
Contents

Part I Evolutionary Mobile Robots

1 Differential Evolution Approach Using Chaotic Sequences Applied to Planning of Mobile Robot in a Static Environment with Obstacles

<i>Leandro dos Santos Coelho, Nadia Nedjah, Luiza de Macedo Mourelle...</i>	3
1.1 Introduction	4
1.2 Differential Evolution	5
1.3 New Approach of Differential Evolution Combined with Chaos Theory	7
1.4 Planning of Mobile Robots.....	11
1.5 Simulation Results.....	13
1.5.1 Case study 1: Environment with 7 obstacles	13
1.5.2 Case study 2: Environment with 14 obstacles	15
1.6 Summary	16
References	19

2 Evolving Modular Robots for Rough Terrain Exploration

<i>Olivier Chocron</i>	23
2.1 Introduction	23
2.2 Means and Goals	25
2.2.1 Modular Robotic Systems	25
2.2.2 Evolutionary Optimization	26
2.2.3 Dynamic Simulation	27
2.3 Evolutionary Task-Based Design	29
2.3.1 Genotype Encoding : Incidence Matrix.....	29
2.3.2 Topology Operators	31
2.3.3 Command operators	34
2.3.4 Phenotype Evaluation	35
2.4 Simulation Results	36
2.4.1 Experimental setup	36
2.4.2 Task 1: Speed up	38

2.4.3 Task 2: Reaching a goal	39
2.4.4 Task 3: Getting altitude	39
2.4.5 Task 4: Increasing angular velocity	41
2.5 Summary and Conclusions	43
References	44

3 Evolutionary Navigation of Autonomous Robots Under Varying Terrain Conditions

<i>Terrence P. Fries</i>	47
3.1 Introduction	47
3.2 Problem Formulation	50
3.2.1 Environment Grid	50
3.2.2 Genetic Algorithms	51
3.3 Motion Planning Algorithm	53
3.3.1 Encoding the Chromosome	53
3.3.2 Initial Population	54
3.3.3 Genetic operators and parameters	54
3.3.4 Fitness function	54
3.3.5 Dynamic Environment	56
3.4 Test Results	56
3.5 Conclusions	60
References	61

4 Aggregate Selection in Evolutionary Robotics

<i>Andrew L. Nelson, Edward Grant</i>	63
4.1 Introduction	64
4.1.1 Evolutionary Robotics Process Overview	65
4.1.2 Bias	66
4.1.3 Fitness Functions	66
4.2 Evolutionary Robotics So Far	70
4.3 Evolutionary Robotics and Aggregate Fitness	73
4.4 Making Aggregate Selection Work	74
4.5 Aggregate Selection and Competition	75
4.6 Conclusion	83
References	85

5 Evolving Fuzzy Classifier for Novelty Detection and Landmark Recognition by Mobile Robots

<i>Plamen Angelov, Xiaowei Zhou</i>	89
5.1 Introduction	89
5.2 Landmark Recognition in Mobile Robotics	91
5.3 Evolving Fuzzy Rule-Based Classifier (eClass)	92
5.3.1 The Informative Data Density and Proximity Measure	93
5.3.2 Landmark Classifier Generation and Evolution	94
5.3.3 Landmark Recognition (real-time classification)	96
5.3.4 Learning of eClass	98

5.4	Case Study: Corner Recognition	99
5.4.1	The Mobile Robotic Platform	100
5.4.2	Experiment Settings	103
5.4.3	Program Structure	104
5.4.4	Results and Analysis	105
5.5	Further Investigations and Conclusion	109
5.5.1	Using Different Devices and Selecting Features	109
5.5.2	Rules Aggregation	110
5.5.3	Applying Variable Radius	111
5.6	Summary	112
	References	112
	Bibliography	112
	Appendix: C++ Class EvolvingClassifier	115

Part II Learning Mobile Robots

6 Reinforcement Learning for Autonomous Robotic Fish

	<i>Jindong Liu, Lynne E. Parker, Raj Madhavan</i>	121
6.1	Introduction	121
6.2	Introduction of Robotic Fish-Aifi	123
6.3	Policy Gradient Learning in Swim Pattern Layer	124
6.4	State-based Reinforcement Learning in Cognitive Layer	127
6.4.1	Action Space and State Space	128
6.4.2	Markov Decision Process Model	128
6.5	Experimental Results	129
6.5.1	Policy Gradient Learning for <i>Sharp-Turning</i> Swim Pattern	129
6.5.2	Q-learning for <i>Tank Border Exploration</i> Task	130
6.6	Summary	133
	References	133

7 Module-based Autonomous Learning for Mobile Robots

	<i>Esther L. Colombini, Carlos H. C. Ribeiro</i>	137
7.1	Introduction	138
7.1.1	Bibliography Review	138
7.2	Reinforcement Learning	140
7.2.1	Markovian Decision Processes	140
7.2.2	Q-learning	141
7.2.3	Features	142
7.2.4	Module-based RL	142
7.3	Generalisation	144
7.3.1	Cerebellar Model Articulation Controller (CMAC)	144
7.4	Experiments	147
7.4.1	Environment	147
7.4.2	Tasks	148
7.4.3	Behaviours	148

7.4.4 Space Discretisation	148
7.4.5 Hand-crafted Policy	149
7.4.6 Learned Policies	149
7.4.7 Results	150
7.4.8 CMAC Experiments	154
7.5 Conclusions	156
References	157

8 A Hybrid Adaptive Architecture for Mobile Robots

Based on Reactive Behaviours

<i>Antonio Henrique Pinto Selvatici, Anna Helena Reali Costa</i>	161
8.1 Introduction	161
8.2 Agent Architectures	163
8.2.1 Simple Reflex Agents	163
8.2.2 Model-Based Reflex Agents	163
8.2.3 Goal-Based Agents	164
8.2.4 Utility-Based Agents	165
8.2.5 Learning Agents	165
8.3 AAREACT	166
8.4 Reactive Layer	168
8.5 Coordination Layer	170
8.5.1 SARSA Algorithm	170
8.5.2 Definition of the Situation Space	172
8.5.3 Definition of the Weights Sets	173
8.5.4 The Reinforcement Function	174
8.6 Experiments with AAREACT	175
8.6.1 The Robot Model	175
8.6.2 Initial Learning Phase	176
8.6.3 Scenario Changing Experiments	177
8.7 Related Work	178
8.8 Conclusion	182
References	183

9 Collaborative Robots for Infrastructure

Security Applications

<i>Yi Guo, Lynne E. Parker, Raj Madhavan</i>	185
9.1 Introduction	185
9.2 Infrastructure Security Scenario and Research Problems	187
9.3 Multi-Robot Positioning and Mapping using Distributed Sensing	188
9.3.1 Heterogeneous Distributed Multi-Robot Localization	188
9.3.2 Terrain Mapping	191
9.4 Dynamic Multi-Robot Motion Planning	192
9.4.1 Area Partition	193
9.4.2 Initial Distribution	193

9.4.3 Complete Coverage Patrolling	194
9.4.4 Point Convergence	196
9.5 System Integration Towards Proof of Principle Demonstration...	197
9.6 Conclusions	198
References	199
 10 Imitation Learning: An Application	
in a Micro Robot Soccer Game	
<i>Dennis Barrios-Aranibar and Pablo Javier Alsina</i>	201
10.1 Introduction	201
10.2 Case Study and Control Architecture	204
10.3 Situations Recognition	206
10.4 Behaviors Patterns Recognition	212
10.5 Experimental Results	213
10.6 Conclusions and Future Works	217
References	218
 Index	221
 Author Index	223



<http://www.springer.com/978-3-540-49719-6>

Mobile Robots: The Evolutionary Approach

Coelho, L.d.S. (Ed.)

2007, XXI, 223 p., Hardcover

ISBN: 978-3-540-49719-6