Evaluation of performance Analysis and Weight Calculation in Multimodal Biometric with Face

Mankame Dattatreya P.[1*] and Subban Ravi[2]
1. Dept. of Information Science and Engineering, KLE Institute of Technology, Opposite to Airport, Gokul, Hubballi- 580 030, INDIA.
2. Dept. of Computer Science, School of Engg. and Tech., Pondicherry University, Puducherry-605015, INDIA
*dpmankame@gmail.com; sravicite@gmail.com

Abstract
Multimodal biometric is fairly a technique now-a-days used, that strive to conquer the issues of uni-modal biometric. This can be done when biometric features of different biometrics are statistically independent. The aim of the multimodal biometric is to minimize the performance matrices like, Specificity, Sensitivity and increase Accuracy etc. This research paper presents, multimodal system comprising of Face, Finger print and Iris. In this research work three separate uni-modal biometric traits, namely, Face, Finger print and Iris are used as virtual input. Most of the existing multimodal biometric recognition systems require/believe that the set of biometric traits to be fused is always present as a whole at the time of authentication. However, it is not true in some cases. For e.g. hurt may be caused, person may be under some medical treatment, correlated trait may be absent etc. Thus it overcomes problems of missing or low quality biometric input. The proposed work calculates the weight of each of the biometric trait, based on the features extracted. If the weight is above the threshold value, the person is authenticated. The method extracts Tamura and Histogram features for face, Gabor features for Finger print and Harlick features for iris. The weight for individual biometric trait is obtained using Relevance Vector Machine (RVM) classifier with trained public dataset. The performance measurement is focused on Specificity, Sensitivity, Recognition rate and Response time. The experimental results are tested with MATLAB version MATLAB R2010a with FVC2004 – Finger Print, CASIA version 3 – Iris and MIT-CBCL - face image public datasets.

Keywords: Multimodal, Gabor features, Relevance Vector Machine (RVM), Specificity, Sensitivity,

Introduction

Identity management is an increasing concern across the public and private sectors. Identity theft is at the heart of significantly broader economic susceptibility and national security concerns. Automated way of recognizing a person based on a biological or behavioral characteristic is the fundamental tenet underlying biometrics. Biometric is the subset of the broader field of human identification. A biometric system is essentially a pattern recognition system that recognizes a person by comparing the binary code (template) of a person to the binary code of the stored template in the database. However, each biometric technology has its own strengths and weaknesses, and no single biometric is perfect or effectively satisfying the stringent performance requirements imposed by various applications[1]. Multimodal biometric systems uses more than one modalities to overcome the drawbacks (like noise, non universality, lack of individuals and spoof attacks) of uni-modal biometric that use single biometric trait. On the other hand, multimodal systems address the problem of non-universality: it is possible for a subset of users who do not possess a particular biometric, for e.g. the feature extraction module of a fingerprint authentication system may be incapable to extract features from fingerprints of individual, due to the poor quality of the ridges and valleys. In such cases, it is useful to attain multiple biometric traits for verifying the identity. The proposed research work addresses these problems and attempt has been made to provide the solution [2].

The structure of the remaining paper is divided into five sections. Related work on Multimodal biometric system is discussed in Section II. Section III illustrates the proposed methodology. Section IV depicts experimental results and performance analysis and Concluded in the last section.

Related work on Multimodal Biometric System

Several multi-modal methods have been projected and implemented by the researchers using combination of diverse biometric traits. But, here work based on multimodal biometric using face, finger print and iris traits are only enlisted.

C. N Dinakardas et.al. [3] explains a multimodal system using face, finger print and iris. The method use PCA (Principal Component Analysis), fisher face projection, minutia extraction and LBP (Local Binary Pattern) for Face, Fingerprints and Iris traits.

The fusion levels for multimodal systems are broadly categorized into four system architectures (J. Fierrez-Aguilar et.al.[4], K. Nanadakumar [5]) based on the method used for information fusion as shown in Fig. 1.

Fusion at the Sensor Level: It combines biometric traits coming from different sensors like, Thumbprint scanner, Video Camera, Iris Scanner etc, to form a combined biometric trait and process.

Fusion at the Feature Extraction Level: Here, information taken from the different sensors is encoded into a combined feature vector, which is in turn compared with combined feature vector which is stored in the database as template and assigned a matching score as in a single biometric system.

Fusion at the Matching Score Level: Here, individual feature vectors from each sensor are compared with individual feature vector of templates which are stored separately in the database. Using this, each subsystem computes its own matching score, which are then finally combined into a total score to pass to the decision module.

Fusion at the Decision Level: Individual authentication decision is made for each biometric trait, which is then combined into a final vote, with each subsystem performing like a single biometric system.

Ashraf Aboshosha et al.[6] illustrated fusion of fingerprint, iris and face traits are used at decision level in order to improve the accuracy of the system. Experimental results show that weighted fuzzy logic gives excellent accuracy.

Ramneet Kaur et al.[7] approach which includes 2-D RBWT used for extracting the features. The algorithm gives a high correct recognition rate with low FAR and FRR using Face, Finger print and Iris traits.

Shalini Verma and Dr. R. K. Singh [8] shown the performance of multi-biometric system is improved as compared to the unimodal biometrics using the weighted method in the term of reliability, security, accuracy and usability on multimodal biometric integrating face, Finger print and iris.

A. Annis Fathima [9] devised A JDL (Joint Directors of Laboratories) framework for Person Authentication.

System has been developed. This framework consists of sensing different biometrics (face, fingerprint, iris) using multiple sensors, multiple algorithms, multiple classifiers and multiple fusion level.

Proposed Methodology

Comparing the techniques available in literature and depicted previously, the proposed methodology introduces an innovative idea to coalesce and regulate the multimodal biometric traits using three independent biometric features—face, fingerprint and iris. The conventional fusion methods [10] [11][12] finds score for each single biometric trait and calculates match score using fusion technique. The fusion score is then compared to authenticate a person. The pitfall of the existing system is requirement of additional time for fusion technique at the score level and/or decision level fusion.

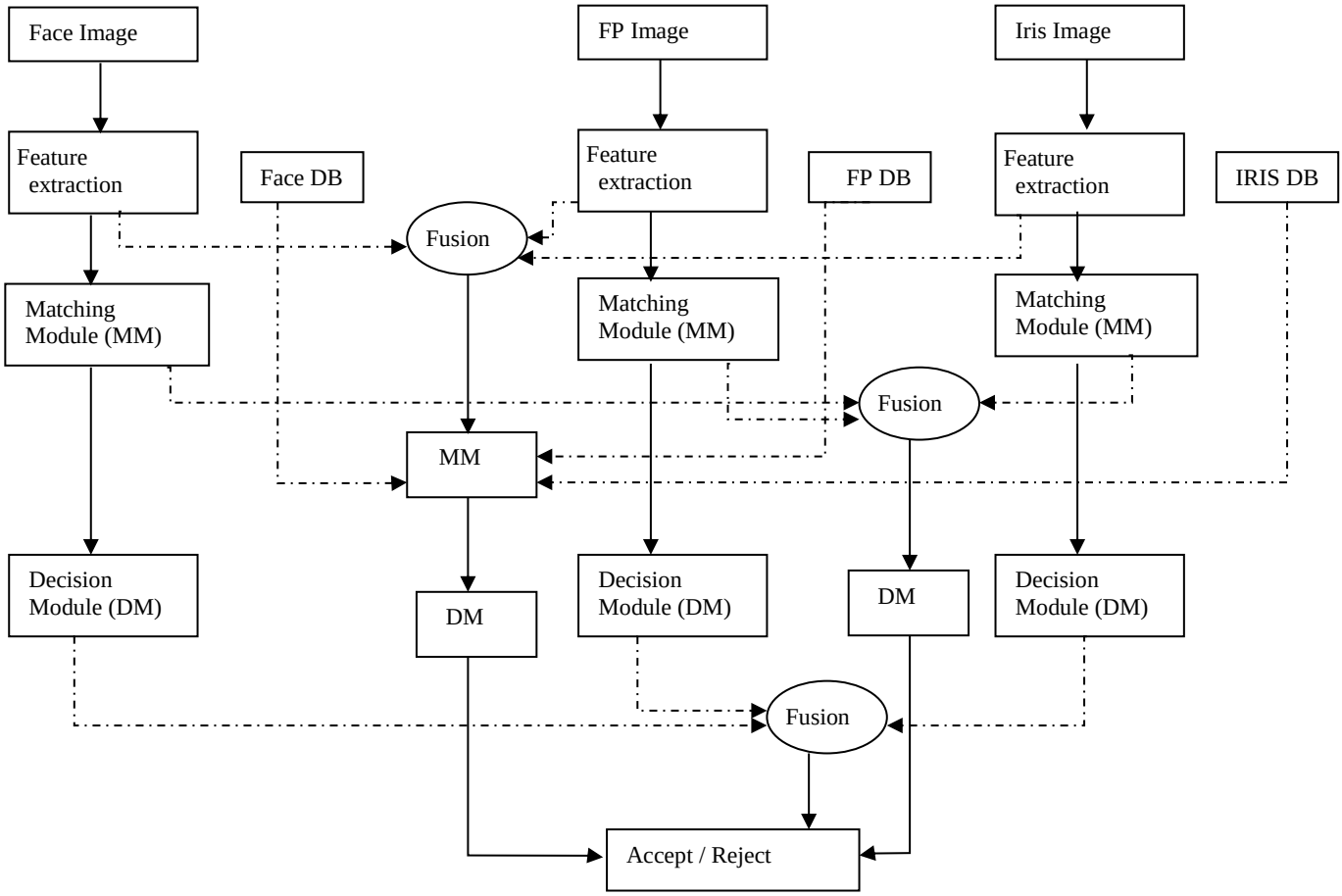

Figure 1: Block Diagram showing different Levels of fusion used in Multimodal Biometric system

The main intention of the proposed system as presented in Fig. 2. is to provide better recognition rate so as to get optimal FAR (False Accept Rate) and FRR (False Reject Rate) by including superior features in biometric security system using facial image, iris image and finger-print image by incorporating enhanced method of feature extraction and classification approach.

The captured image, (in our implementation public database FVC2004 for fingerprint [13], CASIA version 3 for iris[14] and MIT-CBCL for face image [15] database is used) is pre-processed initially. The pre-processing of image is employed through filtering by means of Gaussian filter such-a-way that White Gaussian noise and Poisson distribution noise are eliminated. During segmentation phase, Morphological method was used to segment the ROI of fingerprint to extract minutia points. Iris image is segmented using Geodesic Contour method[16], to separate image from eyelid and eyelashes. Elliptical masking is applied to extract face region.

There are many techniques are used for feature extraction process such as Gaussian Mixture Model (GMM)[10]. In our proposed method, fingerprint minutiae points are extracted using Gabor Convolution method. Iris texture patterns i.e. convoluted features are extracted using Harlick feature extraction method. For face Color histogram features and Tamura texture features are extracted.
Feature selection is vital for effectiveness of the classification process. In this work, feature selection is adopted using PSO (Particle Swarming Optimization) optimization technique.

Classification phase follows the feature selection, in order to recognize multi-class image representation. To attain this in the proposed classification stage, Relevance Vector Machine (RVM) classifier is used. RVM can provide probabilistic interpretation of the output of relevance vector machine, which can be developed for multi-class classification. Using the RVM classifier and feature extraction method, we extract the training features from three of the image database. The extracted features are compared / matched with the image in the database to get the weights for each trait. This weight is compared with the threshold value. If it is more than the threshold, the person is authenticated else rejected.

Experimental Results and Discussion

For the simulation study, MATLAB version R2010a is used. Implementation of the MATLAB code is tested with the Public databases like, FVC2004 for fingerprint images (as shown in Fig.3), MIT-CBCL for face images (as shown in Fig. 4) and CASIA version 3 for Iris images (as shown in Fig. 5) are used.

The performance analysis measuring parameters specificity, sensitivity, recognition accuracy, FAR and FRR are shown in Fig.10. Snapshots of the different phases of face, fingerprint and iris recognition are shown in Fig. 6 to Fig.9. For experimental testing purpose Face, Fingerprint and Iris images of the 50 participants have been taken from the public databases. The experimental results show that recognition accuracy for Face 99.9%, fingerprint 98.4%, and for iris 99.3% is achieved. Sensitivity and specificity obtained for each biometric trait is 100%.

Figure 3: Sample FVC2004 Finger print Images

Figure 4: Sample MIT-CBCL Face Images

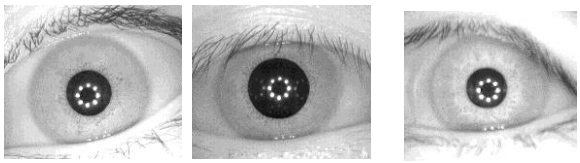

Figure 5: Sample Iris CASIA- version 3 Images

FAR and FRR for individual trait is observed less than 0.1%. Response time overall person authentication is 20.42 seconds as illustrated in Table 1 and Table 2. The advantage of the proposed approach is with the help of RVM classifier, the weights used for authentication purpose for each biometric trait is calculated.

Conclusion

The paper presents multimodal biometric recognition system using three modalities including Fingerprint, Face and Iris.. The simulation test results with FVC2004 – Finger Print, CASIA V3 – Iris and MIT-CBCL - face image datasets prove that the proposed approach is a consistent and attains high degree of security and integrity. The experimental results illustrate that the proposed method provides better results in-terms of specificity, sensitivity, matching accuracy, FAR, FRR and response time as compared with similar kind of work done using with Gabor filter, 2D wavelet, DCT based approach, SVM and by using LBP methods [18]. The result proves that our approach is fastest in terms of matching response time with best of our knowledge. The test result with FAR=0%, FRR=0.05% and Matching time of 0.174 sec is reported. The simulation result also outperforms uni-modal results by analyzing performance measuring parameters.

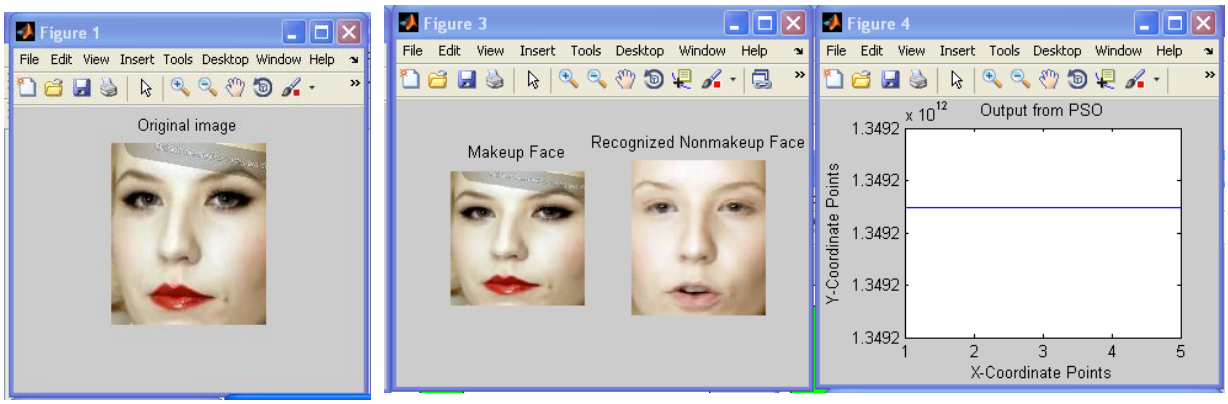

Figure 6: a) Original face image b) Recognized non-makeup face c) PSO output

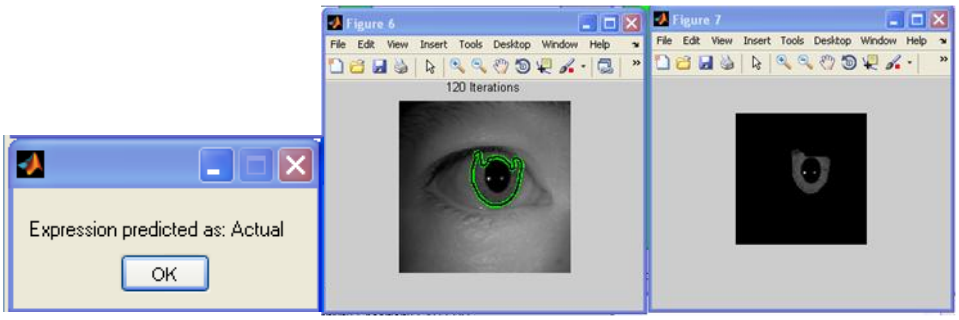

Fig. 7: a) Face expression detected b) & c) Iris segmentation process

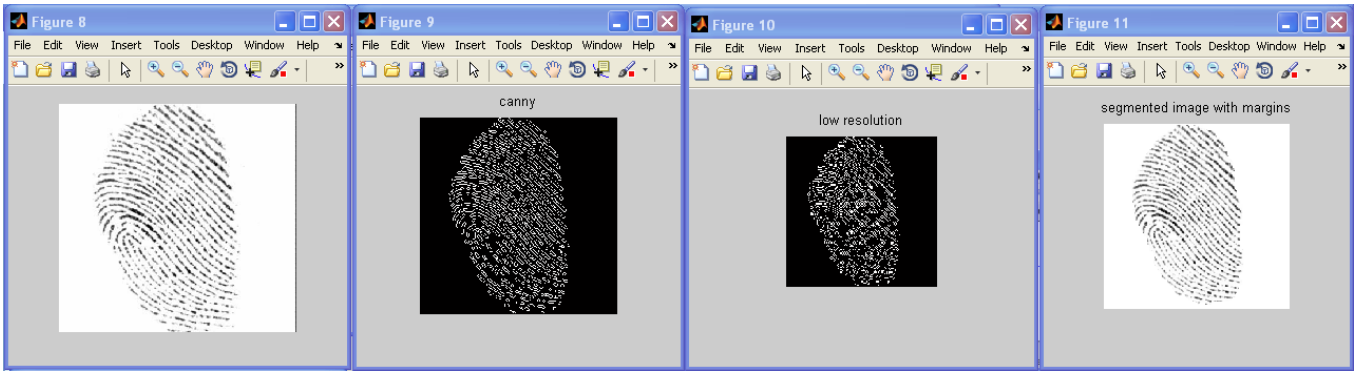

Figure 8: a) to d) Fingerprint preprocessing phases

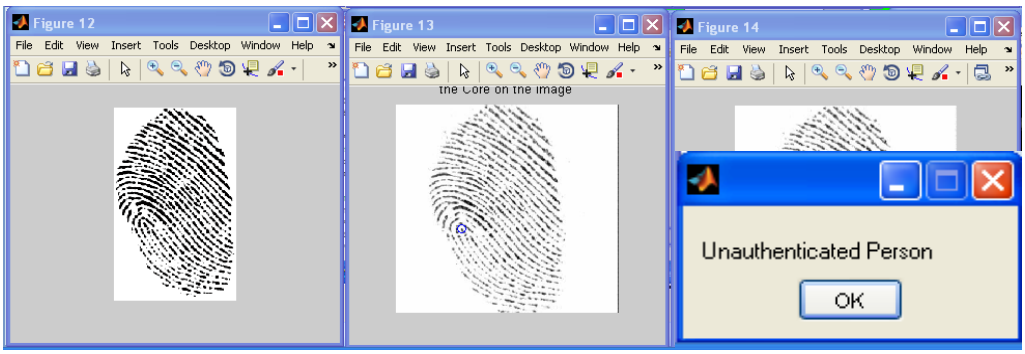

Figure 9: a) to c) Finger print feature extraction phases d) Final authentication result

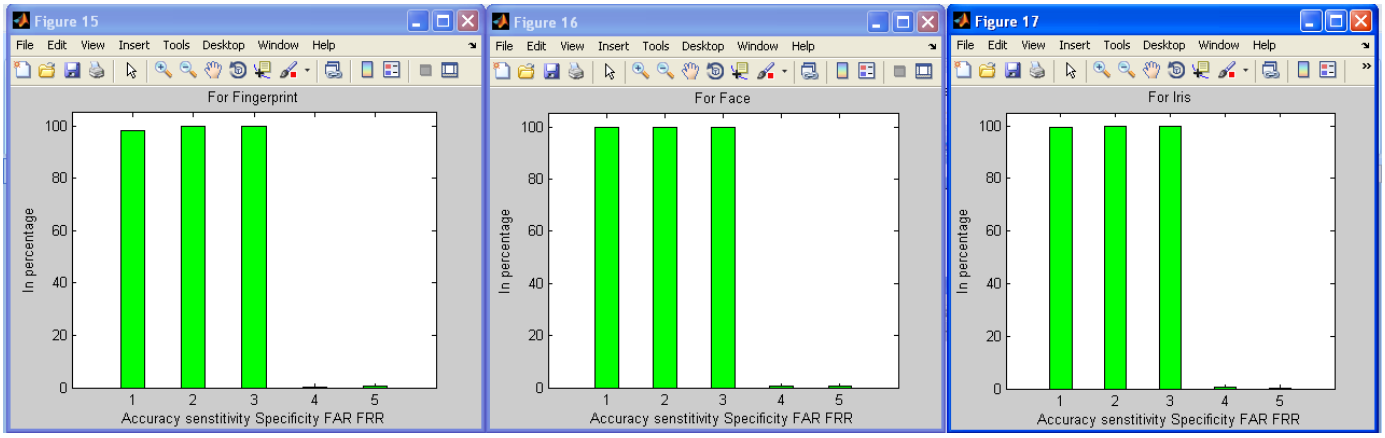

Figure 10: Performance analysis plots a) fingerprint b) face c) Iris

Table 1
Performance Analysis of our proposed approach

Parameters	Face	Finger print	Iris
Accuracy	99.9%	98.4%	99.3%
Sensitivity	100%	100%	100%
Specificity	100%	100%	100%

Table 2
Response time of our proposed approach

Phases	Face	Finger print	Ir is
Preprocessing	0.34	2.25	0. 60
Feature extraction	19.6	1.92	0. 31
Classification	0.48	0.20	0. 18

Table 3
Comparison of Performance Analysis of our approach with various existing methods

Method	Accuracy (%)	Sensitivity (%)	Specificity (%)
2D Wavelet	93.85	92	94
DCT based	90.2370	89	93
LBP	94.32	93	94
Gabor	93.2931	94	95
SVM	95.0704	100	100
Proposed-Face	100	100	100
Proposed-Finger Print	96	100	100
Proposed-Iris	100	100	100

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