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Iris and Palmprint Decision Fusion to Enhance Human Recognition

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ABSTRACT
Multimodal biometric systems are more promised and accurate than unimodal ones. Beside increase the performance, the multimodal system minimize the universality problem. The current research introduces a new iris and palm fusion system. The feature of palm print is extracted using connectivity points and lifelines orientations, while features of iris is extracted using wavelet transform. The classification method was the distance classifier. The score level fusion is applied using modified version of majority voter. The system accuracy was 97.29**%** for palm, 71.97**%** and 98.54**%** for fusion.
Keywords: — Feature Extraction, Score Fusion, Image Processing, Multimodal Biometrics.

I. INTRODUCTION

Unimodal system suffers from different degradations such as universality, Collectability difficultness and permanence problem [1,2]. All these problems decreases significantly or removed using fusion techniques [1,2]. Form that point of view, many of recent researches focused on the multimodal recognition.

Hariprasath [3] proposed packet wavelet transform to extract features of palmprint and iris. At the feature fusion they applied the concatenation process. They used 30 individuals dataset for iris and 20 for palm. They obtain 93% recognition rate but they didn't take in account occlusion.

Jagadeesan [4] at 2011 used the iris and fingerprint and extracted gabor filter features for iris and Minutiae based Method for fingerprint. And at the same year, Shen [5] extracted features of face and palmprint via FPcode technique, and the fusion was done at score level. He used 119 individual database from AR face dataset and 486 images from PolyU palmprint database. The system achieved 91.52% recognition rate at feature level fusion and 91.63% recognition rate at score level fusion.

In 2015, SUDEEP and BHONDAVE [6] introduced a recognition system of iris and palmprint images using the texture features. The researchers used three different features types which are haar, kerke and wlash. The score fusion technique was used and they got 51.8% recognition rate on 10 individuals dataset.

Afzal [7] at 2017 used multispectral palmprint images in a hybrid recognition system using T-conorm operators like Hamacher, Frank, Probabilistic and Scheiwer. He applied the score level fusion and got 99.9% GAR rate and 0.01 FAR error rate.

II. MATERIAL AND METHODS

The suggested system consists of three basic stages illustrated in figure 1.

The system consists of the following steps:
Segmentation
Feature extraction
Classification
Decision Fusion

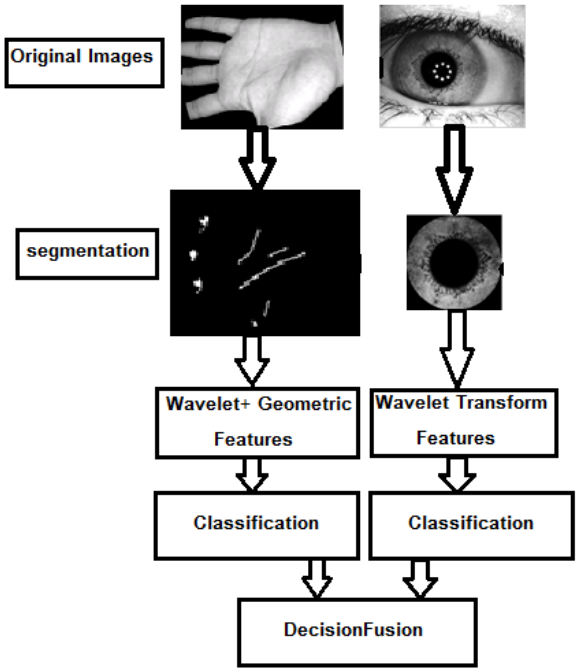


Fig. 1 The System Description

A. Segmentation

At the segmentation process, the connectivity points and lifelines were extracted form palmprint, and the iris region was extracted from the iris images. The following diagram illustrates the iris and palmprint segmentation process.

Figure 2 illustrates the detailed stages of palmprint and iris segmentation.

The iris 2D image is transformed into binary form then the filling holes operation is done to fill gaps, the next step is the boarder remove to obtain the iris region. The center and radius of iris is detected and the pupil is subtracted from the iris circle to get the iris region. The pupil region is detected using algorithm described in an earlier work [8].

For palmprint image, we modified our previous work [9] in palmprint segmentation so, we subtracted the binary image from the dilation image, and the outlier points were omitted via the area open process to get the connectivity points. The second stage of palmprint segmentation is the lifelines detection in which three operations were applied which are the sobel edge detection, enhancement of edges via multiplication process, and the region properties (orientation and extent) to eliminate outliers. At the last stage of palmprint segmentation is the union of the lifelines and connectivity images.

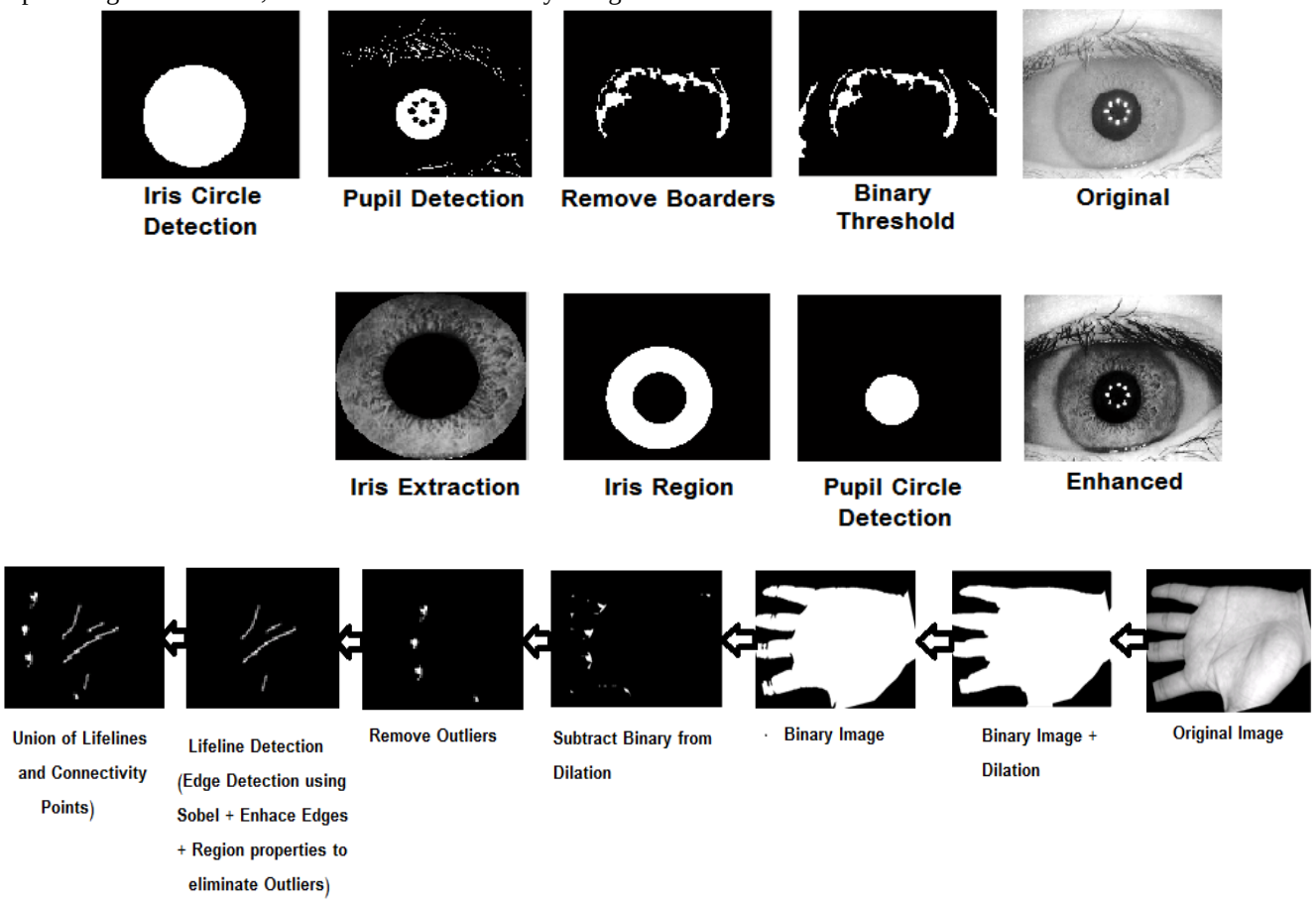


Fig. 2 Iris and Palmprint Segmentation stages

B. Feature Extraction:

The iris features were extracted using the wavelet transform from level 2, and the extracted features are normalized to form a vector consisting of 2500 samples. The normalization process is done by obtaining the approximation coefficients of wavelets and transform them into vector type by the "reshape" process. The features are then minimized using a selection method described in our earlier work [8] to form 408 samples.

The palm features are extracted using two methods, the first is by using the wavelet approximation components, and the second is the geometric features which are the binarized vector of the segmented palm image. Those features are fused together in order to consist the hall palm print feature vector which are 15000 samples. It minimized into 6900 samples under the feature selection described in our earlier work [8].

C. classification:

The classification stage is done after building the training dataset, and when introducing a test feature vector, its distance from the hall database vectors are computed and the minimum distance is defined in order to detect the recognized individual.

D. Decision Fusion

At the decision fusion, we applied the majority selector method to merge the decisions and make the final fused one.

The majority voter modified technique is summarized at the following steps:

If Palm_decision==Iris_decision → Decision is related to Palm or Iris

If Palm_decision~= Iris_decision && Palm_score_degree<= Iris_score_degree → decision is related to Palm

Else decision is related to Iris.

This modified majority selection process is very useful to fuse any two biometrics' decisions together, but it needs a little modifications in case of other biometrics. The reason of why we weighted the palmprint decision over the iris is that the palmprint biometric achieved a higher recognition rates, and this due to the high resolution of palmrpint dataset images comparing to iris dataset ones.

III. RESULTS

The experiments were applied on CASIA [10,11] database for palm and iris datasets. For inside system users, we selected a dataset consists of 480 images for each biometric corresponding to 60 individuals. For outliers users, we selected a dataset consists of 160 images of 20 individuals. The tests were applied and the performance metrics were computed to define the FRR (False Acceptance Rate), FRR (False Rejection Rate), EER (Equal Error Rate) and accuracy of our suggested system. In order to compute those metrics, we used the following equations [12,13]:

FAR=FP/(FP+TN) (1)

FRR= FN/(FN+TP) (2)

EER=1-0.5(FAR+FRR) (3)

Accuracy= 100*(1-0.5*(FAR+FRR)) (4)

GAR=100*(1-FRR) (5)

Examples of our training and test databases are shown at figure 3.

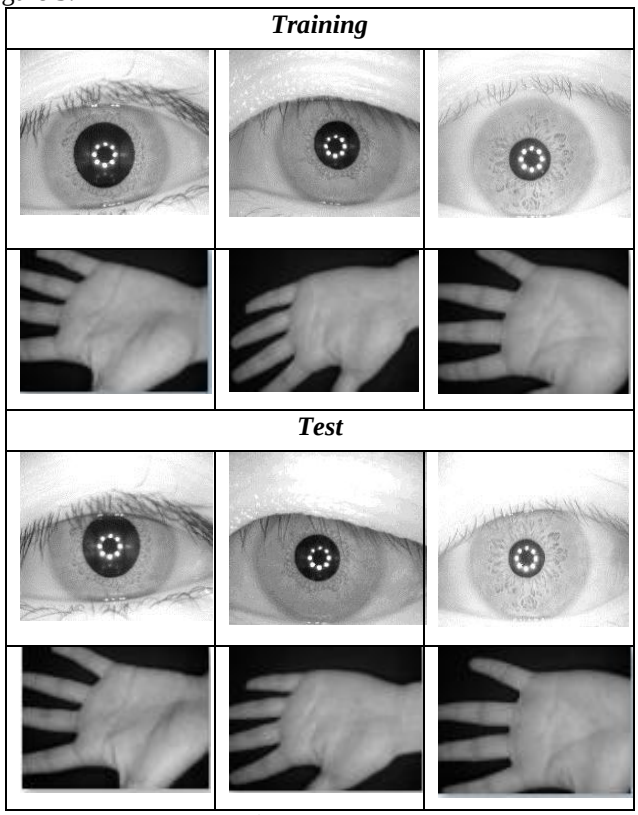


Fig. 3 Examples of our training and test databases

It can be notices that test database contain some challenges such as hand rotation, iris flipping, eyelash occlusion, eye rotation and partial eye closing. This dataset would give us information about FRR, GAR and Recognition Rate.

The outlier's dataset which were used to define the accuracy of the system is also selected from individuals from outside system. This dataset would give us information about FAR and accuracy.

Table 1 includes some examples of unimodal (iris or palm) and fusion system response in different situations of test datasets.

TABLE 1
EXAMPLES OF RESPONSES OF UNIMODAL AND FUSION SYSTEMS.

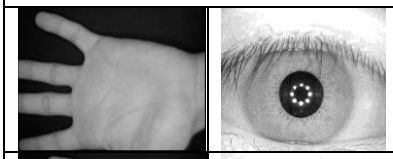
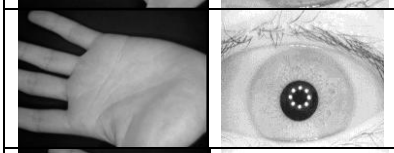
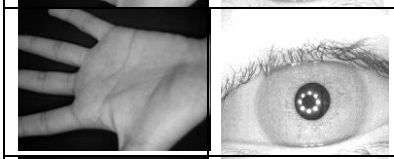
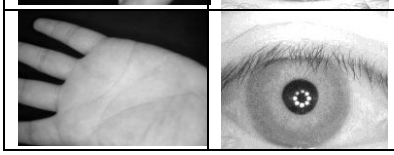
Test Sample	Hand Recognition	Iris Recognition	Fusion Recognition
	True	False	True
	True	False	True
	True	False	True
	False	True	True
	False	True	True

Table 1 shows that the fusion system response is better than the unimodal ones. This point of interest, in which the fusion eliminates the errors of unimodal biometric system, is considered as one of the reasons why we use multimodal systems instead off unimodal ones.

The performance calculations across unimodal and multimodal suggested systems are clarified in table2.

TABLE 2
PERFORMANCE METRICS IN UNIMODAL AND MULTIMODAL SYSTEMS.

Biometrics	Best Thresh	FAR	FRR	EER	GAR	Accuracy

Palm	17	0.025	0.029	2.7%	97.08%	97.29%
Iris	37	0.062	0.12	28.03 %	%87.9	90.83 %
Fusion	22	0.02	0.01	1.5%	99%	98.5%

For more accuracy point of view, here is the FAR and FRR curves for unimodal and multimodal system for all thresholds. For more details, we computed all FAR and FRR values at all thresholds, then the EER value is detected via the intersection between FAR and FRR curves. The more minimum EER, the more accurate system. Therefore, the fusion system achieved the minimum EER value which is almost 0.01 and indicates a high accuracy.

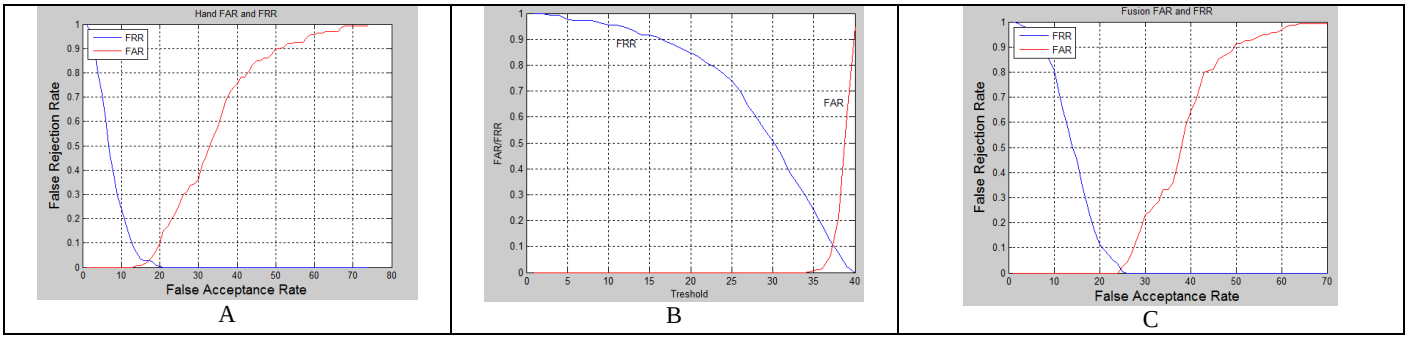


Fig. 4 FAR and FRR curves at all threshold values A: Palmprint curves, B: Iris Curves, C: Fusion Curves.

We also compare our fusion model with the best research at fusion which is related to Kihal's study [13], and the result showed that our study is more promised. Table 2 illustrates the comparative results.

TABLE 3
A COMPARATIVE STUDY BETWEEN OUR RESULT AND KIHAL'S RESULTS.

Biometrics	**Recognition Rate (our study)**	**Average Recognition Time (our study)**	**Recognition Rate (Kihal)**	**Average Recognition Time (Kihal)**
Iris	92.92	1.823	91.58	2.29
Palm	93.75	0.79	83.75	2.19
Fusion	98.95	2.638	94.167	4.486

IV. CONCLUSIONS

In the current study, we introduced a fused human recognition system based on iris and palmprint, we used the wavelet and geometric features and the minimum distance classifier, while at decision level fusion we applied a new version of majority voter method to fuse the decisions.

From experimental results, we conclude the following topics:

- Fusion of iris and palm increases the performance significantly.
- FAR, FRR and EER decreases when applying the Decision fusion of biometrics.
- Accuracy of the fused system is better than unimodal ones.
- Multimodal system reduce the recognition errors that came from bad test images or different situations such as variations and occlusion.

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