

Contents

Preface	V
1 Sensor networks as consensus systems	1
1 A distributed algorithm to determine the centroid of a plane figure	2
2 Convergence analysis of the algorithm	2
3 Results of the consensus algorithm for different communication structures	3
4 Literature on distributed search algorithms	5
2 Solve a set of linear equations as a consensus problem	7
1 A distributed way of solving linear equations	8
2 Selection of the gain matrix	9
3 Illustration of the distributed algorithm	10
4 Convergence analysis	12
5 Discussion of the results and further research topics	14
3 Synchronisation of van der Pol oscillators	15
1 Synchronisability of van der Pol oscillators	16
2 Diffusively coupled oscillators	17
3 Discussion of the results and outlook	17
4 Stabilisation of the inverted pendulum with distributed state observers	19
1 Problem of distributed state observation	20
2 Distributed state observers	21
3 Convergence analysis	23
4 Distributed observers for the inverted pendulum	23
5 Stabilisation of the inverted pendulum	25
6 Discussion	26

5	Synchronisation phenomena in electrical power networks	29
1	Network model	30
2	Synchronisation problems	32
3	Representation of the power network as a multi-agent system	33
4	Synchronous behaviour and stability of linear power networks	34
5	Electrical power networks vs. Kuramoto oscillator networks	36
6	Synchronous behaviour of networks with nonlinear couplings	37
7	Power grids with renewable energy sources	39
8	Discussion of the results and further topics	40
6	Control of an irrigation system	43
1	Control problem	44
2	Model of the pillars	45
3	Irrigation systems with decentralised controller	46
4	Synchronisation of the pillar positions	49
5	Irrigation systems with networked controller	53
6	Generalisation to cooperative control	54
7	Nonlinear vehicle platoons	57
1	Controllers that make vehicles externally positive	58
2	Behaviour of vehicle platoons in emergency braking manoeuvres	67
3	Effects of transmission delays on the platoon behaviour	71
4	Literature	74
8	μ-split braking of a vehicle	77
1	Vehicle braking as a cooperative control problem	78
2	Wheel models	79
3	Model describing the vehicle movement	83
4	Controllers	85
5	Behaviour of the vehicle in μ -split braking manoeuvres	86
6	Discussion of the results and literature	88
9	Motion on demand: Self-service bike hiring in Paris	89
1	Problem statement	90
2	Random graphs representing the bike movement	90
3	Discrete-time model of the docking stations	92
4	Control of the bike parking	94
10	Success probability of dice throwing	95
1	A game of dice	96
2	Analysis of the game	96
3	Discussion	100

11	Self-organising leader selection in a truck platoon	101
1	Structure of the networked controller and way of solution	102
2	Truck model and distance controller	103
3	Controller design	106
4	Disturbance observer	107
5	Truck platoon behaviour	109
6	Discussion of the results and further research topics	113
12	Event-triggered vs. sampled-data control of a thermo-fluid process	115
1	Disturbance behaviour of the reactor	117
2	Event-triggered control	117
3	Sampled-data control	118
4	Balancing the events alerted by the level and by the temperature signal	119
5	Practical stability of the event-triggered control loop	121
6	Evaluation of the results	123
	References	125