

# Index

## A

- active appearance model (AAM) 195, 196, 200, 201, 202
- active shape model (ASM) 23, 31, 32
- AdaBoost 196, 200, 227–242, 260
- anisotropy 20
- artificial neural network (ANN) 48, 49, 52, 53
- ASR system 93
- autoregressive (AR) 372
- average error rate (AER) 47, 48, 49, 51, 52

## B

- background modeling 223
- backpropagation through time (BPTT) 373
- balanced decomposition 268, 275, 278, 280, 281
- Biceps Brachii (BB) 377
- bioinformatics 325–327, 333, 335, 342, 343, 410, 420

## C

- Center of Excellence for Document Analysis and Recognition (CEDAR) 112, 114, 115, 119
- cepstral coefficients (CLPC) 106
- chain code 4, 142–146, 151, 152, 153, 154, 155, 158, 180, 181, 185
- class-dependent feature selection 284, 287, 291, 292, 293, 294, 296
- class-independent feature selection 286, 287, 292, 294, 296
- classification and regression tree (CART) 236

- class separability measure (CSM) 287, 296
- cluster analysis 325, 326, 327, 328, 329, 330, 333, 335, 338, 339, 340, 341, 389, 396
- clustering algorithm 325, 326, 327, 328, 329, 330, 331, 332, 340, 396
- connection scheme 247, 248
- consensus partition 330, 331, 332, 333, 334
- contour smoothing 3
- convolutional neural network (CoNN) 245

## D

- decision surface 301, 302, 307, 310, 316, 317
- deskewing 3
- difference code 142, 143, 146, 149, 150, 152, 177
- digital signal processors (DSP) 205, 207, 208, 265, 266, 267, 277, 278, 279, 280, 281, 282, 385, 389, 405, 406
- discrete wavelet transform (DWT) 267
- dissimilarity representation 47, 56
- distance classifier 47, 48, 52
- distributed arithmetic (DA) 265, 267, 278, 279, 280
- dyadic interaction model 220

## E

- elastic matching (EM) 17–38
- Electromyographic (EMG) 371
- equal error rate (EER) 47, 49, 50, 51
- Extended Shadow Code (ESC) technique 45, 56
- Extensor Carpi Ulnaris (ECU) 377

**F**

face detection 196, 203–210, 229, 230, 240, 241, 243, 244, 251–259, 261, 263, 264, 397, 399, 404, 408, 411, 414, 415, 417, 418  
 face recognition ix, xiii, xiv, 18, 141, 188–197, 202–211, 260, 389, 393, 407, 411, 421  
 false acceptance rate (FAR) 47, 48, 49, 50, 52, 53  
 false rejection rate (FRR) 47, 48, 49, 50, 51, 52, 53  
 fast Fourier transform (FFT) 128  
 feature extraction 2, 5, 9, 12, 15, 390, 419, 421  
 feature map 247, 248, 249, 254, 300–303, 310, 312, 314, 323, 324  
 feature mask 291, 292  
 field programmable gate arrays (FPGA) 204, 207, 210, 265, 267, 268, 276, 265, 275, 278, 280, 281, 282, 283, 407, 410, 411, 413, 415, 417  
 filtered EMG 371  
 FIR filter 277, 278, 281  
 flexible matching 17, 35, 404  
 Flexor Carpi Radialis (FCR) 377  
 Flexor Carpi Ulnaris (FCU) 377  
 forensic analysis of handwriting 110–139  
 forgery detection 63–89  
 functional decomposition x, xv, 265, 268, 272, 281, 283, 413  
 fundamental tone (T0) 106  
 fuzzy ARTMAP 49  
 fuzzy modeling 63, 87

**G**

Gaussian mixture model (GMM) 130, 131, 134, 135, 136, 372  
 gene expression 285, 325, 326, 335, 340, 341, 342, 343, 388, 390, 394, 396, 399, 401–418, 422  
 genetic algorithms 5, 46, 339, 342, 368, 392, 405  
 Gradient, Structural, and Concavity (GSC) technique 45

gradient descent learning 80  
 grid method 63, 73, 75, 86, 87

**H**

Haar-like feature 237  
 handwriting recognition 1–16  
 hidden Markov model (HMM) xii, xvi, 12, 36, 46, 51, 52, 56, 57, 59, 91, 96, 370, 371, 372, 386, 393, 394, 403, 411, 413  
 Hilbert transform 129  
 histogram of oriented gradients (HOG) xv, 227, 228, 232  
 human detection 227–243  
 Hurst parameter 127, 129, 135, 138, 415

**I**

image processing 37, 138, 140–148, 186, 249, 266, 267, 399, 411, 415, 416

**K**

kernel function 290, 291, 313, 314, 324

**L**

linearization viii, xiv, 28, 140, 141, 146, 150–157, 160, 174, 178, 179, 185, 187, 423  
 linear prediction (LP) 101  
 coding (LPC) 94  
 method 100  
 linear spectrum frequencies (LSP) 127, 128

**M**

Matlab Image Processing Toolbox 119  
 mean energy within critical bands (MECB) 127, 130, 133, 134, 135  
 Mel frequency cepstral coefficients (MFCC) 127, 128, 132, 134, 135, 136, 138, 410  
 Mel linear spectral frequencies (MLSF) 127, 128, 132, 134, 135, 137, 394  
 Modified Direction Feature (MDF) technique 45, 50  
 monadic action model 220

morphological structure 140, 141, 157, 160, 163, 166, 170–176, 184, 185, 186  
multi-objective clustering ensemble (MOCLE) 327, 333–339  
multilayer perceptrons (MLPs) 11, 48, 49, 50, 247, 350, 371, 372, 379, 381, 383, 384, 385  
multimodal learning 225

## N

negative correlation learning (NCL) 344–369  
neural filter (NF) 372  
neural networks (NNs) 6, 8, 10–15, 371, 391, 398, 408, 415  
noise elimination 3

## O

occlusion 212–219, 220–229, 400  
off-line signature verification 39–62  
overfitting 20, 27, 29, 30, 33

## P

penalty function 303, 319, 321, 350, 351  
persistence hypothesis 212, 216  
phonetic-based system 92  
pose estimation 193  
pose variability compensation 188  
preprocessing 2, 3, 4  
principal component analysis (PCA) 23, 191, 192, 194, 195, 202, 229, 236, 239, 240, 241, 262, 285, 389  
probabilistic neural networks (PNNs) 370, 371

## R

raw EMG 371  
recurrent NN 374  
RELIEF 285–289, 291–298, 405  
RELIEFF 285, 287, 288, 294

## S

segmentation process 5  
sequence mining 212, 214  
shape recognition 141, 163, 166, 175, 184, 185  
shunting inhibition 244, 246, 249, 261, 262, 264, 390, 412  
signature verification 63–89  
slant estimation 3  
smooth following 140–160, 174, 179, 185  
speciation 344, 345, 356, 358, 367  
stroke model 18, 31, 32  
structural point 153, 161, 163, 164, 166, 175, 178, 180, 181  
structural techniques 47, 52  
support vector machine (SVM) 8, 11, 52, 56, 59, 131, 134, 135, 208, 228–242, 261–285, 287–298, 299–324, 403, 408, 420

## T

Takagi-Sugeno fuzzy model 78, 87  
texture segmentation 244, 251–255, 261  
Triceps Brachii (TB) 377

## U

universal approximator 301, 307  
universal writing model (UWM) 46

## V

VC dimension 233, 305, 306  
very large scale integrated (VLSI) circuit 203, 204, 209, 210, 282, 406, 407, 418

## W

wrapper approach 286, 287, 291