

CONTENTS

<i>Foreword</i>	v
<i>Preface</i>	vii
1 An Introduction to Multi-Objective Evolutionary Algorithms and Their Applications	1
1.1 Introduction	1
1.2 Basic Concepts	3
1.3 Basic Operation of a MOEA	4
1.4 Classifying MOEAs	6
1.4.1 Aggregating Functions	6
1.4.2 Population-Based Approaches	7
1.4.3 Pareto-Based Approaches	8
1.5 MOEA Performance Measures	11
1.6 Design of MOEA Experiments	14
1.6.1 Reporting MOEA Computational Results	15
1.7 Layout of the Book	16
1.7.1 Part I: Engineering Applications	16
1.7.2 Part II: Scientific Applications	19
1.7.3 Part III: Industrial Applications	20
1.7.4 Part IV: Miscellaneous Applications	21
1.8 General Comments	22
References	23
2 Applications of Multi-Objective Evolutionary Algorithms in Engineering Design	29
2.1 Introduction	29
2.2 Multi-Objective Evolutionary Algorithm	31
2.2.1 Algorithms	33

2.3	Examples	36
2.3.1	Design of a Welded Beam	36
2.3.2	Preliminary Design of Bulk Carrier	40
2.3.3	Design of Robust Airfoil	46
2.4	Summary and Conclusions	50
	References	52
3	Optimal Design of Industrial Electromagnetic Devices: A Multiobjective Evolutionary Approach	53
3.1	Introduction	53
3.2	The Algorithms	54
3.2.1	Non-Dominated Sorting Evolution Strategy Algorithm (NSESA)	55
3.2.1.1	Pareto Gradient Based Algorithms (PGBA) and Hybrid Strategies	58
3.2.1.2	Pareto Evolution Strategy Algorithm (PESTRA)	59
3.2.1.3	Multi Directional Evolution Strategy Algorithm (MDESTRA)	61
3.3	Case Studies	61
3.3.1	Shape Design of a Shielded Reactor	62
3.3.1.1	Direct Problem	62
3.3.1.2	Inverse Problem	63
3.3.1.3	Sample-and-Rank Approach	65
3.3.1.4	Optimization Results	67
3.3.2	Shape Design of an Inductor for Transverse-Flux- Heating of a Non-Ferromagnetic Strip	69
3.3.2.1	Direct Problem	70
3.3.2.2	Inverse Problem	72
3.3.2.3	Sample-and-Rank Approach	73
3.3.2.4	Optimization Results	73
3.4	Conclusions	75
	References	75
4	Groundwater Monitoring Design: A Case Study Combining Epsilon Dominance Archiving and Automatic Parameterization for the NSGA-II	79
4.1	Introduction	79
4.2	Prior Work	81

4.3	Monitoring Test Case Problem	83
4.3.1	Test Case Overview	83
4.3.2	Problem Formulation	83
4.4	Overview of the ε -NSGA-II Approach	84
4.4.1	Searching with the NSGA-II	86
4.4.2	Archive Update	87
4.4.3	Injection and Termination	89
4.5	Results	91
4.6	Discussion	97
4.7	Conclusions	97
	References	98
5	Using a Particle Swarm Optimizer with a Multi-Objective Selection Scheme to Design Combinational Logic Circuits	101
5.1	Introduction	101
5.2	Problem Statement	102
5.3	Our Proposed Approach	104
5.4	Use of a Multi-Objective Approach	107
5.5	Comparison of Results	109
5.5.1	Example 1	109
5.5.2	Example 2	110
5.5.3	Example 3	112
5.5.4	Example 4	114
5.5.5	Example 5	117
5.5.6	Example 6	118
5.6	Conclusions and Future Work	120
	Acknowledgements	122
	References	122
6	Application of Multi-Objective Evolutionary Algorithms in Autonomous Vehicles Navigation	125
6.1	Introduction	126
6.2	Autonomous Vehicles	127
6.2.1	Experimental Setup	127
6.2.2	Vehicle Model	128
6.2.3	Relative Sensor Models	129
6.2.3.1	Steering Encoder	129
6.2.3.2	Wheel Encoder	129

6.2.4	Absolute Sensor Models	130
6.2.4.1	Global Positioning Systems	130
6.2.4.2	Inertial Measurement Unit	131
6.2.5	Simulation and Measurement of the Vehicle State . .	131
6.2.6	Prediction of the Vehicle State	131
6.3	Parameter Identification of Autonomous Vehicles	133
6.3.1	Problem Formulation	133
6.3.2	A General Framework for Searching Pareto-Optimal Solutions	134
6.3.3	Selection of a Single Solution by CoGM	136
6.4	Multi-Objective Optimization	138
6.4.1	Evaluation of Functions	138
6.4.1.1	Rank Function	138
6.4.1.2	Fitness Function	139
6.4.2	Search Methods	139
6.4.2.1	MCEA	139
6.4.2.2	MOGM	140
6.5	Application of Parameter Identification of an Autonomous Vehicle	141
6.6	Conclusions	148
6.7	Acknowledgement	151
	References	151
7	Automatic Control System Design via a Multiobjective Evolutionary Algorithm	155
7.1	Introduction	155
7.2	Performance Based Design Unification and Automation . .	158
7.2.1	The Overall Design Architecture	159
7.2.2	Control System Formulation	160
7.2.3	Performance Specifications	161
7.2.3.1	Stability	161
7.2.3.2	Step Response Specifications	162
7.2.3.3	Disturbance Rejection	162
7.2.3.4	Robust Stability	162
7.2.3.5	Actuator Saturation	163
7.2.3.6	Minimal Controller Order	164
7.3	An Evolutionary ULTIC Design Application	165
7.4	Conclusions	172
	References	174

8	The Use of Evolutionary Algorithms to Solve Practical Problems in Polymer Extrusion	177
8.1	Introduction	177
8.2	Polymer Extrusion	178
8.2.1	Single Screw Extrusion	178
8.2.2	Co-Rotating Twin-Screw Extrusion	179
8.2.3	Optimization Characteristics	183
8.3	Optimization Algorithm	184
8.3.1	Multi-Objective Optimization	184
8.3.2	Reduced Pareto Set Genetic Algorithm with Elitism (RPSGAe)	186
8.3.3	Travelling Salesman Problem	187
8.4	Results and Discussion	189
8.4.1	Single Screw Extrusion	189
8.4.2	Twin-Screw Extrusion	194
8.5	Conclusions	196
	Acknowledgments	197
	References	197
9	Evolutionary Multi-Objective Optimization of Trusses	201
9.1	Introduction	201
9.2	Related Work	202
9.3	ISPAES Algorithm	204
9.3.1	Inverted “ownership”	207
9.3.2	Shrinking the Objective Space	207
9.4	Optimization Examples	212
9.4.1	Optimization of a 49-bar Plane Truss	212
9.4.1.1	The 49-bar Plane Truss as a Single-Objective Optimization Problem with Constraints	212
9.4.1.2	The 49-bar Plane Truss as a Multi-Objective Optimization Problem with Constraints	215
9.4.2	Optimization of a 10-bar Plane Truss	215
9.4.2.1	The 10-bar Plane Truss as a Single-Objective Optimization Problem with Constraints	216
9.4.2.2	The 10-bar Plane Truss as a Multi-Objective Optimization Problem with Constraints	217
9.4.3	Optimization of a 72-bar 3D Structure	217

9.4.3.1	The 72-bar 3D Structure in Continuous Search Space as a Single-Objective Optimization Problem with Constraints	219
9.4.3.2	The 72-bar 3D Structure in Discrete Search Space as a Single-Objective Optimization Problem with Constraints	222
9.5	Final Remarks and Future Work	222
	Acknowledgments	223
	References	223
10	City and Regional Planning via a MOEA:	
	Lessons Learned	227
10.1	The Traditional Approach	227
10.2	The MOEA Approach	229
10.3	City Planning: Provo and Orem	231
10.4	Regional Planning: The WFMR	235
10.5	Coordinating Regional and City Planning	238
10.6	Conclusions	239
	Acknowledgments	240
	References	240
11	A Multi-Objective Evolutionary Algorithm for the Covering Tour Problem	247
11.1	Introduction	248
11.2	The Covering Tour Problem	251
11.2.1	The Mono-Objective Covering Tour Problem	251
11.2.2	The Bi-Objective Covering Tour Problem	252
11.2.3	Optimization Methods	253
11.2.3.1	A Heuristic Method	253
11.2.3.2	An Exact Method	254
11.3	A Multi-Objective Evolutionary Algorithm for the Bi-Objective Covering Tour Problem	255
11.3.1	General Framework	255
11.3.2	Solution Coding	256
11.3.3	Genetic Operators	257
11.3.3.1	The Crossover Operator	257
11.3.3.2	The Mutation Operator	258
11.4	Computational Results	258
11.5	Conclusions and Outlooks	260

Acknowledgement	261
References	261
12 A Computer Engineering Benchmark	
Application for Multiobjective Optimizers	269
12.1 Introduction	269
12.2 Packet Processor Design	271
12.2.1 Design Space Exploration	272
12.2.2 Basic Models and Methods	274
12.3 Software Architecture	281
12.3.1 General Considerations	281
12.3.2 Interface Description	283
12.4 Test Cases	284
12.4.1 Problem Instances	284
12.4.2 Simulation Results	286
12.5 Summary	289
Acknowledgments	292
References	292
13 Multiobjective Aerodynamic Design and Visualization of Supersonic Wings by Using Adaptive Range Multiobjective Genetic Algorithms	295
13.1 Introduction	295
13.2 Adaptive Range Multiobjective Genetic Algorithms	297
13.3 Multiobjective Aerodynamic Optimization	300
13.3.1 Formulation of Optimization	300
13.3.2 CFD Evaluation	302
13.3.3 Overview of Non-Dominated Solutions	303
13.4 Data Mining by Self-Organizing Map	305
13.4.1 Neural Network and SOM	305
13.4.2 Cluster Analysis	307
13.4.3 Visualization of Design Tradeoffs: SOM of Tradeoffs	308
13.4.4 Data Mining of Design Space: SOM of Design Variables	310
13.5 Conclusions	311
Acknowledgements	312
References	313

14 Applications of a Multi-Objective Genetic Algorithm in Chemical and Environmental Engineering	317
14.1 Introduction	317
14.2 Physical Problem	319
14.3 Genetic Algorithm	320
14.4 Problem Formulation	322
14.5 Conclusions	337
References	338
15 Multi-Objective Spectroscopic Data Analysis of Inertial Confinement Fusion Implosion Cores: Plasma Gradient Determination	341
15.1 Introduction	342
15.2 Self-Consistent Analysis of Data from X-ray Images and Line Spectra	344
15.3 A Niche Pareto Genetic Algorithm for Multi-Objective Spectroscopic Data Analysis	347
15.4 Test Cases	349
15.5 Application to Direct-Drive Implosions at GEKKO XII . .	354
15.6 Application to Indirect-Drive Implosions at OMEGA . . .	357
15.7 Conclusions	359
Acknowledgments	361
References	361
16 Application of Multiobjective Evolutionary Optimization Algorithms in Medicine	365
16.1 Introduction	365
16.2 Medical Image Processing	366
16.2.1 Medical Image Reconstruction	367
16.3 Computer Aided Diagnosis	369
16.3.1 Optimization of Diagnostic Classifiers	370
16.3.2 Rules-Based Atrial Disease Diagnosis	370
16.4 Treatment Planning	372
16.4.1 Brachytherapy	373
16.4.1.1 Dose Optimization for High Dose Rate Brachytherapy	373
16.4.1.2 Inverse Planning for HDR Brachytherapy . .	374
16.4.2 External Beam Radiotherapy	376

16.4.2.1 Geometrical Optimization of Beam Orientations	377
16.4.2.2 Intensity Modulated Beam Radiotherapy Dose Optimization	379
16.4.3 Cancer Chemotherapy	381
16.5 Data Mining	382
16.5.1 Partial Classification	383
16.5.2 Identification of Multiple Gene Subsets	385
16.6 Conclusions	386
References	387

17 On Machine Learning with Multiobjective

Genetic Optimization	393
17.1 Introduction	393
17.2 An Overview	396
17.2.1 Machine Learning	396
17.2.2 Generalization	398
17.2.3 Multiobjective Evolutionary Algorithms (MOEA) & Real-World Applications (RWA)	401
17.2.3.1 Achieving Diversity	403
17.2.3.2 Monitoring Convergence	403
17.2.3.3 Avoiding Local Convergence	405
17.3 Problem Formulation	406
17.4 MOEA for Partitioning	410
17.4.1 The Algorithm	411
17.4.2 Chromosome Representation	412
17.4.3 Genetic Operators	412
17.4.4 Constraints & Heuristics	412
17.4.5 Convergence	413
17.5 Results and Discussion	415
17.6 Summary & Future Work	419
Acknowledgements	421
References	421

18 Generalized Analysis of Promoters: A Method for DNA Sequence Description

DNA Sequence Description	427
18.1 Introduction	428
18.2 Generalized Clustering	429
18.3 Problem: Discovering Promoters in DNA Sequences	432

18.4 Biological Sequence Description Methods	434
18.5 Experimental Algorithm Evaluation	438
18.6 Concluding Remarks	442
Appendix	443
References	443
19 Multi-Objective Evolutionary Algorithms for Computer Science Applications	451
19.1 Introduction	451
19.2 Combinatorial MOP Functions	452
19.3 MOP NPC Examples	453
19.3.1 Multi-Objective Quadratic Assignment Problem	453
19.3.1.1 Literary QAP Definition	455
19.3.1.2 Mathematical QAP Definition	455
19.3.1.3 General mQAP	455
19.3.1.4 Mathematical mQAP	455
19.3.1.5 Mapping QAP to MOEA	457
19.3.2 MOEA mQAP Results and Analysis	459
19.3.2.1 Design of mQAP Experiments and Testing	459
19.3.2.2 QAP Analysis	460
19.3.3 Modified Multi-Objective Knapsack Problem (MMOKP)	465
19.3.4 MOEA MMOKP Testing and Analysis	471
19.4 MOEA BB Conjectures for NPC Problems	476
19.5 Future Directions	478
References	478
20 Design of Fluid Power System Using a Multi Objective Genetic Algorithm	483
20.1 Introduction	483
20.2 The Multi-Objective Optimization Problem	485
20.3 Multi-Objective Genetic Algorithms	486
20.3.1 The Multi-Objective Struggle GA	487
20.3.2 Genome Representation	489
20.3.3 Similarity Measures	489
20.3.3.1 Attribute Based Distance Function	490
20.3.3.2 Phenotype Based Distance Function	490
20.3.3.3 Real Number Distance	490
20.3.3.4 Catalog Distance	491

20.3.3.5 Overall Distance	492
20.3.4 Crossover Operators	493
20.4 Fluid Power System Design	494
20.4.1 Optimization Results	496
20.5 Mixed Variable Design Problem	498
20.5.1 Component Catalogs	499
20.5.2 Optimization Results	499
20.6 Discussion and Conclusions	500
References	502

21 Elimination of Exceptional Elements in Cellular Manufacturing Systems Using Multi-Objective Genetic Algorithms	505
21.1 Introduction	506
21.2 Multiple Objective Optimization	510
21.3 Development of the Multi-Objective Model for Elimination of EEs	511
21.3.1 Assumptions	511
21.3.2 The Set of Decision Criteria	511
21.3.3 Problem Formulation	511
21.3.3.1 Notation	511
21.3.3.2 The Objective Functions	512
21.3.3.3 The Constraints	514
21.3.3.4 The Multi-Objective Optimization Problem (MOP)	514
21.3.4 A Numerical Example	515
21.4 The Proposed MOGA	517
21.4.1 Pseudocode for the Proposed MOGA	518
21.4.2 Fitness Calculation	519
21.4.3 Selection	520
21.4.4 Recombination	520
21.4.5 Updating the Elite Set	520
21.4.6 Stopping Criteria	520
21.5 Parameter Setting	521
21.6 Experimentation	522
21.7 Conclusion	525
References	526

22	Single-Objective and Multi-Objective Evolutionary Flowshop Scheduling	529
22.1	Introduction	529
22.2	Permutation Flowshop Scheduling Problems	531
22.3	Single-Objective Genetic Algorithms	532
22.3.1	Implementation of Genetic Algorithms	532
22.3.2	Comparison of Various Genetic Operations	535
22.3.3	Performance Evaluation of Genetic Algorithms	539
22.4	Multi-Objective Genetic Algorithms	541
22.4.1	NSGA-II Algorithm	542
22.4.2	Performance Evaluation of the NSGA-II Algorithm	544
22.4.3	Extensions to Multi-Objective Genetic Algorithms	548
22.5	Conclusions	551
	References	552
23	Evolutionary Operators Based on Elite Solutions for Bi-Objective Combinatorial Optimization	555
23.1	Introduction	556
23.2	MOCO Problems and Solution Sets	557
23.3	An Evolutionary Heuristic for Solving biCO Problems	559
23.3.1	Overview of the Heuristic	559
23.3.2	The Initial Population	561
23.3.3	Bound Sets and Admissible Areas	562
23.3.4	The Genetic Map	563
23.3.5	The Crossover Operator	564
23.3.6	The Path-Relinking Operator	565
23.3.7	The Local Search Operator	566
23.4	Application to Assignment and Knapsack Problems with Two Objectives	567
23.4.1	Problem Formulation	567
23.4.2	Experimental Protocol	568
23.5	Numerical Experiments with the Bi-Objective Assignment Problem	569
23.5.1	Minimal Complete Solution Sets and Initial Elite Solution Set	569
23.5.2	Our Results Compared with Those Existing in the Literature	571
23.6	Numerical Experiments with the Bi-Objective Knapsack Problem	573

23.6.1 Minimal Complete Solution Sets and the Initial Elite Solution set	574
23.6.2 Our Results compared with Those Existing in the Literature	575
23.7 Conclusion and Perspectives	575
References	577
24 Multi-Objective Rectangular Packing Problem	581
24.1 Introduction	582
24.2 Formulation of Layout Problems	583
24.2.1 Definition of RP	583
24.2.2 Multi-Objective RP	583
24.3 Genetic Layout Optimization	584
24.3.1 Representations	585
24.3.1.1 Sequence-Pair	586
24.3.1.2 Encoding System	586
24.3.2 GA Operators	587
24.3.2.1 Placement-Based Partially Exchanging Crossover	589
24.3.2.2 Mutation Operator	589
24.4 Multi-Objective Optimization Problems by Genetic Algorithms and Neighborhood Cultivation GA	589
24.4.1 Multi-Objective Optimization Problems and Genetic Algorithm	589
24.4.2 Neighborhood Cultivation Genetic Algorithm	591
24.5 Numerical Examples	593
24.5.1 Parameters of GAs	594
24.5.2 Evaluation Methods	594
24.5.2.1 Sampling of the Pareto Frontier Lines of Intersection(I_{LI})	594
24.5.2.2 Maximum, Minimum and Average Values of Each Object of Derived Solutions (I_{MMA})	595
24.5.3 Results	595
24.5.3.1 Layout of the Solution	596
24.5.3.2 AMI33	597
24.5.3.3 rdm500	598
24.6 Conclusion	600
References	600

25 Multi-Objective Algorithms for Attribute Selection in Data Mining	603
25.1 Introduction	603
25.2 Attribute Selection	605
25.3 Multi-Objective Optimization	606
25.4 The Proposed Multi-Objective Methods for Attribute Selection	608
25.4.1 The Multi-Objective Genetic Algorithm (MOGA)	609
25.4.1.1 Individual Encoding	610
25.4.1.2 Fitness Function	610
25.4.1.3 Selection Methods and Genetic Operators	610
25.4.2 The Multi-Objective Forward Sequential Selection Method (MOFSS)	611
25.5 Computational Results	612
25.5.1 Results for the “Return All Non-Dominated Solutions” Approach	615
25.5.2 Results for the “Return the ‘Best’ Non-Dominated Solution” Approach	616
25.5.3 On the Effectiveness of the Criterion to Choose the “Best” Solution	620
25.6 Conclusions and Future Work	623
References	624
26 Financial Applications of Multi-Objective Evolutionary Algorithms: Recent Developments and Future Research Directions	627
26.1 Introduction	627
26.2 A Justification for MOEAs in Financial Applications	628
26.3 Selected Financial Applications of MOEAs	631
26.3.1 Portfolio Selection Problems	631
26.3.2 Vederajan et al.	633
26.3.3 Lin et al.	636
26.3.4 Fieldsend & Singh	639
26.3.5 Schlottmann & Seese	642
26.4 Conclusion and Future Research Directions	646
26.5 Acknowledgement	649
References	649

27 Evolutionary Multi-Objective Optimization	
Approach to Constructing Neural Network	
Ensembles for Regression	653
27.1 Introduction	653
27.2 Multi-Objective Optimization of Neural Networks	655
27.2.1 Parameter and Structure Representation of the Network	655
27.2.2 Objectives in Network Optimization	656
27.2.3 Mutation and Learning	658
27.2.4 Elitist Non-Dominated Sorting and Crowded Tournament Selection	659
27.3 Selecting Ensemble Members	659
27.4 Case Studies	661
27.4.1 Experimental Settings	661
27.4.2 Results on the Ackley Function	661
27.4.3 Results on the Macky-Glass Function	666
27.5 Discussions and Conclusions	669
Acknowledgements	672
References	672
28 Optimizing Forecast Model Complexity Using	
Multi-Objective Evolutionary Algorithms	675
28.1 Introduction	675
28.2 Artificial Neural Networks	677
28.3 Optimal Model Complexity	681
28.3.1 Early Stopping	681
28.3.2 Weight Decay Regularization and Summed Penalty Terms	681
28.3.3 Node and Weight Addition/Deletion	682
28.3.4 Problems with These Methods	682
28.4 Using Evolutionary Algorithms to Discover the Complexity/ Accuracy Trade-Off	684
28.4.1 Pareto Optimality	684
28.4.2 Extent, Resolution and Density of Estimated Pareto Set	685
28.4.3 The Use of EMOO	687
28.4.4 A General Model	689
28.4.4.1 <i>mutate()</i>	689
28.4.4.2 <i>weightadjust()</i>	691

28.4.4.3	<i>unitadjust()</i>	691
28.4.4.4	The Elite Archive	691
28.4.4.5	<i>replace()</i>	692
28.4.5	Implementation and Generalization	692
28.5	Empirical Validation	693
28.5.1	Data	694
28.5.2	Model Parameters	694
28.6	Results	695
28.7	Discussion	697
	Acknowledgments	697
	References	698
29	Even Flow Scheduling Problems in Forest Management	701
29.1	Benchmark Problem	701
29.1.1	Introduction	701
29.1.2	Methodology	703
29.1.3	Results and Discussion	703
29.1.3.1	Visual Interpretation	703
29.1.3.2	Performance Indices	704
29.1.3.3	Statistical Approaches	706
29.1.3.4	Implications for Forest Management Problems	707
29.2	Applying Single Objective Genetic Algorithms to a Real-World Problem	708
29.2.1	Introduction	708
29.2.2	Methodology	709
29.2.2.1	Input Data	709
29.2.2.2	Implementation	709
29.2.3	Results and Discussion	710
29.2.4	Conclusion	712
29.3	Applying NSGA-II: A Truly Bi-Objective Approach	715
29.3.1	Introduction	715
29.3.2	Methodology	715
29.3.3	Results	715
29.3.3.1	Effect of Encoding on the Spread and Pareto- Optimality	715
29.3.3.2	Comparing the Single and Multiple Objective Genetic Algorithm	716
29.3.3.3	Effect of Population Size on Solution Quality	718

29.3.3.4 Validity of the Plans	719
29.3.4 Conclusion	722
29.4 Speeding Up the Optimization Process	723
29.4.1 Introduction	723
29.4.2 Methodology	723
29.4.3 Results and Discussion	723
29.4.4 Conclusions	724
Acknowledgements	724
References	724

30 Using Diversity to Guide the Search in

Multi-Objective Optimization	727
30.1 Introduction	727
30.2 Diversity in Multi-Objective Optimization	729
30.3 Maintaining Diversity in Multi-Objective Optimization . .	730
30.3.1 Weighted Vectors	731
30.3.2 Fitness Sharing	732
30.3.3 Crowding/Clustering Methods	732
30.3.4 Restricted Mating	733
30.3.5 Relaxed Forms of Dominance	733
30.3.6 Helper Objectives	735
30.3.7 Objective Oriented Heuristic Selection	735
30.3.8 Using Diversity to Guide the Search	736
30.4 The Two-Objective Space Allocation Problem	736
30.4.1 Problem Description	737
30.4.2 Measuring Diversity of Non-Dominated Sets	739
30.5 Using Diversity to Guide the Search	740
30.5.1 Diversity as a Helper Objective	740
30.5.2 Diversity to Control Exploration and Exploitation .	741
30.5.3 The Population-Based Hybrid Annealing Algorithm	742
30.6 Experiments and Results	744
30.6.1 Experimental Setting	744
30.6.2 Discussion of Obtained Results	745
30.7 Summary	747
References	748