

# Contents

<b>1</b>	<b>Background</b>	<b>1</b>
1.1	Introduction	1
1.2	Preliminaries	5
1.2.1	Dynamical Systems and Control	5
1.2.2	Graph Theory	7
1.2.3	Cartesian Product	9
1.2.4	Kronecker Product	10
1.3	Organization and Contribution	11
	References	12
 <b>Part I Can One Hear the Shape of Coordination?</b>		
<b>2</b>	<b>Network Identification via Node Knockout</b>	<b>17</b>
2.1	Problem Formulation	17
2.2	System Identification	19
2.3	Characterization of the Network Topology via Node Knockout	21
2.4	Edge Faults in the Network	28
	References	29
<b>3</b>	<b>A Sieve Method for Consensus-Type Network Tomography</b>	<b>31</b>
3.1	Graph Characterization via Characteristic Polynomial	31
3.2	Graph Characterization via Graph Sieve	32
3.2.1	Integer Partitioning Algorithms and Complexity Analysis	33
3.2.2	Degree Based Graph Construction Algorithms and Complexity Analysis	35
	References	38
<b>4</b>	<b>Network Identification via Graph Realization</b>	<b>39</b>
4.1	Summary of the Previous Two Chapters	39
4.2	Similarity Transformation Approach	41
4.2.1	Numerical Considerations	45

4.3	A Numerical Example. . . . .	47
	References . . . . .	49

## Part II Controllability Over Networks

<b>5</b>	<b>Controllability and Observability of Circulant Networks . . . . .</b>	<b>53</b>
5.1	Introduction . . . . .	53
5.2	Fault Detection and Clock Synchronization Over Distributed Computing Supercomputers. . . . .	56
5.3	Basic Setup and Preliminaries . . . . .	58
5.3.1	Cauchy-Binet Formula . . . . .	60
5.3.2	Vandermonde Structure of DFT Matrices . . . . .	60
5.4	Controllability of Circulant Networks . . . . .	62
	References . . . . .	66
<b>6</b>	<b>Controllability Gramian, Symmetry Structures, and Application of Circulant Networks . . . . .</b>	<b>69</b>
6.1	Introduction . . . . .	69
6.2	Controllability Gramian: The Most Controllable Node in a Circulant Network . . . . .	70
6.3	Symmetry Structures. . . . .	74
	References . . . . .	76
<b>7</b>	<b>Controllability and Observability of Path Networks. . . . .</b>	<b>79</b>
	References . . . . .	83

## Part III System Properties of Stochastic Networks

<b>8</b>	<b>System Properties of Stochastic Networks: Controllability and Optimality . . . . .</b>	<b>87</b>
8.1	Introduction . . . . .	87
8.2	Problem Formulation . . . . .	89
8.3	Controllability/Observability of Stochastic Systems . . . . .	91
8.4	Linear Quadratic Regulator Over Random Networks. . . . .	96
8.5	A Numerical Example. . . . .	100
	References . . . . .	103
<b>9</b>	<b>Coordinated Decentralized Estimation Over Random Networks . . . . .</b>	<b>105</b>
9.1	Considered Problems . . . . .	105
9.2	Deterministic Setup. . . . .	109
9.3	Random Setup . . . . .	110

9.4	Random Communication and Estimation Performance . . . . .	116
9.5	Coordinated Distributed Estimation Over Opinion Dynamics . . . . .	121
	References . . . . .	122
<b>10</b>	<b>Online Coordinated Decentralized Localization of the Seaglider with Intermittent Observations.</b> . . . . .	125
10.1	Introduction . . . . .	125
10.2	Underwater Acoustic Ranging . . . . .	128
10.3	Dynamic Filtering. . . . .	130
	10.3.1 Vehicle Model . . . . .	130
	10.3.2 Hybrid Extended Kalman Filter . . . . .	131
10.4	Experimental Results . . . . .	133
	References . . . . .	135
<b>11</b>	<b>Social Control and Optimal Marketing</b> . . . . .	137
11.1	Introduction . . . . .	137
11.2	Opinion Dynamics and Social Control Models. . . . .	138
11.3	Controllability and Observability . . . . .	141
11.4	Estimation and Linear Quadratic Regulators . . . . .	143
	References . . . . .	145
<b>12</b>	<b>Concluding Remarks and Future Directions</b> . . . . .	147
12.1	Conclusions . . . . .	147
12.2	Future Directions and Open Problems. . . . .	149
	Reference . . . . .	151

Controllability, Identification, and Randomness in  
Distributed Systems

Nabi, M.

2014, XVII, 151 p. 39 illus., 30 illus. in color., Hardcover

ISBN: 978-3-319-02428-8