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Feature Level Fusion of Palmprint and Iris

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Abstract

In many real-life usages, single modal biometric systems repeatedly face significant restrictions due to noise in sensed data, spoof attacks, data quality, nonuniversality, and other factors. However, single traits alone may not be able to meet the increasing demand of high accuracy in today's biometric system.Multibiometric systems is used to increase the performance that may not be possible using single biometrics. In this paper we propose a novel feature level fusion that combines the information to investigate whether the integration of palmprint and iris biometric can achieve performance that may not be possible using a single biometric technology. Proposed system extracts Gabor texture from the preprocessed palm print and iris images. The feature vectors attained from different methods are in different sizes and the features from equivalent image may be correlated. Therefore, we proposed wavelet-based fusion techniques. Finally the feature vector is matched with stored template using KNN classifier. The proposed approach is authenticated for their accuracy on PolyU palmprint database fused with IITK iris database of 125 users. The experimental results demonstrated that the proposed multimodal biometric system achieves a recognition accuracy of 99.2% and with false rejection rate (FRR) of = 1.6%.

***Key words*:*Authentication, Biometric, Fusion, Iris, KNN classification,Multimodal,Palmprint, Wavelet, Gabor.*

1.Introduction

Biometrics is the science of determining the identity of a person based on the behavioral physical and chemical attributes. The importance of the biometrics has been strengthened by the claim for large-scale identity management systems whose functionality relies on the accurate determination of an individual's identity in the context of several different applications. A multimodal biometric systems fuse the evidence presented by multiple biometric sources and typically better recognition performance compete to system based on a single biometric modality. Biometric modalities including, face, iris, voice, signature, palmprint, fingerprint etc. are now widely used in security applications. Each modality has its individual merits and demerits. The selection of a biometric characteristic highly depends on its usage and application. The hand-based biometric acquisition has higher user acceptance and is more user friendly. The fingerprint, face, iris, palmprint modalities have been highly explored, and are nowadays available in real-world practice.A palm print contains distinctive features such as principal lines, wrinkles, ridges and valleys on the surface of the palm. Palmprint has abundant lines and ridge structure, which can be used for matching[1] – [5].To localize the iris image [6] proposed integrodifferential operator (IDO), and [7] used Hough transform technique. For example, [8]estimated the pupil position [9] implemented an edge detection method for iris boundary extraction.[10] deployed a wavelet transform to locate the iris inner boundary, and used Daugman's IDO for the outer boundary. [11]applied mixtures of three Gaussian distributions. To improve the Hough transform result [12]used some heuristics. Therefore, in order to increase the performance of the automated system, it is advisable to go for multimodal biometrics.Multimodal biometric techniques have attracted much attention as the additional information between different biometric could get better recognition performance.

Before performing multi-biometrics on palmprint and iris, it is important to understand the background for mono-modal biometrics involving these sites. Various studies have shown how the palmprint and iris are viable biometric features. Due to theavailabilityof different features, different methods of evaluation, here we will analysis some commonly available biometric methods and their evaluation and describe how they can be fused.

The important aspect in multimodal biometric is the fusion or the combination of modalities at the score level decision level match level or feature level [13].There are four levels for information fusion [14],[15]: pixel level fusion, feature level fusion, match score level fusion and decision level fusion. Many studies in biometrics fusion have been done at match score level and decision level [15].Since feature level fusion contains richer information of the multibiometrics than match score level fusion and decision level fusion, it is able to obtain a better performance.

Although existing multimodal fusion techniques have been shown effectively to improve the accuracy of biometrics-based verification, they also face some limitations. For example, most existing multimodal fusion schemes, exclusively some single parametric machine learning fusion strategies, are based on the assumptions that each biometric modality is available and complete [14], [16], [17] so each registered person must be entered into every modality. Once a modality is unavailable or missed, the multimodal systems break down or the accuracy degrades. This may not be plausible and is very restrictive. Additionally, in existing multimodal fusion techniques, when the parametric learning fusion strategies are adopted at the matching score level [14], [16], [17],[18] the fusion is viewed as a classification problem, in which the score vector is classified into one of two classes: “Accept” (genuine user) or “Reject” (impostor). However, the above approach seems to lack flexibility when different performance demands are required in real applications. Concerning these problems, some solutions are given in this work. In this paper, we proposed a robust multimodal authentication scheme which addresses the problem mentioned above. The proposed multimodal scheme integrates two biometric modalities face and palmprint. Two biometric verifiers are fused at the feature level fusion.

This paper proposes an efficient multimodal biometric identification method which involving two biometric traits namely iris and palmprint. The proposed systems are intended for application where we have to use iris and palmprint. Combining the palmprint and iris enhances the sturdiness of the individual authentication. Multimodal biometric system is developed through combination of iris and palmprint recognition.

2. Basic Block Diagram

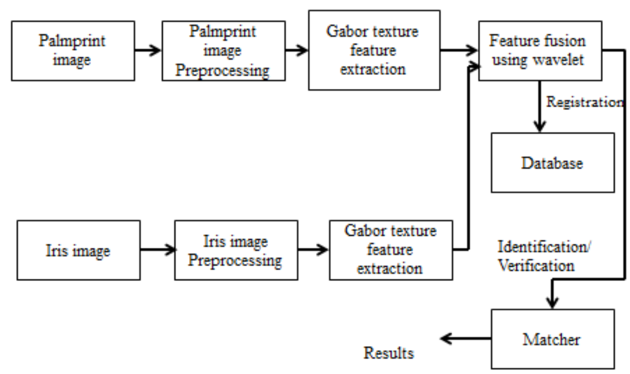


Fig. 1 Typical Block Diagram of aMultimodal Biometrics

This paper mainly discusses the fusion of palmprint and iris biometrics. However, the algorithm and analysis presented here can also be applied to other multimodal biometric fusion applications.Here Figure 1 illustrates a typical multimodal biometric authentication system. It consists of three main blocks that of preprocessing feature extraction and fusion.

- Input the palmprint and iris image as input.
- Selected features texture using Gabor.
- The features are merged by wavelet fusion.
- Nearest neighborhood algorithm with distance calculation is used for classification of image.
- The test image is classified and the score of matching is calculated and the matched image is taken as output.

3.Proposed Multimodal Biometric Recognition Block Diagram

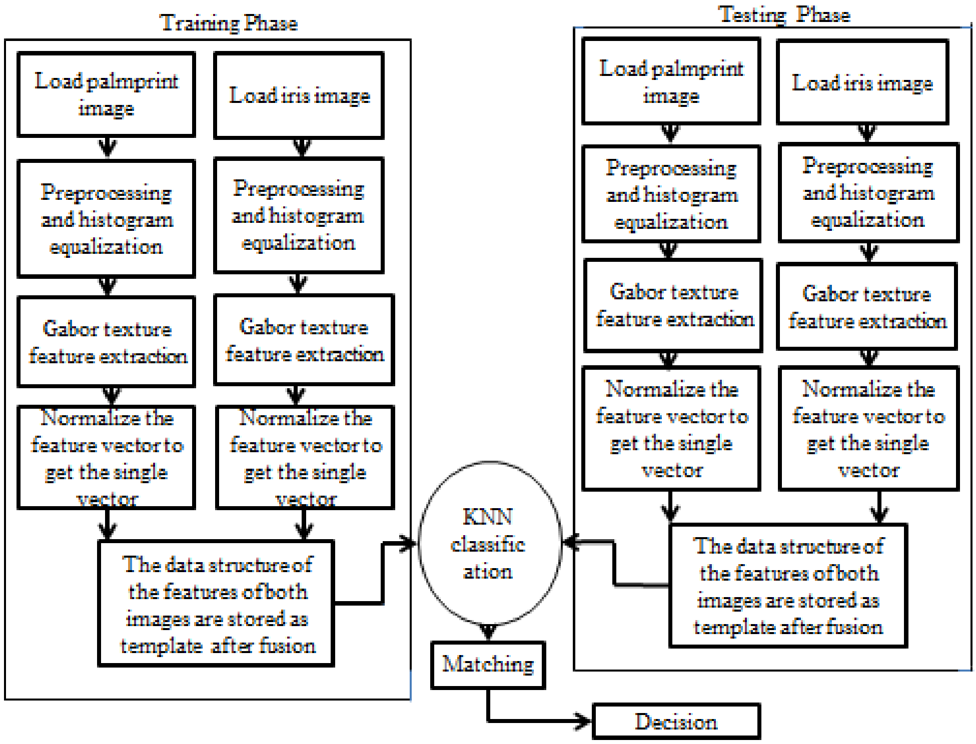


Fig. 2. Proposed Multimodal Biometric Recognition System

Our methodology for testing multimodal biometric systems focuses on the feature level fusion. This methodology has the benefit of exploiting more amount of information from each biometric. Figure 3 comprises of feature extraction of palmprint and iris using Gabor texture feature. These features are fused and stored as a parameter for finding the matched image from the database. The feature vectors are extracted independently from the pre-processed images of palmprint and iris. The feature vectors are extracted independently from the pre-processed images of palmprint and fingerprint. The feature vectors of input images are then compared with the templates of the database to produce the output. Combining more than one biometric modality progresses the recognition accuracy, reduces FAR and FRR. The proposed multimodal biometric system overcomes the limitations of individual biometric systems and also meets the accuracy requirements.

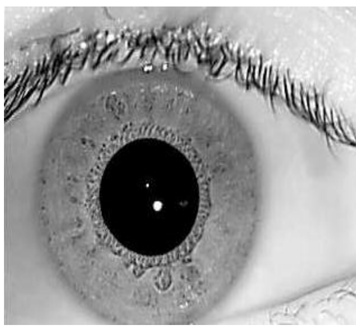
4.Gabor Filter

Dennis Gabor proposed the famous "Window" Fourier Transform (also known as short-time Fourier transform, STFT) in the paper "Theory of Communication" in 1946, which was later called Gabor transforms. The Gabor transform function *f (t)* isdefined in Eqn. (1).

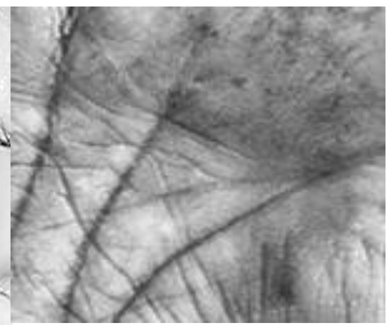
$$G_f(\omega,\tau) = \int_{-\infty}^{\infty} f(t)g(t-\tau)e^{-j\omega t}\,dt \qquad (1)$$

g (t) is a window function i.e., Gaussian function.Reports have suggested that the Gabor function is the solitary function to accomplish the lower bound of uncertainty relation which can accomplish the best localization in time-frequency domain at the same time. [20] Made Gabor function and expanded into two-dimensional form, and on this basis constructed a 2D Gabor filter. The general form of 2D Gabor filter basis functions is given in Eqn. (2).Were ω is oscillation frequency, $\alpha^{-m}{}_0$ is the scale factor, and K is the number of filters. In order to construct the filters in different scales and orientations we have to vary the value of m and n. An image can be represented by the Gabor wavelet by allowing the description of both the spatial frequency and orientation relation. Convoluting the palm image with complex Gabor filter with 3 spatial frequencies and 4 orientations captures the whole frequency spectrum both amplitude and phase. In Figure 3, magnitude and phase of the Gabor filter responses are shown.

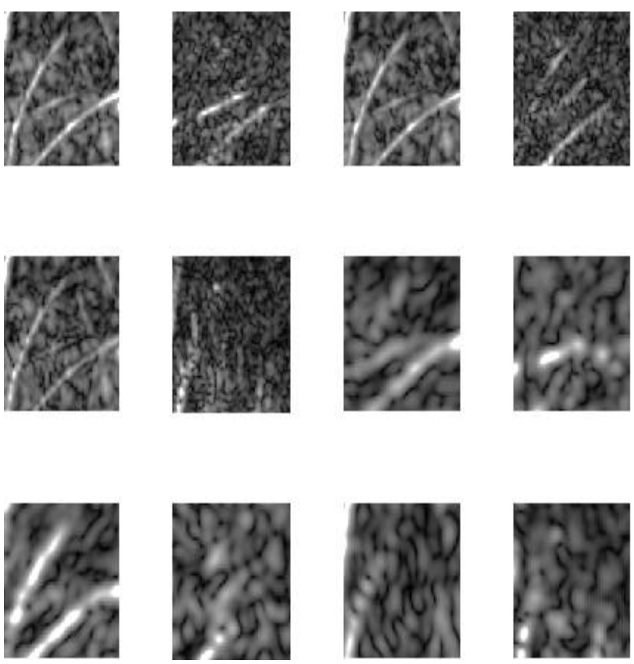
$$\psi_{m\,n(xy)} = \alpha_0{}^{-m} exp\left\{\frac{a_0{}^{-2m}}{8}\left[4\left(xcos\frac{n\pi}{K}+ysin\frac{n\pi}{K}\right)^2 \quad \mathrm{I}\omega + \left(-xsin\frac{n\pi}{K}+ysin\frac{n\pi}{K}\right)^2\right]\right\} \times exp\left[I\omega\omega_0{}^{-m}\left(xcos\frac{n\pi}{K}+ysin\frac{n\pi}{K}\right)\right] \quad (2)$$



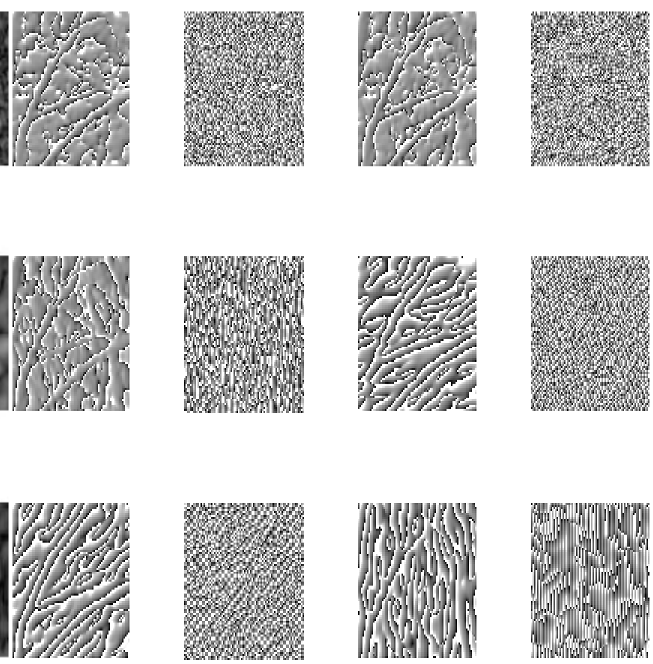
(i)



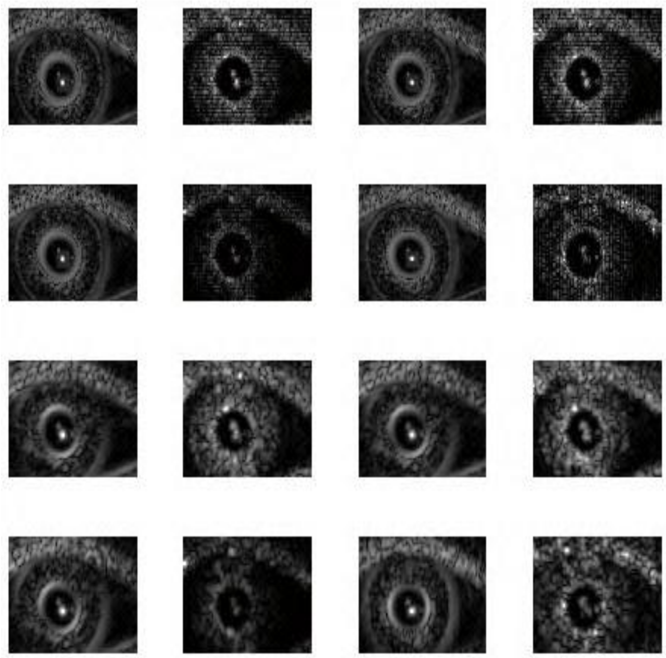
(ii)



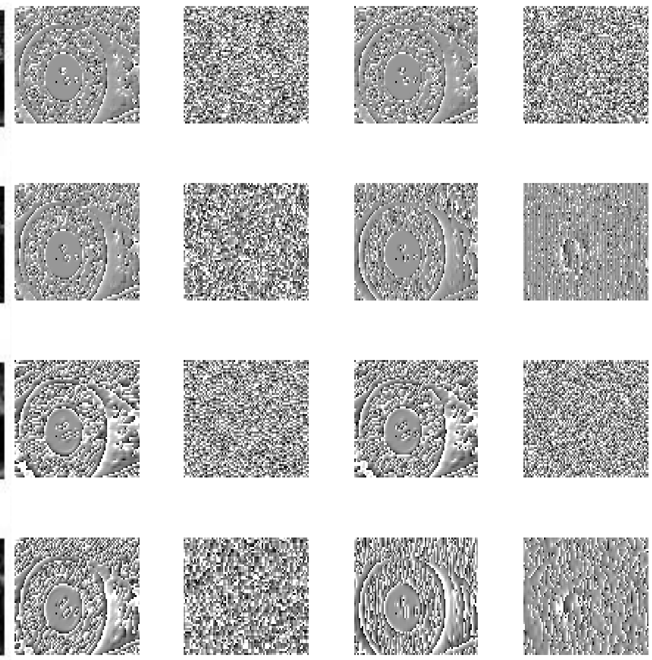
(iii)



(iv)



(v)



(vi)

Fig. 3 Palmprint and Iris image response to above Gabor filter: (i) Iris image, (ii) Palmprint image, (iii) Gabor palmprint magnitude response, (iv) Gabor palmprint phase response, (v) Gabor iris magnitude response and (vi) Gabor iris phase response

5.Sample Images From Database

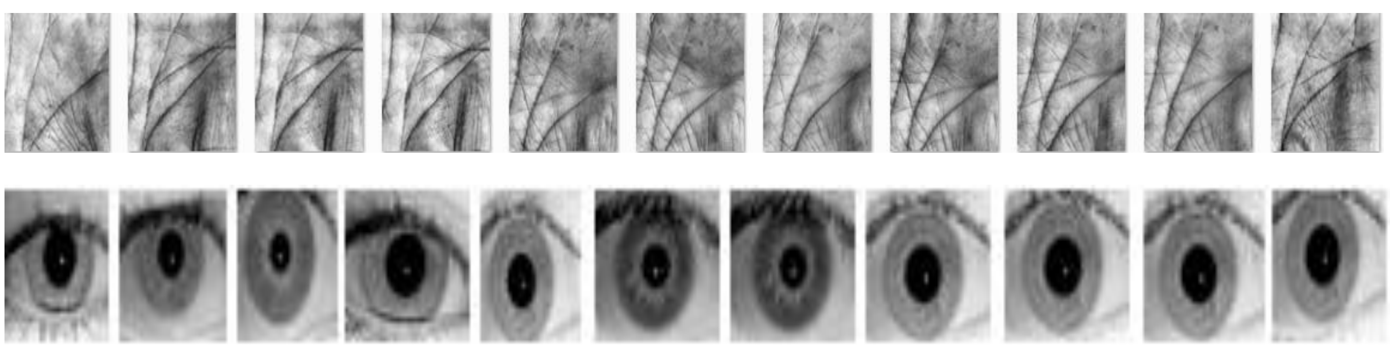


Fig. 4 Palmprint and Iris image samples from Hong Kong poly U and IITK database respectively

6. Wavelet Fusion

To fuse two images using wavelet fusion the two images should be of same size and is should be associated with same colour. Figure 6 explains the 2 level wavelet decomposition of iris and palmprint image and the respective fused image of palmprint and iris. Figure 5 explain the palmprint and iris Gabor texture image and the respective fusion by using wavelet fusion technique.

(i) (ii) (iii)

Fig. 5.Wavelet fusion of texture image (i) Gabor iris magnitude response (ii) Gabor palmprint magnitude response (iii)Synthesized image(fused image)

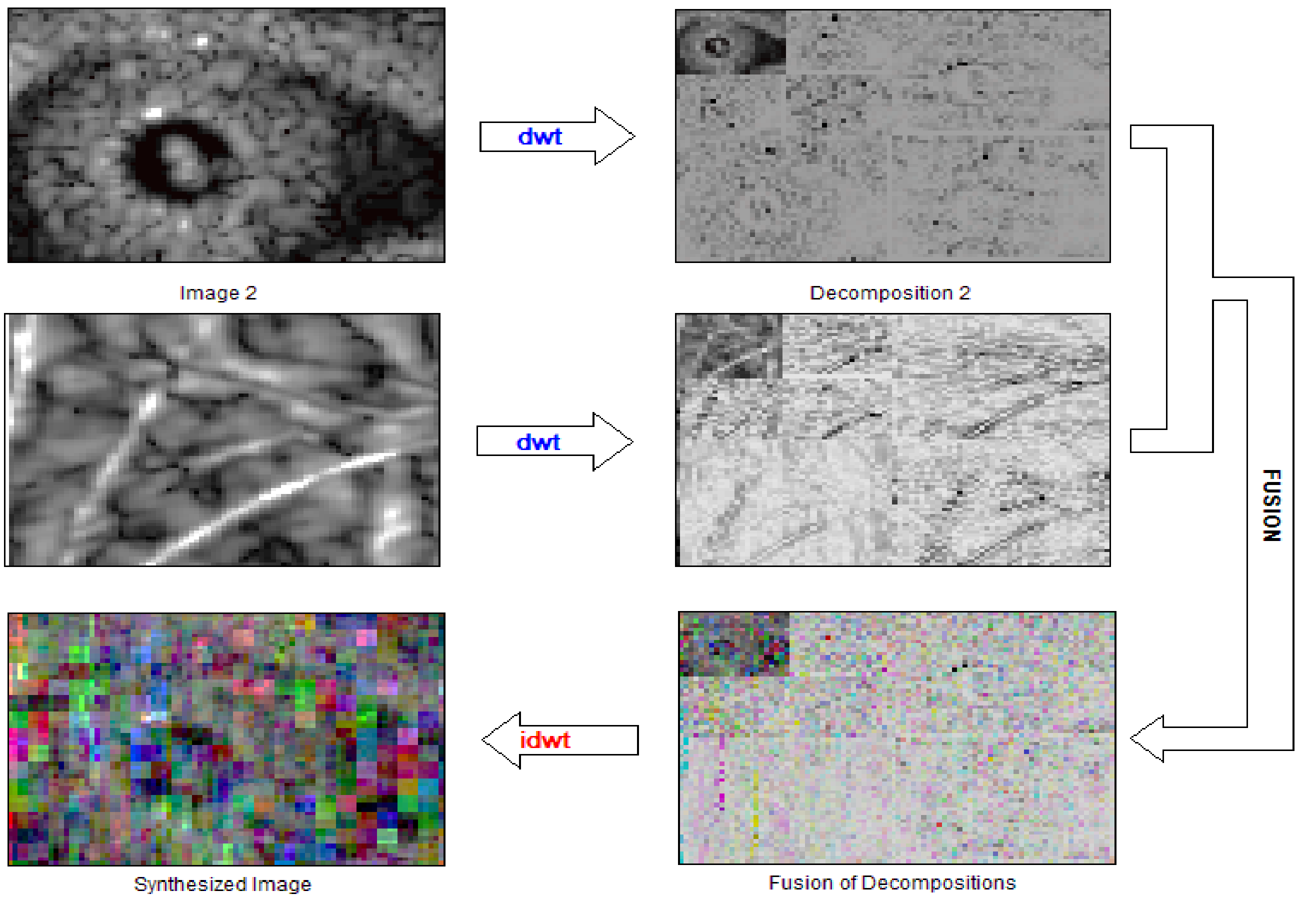


Fig 6. Wavelet feature level fusion

7. KNN Classification

The classification is the combining of the cluster of images between the test image and train image. The mean distance between the centroid of the train image and the test image is computed. The closest point is chosen and plots the value which forms a cluster. The distance computation is based on Euclidean distance weight function. If the value is too extreme it is not considered. In 2-D, the Euclidean distance [20] between (x_1, y_1) and (x_2, y_2) is given by Eq.3:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} = \mathrm{c} \qquad (3)$$

Euclidean distance algorithm of classification is non-parametric as their classification is directly subject on the data [21]. The objects are trained corresponding to the data and the test image can be classified using the same process as the object or image was trained.

Non-parametric classifiers have several very important improvements that are not shared by most learning-based approaches:

- Can naturally deal with a vast number of classes
- Evade over fitting of parameters, which is a central issue in learning based approaches
- Not necessitate learning/ training phase.

The nearest neighbor classifier [21] relies on a metric or a distance function between points. For all points x, y and z, a metric H(x, y, z) which should satisfy the following constrains:

- No negativity : $H(x, y) \geq 0$
- Reflexivity : $H(x, y) = 0$ if and only if $x = y$
- Symmetry : $H(x, y) = H(y, x)$
- Triangle inequality : $H(x, y) + H(y, z) \geq H(x, z)$

The nearest neighbor classifier is used to compare the feature vector of the prototype image and feature vectors stored in the database. It is obtained by finding the distance between the prototype image and the database. Let C_{11}, C_{21}, C_{31}… C_{k1} be the k clusters in the database. The class is found by measuring the distance $H(x(q),C_k)$ between x(q) and the k^{th} cluster $C^{k1.}$ The feature vector with minimum difference is found to be the closest matching vector. It is given by [22]:

$$T(x(q),C_K) = \min\{\|x(q) - x\| : x \in C_k$$

Nearest-neighbor classifiers provide good image classification when the query image is similar to one of the labeled images in its class:

8. Experiment and Result

The effectiveness of our proposed multimodal biometric authentication scheme is evaluated on palmprint database and iris database. In this work, we used PolyU palmprint database, collected by the Biometric Research Center at The Hong Kong Polytechnic University, and iris database from IITK which is a widely used database in palmprint and iris research. The database contains 7,752 grey-scale images' corresponding's to 386 different palms with 20 to 21 samples for each, in bit-map image format. Totally 625 images of 125 individuals, 4 samples for each palm and iris are randomly selected to train in this research. Then we get every person's each palm and iris image as a template (total 125). The proposed algorithms have been evaluated on IITK iris database. The experiments are conducted in MATLAB with imageprocessing Toolbox and on a machine with an Intel core 2 Duo CPU processor.Table 1 explains the comparisons of various modalities combinations and their respective recognition percentage.From the above comparison we can conclude that the proposed feature level wavelet fusion is comparable with all the methods mentioned.

Table 1: Comparision Table

Method	**Recognition Percentage**	**Modalities**
PCA [23]	79.79	Face and palmprint
Single scale LBP [23]	81.46	Face and palmprint
Multiscale LBP [23]	94.79	Face and palmprint
DICA [23]	95.83	Face and palmprint
Modified multiscale LBP [23]	96.67	Face and palmprint
Feature fusion [25]	95	Face and palmprint
Multiple feature extraction [24]	98.82	Fingerprint and palmprint
Proposed Feature level fusion using Wavelet Fusion	99.2	Iris and palmprint

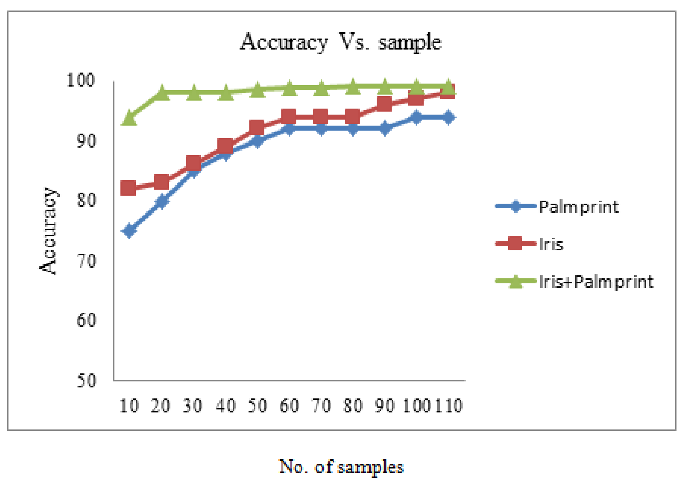


Fig.7 Recognition accuracy of iris and palmprint fusion

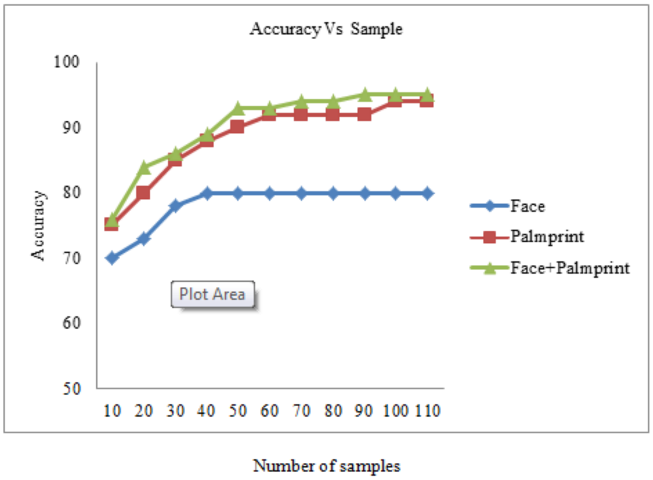


Fig. 8 Recognition accuracy face fusion with palmprint

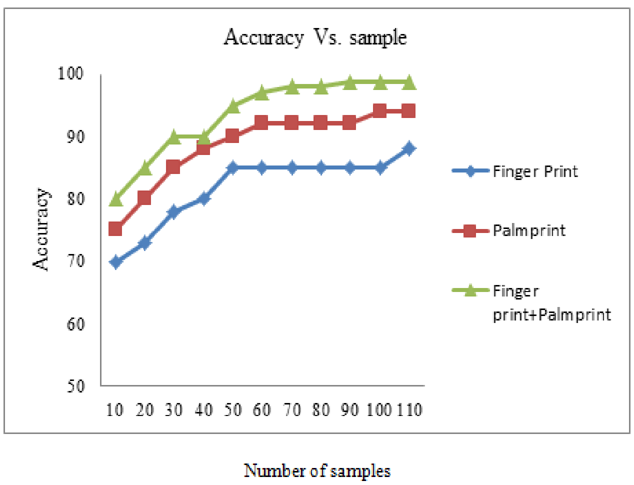


Fig. 9 Recognition accuracy of fingerprint fusion with palmprint

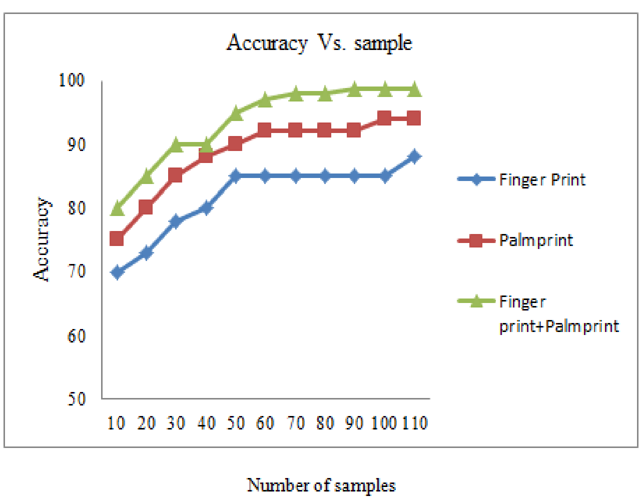


Fig 10. Comparision of recognition accuracy

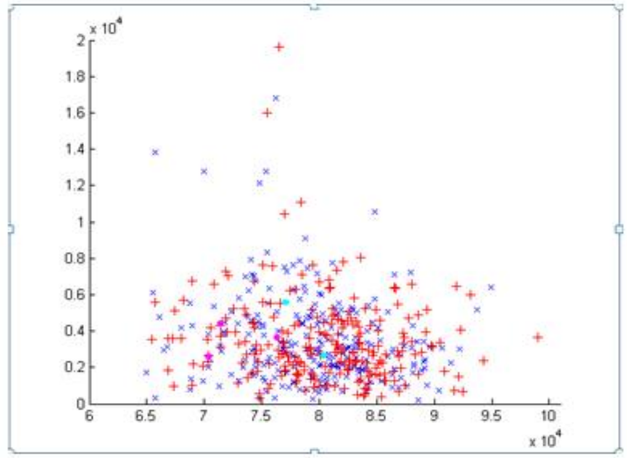


Fig 11. KNN Classification Result

From the figure 7,8,9 and 10 it was observed that the experimental results demonstrated that the proposed multimodal biometric system achieves a recognition accuracy of 99.2% and with false rejection rate (FRR) of = 1.6%. Figure 11 explains the nearest neighbor classification result.

9. Conclusion

In this paper, a multimodal biometric identification method integrating iris and palmprint is proposed. We have presented a feature level fusion scheme using wavelet for palmprint and iris verification and identification system. The extracted Gabor texture features are fused using a wavelet based feature fusion technique supported by wavelet extensions for feature reduction and mean and max fusion rule to avoid correlation. The experimental results show that the combination palmprint and iris outperforms than using them individually. Finally, the proposed multimodal biometric system achieves a recognition accuracy of 99.2% and with false rejection rate (FRR) of = 1.6%. Furthermore the proposed method obtains a better recognition results than the other methods when only one modality is used. In the future work, more experimental test will be performed on the real multimodal biometric data.

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