FACE AND PALMPRINT IMAGE FUSION FOR AUTHENTICATION OF MULTIMODAL BIOMETRICS

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Abstract: Biometric system is nothing but the pattern recognition system in which we use different biometrics to recognize the individuals. The traditional biometric system depends upon unimodal biometrics which is used for the recognition and authentication. This unimodal system has lots of problems like noisy data, non universality, spoof attack etc. So, in order to overcome these problems we used multimodal biometric system. Here two biometric are used as face and palmprint and fusion of these two biometrics has four at four different levels like sensor level, feature extraction level, matching score level and decision level. All fusion techniques carried out under clean and noisy conditions. For feature extraction we used two different algorithms as LDA (Linear Discriminant Analysis) and LPQ (Local Phase Quantization) for face and palmprint respectively.

Index Terms: Multimodal biometrics, Face, Palm print, fusion, LDA, LPQ.

I. INTRODUCTION

The single mode biometrics means unimodal biometric has lots of limitations in recognition and authentication process like high error rate, spoof attack, noise and non universality e.g. in recognition of face images, it is affected by different facial expressions and the light exposure on faces. So, in order to overcome these limitations we have used two modalities as face and palmprint. This multimodal biometric system is used to recognize and identifies individuals which increases accuracy, more robustness and decreases the different spoof attacks. We are going to fuse these two modalities as face and palmprint at four different levels like sensor level, feature extraction level, matching score level and finally decision level.

(a) At sensor level two different images from two different sources are fused.
(b) At feature extraction level two different feature extraction algorithms are used as LDA (Linear Discriminant Analysis) and LPQ (Local Phase Quantization) for face and palmprint respectively.
(c) At matching score level the different matching scores are taken from different matchers and then combined and fusion of images takes place.
(d) At decision level final result is obtained where the image acceptance and rejection is carried out.

The face and palmprint images at these four levels are fused by using different techniques. Here, performance evaluation is carried out by fusing these both modalities under clean and noisy conditions.

It is preferable to use two modalities as face and palm print because they has several advantages such as, strongly available feature extraction algorithm for both modalities, non-intrusiveness in nature (for face). In order to evaluate the deployment of these two modalities in real time scenarios, performance analysis needs to be carried out under noise conditions, so that we are evaluate performance under both clean and noisy condition.

II. PROPOSED WORK

Traditional biometric system has different disadvantages, to order to get better performance and high accuracy we here used the multimodal biometric system. In this system fusion of face and palmprint images takes place and this fusion is based on multi resolution system. Here, for feature extraction we are going to consider two different feature extraction algorithms as LDA (Linear Discriminant Analysis) and LPQ (Local Phase Quantization) for face and palmprint images respectively. These two algorithms extract specific features of images and also reduce the dimensions of images. These algorithms are used to raise the Discriminant power analysis of the fused feature vector. The proposed system is used to increase security of biometric system at different levels by fusing the face and palm print images. Block diagram of multimodal biometric system of face and palmprint at four different levels is shown in figure 1. For fusion of face and palmprint images two conditions are considered as,

(a) Pre matching fusion, here different images from different sources are carried out either at sensor level or feature level and then fusion is performed and fused information is carried out.
(b) Post matching fusion, here matching information is carried out at score level fusion after matching and classification of final result is carried at decision level.

In our multimodal biometric system we are going to fuse two modalities as face and palm print at four different levels and they are given as,

![Fig. 1 Block diagram on different levels of fusion of face and palmprint](image-url)
1. Sensor/source level fusion: Here, we have used wavelet based image fusion technique [2]. This technique is used to fuse input images as face and palm print. The wavelet based technique is used to recover the image without any information loss. DWT (Discrete Wavelet Transform) is performed on two modalities and then their wavelet coefficients are fused in wavelet transform domain.

2. Ordinal feature extraction level fusion: Here, first we are going to use feature extraction algorithm as Linear Discriminant Analysis (LDA) for face and Local Phase Quantization (LPQ) for palm print modality. Then we employed fusion methods as different normalization techniques namely Min- Max, Z-Score and Hyperbolic tangent (Tanh) [9] and they are given as follows:

a) Min-Max fusion rule:

\[ n = \frac{s - \min(s)}{\max(s) - \min(s)} \]

max(S) and min(S) specify the end points of the matching score range (S).

b) Z-Score fusion rule:

\[ n = \frac{s - \text{mean}(s)}{\text{std}(s)} \]

The operators mean (s) and std (s) denote the mean operator and standard deviation operator, respectively.

c) Hyperbolic tangent (Tanh) fusion rule:

\[ n = \frac{1}{2} \left[ \tanh \left( 0.01 \frac{s - \text{mean}(s)}{\text{std}(s)} \right) + 1 \right] \]

This technique is also called as robust statistical technique. It maps raw score to (0, 1) range.

3. Normalized score level fusion: Here, we considered different fusion rules such as Sum, Max and Min rule, to combine the two matching scores. The Max and Min rule are given by,

\[ S_n = \frac{(S_i - S_{\min})}{(S_{\max} - S_{\min})} \]

And the Sum rule is given by,

\[ \text{SUM} = \sum_{i=1}^{N} S_i \]

Where, \( S_i \): the matching scores, \( i = 1, 2 \ldots \)

\( S_n \): the normalized matching scores.

\( S_{\min} \) and \( S_{\max} \): the min and max match scores.

4. Decision/final level fusion: Here, we adopted logical AND and logical OR to combine the output decisions by different matchers [11]. We are going to calculate False Accept and False Reject error rates of the combined biometric by using both AND and OR fusion rules.

i) OR rule: False Reject can only occur if both modalities of face and palm print produce a False Reject [14].

\[ \text{PA} \left( FR \right) = P_1 \left( FR \right) P_2 \left( FR \right) \]

Where, \( \text{PA} \left( FR \right) \) = combined probability of a False Reject. \( P_1 \left( FR \right) \) = probability of face modality. \( P_2 \left( FR \right) \) = probability of palm print modality. But the probability of a False Accept is expressed as the complement of the probability that neither modality of face nor palm print produces a False Accept [14].

\[ \text{PA} \left( FA \right) = 1 - \left[ \left( 1 - P_1 \left( FA \right) \right) \left( 1 - P_2 \left( FA \right) \right) \right] \]

\[ = P_1 \left( FA \right) + P_2 \left( FA \right) - P_1 \left( FA \right) P_2 \left( FA \right) \]

ii) AND rule: False Accept can only occur if both modalities of face and palm print produce a False Accept [14].

\[ \text{PB} \left( FA \right) = P_1 \left( FA \right) P_2 \left( FA \right) \]

Where, \( \text{PB} \left( FA \right) \) = combined probability of a False Accept. \( P_1 \left( FR \right) \) = probability of face modality. \( P_2 \left( FR \right) \) = probability of palm print modality. But the probability of a False Reject is expressed as the complement of the probability that neither modality of face nor palm print produces a False Reject [14].

\[ \text{PB} \left( FR \right) = 1 - \left[ \left( 1 - P_1 \left( FR \right) \right) \left( 1 - P_2 \left( FR \right) \right) \right] \]

\[ = P_1 \left( FR \right) + P_2 \left( FR \right) - P_1 \left( FR \right) P_2 \left( FR \right) \]

III. RESULTS

In this system we have carried out the genuine verification rate and false verification rate at three different levels as 0.01%, 0.1%, 1% [15]. We also carried out the different ROC curve for different fusion levels as sensor level, feature extraction level, matching score level and decision level and different results are obtained by applying different techniques on face and palmprint images.

![ROC curves of modality system at sensor level fusion.](image-url)

Fig. 2 ROC curves of modality system at sensor level fusion. Figure 2 gives ROC curve of sensor level fusion which shows percentage rate of False Verification rate and Genuine Verification rate at 0.01%, 0.1%, 1% [15]. For above ROC curve:

Genuine Verification rate at 0.01% False Verification rate = 61.07%

Genuine Verification rate at 0.1% False Verification rate = 66.07%

Genuine Verification rate at 1% False Verification rate = 81.79%
Fig. 3 ROC curves of modality system at feature extraction level fusion.

(a) Min-Max:
Genuine Verification rate at 0.01% False Verification rate = 72.14%
Genuine Verification rate at 0.1% False Verification rate = 87.86%
Genuine Verification rate at 1% False Verification rate = 97.86%

(b) Tanh:
Genuine Verification rate at 0.01% False Verification rate = 75.00%
Genuine Verification rate at 0.1% False Verification rate = 87.86%
Genuine Verification rate at 1% False Verification rate = 97.86%

(c) Zscore:
Genuine Verification rate at 0.01% False Verification rate = 75.00%
Genuine Verification rate at 0.1% False Verification rate = 87.86%
Genuine Verification rate at 1% False Verification rate = 97.86%

IV. CONCLUSION AND FUTURE WORK
By using different fusion techniques we have fused face and palmprint images at different levels. At each level different algorithms, techniques are used which is shown in results. From ROC curves we are found the genuine verification rate at three different factors of false verification rate as 0.01%, 0.1% and 1%. From ROC curves we have found that matching score level and feature extraction level fusion works better than sensor level fusion. For future use we will find the decision level fusion of face and palm print images and also find the acceptance or rejection criteria for face and palmprint images respectively.

REFERENCE


