

Contents

1	Introduction	1
2	Basic Models for Distributed Detection	5
2.1	Sensor Observations	6
2.2	Distributed Detection	7
2.3	Fusion Topologies	7
2.3.1	Parallel Topology	8
2.3.2	Serial Topology	10
2.3.3	Tree Topology	11
3	Ultra-Wideband Networks	15
3.1	System Model	16
3.1.1	IR-UWB Transmitters	16
3.1.2	UWB Communication Channel	17
3.1.3	IR-UWB Receivers	18
3.1.4	Signal-to-Interference-and-Noise Ratio	18
3.2	Power Control in IR-UWB Networks	20
3.2.1	Power Control with Reduced Complexity	22
3.2.2	Distributed Power Control	27
3.2.3	Control with IR-UWB Parameters	30
4	Distributed Detection in UWB Sensor Networks with Parallel Topology	31
4.1	Extended Model for Distributed Detection with Parallel Topology	32
4.2	Power Control for Distributed Detection with Parallel Topology	34
4.2.1	Power Control in Case of Orthogonal Channels	35
4.2.2	Power Control in Case of Non-Orthogonal Channels	39
4.3	Numerical Results	43
5	Distributed Detection in UWB Sensor Networks with Serial and Tree Topology	45
5.1	Distributed Detection with Serial Topology	45
5.1.1	Extended Model for Distributed Detection with Serial Topology	46
5.1.2	Routing Path Selection	47
5.1.3	Power Control for Distributed Detection with Serial Topology	50
5.1.4	Numerical Results	51
5.1.5	Performance Comparison of Parallel and Serial Topology	53
5.2	Distributed Detection with Tree Topology	57

5.2.1	Extended Model for Distributed Detection with Tree Topology	57
5.2.2	Node Clustering	60
5.2.3	Power Control for Distributed Detection with Tree Topology	62
5.2.4	Numerical Results	63
5.2.5	Performance Comparison of Parallel and Tree Topology	65
6	Concepts for Reducing Complexity	67
6.1	Power-Aware Sensor Selection	68
6.1.1	Sensor Selection Strategy	68
6.1.2	Numerical Results	69
6.2	Transmit-Only Sensors and a SIC Receiver	71
6.2.1	Transmission Model	72
6.2.2	Application-Specific Detection Ordering	72
6.2.3	Numerical Results	74
6.3	Node Clustering with Two Classes of Nodes	78
6.3.1	Network Model for Clustering with Two Classes of Nodes	78
6.3.2	Node Clustering with Two Classes of Nodes	78
6.3.3	Numerical Results	81
7	Case Studies of IR-UWB Sensor Networks for Distributed Detection	85
7.1	Distributed Target Detection with UWB Sensor Nodes	85
7.1.1	Model for Distributed Target Detection	86
7.1.2	Experimental Setup for Radar Measurements	86
7.1.3	Performance Evaluation	91
7.2	Cooperative Spectrum Sensing with UWB Signaling	93
7.2.1	Model for Cooperative Spectrum Sensing	94
7.2.2	Optimization of Decision Rules	96
7.2.3	Experimental Setup for Spectrum Measurements	99
7.2.4	Performance Evaluation	100
8	Conclusions	105
8.1	Summary	105
8.2	Outlook	106
A	Simulation Setup	109
A.1	Observation Model	109
A.2	IR-UWB Transceiver Parameters	110
A.3	Node Deployment and Channel Parameters	110
	Notation	111
	Bibliography	117