

Contents

1	Design of Static Metaheuristics for Medical Image Analysis	1
	Amir Nakib	
1.1	Introduction	1
1.2	Image Segmentation as an Optimization Problem	2
1.3	Metaheuristics' Enhancement for Medical Image Segmentation	3
1.3.1	Hybrid Ant Colony System (ACS)	3
1.3.2	Enhanced BBO for Image Segmentation.	8
1.3.3	Enhanced DE for Image Thresholding	13
1.3.4	Metaheuristic for Contours Detection in 2D Ultrasound Images	16
1.4	Conclusion	21
	References	21
2	Multi-level Image Thresholding Based on Hybrid Differential Evolution Algorithm. Application on Medical Images	23
	M. Ali, P. Siarry and M. Pant	
2.1	Introduction	23
2.2	Gaussian Curve Fitting.	24
2.3	Overall Probability of Error	25
2.4	Hybrid Differential Evolution (HDE)	26
2.5	Experimental Results	28
2.6	MRI Slices Segmentation.	32
2.7	Conclusions	35
	References	35
3	Fuzzy Edge Detection in Computed Tomography Through Genetic Algorithm Optimization	37
	A.M.T. Gouicem, M. Yahia and A. Taleb-Ahmed	
3.1	Introduction	37

3.1.1	Problem Statement	38
3.2	Applied Methods	39
3.2.1	Implementation of Fuzzy Inference.	40
3.2.2	Genetic Algorithm (GA).	41
3.2.3	Optimization by Genetic Algorithm	43
3.3	Results and Discussion.	44
3.4	Conclusion.	46
	References	47
4	Particle Swarm Optimization Based Fast Chan-Vese	
	Algorithm for Medical Image Segmentation	49
	Devraj Mandal, Amitava Chatterjee and Madhubanti Maitra	
4.1	Introduction	49
4.2	The C-V Model (Piecewise-Constant Model) for Image	
	Segmentation	51
4.2.1	Level Set Formulation of the Model.	52
4.2.2	The C-V Algorithm	53
4.2.3	The Strengths and Drawbacks of the C-V	
	Algorithm	53
4.2.4	Extension of C-V Model for Vector-Valued Images . . .	55
4.2.5	Extension of C-V Model for Multi-phase Level	
	Set Implementation	56
4.3	Evolutionary Formulation of Our Fast C-V Model.	58
4.4	Particle Swarm Optimization (PSO) Based Fast C-V Model . . .	58
4.5	Implementation and Results	62
4.5.1	Two-Class Implementation for Scalar Images.	62
4.5.2	Two-Class Implementation for Vector Valued	
	Images	65
4.5.3	Multi-class Implementation of Our Proposed	
	Model	66
4.6	Conclusions	71
	References	72
5	Evidential Deformable Model for Contour Tracking.	
	Application on Brain Cine MR Sequences	75
	Sarra Naffakhi, Amir Nakib and Atef Hamouda	
5.1	Introduction	75
5.2	Related Works	76
5.3	The Evidence Theory.	78
5.4	Proposed Method	78
5.4.1	Description	79
5.4.2	Evidential Modeling	80
5.4.3	Combination Rule from Each Source	81

5.4.4	Decision Strategy	82
5.4.5	Proposed Algorithm	83
5.5	Results	83
5.5.1	Tracking Synthetic Ball	84
5.5.2	Datasets and Data Acquisition	89
5.5.3	Tracking Real Dynamic Membrane of the Third Ventricle	90
5.5.4	Tracking Accuracy	94
5.6	Conclusion	100
5.7	Annex	101
5.7.1	Bayesian Filtering	101
5.7.2	Kalman Filter	102
5.7.3	Extended Kalman Filter	103
5.7.4	Particle Filter	104
	References	105
6	Microscopic Image Segmentation Based on Based Branch and Bound and Game Theory	109
	Amira Kouzana, Amir Nakib and Narjes Dogaz	
6.1	Introduction	109
6.2	Image Segmentation as a Graph-Cut Problem	112
6.3	Formulation of the Segmentation Problem as Non-cooperative Strategic Game	112
6.3.1	Formulation of the Segmentation Problem	113
6.4	Branch and Bound Algorithm to Achieve the Nash Equilibrium	114
6.5	Results and Discussions	115
6.5.1	Evaluation on Synthetic Images	115
6.6	Conclusion	118
	References	118
7	Dynamic Metaheuristics for Brain Cine-MRI	121
	Amir Nakib	
7.1	Introduction	121
7.2	Problem Formulation	122
7.3	Data Acquisition	123
7.4	Proposed Framework	124
7.4.1	Segmentation Problem	124
7.4.2	Geometric Matching of the Contours	127
7.4.3	Cine-MRI Registration as a DOP	129
7.5	Results and Discussions	130
7.6	Conclusion	134
	References	134

8 Lexicographic Approach Based on Evidence Theory for Blood Cell Image Segmentation. 137
Ismahan Baghli and Amir Nakib

8.1 Introduction 137

8.2 Background 139

8.2.1 Projection on Different Color Spaces 140

8.2.2 Recall on Evidence Theory 140

8.3 The Proposed Framework 142

8.3.1 Initial Segmentation Using Watersheds 143

8.3.2 Evidential Regions Merging 144

8.4 Results and Discussion. 145

8.4.1 Performances Evaluation. 148

8.5 Conclusion. 152

References 152

9 Medical Image Denoising Using Metaheuristics 155
Serdar Kockanat and Nurhan Karaboga

9.1 Introduction 155

9.2 Noise Elimination Approach 156

9.3 Parameter Adaptation Algorithm 158

9.3.1 Artificial Bee Colony Algorithm. 158

9.3.2 Particle Swarm Optimization Algorithm 159

9.3.3 Genetic Algorithm 160

9.3.4 Differential Evolution 160

9.4 Results and Discussion. 161

9.5 Conclusion. 168

References 168

10 Medical Image Registration Based on Metaheuristics: A Comparative Study 171
A. Nakib, E.-G. Talbi and S. Corniglion

10.1 Introduction 171

10.2 The Registration Process 172

10.3 Particle Swarm Optimization 175

10.4 Differential Evolution. 177

10.5 The CMA-ES Algorithm 178

10.6 Experimental Results and Discussion. 180

10.7 Conclusion. 185

References 185

11 Adaptive ECG Signal Filtering Using Bayesian Based Evolutionary Algorithm 187
Thibaut Bernard and Amir Nakib

11.1 Introduction 187

11.2 Methods. 188

- 11.2.1 State of the Art 188
 - 11.2.2 Choice on Our Algorithm 190
 - 11.2.3 Bayes Theory 194
 - 11.2.4 Algorithm 195
 - 11.2.5 Image Color Population Representation 195
- 11.3 Results 202
 - 11.3.1 Comparison on Test Functions 202
 - 11.3.2 Interpretation. 202
- 11.4 BEA for Adaptive Signal ECG Signal Filtering. 203
- 11.5 Discussion and Conclusions. 208
- References 211