6.4	Computation of α	121
6.5	Main Stability and Performance Results	125
6.6	Design of Good Running Costs ℓ	133
6.7	Semiglobal and Practical Asymptotic Stability	142
6.8	Proof of Proposition 6.17	150
6.9	Notes and Extensions	159
6.10	Problems	161
	References	162
7	Variants and Extensions	165
7.1	Mixed Constrained–Unconstrained Schemes	165
7.2	Unconstrained NMPC with Terminal Weights	168
7.3	Nonpositive Definite Running Cost	170
7.4	Multistep NMPC-Feedback Laws	174
7.5	Fast Sampling	176
7.6	Compensation of Computation Times	180
7.7	Online Measurement of α	183
7.8	Adaptive Optimization Horizon	191
7.9	Nonoptimal NMPC	198
7.10	Beyond Stabilization and Tracking	207
	References	209
8	Feasibility and Robustness	211
8.1	The Feasibility Problem	211
8.2	Feasibility of Unconstrained NMPC Using Exit Sets	214
8.3	Feasibility of Unconstrained NMPC Using Stability	217
8.4	Comparing Terminal Constrained vs. Unconstrained NMPC	222
8.5	Robustness: Basic Definition and Concepts	225
8.6	Robustness Without State Constraints	227
8.7	Examples for Nonrobustness Under State Constraints	232
8.8	Robustness with State Constraints via Robust-optimal Feasibility	237
8.9	Robustness with State Constraints via Continuity of V_N	241
8.10	Notes and Extensions	246
8.11	Problems	249
	References	249

- 9 Numerical Discretization** 251
 - 9.1 Basic Solution Methods 251
 - 9.2 Convergence Theory 256
 - 9.3 Adaptive Step Size Control 260
 - 9.4 Using the Methods Within the NMPC Algorithms 264
 - 9.5 Numerical Approximation Errors and Stability 266
 - 9.6 Notes and Extensions 269
 - 9.7 Problems 271
 - References 272
- 10 Numerical Optimal Control of Nonlinear Systems** 275
 - 10.1 Discretization of the NMPC Problem 275
 - 10.2 Unconstrained Optimization 288
 - 10.3 Constrained Optimization 292
 - 10.4 Implementation Issues in NMPC 315
 - 10.5 Warm Start of the NMPC Optimization 324
 - 10.6 Nonoptimal NMPC 331
 - 10.7 Notes and Extensions 335
 - 10.8 Problems 337
 - References 337
- Appendix NMPC Software Supporting This Book** 341
 - A.1 The MATLAB NMPC Routine 341
 - A.2 Additional MATLAB and MAPLE Routines 343
 - A.3 The C++ NMPC Software 345
- Glossary** 347
- Index** 353



<http://www.springer.com/978-0-85729-500-2>

Nonlinear Model Predictive Control

Theory and Algorithms

Grüne, L.; Pannek, J.

2011, XII, 360 p. With online files/update., Hardcover

ISBN: 978-0-85729-500-2