

Contents

1	Introduction to Gait Biometrics	1
1.1	Context	1
1.2	Objectives	3
1.3	Summary of Contributions	5
1.3.1	Feature Extraction	5
1.3.2	Normalization	5
1.3.3	Classification	5
1.3.4	Shoe Variation	6
	References	6
2	Gait Biometric Recognition	9
2.1	Introduction to Machine Learning	9
2.1.1	Machine Learning Paradigm	9
2.1.2	Machine Learning Design Cycle	10
2.2	General Principles of Designing Gait Biometric-Based Systems	16
2.3	Authentication Using the Gait Biometric	22
2.3.1	Privacy and Security Implications of Gait Biometrics	23
2.3.2	Gait Biometric Approaches	24
2.4	Summary	32
	References	33
3	Gait Biometric Recognition Using the Footstep Ground Reaction Force	37
3.1	The Ground Reaction Force	37
3.2	Feature Extraction	42
3.3	Normalization	44
3.4	Classification Approaches	45
3.5	Shoe Type	48

3.6	The Demonstrative Experiment	49
3.7	Summary	50
	References	50
4	Feature Extraction	53
4.1	Geometric	53
4.2	Holistic	64
4.3	Spectral	72
4.4	Wavelet Packet	78
4.5	Summary	85
	References	86
5	Normalization	89
5.1	Scaling and Shifting	90
5.2	Regression	94
5.3	Dynamic Time Warping	99
5.4	Summary	109
	References	110
6	Classification	111
6.1	K -Nearest Neighbors	112
6.2	Multilayer Perceptron Neural Network	116
6.3	Support Vector Machine	122
6.4	Linear Discriminant Analysis	132
6.5	Least Square Probabilistic Classifier	145
6.6	Summary	153
	References	154
7	Experimental Design and Dataset	157
7.1	Evaluation of Gait Biometric-Based Systems	157
7.2	Experimental Design	161
7.2.1	Recognition Techniques	162
7.2.2	Experimental Biometric System	163
7.2.3	Experimental Scope	165
7.3	Experimental Data	167
7.4	Summary	171
	References	172
8	Measured Performance	175
8.1	Evaluation Dataset	175
8.2	Stepping Speed Normalization	179
8.3	Shoe Type Variation	183
8.4	Summary	188
	Reference	188

9	Experimental Analysis	189
9.1	Findings	189
9.1.1	Shoe Type	190
9.1.2	Normalization	191
9.1.3	Biometric System	193
9.2	Considerations and Implications	195
9.2.1	Data	196
9.2.2	Preprocessing	196
9.2.3	Classification	197
9.3	Potential Improvements	198
9.3.1	Feature Extraction	199
9.3.2	Normalization	199
9.3.3	Classification	200
9.4	Summary	200
	References	201
10	Applications of Gait Biometrics	203
10.1	Application Areas	203
10.2	Modes of Operation	204
10.3	Gait Biometric Methods in Commercial Use and Research and Development	205
10.4	Integration of Gait Biometrics with Other Biometrics or Technologies	207
	References	207
11	Conclusion and Remarks	209
11.1	Conclusion	209
11.2	Future Perspectives	212
11.2.1	Gait Biometric Trends and Challenges	212
11.2.2	Advances in Biometric Gait Recognition	214
	References	215
	Appendix: Experiment Code Library	217
	Index	219

Machine Learning Techniques for Gait Biometric
Recognition

Using the Ground Reaction Force

Mason, J.E.; Traore, I.; Woungang, I.

2016, XXXIV, 223 p. 76 illus., 3 illus. in color., Hardcover

ISBN: 978-3-319-29086-7