# Contents

**Part I Computational Intelligence in Visual Pattern Recognition**

**1 Visual Pattern Recognition** . . . . . 3
1.1 Introduction . . . . . 3
1.2 Overview . . . . . 4
1.2.1 The Visual Pattern Recognition Pipeline . . . . . 4
1.3 Hand Gestures: Variation in Appearance, Large Number of Features and Complex Backgrounds . . . . . 6
1.4 The Algorithms: Fuzzy-Rough Classifier, Biologically Inspired Feature Extraction and Visual Attention. . . . . 7
References . . . . . 8

**2 Computational Intelligence Techniques** . . . . . 11
2.1 Fuzzy and Rough Sets . . . . . 11
2.1.1 Fuzzy-Rough Sets . . . . . 13
2.1.2 Feature Selection and Classification Using Fuzzy-Rough Sets . . . . . 13
2.1.3 Genetic Algorithm. . . . . 14
2.2 Computational Model of Visual Cortex . . . . . 15
2.2.1 Biologically Inspired Feature Extraction System . . . . . 16
References . . . . . 17

**3 Multi-Feature Pattern Recognition** . . . . . 21
3.1 Feature Selection and Classification of Multi-Feature Patterns . . . . . 21
3.2 Cancer Classification . . . . . 22
3.3 Face Recognition. . . . . 22
3.4 Hand Gesture Recognition . . . . . 23
3.4.1 Hand Gesture Recognition Techniques . . . . . 24
3.4.2 Hand Gesture Databases . . . . . 32
3.4.3 Comparison of Methods. . . . . 32
References . . . . . 34

## Part II Feature Selection and Classification

**4 Fuzzy-Rough Discriminative Feature Selection and Classification** . . . . . 41
4.1 Introduction . . . . . 42
4.2 Fuzzy-Rough Single Cluster Feature Selection and Classification Algorithm . . . . . 42
4.2.1 Training Phase: Discriminative Feature Selection and Classifier Rules Generation . . . . . 43
4.2.2 The Testing Phase: The Classifier . . . . . 49
4.2.3 Computational Complexity Analysis . . . . . 50
4.3 Performance Evaluation and Discussion . . . . . 52
4.3.1 Cancer Classification . . . . . 52
4.3.2 Image Pattern Recognition . . . . . 57
4.4 Summary . . . . . 59
References . . . . . 60

**5 Hand Posture and Face Recognition Using Fuzzy-Rough Approach** . . . . . 63
5.1 Introduction . . . . . 64
5.2 The Fuzzy-Rough Multi Cluster Classifier . . . . . 64
5.2.1 Training Phase: Identification of Feature Cluster Centers and Generation of Classifier Rules . . . . . 65
5.2.2 Genetic Algorithm Based Feature Selection . . . . . 69
5.2.3 FRMC Classifier Testing Phase . . . . . 72
5.2.4 Computational Complexity Analysis . . . . . 72
5.3 Experimental Evaluation of FRMC Classifier . . . . . 72
5.3.1 Face Recognition . . . . . 74
5.3.2 Hand Posture Recognition . . . . . 76
5.3.3 FRMC Classifier Online Implementation . . . . . 78
5.4 Summary . . . . . 79
References . . . . . 79

**6 Boosting Based Fuzzy-Rough Pattern Classifier** . . . . . 81
6.1 Introduction . . . . . 81
6.2 Fuzzy-Rough Sets for Classification . . . . . 82
6.3 Boosting Based Fuzzy-Rough Multi-cluster Classifier . . . . . 83
6.3.1 Stage 1: Membership Functions from Cluster Points . . . . 84
6.3.2 Stage 2: Generation of Certain Rules from Membership Functions . . . . . 84
6.3.3 Stage 3: Generation of Possible Rules from Membership Functions . . . . . 86

6.4 Performance Evaluation and Discussion . . . . . 89
6.5 Conclusion . . . . . 90
References . . . . . 91

**Part III Biologically Inspired Approaches in Hand Posture Recognition**

**7 Hand Posture Recognition Using Neuro-Biologically Inspired Features** . . . . . 95
7.1 Introduction . . . . . 95
7.2 Graph Matching Based Hand Posture Recognition: C1 Features . . . . . 96
7.2.1 Elastic Graph Matching Based Hand Posture Classifier . . . . . 96
7.2.2 Experimental Results . . . . . 98
7.2.3 Summary: Graph Matching Based Hand Posture Recognition Algorithm . . . . . 100
7.3 Feature Extraction and Selection for Hand Posture Recognition: C2 Features . . . . . 101
7.3.1 Discriminative Feature Extraction and Selection . . . . . 101
7.3.2 Real-time Implementation and Experimental Results . . . . 103
7.3.3 Summary: Feature Extraction and Selection for Hand Posture Recognition . . . . . 105
References . . . . . 105

**8 Attention Based Segmentation and Recognition Algorithm for Hand Postures Against Complex Backgrounds** . . . . . 107
8.1 Introduction . . . . . 108
8.2 The Feature Extraction System and the Model of Attention . . . . 110
8.2.1 Extraction of Shape and Texture Features . . . . . 110
8.2.2 Bayesian Model of Visual Attention . . . . . 112
8.3 Attention Based Detection, Segmentation and Recognition . . . . . 114
8.3.1 Image Pre-processing . . . . . 114
8.3.2 Extraction of Color, Shape and Texture Features . . . . . 117
8.3.3 Feature Based Visual Attention and Saliency Map Generation . . . . . 119
8.3.4 Hand Segmentation and Classification . . . . . 121
8.4 Experimental Results and Discussion . . . . . 123
8.4.1 The Dataset and the Experimental Set-up . . . . . 123
8.4.2 Hand Posture Detection . . . . . 124
8.4.3 Hand Region Segmentation . . . . . 124
8.4.4 Hand Posture Recognition . . . . . 125

8.4.5 Performance with Human Skin and Body Parts as Noises . . . . . 127
8.4.6 Comparison of the Recognition Time . . . . . 128
8.4.7 Recognition of Hand Postures with Uniform Backgrounds. . . . . 129
8.5 Summary . . . . . 129
8.5.1 Possible Extension and Application of ASR Algorithm. . . . . 130
References . . . . . 130

**Appendix A: Illustration of the Formation of Fuzzy Membership Functions, and the Calculation of $\{\mu_{A_L}, \mu_{A_H}\}$ and $\{A_L, A_H\}$: Object Dataset** . . . . . 133

**Index** . . . . . 137



http://www.springer.com/978-981-287-055-1

Computational Intelligence in Multi-Feature Visual Pattern Recognition
Hand Posture and Face Recognition using Biologically Inspired Approaches
Pisharady, P.; Vadakkepat, P.; Poh, L.A.
2014, XIII, 138 p. 50 illus., 25 illus. in color., Hardcover
ISBN: 978-981-287-055-1