Table of Contents

Notation vii

Abstract xi

Deutsche Kurzzusammenfassung xiii

1. Introduction 1
- 1.1. Motivation . . . 1
- 1.2. Related work . . . 4
- 1.3. Contribution and outline . . . 7

2. Preliminaries 11
- 2.1. Nominal MPC with terminal ingredients . . . 12
- 2.2. Nominal tracking MPC without terminal ingredients . . . 16
- 2.3. Disturbances and uncertainty in MPC . . . 25
- 2.4. Summary . . . 32

3. Dual adaptive MPC 35
- 3.1. Augmenting MPC schemes with active learning . . . 35
- 3.2. Dual adaptive MPC for linear systems . . . 49
- 3.3. Summary . . . 65

4. Guaranteed closed-loop learning in MPC 67
- 4.1. Problem setup . . . 68
- 4.2. MPC framework for closed-loop learning . . . 72
- 4.3. Theoretical analysis . . . 79
- 4.4. Application to learning approaches . . . 85
- 4.5. Numerical example . . . 94
- 4.6. Summary . . . 96

5. Learning the constraints through safe exploration 97
- 5.1. Problem setup . . . 98
- 5.2. Preliminaries for MPC scheme . . . 101
- 5.3. Proposed MPC framework . . . 108
- 5.4. Theoretical analysis . . . 114
- 5.5. Numerical example . . . 120

5.6. Summary 124

6. Conclusions **125**
6.1. Summary 125
6.2. Future work 126

A. Technical results for Section 2.2.3 **129**
A.1. Proof of Proposition 2.1 129
A.2. Proof of Proposition 2.2 130
A.3. Proof of Theorem 2.4 131
A.4. Proof of Proposition 2.3 133

B. Additional results for Chapter 4 **135**
B.1. MPC scheme with nominal cost function 135
B.2. Lemma B.1 140

Bibliography **143**