Organization of the Thesis

Chapter 1: Introduction

This chapter elaborates different types of biometrics, performance metrics, and sensors. Different physiological as well as behavioral biometric traits are discussed here. This chapter is also elaborating various types of sensors used for capturing the biometric samples. Different performance metrics and issues in practical implementation also discussed here. Finally multimodal biometric systems, their need and various types are presented.

Chapter 2: Review of Literature

This chapter presents the review of the research in biometric recognition methodologies. Review is presented for face, iris, palmprint, finger-knuckle print, on-line & off-line signature recognition system and different approaches for implementations are discussed here. Unimodal as well as multimodal biometric systems and fusion techniques are reviewed.

Chapter 3: Fingerprint, Palmprint, Finger-Knuckle Print Biometrics

Biometric traits present on hand are discussed here. Fingerprint segmentation, core point detection, orientation estimation algorithms are presented. Palmprint and finger-knuckle print recognition results are presented here. The proposed techniques are based on feature extraction using kekre's wavelets & various orthogonal transforms such as Walsh, Hartley, DCT, Kekre's Transforms.

Chapter 4: Face & Iris

Gabor filter, Kekre's & Haar Wavelets, LBG, KFCG, KMCG based vector quantization techniques are used for face feature vector extraction. Wavelet based energy entropy feature is applied for face recognition, the results and algorithms are discussed here. Iris localization and recognition methodology is presented in this chapter. Iris recognition systems and their performance with pre-processing and without preprocessing are compared.

Chapter 5: Signature Recognition & Keystroke Dynamics

This chapter presents the research in handwritten signature recognition. On line signature recognition is discussed in this chapter. Signature recognition using vector quantization, transforms, and vector quantization based techniques are explored here. Keystroke dynamics is another behavior based biometric trait discussed in this chapter, Euclidian distance and relative entropy based distance metrics are used for classification of keystrokes.

Chapter 6: Multimodal Biometrics

Multimodal biometrics systems and feature fusion and possible variations are presented here. A special type of multimodal system called as hybrid multimodal system is presented here. Besides this multi-algorithmic & multi-instance biometrics systems based on fingerprint & iris biometrics are explored. Need of biometric fusion and achieved performance improvements are discussed. Adaptive feature set update algorithm is presented, this is a novel algorithm aimed for making multimodal biometric system adaptive to change in biometric traits due to ageing in humans.

Chapter 7: Conclusions and Further work

The conclusion based on the techniques and results discussed in Chapter 3 to 7 are presented in this chapter. It is found that the accuracy of multimodal biometric systems is higher than individual unimodal systems. Contributions and future directions based on existing research are given here.

References

List of references used in earlier chapters is given.

Appendix – I

List of Publications

Appendix – II

Concept of ageing adaptation for multimodal biometrics. Adaptive Feature Set Updating (AFSU) algorithm & proposed system architecture.

Appendix – III

Sample images from following biometric databases:

Fingerprint, Palmprint, Finger-knuckle print, Face, Iris, Dynamic Handwritten Signature

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7 Conclusions and Further Work

Abbreviations

2DPCA	2 Dimensional PCA
AFIS	Automatic Fingerprint Identification Systems
ANN	Artificial Neural Networks
API	Application Programming Interface
CCA	Canonical Correlation Analysis
CCD	Charge Coupled Device
CCR	Correct Classification Rate
CHT	Circular Hough Transform
COM	Component Object Model
CVF	Continuous Vector Field
DDA	Digital Difference Analyzer
DNA	Deoxy-Ribo Nucleic Acid
DPI	Dots Per Inch
DTW	Dynamic Time Warping
ED	Euclidian Distance
EER	Equal Error Rate
EGM	Elastic Graph Matching
ER^2	Extended Regression Square
FAR	False Acceptance Rate
FKP	Finger Knuckle Print
FMR	False Match Rate
FNMR	False Non Match Rate
FRR	False Rejection Rate
FTC	Failure to Capture Rate
FTE	Failure to Enroll Rate
FTIR	Frustrated Total Internal Reflection
GLA	Generalized Lloyd Algorithm
GWNN	Gabor Wavelet Neural Network
IBG	International Biometric Group
INCITS	International Committee for Information Technology Standards
KCCA	Kernel Canonical Correlation Analysis
KFCG	Kekre's Fast Codebook Generation Algorithm
KFDA	Kernel Fisher discriminant analysis
KMCG	Kekre's Median Codebook Generation Algorithm
K-NN	K Nearest Neighborhood
KPE	Kekre's Proportionate Error Algorithm
KPCR	Kernel Principal Component Regression
KPCSR	Kernel Principal Component Self Regression

KWEFV	kekre's Wavelet Energy Feature Vector
LBG	Linde-Buzo-Grey
LDA	Linear Discriminant Analysis
LED	Light Emitting Diode
LFD	Live Finger Detection
LGBP	Local Gabor Binary Patterns
LPCC	Linear Predictive Cepstral Coding
MDDA	Modified Digital Difference Analyzer
MFCC	Mel-Frequency Cepstral Coefficients
MRTD	Machine Readable Travel Document
MSE	Mean Squared Error
NoN	Network of Networks
ORF	Orientation Flag Array
ONA	Optimized Neighborhood Averaging
OCON	One Class One Network
PCA	Principal Component Analysis
PSO	Particle Swarm Optimization
ROI	Region of Interest
PNN	Probabilistic Neural Network
RKEEF	Relative Kekre’s Energy Entropy Full Sequence
RWE	Relative Wavelet Entropy
SDK	Software Development Kit
SFV	Signature Feature Vector
SIFT	Scale Invariant Feature Transform
SQG	Squared Gradients
STFT	Short Term Fourier Transform
SVM	Support Vector Machines
UMACE	Unconstrained Minimum Average Correlation Energy
USB	Universal Serial Bus
US-VISIT	United States - Visitor and Immigrant Status Indicator Technology
WEC	Wavelet Energy Component-wise
WEE	Wavelet Energy Entropy
WEF	Wavelet Energy Feature
WEL	Wavelet Energy level-wise
WHT	Walsh Hadamard Transform