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# PERFORMANCE ENHANCEMENT FOR BIOMETRIC 3 TRAITS IMAGE FUSION USING SINGULAR VALUE DECOMPOSITION IN 3-DWT

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**ABSTRACT**

A novel method of palm, iris & fingerprint is proposed based on discrete wavelet transform (DWT) and singular value decomposition (SVD). Multimodal Biometrics is more robust and secures then unimodal biometrics. In multimodal fusion at compression level is considered more effective. This work focuses on fusion of Fingerprint, palm and Iris biometrics at 3 level compressions. This paper describes a multimodal biometric system by combining iris, fingerprint and palm at match score level using simple sum rule.The identity established by this system is much more reliable and precise than the individual biometric systems. Experimental evaluations are performed on a public dataset which is 100 image demonstrating the accuracy of the proposed system. The effectiveness of proposed system regarding FAR (False Accept Rate) and FRR (False regression Rate) is demonstrated with the help of MATLAB software.

***Keywords: Multimodal biometrics, fusion, average fusion, discrete wavelet, SVD, FFT etc.***

## I. INTRODUCTION

Security has become an integral part of our lives today with people having numerous accounts and carrying out high value transactions. The advent of technology has helped the criminal to become more intelligent. For example the internet has provided him with easy access to data. Biometrics is increasingly being preferred for security, owing to its uniqueness and being difficult to replicate. Face is used for recognition by humans and was also one of the first modalities to be used for recognition. In automated person identification systems, face is often favored due to the fact that it is a non-intrusive system where very little cooperation is required from the user.

Iris, Palm and fingerprint biometrics perform better as compared to other available traits due to their accuracy, reliability and simplicity. These properties make iris and fingerprint recognition particularly promising solution to the society.The process starts with preprocessing of the acquired images which removes the effect of noise. Further, features are extracted for the training and testing images and matched to find the similarity between two feature sets. The matching scores generated from the individual recognizers are passed to the decision module where a person is declared as genuine or an imposter.

**FAR**

The false acceptance rate, or FAR, is the measure of the likelihood that the biometric security system will incorrectly accept an access attempt by an unauthorized user. A system's FAR typically is stated as the ratio of the number of false acceptances divided by the number of identification attempts

**FRR**

The FRR or False Rejection Rate is the probability that the system incorrectly rejects access to an authorized person, due to failing to match the biometric input with a template. The FRR is normally expressed as a percentage, following the FRR definition this is the percentage of valid inputs which are incorrectly rejected.

### 1. Iris Detection

To find the outer iris boundary intensity variation approach is used. In this approach concentric circles of different radii are drawn from the detected center. The circle having maximum change in intensity with respect to previous drawn circle is iris circle.

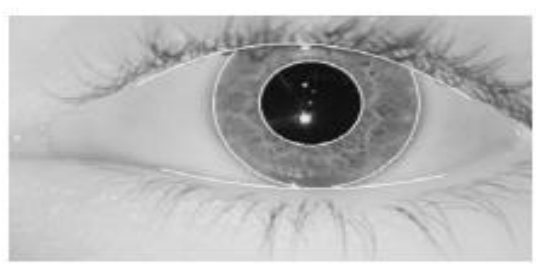

**Fig. 1: White outlines indicate the localization of the iris and eyelid boundaries.**

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The approach works fine for iris images having sharp variation between iris boundary and sclera. The radius of iris and pupil boundary is used to transform the annular portion to a rectangular block, known as strip.

### 2. Fingerprint Recognition

A fingerprint usually appears as a series of dark lines that represent the high, peaking portion of the friction ridge skin, while the valleys between these ridges appears as white space and are the low, shallow portion of the friction ridge skin. Fingerprint identification is based primarily on the minutiae, or the location and direction of the ridge endings and bifurcations (splits) along a ridge path. The images below present examples of fingerprint features: (a) two types of minutiae and (b) examples of other detailed characteristics sometimes used during the automatic classification and minutiae extraction processes.

The use of minutiae feature for single fingerprint classification has been shown below.


**Fig. 2 (a): Minutiae Fingerprint**


**Fig. 2(b): Other Fingerprint**

The major steps involved in fingerprint recognition using minutiae matching approach after image acquisition isImage Enhancement, Minutiae Extraction and Matching.

### 3. Palm recognition

Palm recognition technology exploits some of these palm features. Friction ridges do not always flow continuously throughout a pattern and often result in specific characteristics such as ending ridges or dividing ridges and dots. A palm recognition system is designed to interpret the flow of the overall ridgesto assign a classification and then extract the minutiae detail — a subset of the total amount of information available, yet enough information to effectively search a large repository of palm prints. Minutiae are limited to the location, direction, and orientation of the ridge endings and bifurcations (splits) along a ridge path.

The images in Figure 2 present a pictorial representation of the regions of the palm, twotypes of minutiae, andexamples of
other detailed characteristics used during the

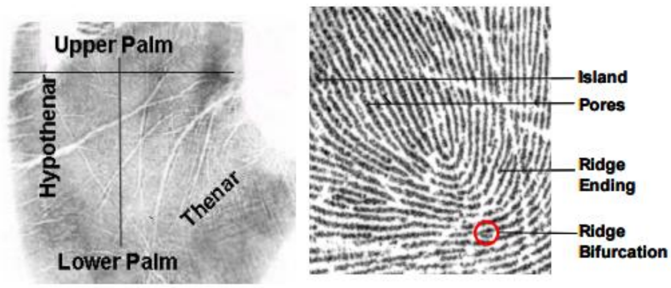


**Figure 3: Palm Print and Close-up Showing Two Types of Minutiae and Other Characteristics**.

automatic classification and minutiae extraction processes.

## II. LITRATURE REVIEW

A variety of articles can be found which propose different approaches for traditional and multimodal biometric system.

ShekharKaranwalet. al. presented a comparison of two biometric traits (face and palm print) and three biometric traits (face, palm print and fingerprint). The system is followed by fusing the two and three biometric traits with the help of wavelet transform. Then the feature is been extracted by SIFT(Scale invariant fourier transform). The comparison was show by the help of FAR (False acceptance ratio) and FRR(False rejection ratio)

P.U.Lahaneet. al presented a fusion of iris and fingerprint biometric for security purpose. The system is going to check the value of the FAR (False acceptance ratio) and FRR (False rejection ratio) with different threshold value.

S. Prabhakaret. al. presented a unimodal fingerprint verification and classification system. The system is based on a feedback path for the feature-extraction stage, followed by a feature-refinement stage to improve the matching performance. This improvement is illustrated in the contest of a minutiae-based fingerprint verification system. The Gabor filter is applied to the input image to improve its quality [2].

N. K. Rathaet. al. proposed a unimodal distortion-tolerant fingerprint authentication technique based on graph representation. Using the fingerprint minutiae features, a weighted graph of minutiae is constructed for both the query fingerprint and the reference fingerprint. The proposed algorithm has been tested on a large private database with the use of an optical sensor [3].

## III.PROBLEM STATEMENT

Palm print, Fingerprint and Iris recognitions has been investigated over the past years. During this Period, many different problems related to palm print recognition have been addressed.This was believed to increase user acceptance and reduce maintenance effort of the system. Nevertheless, they might cause problem as the image quality may be low due to uncontrolled illumination variation and distortion due to hand movement. Any biometric method may present some rejection problem, because they involve human and biological characteristics. That means that even a person whose fingerprint is already recorded may not be recognized. This is called "false rejection" and happens with any technology and manufacturer.

## IV. SYSTEM MODEL

### Fusion

The different biometrics systems can be integrated at multi-classifier and multi-modality level to improve the performance of the verification system. However, it can be thought as a conventional fusion problem i.e. can be thought to combine evidence provided by different biometrics to improve the overall decision accuracy.

S1: Given a query image as input, features are extracted by the individual recognizers and then an individual comparison algorithm for each recognizer compares the set of features and calculates the matching scores or distances corresponding to each recognizer for various traits.

S2: The scores/distances obtained in S1 are normalized to a common range between 0 to1.

S3: These scores are then converted from distance to similarity score by subtraction from 1 if it is a dissimilarity score. For example the dissimilarity scores, in case of fingerprint recognition using reference point algorithm ($D_{Ref}$), iris recognition using Haar Wavelet ($D_{Haar}$) and Circular Mellin operator ($D_{Mellin}$) are converted to similarity scores ($MS_{Ref}$, $MS_{Haar}$, $MS_{Mellin}$)

S4: The matching scores are further rescaled so that threshold value becomes same for each recognizer.

S5: Then the combined matching score is calculated by fusion of the matching scores of multiple classifiers using sum rule technique.

$$MS_{Face} = \frac{\alpha \times MS_{EBGM} + \beta \times MS_{KDDA}}{2},$$

$$MS_{Finger} = \frac{\alpha \times MS_{\mathrm{Re}\,f} + \beta \times MS_{MIN}}{2}$$

$$MS_{Iris} = \frac{\alpha \times MS_{Haar} + \beta \times MS_{Mellin}}{2}$$

where α and β are the weights assigned to individual classifiers. Currently equal weightage is given to each classifiers and the value of α and β is one.

$$MS_{Final} = \frac{1}{4}(\alpha \times MS_{Face} + b \times MS_{Finger} + c \times MS_{Iris} + d \times MS_{Sign})$$

where$MS_{Face}$ = matching score of face, $MS_{Finger}$ = matching score of fingerprint, $MS_{Iris}$ = matching score of iris, and $MS_{Sign}$ = matching score of signature and a, b, c and d are the weights assigned to the various traits. Currently, equal weightage is assigned to each trait so the value of a, b, c and d is one. The final matching score ($MS_{Final}$) is compared against a certain threshold value to recognize the person as genuine or an imposter.

### Fast Fourier Transform

We have seen that N- point DFT is given by the following expression

$$X(m) = \sum_{n=0}^{N-1} x_n e^{\frac{-j2\pi nm}{N}}$$

Let $a = e^{\frac{j2\pi}{N}}$, the $N^{th}$ root of unit. Then the following relationships can be easily derived.

1) $1 + a + a^2 + - - - - - - + a^{N-1} = 0$

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*Proof:* using Geometric progression series formula

$$x + xr + xr^2 + ----- + xr^{N-1} = \frac{x(1-r^N)}{(1-r)}$$

We get,

$$1 + a + a^2 + ----- + a^{N-1} = \frac{1(1-a^N)}{(1-a)} = \frac{(1-1)}{(1-a)} = 0$$

because $a^N = 1$

2) From $a^m a^{N-m} = 1$ and $a^m (a^m)^* = 1$,

we get

$$(a^m)^* = a^{N-m}$$

Hence $a^* = a^{N-1}$, $(a^2)^* = a^{N-2}$ etc.

3) From the fact $a^{-1}a = 1$ and $a^* a = 1$, we have

$a^{-1} = a^* = a^{N-1}$ and $a^{-2} = (a^*)^2 = a^{N-2}$

etc.

## V. PROPOSED IMPLEMENTATION SVD AND DWT

The basic principle used in linear algebra for SVD is the factorization of rectangular real or complex matrix into diagonal symmetric or Hermitian square matrices using eigenvectors [4]. SVD of an m n × matrix X is given by:

$X = U_x \Sigma x V_x^T$……………………………………………………(1)

where the columns of the m *n matrix $U_x$ are called the left singular vectors, the rows of the n*n matrix $V_x^T$ contain the elements of the right singular vectors, and the diagonal elements of the n*n diagonal matrix $\Sigma_x = diag(\sigma_1, \ldots\ldots, \sigma_n)$ are called the singular values.

The singular value matrix ∑x represents the intensity information of a given image [5], where the highest singular values have a great amount of image information. Wavelet-based analysis of signals is an interesting tool. Like Fourier series analysis, where sinusoids are chosen as the basic functions, wavelet analysis is based on a decomposition of a signal using an orthonormal family of basic functions [6]. Wavelet signal have its energy in time and are suitable for the analysis of transient, time varying signals. Accordingly, Discrete Wavelet Transformation (DWT) analysis in spatial domain gives good performance in detecting discontinuities or subtle changes in gray level. If the function being expanded is a sequence of numbers, the resulting coefficients are called the DWT of f (x). The DWT transform pair is defined as following

$$W_\varphi(j_0, k) = \frac{1}{\sqrt{M}} \sum_x f(x) \varphi_{j_0,k}(x) \quad \ldots 2$$

$$W_\psi(j, k) = \frac{1}{\sqrt{M}} \sum_x f(x) \psi_{j,k}(x), \quad \ldots 3$$

for $j = j_0$

$$f(x) = W_\varphi(j_0, k) + W_\psi(j, k) \quad \ldots 4$$

where f(x ), $\varphi_{j_0,k}(x)$, and $\psi_{j,k}(x)$, are functions of the discrete variable

x = 0,1,2, ... , M-1.

The coefficients defined in Equation (1) and (2) are usually called approximation and detail coefficients, respectively. The process of computing these coefficients is referred to as DWT analysis.

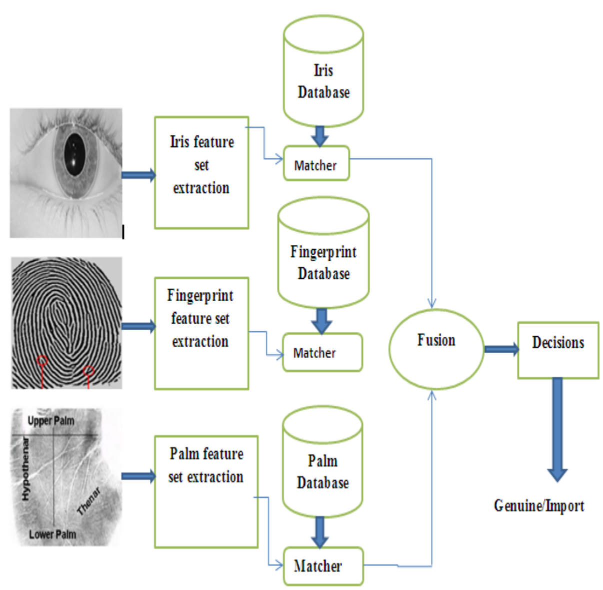


**Fig. 4 Architecture of proposed multimodal biometric Fusion of Iris, Palm & Fingerprint**

## VI.RESULT

The performance of proposed method of SVD and DWT image fusion is tested using different levels of distorted images.

**Table 1**

| Performace Measure | Multimodal (Iris + Fingerprint + Palm Print) |
|---|---|
| FAR | 1.7 |
| FRR | 3.9 |
| ACCURACY | 96.8 |

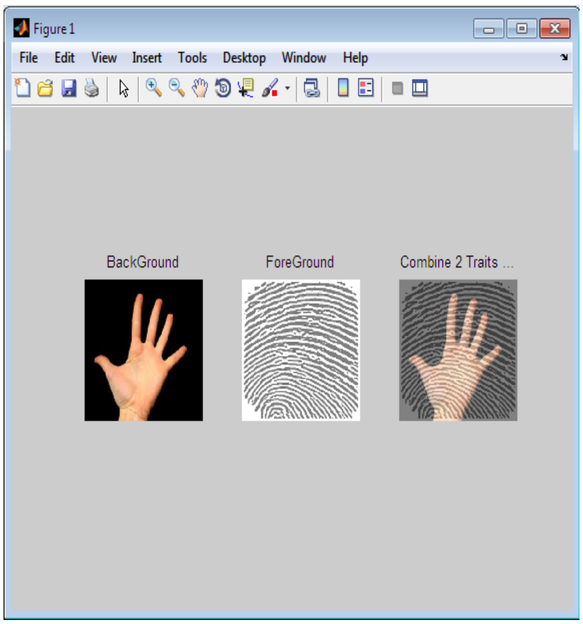


**Figure 1: Combination of 2 Traits**

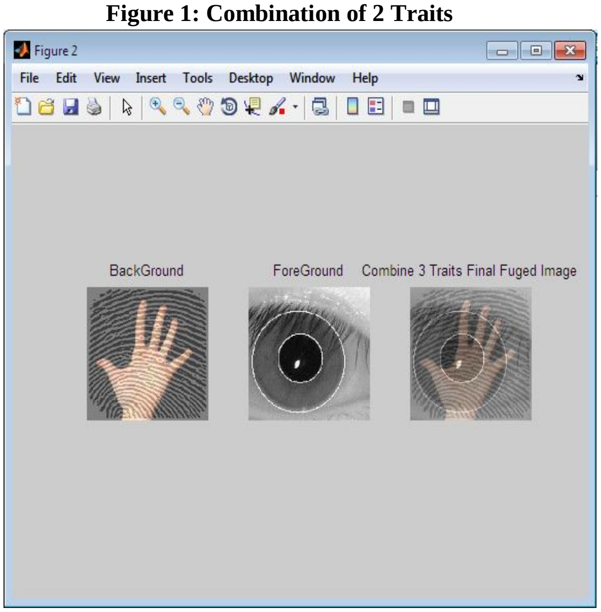


**Figure 2: Combination of 3 Traits**

## VII.CONCLUSION

Biometric systems offer several advantages over traditional based methods. This work focuses on using the multimodal biometrics. A New framework for fingerprint, palm and iris recognition using support vector decomposition based 2 Traits & 3 Traits fusion. The individual scores of two traits, palm and fingerprint are combined at the matching score level to develop a multimodal biometric authentication system.The noise present in the image (i.e, Iris, Palm & Fingerprint) is eliminated by setting threshold. By this technique, the effective data from the input image can be easily extracted and FFT is used for Noise variance with DWT 3 level from Wavelet transform and SVD and it is observed that SVD algorithm gives better results.

In future, the results on hardware can be improved for larger database and further using new techniques, an efficient feature extraction can be done.

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