An Overview of Multimodal Biometrics using Meta-Heuristic Optimization Techniques for F2R System

Karthikeyan Shanmugasundaram, Ahmad Sufril Azlan Mohamed, Ibrahim Venkat

***Abstract*—Multimodal biometrics is the combination of more than one unimodal biometrics which involves more accuracy by implementing F2R(Face and Fingerprint Recognition) .This survey paper deals with the review of multimodal biometrics using F2R and analyzing various meta heuristic optimization algorithms used at the feature selection level of F2R.**

Index Terms* — F2R - Face and Fingerprint Recognition, multimodal biometrics, Meta *heuristics, Optimization.

I. INTRODUCTION

A biometric system is usually used for recognition based on physiological or behavioral characteristics of an individual. Biometrics system becomes robust method for authentication [1].Biometrics can be classified as Finger print, Face, Knuckle print, palm print, Iris are comes under physiological characteristics whereas Gait, signature and voice are comes under behavioral characteristics.Uniqueness, universality and permanence are the three important aspects in biometrics system.[2].

II. MULTIMODAL BIOMETRICS

Biometrics systems are divided into two categories namely unimodal systems and multimodal systems. Unimodal systems uses only one biometric whereas the multimodal systems uses more than one biometric for identification and verification.[2]. It is commonly used in various engineering applications , border security and immigration purposes and financial applications like ATM withdrawal and fund transfer. The use of multimodal biometrics rather than unimodal biometric will lead to more security and robustness.

A. Multimodal vs UnimodalBiometrics

The advantages of Multimodal biometrics over Unimodal biometric is listed below

- More security
- More Accuracy
- Anti spoofing
- Universality
- Noisy data resistance
- More Robustness

III. F2R SYSTEM

Most of the successful commercial biometric systems currently rely on either Fingerprint or Facerecognition[3]. So, the Face Recognition and Fingerprint Recognition are taken into account on behalf of multimodal biometric system. The F2R system which involves three stages of implementation. They are i)Face Recognition ii) Fingerprint Recognition and iii) Fusion Method.

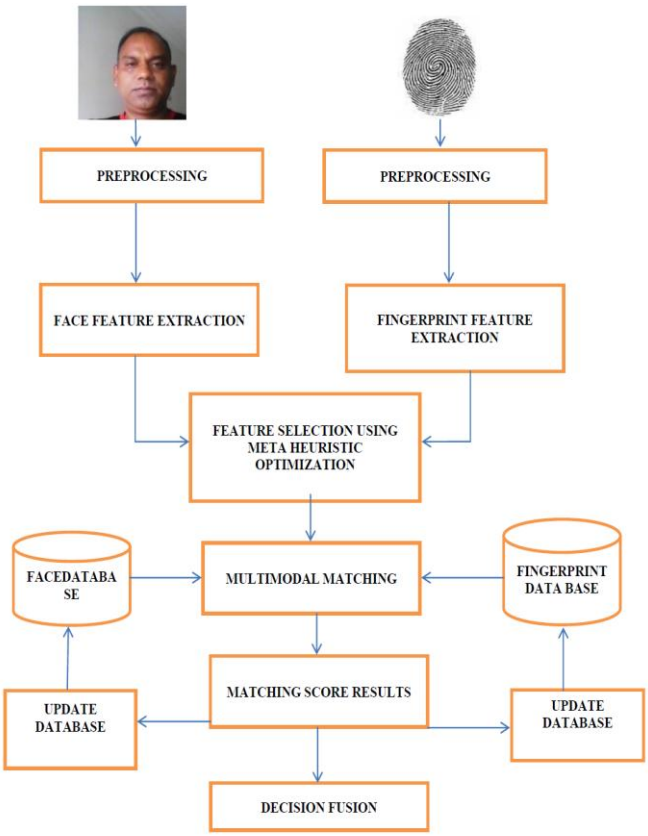

Fig. 1 General framework for F2R system

A. Face Recognition System

Table 1. Summary of Various Face Recognition Techniques

.Methods	Approaches
1.Holistic Methods	Principal component Analysis[PCA] eigenfaces
	Probabilistic eigenfaces
	Fisherfaces/subspace LDA
	SVM
	Evolution pursuit
	Linear Discriminant Analysis(LDA)
	Probabilistic Decision Based Neural Network(PDBNN)
2.Feature Based Methods	Pure Geometry Methods
	Dynamic Link architecture
	Hidden Markov Model(HMM)
	Convolution neural network
	Modular eigenfaces

Revised Version Manuscript Received on October 24, 2015.

KarthikeyanShanmugasundaram, Research Scholar, School of Computer Science, University Sains Malaysia, Penang, Malaysia.

Dr. Ahmad SufrilAzlan Mohamed, Lecturer,School of Computer Science, University Sains Malaysia, Penang, Malaysia.

Dr. Ibrahim Venkat, Senior Lecturer, School of Computer Science, University Sains Malaysia, Penang, Malaysia.

3.Hybrid methods	Hybrid LFA(Local Feature Method)
	Shape normalized
	Component based

Face recognition comes with three technical approaches, holistic approach, Feature-based approach and hybrid methods[4].

B. Fingerprint Recognition System

Fingerprint recognition comes with three technical approaches, correlation based matching, minutiae matching and non-minutiae feature based matching [5].

Table 2. Summary of Various Fingerprint Recognition Techniques

Methods	Approaches
1.Correlation-based Matching	Fourier Transform
	Fourier-Mellin transform
	Correlation filters
2.Minutiae based matching	Similarity score
	Point pattern matching
	Simple algebraic geometry
	Hough transform based approach
	Minutiae matching with pre-alignment
	Intrinsic co-ordinate system
3.Non-minutiae feature based matching	Global and local texture information
	Geometrical attributes and spatial relationship of the ridge lines
	Level 3 features

C. Fusion Techniques

Fusion can be accomplished at various levels in a biometric system. Most multi biometric systems fuse information at the match score level or at the decision level.[10] various types of fusion techniques are summarized[5].

Table 3. summary of various fusion techniques

Information level	Fusion Techniques
Image (or) sensor	Image mosaicking, Image compositing
Feature	Feature concatenation, template consolidation, template adaptation
Score	Sum, mean, median, product, min, max
	Linear discriminant function, logistic regression, neural networks, quadratic classifiers, *k*-nearest neighbor, decision trees, support vector machines
	Generalized ensemble, adaptive weighting, stacking, mixture of local experts (MLE), bagging, boosting, random subspace
Rank	Highest rank, Borda count, weighted Borda count, Dempster-Shafer
Decision	AND, OR, voting, weighted voting

IV. META HEURISTIC OPTIMIZATION

Heuristic is a technique that improves the efficiency of the search process. Metaheuristics are widely recognized as efficient approaches for many hard optimization problems especially for Biometric authentication techniques. The taxonomy of various meta heuristic optimization algorithms are listed .[6]

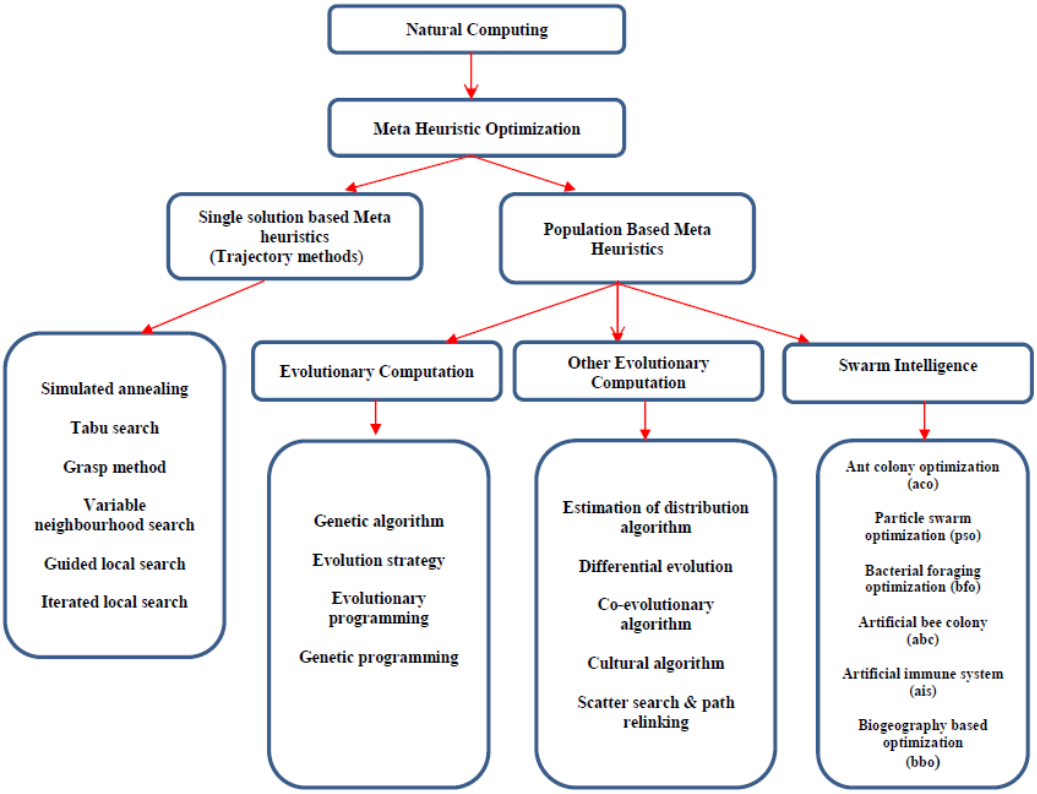

Fig. 2 Taxonomy for Metaheuristic Optimization Techniques

V. COMPARISON OF META HEURISTIC OPTIMIZATION ALGORITHMS

The various meta heuristic optimization algorithms that can be used for Face recognition system and Fingerprint recognition system at the feature selection level , are summarized based on their speed and accuracy levels. [7]

Table 4. Comparison of Accuracy and Speed of Meta Heuristic Algorithms Using the ORL Database

Algorithms	Accuracy	Speed (Sec)	Reference
GA	86.17%	1.334	Li et al. [2010]
GP	63.5%	–	Bozorgtabar et al. [2010]
DE	63.12%	6.4	Mallipeddi and Lee [2012]
ABC	99%	160	Tran and Liatsis [2011b]
PSO	94.5%	160	Cheng et al. [2011]
BFO	100%	272.1	Jakhar et al. [2011]
ACO	96%	960	Kanan et al. [2007]

VI. PERFORMANCE MEASURE

The performance of Face and Fingerprint recognition is measured by two error rates ,False Rejection Rate (FRR) and False Acceptance Rate (FAR).

1) ***False acceptance rate (FAR)***, which is defined asthe probability of an impostor being accepted as agenuine individual. It is measured as the fraction ofimpostor score exceeding the predefined threshold.[8,9].

FAR (%) =no. of accepted attempts by imposter X100%
total no. of attemptsby impostor

2) ***False rejection rate (FRR)****,* which is defined as the probability of a genuine individual being rejected asan impostor. It is measured as the fraction of genuinescore below the predefined threshold.[8,9]

FRR (%) =no. of failed attempts by authorized user$X$ 100%
total no. of attempts by authorized user

VII. CONCLUSION

In this paper, we reviewed the multimodal biometrics system using Face and Fingerprint recognition with various implementation techniques and fusion techniques at various levels . The impact of meta heuristic algorithms takes place at the feature selection level to enhance the performance. Since multimodal biometrics is the emerging technology in the biometric authentication, deploying meta heuristic techniques will effect in high performance and less computational complexity to solve engineering and commercial problems. We reveal that from the survey using the hybrid meta heuristic optimization algorithm will lead to one step ahead to achieve more performance, speed and accuracy than the meta heuristic optimization algorithm.

APPENDIX

F2R- FACE AND FINGERPRINT RECOGNITION
PCA – PRINCIPAL COMPONENT ANALYSIS
LDA – LINEAR DISCRIMINANT ANALYSIS
HMM-HIDDEN MARKOV MODEL
SVM – SUPPORT VECTOR MACHINE
PDBNN- PROBABILISTIC DECISION BASED NEURAL NETWORK
LFA – LOCAL FEATURE METHOD
GA - GENETIC ALGORITHM
DE - DIFFERENTIAL EVOLUTION
GP – GENETIC PROGRAMMING
AIS – ARTIFICIAL IMMUNE SYSTEM
ACO – ANT COLONY OPTIMIZATION
PSO – PARTICLE SWARM OPTIMIZATION
ABC – ARTIFICIAL BEE COLONY
BFO – BACTERIAL FORAGING OPTIMIZATION

REFERENCES

1. M. Deriche, “Trends and Challenges in Mono and Multi Biometrics,” in Proc. of Image Processing Theory, Tools and Application (IPTA), Sousse, pp.1-9, 23-26 Nov 2008.
2. A. Ross, K. Nandakumar and A. K. Jain. Handbook of Multibiometrics. Springer, New York, USA, 1st edition, 2006.
3. A.K.Jain,LinHong and YatinKulkarni, A Multimodal Biometric system Using Fingerprint ,Face and Speech. 2nd International conference on Image Processing, 1999.
4. Zhao et al, “Face Recognition :A Literature survey”,ACM computing surveys,pp399-458,Vol.35,No.4,December 2003.
5. DavideMaltoni et al, “Handbook of Fingerprint Recognition,” springer 2009.
6. IlhemBoussaïd et al, “A survey on optimization meta heuristics”Information Sciences 237 (2013) 82–117.
7. B. Alsalibi et al, “The impact of bio inspired approached towards the advancement of Face recognition,” ACM Computing Surveys, Vol. 48, No. 1, Article 5, Publication date: August 2015
8. M.T. Das, L.C. Dulger,”signature verification (SV)tool box: Application of PSO-NN,” Engineering Applications of Artificial Intelligence 22 (2009) 688–694.
9. L. Hong and A. Jain, “Integrating faces and fingerprints for personal identification”, IEEE Trans. Pattern Anal. Mach. Intell. , Vol. 20, No. 12, pp. 1295– 1307, December 1998.
10. A. Pour, K. Faez, and R. Amirfattahi “Multimodal biometric system using face, ear and gait biometrics”, 10th International Conference on Information Science, Signal Processing and their Applications (ISSPA 2010).