

Contents

1 Introduction

<i>Lawrence B. Wolff</i>	1
1.1 Motivations, General Addressed Problems, Trends, Terminologies	1
1.2 Inside This Book	2
1.3 Evaluation of This Book	5

Part I Space/Time Emerging Face Biometrics

2 Pose and Illumination Invariant Face Recognition Using Video Sequences

<i>Amit K. Roy-Chowdhury and Yilei Xu</i>	9
2.1 Introduction	9
2.1.1 Overview of the Approach	9
2.1.2 Relation to Previous Work	10
2.1.3 Organization of the Chapter	13
2.2 Integrating Illumination and Motion Models in Video	13
2.3 Learning Joint Illumination and Motion Models from Video	16
2.3.1 Algorithm	17
2.3.2 Handling Occlusions	17
2.4 Face Recognition From Video	18
2.5 Experimental Results	20
2.5.1 Tracking and Synthesis Results	20
2.5.2 Face Recognition Results	22
2.6 Conclusions	25

3 Recognizing Faces Across Age Progression

<i>Narayanan Ramanathan and Rama Chellappa</i>	27
3.1 Introduction	27
3.1.1 Previous work on Age Progression	27
3.1.2 Problem Statement	30
3.2 Age Difference Classifier	31
3.2.1 Bayesian Framework	32
3.2.2 Experiments and Results	35
3.3 Facial Similarity	36

XII Contents

3.4	Craniofacial Growth Model	38
3.4.1	Model Computation: An Optimization Problem	39
3.5	Conclusions	42

**4 Quality Assessment and Restoration of Face Images
in Long Range/High Zoom Video**

<i>Yi Yao, Bisma Abidi, and Mongi Abidi</i>	43
4.1 Introduction	43
4.1.1 Scope	43
4.1.2 Related Work	44
4.1.3 Chapter Organization	46
4.2 Database Acquisition	46
4.2.1 Indoor Sequence Acquisition	47
4.2.2 Outdoor Sequence Acquisition	49
4.3 Face Image Quality Assessment	49
4.3.1 Face Recognition Rate vs. System Magnification	49
4.3.2 Adaptive Sharpness Measures	50
4.3.3 Image Sharpness and System Magnification	53
4.4 Face Image Enhancement	54
4.5 Result Validation	56
4.6 Conclusions	60

**5 Core Faces: A Shift-Invariant Principal Component Analysis (PCA)
Correlation Filter Bank for Illumination-Tolerant Face Recognition**

<i>Marios Savvides, B.V.K. Vijaya Kumar, and Pradeep K. Khosla</i>	61
5.1 Introduction	61
5.1.1 Advanced Correlation Filters	62
5.2 Eigenphases vs. Eigenfaces	64
5.3 CoreFaces	68
5.4 Discussion	71

Part II Multi-Sensory Face Biometrics

**6 Towards Person Authentication by Fusing Visual and Thermal
Face Biometrics**

<i>Ognjen Arandjelović, Riad Hammoud, and Roberto Cipolla</i>	75
6.1 Introduction	75
6.1.1 Mono-Sensor Based Techniques	75
6.1.2 Multi-Sensor Based Techniques	77
6.2 Method Details	77
6.2.1 Matching Image Sets	77
6.2.2 Data Preprocessing and Feature Extraction	79
6.2.3 Single Modality-Based Recognition	80
6.2.4 Fusing Modalities	81
6.2.5 Dealing with Glasses	83

6.3	Empirical Evaluation	84
6.3.1	Results	85
6.4	Conclusion	90

7 Multispectral Face Recognition: Fusion of Visual Imagery with Physiological Information

	<i>Pradeep Buddharaju and Ioannis Pavlidis</i>	91
7.1	Introduction	91
7.2	Physiological Feature Extraction from Thermal Images	92
7.2.1	Face Segmentation	92
7.2.2	Segmentation of Superficial Blood Vessels	96
7.2.3	Extraction of TMPs	99
7.2.4	Matching of TMPs	100
7.3	PCA-Based Feature Extraction from Visual Images	102
7.4	Experimental Results and Discussion	103
7.5	Conclusions	108

8 Feature Selection for Improved Face Recognition in Multisensor Images

	<i>Satyanadh Gundimada and Vijayan Asari</i>	109
8.1	Introduction	109
8.1.1	Sensors and Systems	109
8.1.2	Related Work	109
8.1.3	Proposed Methodologies	110
8.1.4	Organization of the Chapter	111
8.2	Phase Congruency Features	111
8.3	Feature Selection	113
8.4	Image Fusion	114
8.4.1	Data Level Fusion	115
8.4.2	Decision Level Fusion	115
8.5	Experimental Results	115
8.6	Conclusion	120

Part III Multimodal Face Biometrics

9 Multimodal Face and Speaker Identification for Mobile Devices

	<i>Timothy J. Hazen, Eugene Weinstein, Bernd Heisele, Alex Park, and Ji Ming</i>	123
9.1	Introduction	123
9.2	Person Identification Technologies	124
9.2.1	Speaker Identification	124
9.2.2	Face Identification	126
9.2.3	Multimodal Fusion	128
9.3	Multimodal Person ID on a Handheld Device	128
9.3.1	Overview	128
9.3.2	Data Collection	128

XIV Contents

9.3.3	Training	130
9.3.4	Face Detection Issues	130
9.3.5	Experimental Results	130
9.4	The Use of Dynamic Lip-Motion Information	132
9.5	Noise Robust Speaker Identification	134
9.5.1	The Posterior Union Model	134
9.5.2	Universal Compensation	135
9.5.3	Experimental Results	136
9.6	Summary	138

10 Quo Vadis: 3D Face and Ear Recognition?

I. Kakadiaris, G. Passalis, G. Toderici, N. Murtuza, and T. Theoharis 139

10.1	Introduction	139
10.2	Related Work	140
10.2.1	Face Recognition	140
10.2.2	Ear Recognition	141
10.3	Methods	142
10.3.1	Generic 3D-Driven Recognition System	142
10.3.2	Data Preprocessing	143
10.3.3	Annotated Model	144
10.3.4	Alignment	144
10.3.5	Deformable Model Fitting	145
10.3.6	Geometry Image Representation	146
10.3.7	Distance Metrics	148
10.4	3D Face Recognition	150
10.4.1	Databases	150
10.4.2	Results	150
10.4.3	Discussion	156
10.4.4	3D Face Recognition Hardware Prototype	156
10.5	3D Ear Recognition	157
10.5.1	Ear-Specific Issues	157
10.5.2	Annotated Ear Model	158
10.5.3	Ear-Specific Algorithm	159
10.5.4	3D Ear Databases	160
10.5.5	Results	161
10.5.6	Discussion	163
10.6	Conclusion	164

11 Human Recognition at a Distance in Video by Integrating Face Profile and Gait

Xiaoli Zhou, Bir Bhanu, and Ju Han 165

11.1	Introduction	165
11.2	Technical Approach	166
11.2.1	High-Resolution Image Construction for Face Profile	167
11.2.2	Face Profile Recognition	170

11.2.3 Gait Recognition	175
11.2.4 Integrating Face Profile and Gait for Recognition at a Distance . .	177
11.3 Experimental Results	178
11.3.1 Data	178
11.3.2 Experiments	178
11.4 Conclusions	181

Part IV Generic Approaches to Multibiometric Systems

12 Fusion Techniques in Multibiometric Systems

<i>Arun Ross and Anil K. Jain</i>	185
12.1 Introduction	185
12.2 Multibiometric Systems	188
12.3 Taxonomy of Multibiometric Systems	190
12.4 Levels of Fusion	193
12.4.1 Sensor-Level Fusion	193
12.4.2 Feature-Level Fusion	196
12.4.3 Score-Level Fusion	200
12.4.4 Rank-Level Fusion	207
12.4.5 Decision-Level Fusion	208
12.5 Summary	212

13 Performance Prediction Methodology for Multibiometric Systems

<i>Natalia A. Schmid and Joseph A. O'Sullivan</i>	213
13.1 Introduction	213
13.2 Stochastic Model for Multimodal Biometric Signatures	215
13.3 Performance of a Multimodal Biometric Recognition System with M Templates	216
13.3.1 Exponential Error Rate Analysis	218
13.4 Recognition Capacity	221
13.5 Examples	222
13.5.1 M -ary Gaussian Example	222
13.5.2 Capacity of the Multimodal System Based on PCA Signatures of the Face and Iris	225
13.6 Summary	227

Part V Acknowledgments, Biographies, References and Index items

Acknowledgments	231
Biographies	233
References	247
Index	273

Face Biometrics for Personal Identification

Multi-Sensory Multi-Modal Systems

Abidi, B.; Abidi, M.A. (Eds.)

2007, XV, 275 p. 68 illus. in color., Hardcover

ISBN: 978-3-540-49344-0