

Contents

1	Overview	1
1.1	Introduction	1
1.2	Synchronization of Complex Dynamical Networks via Pinning	3
1.2.1	Stability Conditions for Complete Synchronization	4
1.2.2	Stability Conditions for Cluster Synchronization	5
1.2.3	Selective Strategies of Pinning Control	7
1.2.4	Controllable Regions	8
1.2.5	Control Methodologies	8
1.3	Consensus and Flocking of Multi-Agent Systems via Pinning	9
1.3.1	Single Virtual Leader Case	9
1.3.2	Multiple Virtual Leaders Case	10
1.3.3	Connectivity Maintenance	10
1.4	Conclusions and Notes	11
	References	11
2	Pinning Control for Complete Synchronization of Complex Dynamical Networks	17
2.1	Complex Network Models	17
2.1.1	ER Random Network Model	17
2.1.2	BA Scale-Free Network Model	19
2.1.3	A Directed Scale-Free Network Model	20
2.2	Stability Conditions for Complete Synchronization of Complex Dynamical Networks	20
2.2.1	Global Stability Conditions	24
2.2.2	Local Stability Conditions	25
2.3	Virtual Control of Pinned Complex Dynamical Networks	27
2.4	Selective Strategies of Pinning Control	32
2.4.1	Pinning Control Based on Node-Degree	32
2.4.2	Pinning Control Based on ControlRank	37
2.5	Conclusions and Notes	41
	References	42

3	Pinning Control for Cluster Synchronization of Complex Dynamical Networks	45
3.1	Problem Statement	45
3.2	Decentralized Adaptive Pinning Control Scheme	46
3.2.1	Algorithm Description	46
3.2.2	Main Results and Theoretical Analysis	46
3.2.3	Complete Synchronization Case	52
3.3	Simulation Study	53
3.3.1	Example 1: Three Clusters	54
3.3.2	Example 2: One Cluster	56
3.4	Conclusions and Notes	59
	References	59
4	Distributed Pinning-Controlled Second-Order Consensus of Multi-Agent Systems	61
4.1	Consensus Without Connectivity Assumptions	61
4.1.1	Problem Statement	62
4.1.2	Consensus Without a Leader	63
4.1.3	Consensus with a Leader	67
4.1.4	Simulation Study	70
4.2	Consensus with Preserved Network Connectivity	71
4.2.1	Problem Statement	72
4.2.2	Algorithm Design and Main Results	73
4.2.3	Consensus with a Virtual Leader	78
4.2.4	Simulation Study	83
4.3	Adaptive Consensus of Networked Mobile Agents with Nonlinear Dynamics	89
4.3.1	Problem Statement	90
4.3.2	Main Results	91
4.3.3	Simulation Study	96
4.4	Conclusions and Notes	99
	References	99
5	Distributed Pinning-Controlled Consensus in a Heterogeneous Influence Network	103
5.1	Backgrounds and Problem Statement	103
5.2	Consensus in a Heterogeneous Influence Network	104
5.3	Pinning Controlled Consensus in a Heterogeneous Influence Network	107
5.4	Conclusions and Notes	110
	References	110
6	Distributed Pinning-Controlled Flocking with a Virtual Leader	111
6.1	Introduction	111
6.2	Backgrounds and Problem Statement	113
6.3	Flocking with a Fraction of Informed Agents	115

6.3.1	Algorithm Description and Main Results	115
6.3.2	Cohesive Analysis	117
6.3.3	Velocity Matching Analysis	118
6.3.4	Collision Avoidance Analysis	123
6.4	Flocking with a Virtual Leader of Varying Velocity	123
6.4.1	Algorithm Description and Main Result	123
6.4.2	Theoretical Analysis	125
6.5	Simulation Study	128
6.5.1	Flocking with a Fraction of Informed Agents	128
6.5.2	Flocking with a Virtual Leader of Varying Velocity	130
6.5.3	Flocking with a Fraction of Informed Agents and a Virtual Leader of Varying Velocity	131
6.6	Conclusions and Notes	133
	References	135
7	Distributed Pinning-Controlled Flocking with Preserved Network Connectivity	137
7.1	Flocking Based only on Position Measurements	137
7.1.1	Background and Problem Statement	138
7.1.2	Fundamental Flocking Algorithm	138
7.1.3	Flocking with a Virtual Leader	143
7.1.4	Simulation Study	145
7.2	Adaptive Flocking of Multiple Agents Governed by Nonlinear Dynamics	149
7.2.1	Preliminaries and Problem Statement	150
7.2.2	Main Results	151
7.2.3	Simulation Study	156
7.3	Conclusions and Notes	158
	References	159
	Index	161