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***Research paper***

# Features Level Fusion through Multimodal Biometrics by using Face, Finger Vein, Fingerprint and Iris

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**Abstract**

The fusion of the extracted attributes of the individual two biometrics (such as Face & Fingerprint – Face & Iris – Fingervein and Fingerprint …..) were analyzed. The effect of the Discrete Cosine Transform (DCT) were obtained for compression dataset images and normalize attributes. This fusion increases the strength of system security and authentication, noise when using authentication devices. The authentication procedure plays a pivotal role in the process of security and confidentiality of information as it involves in recognising the users of the device and it might be the failure of the devices to recognise the person via a single dynamic measurement such as fingerprint only become what might be altered by some noise or the effect of lighting. This paper will be dealt with the fusion of four attributes extraction of all the existing biometrics with minimum, maximum, summation, average, and standard deviation for every attributes and fusion them in a new matrix and the similar procedures used before (such as Fingerprint & Face & Fingervein & Iris). After executing this proposal, the best rate of recognition is (100%) when used fusion among the attributes for four biometric including the best accuracy rate (98.9247%).

***Keywords***: *Multimodal Biometrics; Fusion; Features Extraction; Accuracy Rate.*

## 1. Introduction

The usual way of authenticating a person depends on ID cards, password, PIN, etc. Biometric system is recognition on a person automatically and it gained its popularity for its applicability in sectors such as airports, secure financial and information transaction, banking and even in accessing mobile and computer [1].
The unimodal biometrics systems performance comprises of different kinds of problems such as background and signal noise, distortion and environment of device variations. Currently, Biometrics has drawn wide-ranging attention. Multimodal biometric systems are devised to rectify the problems above [2, 3]. Also, the fusion between biometrics is regarded to solve the above problems. The primary notion for fusion in the biometric systems is that there are different stages of fusion to combine two (or more) biometric systems. One of these levels is features level fusion which is followed in the paper by us.

### 1.1. Previous Approaches to Multimodal Biometrics Recognition

In [4] came up with a multimodal biometric identification system based on iris and fingerprint. They rely on attributes fusion that a frequency –based approach outcomes in a homogeneous biometric vector. This proposed system is making the use of fingerprint verification competition (FVC) 2002.
In [5] proposed a feature-level fusion framework to concurrently shield multiple templates of a user as a single secure sketch. The main contributions that are existing there are: (1) practical implementation of the proposed feature-level fusion framework using two renowned biometric cryptosystems namely fuzzy vault and fuzzy commitment, and (2) comprehensive analysis of the interchange between matching accuracy and security in the proposed multibiometric cryptosystems based on two various databases (real and virtual multimodal database), each consisting of the three most widespread biometric modalities namely fingerprint, iris, and face. Experimental outcomes display that both the multibiometric cryptosystems proposed here have higher security and similar performance related to their unibiometric counterparts.
In [6] proposed a multimodal sparse representation method, which characterizes the test data by a sparse linear combination of training data, and it constrains the remarks from diverse modalities of the test subject so that they can share their sparse representations. Thus, they concurrently consider account correlations alongside coupling information among biometric modalities. A multimodal quality measure is also proposed to evaluate each modality as it gets fused. Furthermore, they kernelize the algorithm to maintain nonlinearity in data. The optimization problem is solved using an effective alternative direction method. Various experiments display that the proposed method compares favorably with competing fusion-based methods.
In [7] proposed a multimodal recognition system that fusion results from both PCA, Minutia extraction and Weighred LBP feature extraction on different biometric behaviors. They design the authentication system and it is used for the Iris and Fingerprint to recognize an individual. SVM and ANN classifiers are used for matching.
In [8] proposed new structures based on score, feature, and decision level fusion to efficiently fuse face and iris modalities. Log-Gabor transformation is initialized as the feature extraction method on face and iris modalities. As a mode of evaluation, they used Backtracking Search Algorithm (BSA) to improve the recognition accuracy.

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### 1.2. Approach Taken for Multimodal Biometrics Recognition

This paper represented a recognizing system for Multimodal Biometrics that can be utilized in application of computer vision. This section consists of a comprehensive discussion on fusion details from every two biometrics samples of face, fingerprints, fingervein and iris individually.

## 2. Fusion in Multimodal Biometrics System:

Figure 1 shows the diagram for the system proposed by us and explains how the features extraction will be fusioned. We proposed fusion between every three biometrics (such as Face & Fingerprint & Fingervein & Iris).

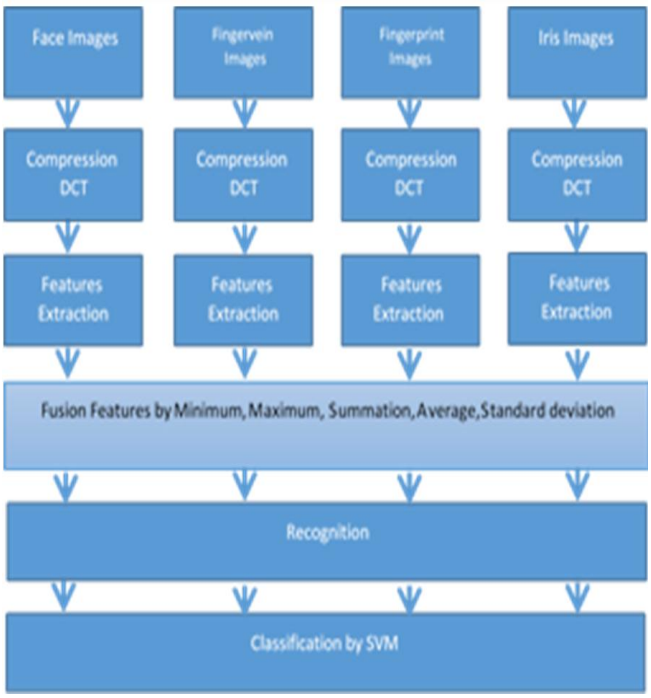



**Fig. 1:** The Proposed System

### 2.1. Features Level Fusion

Fusion is defined as a procedure of combining the significant extracted features, which are stored in a dictionary to gain a single feature file that contains of a lot of information. The relative analysis of feature fusion methods signify that diverse metrics support diverse user needs and to be altered to the application.
In the system that we proposed, we compressed data set images by using Discrete Cosine Transform (DCT). The extraction of the features of fingervein images are done by using Principal Component Analysis (PCA), the features of fingervein images are extracted by using Gray Level Co-Occurrence Matrix (GLCM) Features [9], Minutiae Features will be extracted for fingerprint imaged [10] and Gabor filter Features will be extracted for Iris images. The steps involved in fusion algorithm are summarized as follows:

1) Compression database images for every biometrics using DCT [11].
2) Extract the features: Using different kinds of feature extraction procedures for (PCA for Face – GLCM for fingervein – Minutiae for fingerprint – Gabor Filter for iris) and stock them in a dataset.
3) Implement the fusion method that is proposed (minimum, maximum, summation, average, standard deviation) for all of the features' extraction.
4) Combine the features for four biometrics and generate training dataset.
5) Repeat the steps 1-3 for the test images and carry out the recognition and classification.

Figure 1 represents the proposed system for fusion level. The proposed feature level fusion:

1) Let $X = \{X_1; X_2; X_3; \ldots; X_i\}$ where $X_1$ features extraction for biometric ex: face and $X_2$ features extraction for biometric ex: fingervein.

2) Let 'y' get number of features from every database where

[z y] = size($X_1$)

3) Minimum Rule is that it takes the minimum value of every image in datasets features:

$$F(X)_i = min_{j=y}^{1} X_{i,j} \qquad i = 1,2,\ldots,m.$$

4) Maximum Rule is takes the maximum value of every image in datasets features:

$$F(X)_i = max_{j=y}^{1} X_{i,j} \qquad i = 1,2,\ldots,m.$$

5) Summation Rule is takes the Summation value from every row in datasets features (sum features for every image):

$$F(X)_i = \sum_{j=y}^{1} X_{i,j} \qquad i = 1,2,\ldots,m.$$

6) Average Rule is takes the Average values from every row in datasets features (mean features for every image):

$$F(X)_i = mean_{j=y}^{1} X_{i,j} \qquad i = 1,2,\ldots,m.$$

7) Standard deviation Rule is takes the Standard values from every row in datasets:

$$F(X)_i = \sigma_{j=y}^{1} X_{i,j} \qquad i = 1,2,\ldots,m.$$

When this proposed fusion is applied for every dataset features to get minimum feature per image and maximum, summation, average and standard deviation. Then, we have combined this fusion for every biometrics.

$$F(X) = \{F(X_1); F(X_2); F(X_3); \ldots; F(X_i)\}$$

The output of all the fusion rule can be represented as the matrix.

$$F(X) = \begin{bmatrix} X_{1-min} & \cdots & X_{1-std} \\ \vdots & & \vdots \\ X_{i-min} & \cdots & X_{i-std} \end{bmatrix}$$

### 2.2. Classification

Currently, there are several practical classification algorithms such as support vector machine, the nearest- neighbor algorithm, linear classifiers, the minimum distance algorithm and artificial neural networks. The support vector machine mainly creates a hyper plane in between datasets, so that it can indicate its class. It produces a classifier that can separate the data. There are several imaginable linear classifiers that have the ability to separate data, but there is only one that maximizes the margin i.e. maximizes the distance between it and the nearest data point of the individual classes.

## 3. Results and Discussion

The proposed system was applied under a platform MATLAB 2014. The database that was used contained of four parts CASIA Face Image Database, CASIA Fingerprint Image Database, CASIA Fingervein Image Database and CASIA Iris Image Database. In this paper, fusion among the four biometrics was achieved (Face & Fingerprint & Fingervein & Iris) and show result as shown in Table 1 the best accuracy rate was achieved (98.9247%).

Table 2 shows the outcomes of the previous literature that used the fusion of each of the two biometrics. By comparing the results, a significant improvement is visible in the authentication process when using (Face + Fingerprint + Fingervein + Iris) and comparing our results with other results. The best results have been achieved by us.

**Table 1:** The best accuracy rate

| Fusion Between | Accuracy Rate % |
|---|---|
| Face & Fingerprint & Fingervein & Iris | 98.9247 % |

**Table 2:** Comparison with existing methods

| References | Biometric Modalities | Level of Fusion | Accuracy (%) |
|---|---|---|---|
| [4] | Fingerprint and iris | Feature Level Fusion | 96 % |
| [5] | Iris, Fingerprint and Face | Feature Level Fusion | 97% |
| [6] | Iris, Fingerprint and Face | Sparse matrices | 97.5% |
| [7] | Iris and Fingerprint | Feature Level Fusion | 97.5% |
| [8] | Iris and Face | Score level fusion<br>Feature level fusion<br>Decision level fusion | 95 %<br>94.91 %<br>96.87 % |
| Proposed method | Face + fingerprint + fingervein + iris | Feature Level Fusion | 98.9247% |

## 4. Conclusion

The authentication process is considered as one of the primary pillars in the information technology field, so it had to be thought by us that with a view to reach the best solutions and overcome some of the obstacles we encounter which includes not identifying the identity of an individual when using a single biometric in the identification process. This paper discusses about the fusion of the attributes of all four different biometrics with a view to achieve the optimal results and improve the recognition rate. This is done by using the fusion of the biometrics (Face and x and y) and the best recognition rate () and also accuracy rate ().

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