

Contents

1	Introduction	1
1.1	Background on Distributed Control	1
1.2	Control Architectures	3
1.2.1	Centralized Architecture	4
1.2.2	Heterarchical Architecture	5
1.2.3	Distributed Architecture	6
1.3	Supervisor Localization Approach	7
2	Localization: Fundamental Results	13
2.1	Supervisory Control Theory	13
2.2	Distributed Control Problem	16
2.3	Control Covers and Localization Procedure	20
2.4	Necessity of Control Covers	26
2.5	Localization Algorithm	29
2.6	Language Interpretation of Localization	33
2.7	Boundary Cases of Localization	35
2.7.1	Fully-Localizable	35
2.7.2	Non-Localizable	36
3	Localization: Further Results and Examples	39
3.1	Extended Localization Theory	39
3.1.1	Control Localization	41
3.1.2	Marking Localization	43
3.1.3	Main Result	44
3.2	Multi-Robot Formations	46
3.2.1	Formulation of Multi-Robot Formation	47
3.2.2	Convergence to Formation	49
3.2.3	Shortest Paths to Formation	51

3.3	Smart Machines in Manufacturing Workcells	53
3.3.1	Workcell 1	53
3.3.2	Workcell 2	56
3.3.3	Workcell 3	59
3.4	Distributed Algorithms in Computer Science	62
3.4.1	Mutual Exclusion.	63
3.4.2	Dining Philosophers.	65
3.4.3	Cigarette Smokers	68
4	Localization for Large-Scale Systems	73
4.1	Heterarchical Supervisor Synthesis	74
4.1.1	Natural Observer and Local Control Consistency	78
4.2	Heterarchical Localization	82
4.3	Case Study: Automated Guided Vehicles	91
5	Case Study: Production Cell	103
5.1	System Description	103
5.2	Distributed Control by Heterarchical Localization.	112
5.3	Control Architecture Comparisons	123
6	Localization Based on State Tree Structures	127
6.1	Preliminaries on State Tree Structures.	127
6.2	Problem Formulation	131
6.3	Localization Procedure	134
6.3.1	Necessary Structure	138
6.4	Symbolic Localization Algorithm.	141
6.5	Case Study: Cluster Tool	144
7	Localization of Timed Discrete-Event Systems	153
7.1	Preliminaries on Timed Discrete-Event Systems.	154
7.2	Timed Localization Problem	158
7.3	Timed Localization Procedure	160
7.3.1	Localization of Preemptive Action	161
7.3.2	Localization of Disabling Action	163
7.3.3	Main Result	165
7.4	Case Study: Manufacturing Cell.	167
8	Conclusions	175
	Appendix A: Nerode Equivalence and Canonical Recognizer	179
	Appendix B: NP-Hardness of Minimal-State Localization	183

Appendix C: Quasi-Congruence of Nondeterministic Generator	187
References	191
Index	197