

Contents

- 1 Introduction** 1
 - 1.1 The Brain as an Information Processing System 4
 - 1.2 Synaptic Learning 6
 - 1.2.1 Neurons and Synapses 6
 - 1.2.2 Transmission of Information 7
 - 1.2.3 Storage and Processing of Information 9
 - 1.2.4 Long-Term Potentiation 10
 - 1.3 Neural Network and Human Brain 11
 - 1.4 Artificial Neural Network 12
 - 1.5 Applications of Artificial Neural Networks 16
 - 1.6 Artificial Neural Network Models 17
 - 1.6.1 Simple Artificial Neuron..... 17
 - 1.6.2 Multilayer Perceptron..... 22
 - 1.6.3 Kohonen’s Self Organizing Feature Map (SOFM) 30
 - 1.7 Fuzzy Sets and Fuzzy Logic 32
 - 1.7.1 Fuzzy Set-Theoretic Concepts..... 34
 - 1.7.2 Fuzzy Set-Theoretic Operations..... 35
 - 1.7.3 Fuzzy Cardinality 35
 - 1.7.4 Measures of a Fuzzy Set 36
 - 1.7.5 Fuzzy Operators..... 37
 - 1.7.6 Fuzzy Hostility Index 38
 - 1.8 Rough Sets 40
 - 1.8.1 Set-Theoretic Formalism 40
 - 1.8.2 Equivalence Classes 41
 - 1.9 Optimization Problems and Solution Techniques 42
 - 1.10 Genetic Algorithms 43
 - 1.10.1 Basic Principles and Features 44
 - 1.10.2 Encoding Strategy and Population 44
 - 1.10.3 Evaluation Technique 45
 - 1.10.4 Genetic Operators 45
 - 1.10.5 Parameters of GA 47

1.11	Classical Differential Evolutionary Algorithm	47
1.11.1	Mutation	48
1.11.2	Crossover	48
1.11.3	Selection	49
1.12	Simulated Annealing	49
1.13	Particle Swarm Optimization	50
1.13.1	The PSO Algorithm	51
1.13.2	Main PSO Variants	52
1.14	Multiobjective Optimization	54
1.15	Approaches to Multiobjective Optimization	55
1.16	Mathematical Formulation	55
1.17	Multiobjective Genetic Algorithms	55
1.17.1	Design Issues of Multiobjective Genetic Algorithms	56
1.18	Multiobjective Differential Evolutionary Algorithms.....	62
1.18.1	Non-Pareto-Based Techniques	63
1.18.2	Pareto-Based Techniques	63
1.18.3	Mixed Techniques.....	68
1.19	Multiobjective Simulated Annealing	69
1.20	Conclusions	70
2	Transformation Invariant Image Recognition Using Multilayer Perceptron	73
2.1	Introduction	73
2.2	Image Recognition by an MLP Architecture	74
2.2.1	Image Acquisition Phase	75
2.2.2	Training the MLP Architecture.....	76
2.2.3	Recognition of Test Images.....	76
2.2.4	Detection of Transformations	76
2.3	Results of Image Recognition	76
2.3.1	Results of Real-Life Image Recognition.....	78
2.4	Transformation Detection by an MLP Architecture	79
2.5	Results of Transformation Detection	82
2.6	Conclusions	87
3	Energy-Efficient Intelligent Lighting Control Using a Multilayer Perceptron	89
3.1	Introduction	89
3.2	Principle of Lighting Control by a Multilayer Neural Network	90
3.3	Proposed Methodology	91
3.3.1	Detection of Brightness/Darkness in an Illuminated Scene Using a Trained MLP Architecture	91
3.3.2	Conversion of Network Outputs into Analog Voltage Levels to Adjust Artificial Lights	92
3.3.3	Continuous Acquisition of Illuminated Scene Images by a CCD Camera	92

3.4	Results of Lighting Control by MLP Architecture	93
3.5	Conclusions	95
4	Target Tracking Using Fuzzy Hostility Induced Segmentation of Optical Flow Field	97
4.1	Introduction	97
4.2	Optical Flow Field Technique	98
4.3	Optical Flow Field in the Light of Fuzzy Hostility Index	100
4.4	Fuzzy Hostility-Based Optical Flow Field Segmentation	100
4.4.1	Extraction of Time-Ordered Image Frames from a Video Sequence	101
4.4.2	Computation of Optical Flow Field Between the First Two Image Frames	101
4.4.3	Determining Optical Flow Regions of Interest (ROI) Using Pixel Hostility Index	101
4.4.4	Detecting a Point of Interest (POI) on ROI by Detecting Maximum Density Optical Flow Regions ...	102
4.4.5	Computation of Optical Flow in the Neighborhood of POI in Subsequent Image Frames	103
4.5	Results of Target Tracking with Fuzzy Hostility-Based Segmentation of Optical Flow Field	105
4.5.1	Computational Time Requirements of the Proposed Method	105
4.6	Conclusions	107
5	Binary Object Extraction by Bidirectional Self-Organizing Neural Network Architecture	109
5.1	Introduction	109
5.2	Bidirectional Self-Organizing Neural Network (BDSONN) Architecture	111
5.2.1	Network Dynamics	112
5.2.2	Network Operation	113
5.2.3	BDSONN Self-Organization Algorithm	115
5.2.4	Stabilization of the Network	116
5.3	Implementation Results	118
5.3.1	Binary Object Extraction with a Sigmoidal Activation Function	118
5.3.2	Binary Object Extraction with a Beta Activation Function	132
5.4	Conclusions	157
6	Multilevel Object Extraction by BDSONN Architecture	159
6.1	Introduction	159
6.2	Related Work	160

6.3	The Image Segmentation/Classification Problem	162
6.3.1	Formal Definition	162
6.4	Multilevel Sigmoidal (MUSIG) Activation Function	164
6.5	Thresholding Aspects of a Multilevel Sigmoidal (MUSIG) Activation Function	166
6.5.1	Threshold (θ_β) Based on a Beta Distribution of Image Intensity Information	167
6.5.2	Threshold ($\theta_{\chi_1}, \theta_{\chi_2}$) Based on Skewness of Intensity Distribution of Image Pixel Neighborhoods...	168
6.5.3	Threshold (θ_ζ) Based on the Heterogeneity of Pixel Neighborhood Fuzzy Subsets	169
6.5.4	Threshold (θ_ξ) Based on the Fuzzy Cardinality Estimates of Pixel Neighborhood Fuzzy Subsets.....	170
6.6	Principle of Multilevel Image Segmentation by a MLSONN Architecture	171
6.7	Principle of Multilevel Image Segmentation by a Pyramidal Neural Network Architecture	172
6.8	Principle of Multilevel Image Segmentation by a BDSONN Architecture with CONSENT	174
6.9	Evaluation of the Quality of Segmented Images	176
6.10	Experimental Results	178
6.10.1	Segmentation by MLSONN Architecture	179
6.10.2	Segmentation by PyraNet Architecture	183
6.10.3	Segmentation by BDSONN Architecture	186
6.11	Conclusions	194
7	Color Object Extraction by Parallel BDSONN Architecture	195
7.1	Introduction	195
7.2	Related Work	197
7.3	Principle of Color Image Extraction and Segmentation by PSONN	199
7.3.1	Thresholding Characteristics of PSONN	199
7.4	Results of Color Image Extraction and Segmentation by PSONN	200
7.4.1	Extraction of Pure Color Images from a Noisy Background.....	200
7.4.2	Segmentation of True Color Images	203
7.5	Parallel Bidirectional Self-Organizing Neural Network (PBDSONN) Architecture	211
7.5.1	Operation of PBDSONN Architecture	216
7.5.2	PBDSONN Self-Organization Algorithm	218
7.6	Results of Color Image Extraction and Segmentation by PBDSONN	220
7.6.1	Extraction of Pure Color Images from a Noisy Background.....	220
7.6.2	Segmentation of True Color Images	220

7.7	Comparative Performance Study of PBDSONN and PSONN Architectures	224
7.8	Conclusions	226
8	Gray Scale Image Edge Detection Using Rough Sets	229
8.1	Introduction	229
8.2	Rough Set Concepts	231
8.2.1	Roughness of Image Pixels	232
8.2.2	Rough Pixel Neighborhood Hostility Index	234
8.3	Classical Methods of Edge Detection.....	234
8.4	Edge Detection Methodology Using Pixel Roughness	235
8.4.1	Input Image.....	235
8.4.2	Determine Granules/Equivalence Classes	235
8.4.3	Determine Pixel Roughness	236
8.4.4	Extract Image Edges Based on Pixel Roughness	237
8.5	Experimental Results of Edge Detection Obtained Using Pixel Roughness	237
8.6	Edge Detection Methodology Using Rough Pixel Hostility Index	242
8.6.1	Determination of Rough Pixel Neighborhood Hostility Index	242
8.6.2	Extraction of Image Edges Based on Rough Pixel Neighborhood Hostility Index	243
8.7	Experimental Results of Edge Detection Using Rough Pixel Neighborhood Hostility	243
8.8	Conclusions	248
	References.....	249
	Index	265

Soft Computing for Image and Multimedia Data
Processing

Bhattacharyya, S.; Maulik, U.

2013, XV, 267 p. 171 illus., 53 illus. in color., Hardcover

ISBN: 978-3-642-40254-8