# Human Authentication Using Score Level Fusion of Face and Palm Print Biometrics


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**Abstract** Human authentication has always been of significant concern for research. Different methodologies and approaches have been proposed in the last few years to accurately authenticate humans on different biometric characteristics. For the accurate authentication process, there is a requirement of a template, which can identify humans from a given set of images. For the generation of templates, various biometric features have been tested and different methodologies have been applied. Out of these methods, the most prominent biometric features identified are face and palm print. These biometric traits have given the maximum authentication rate when applied as a single biometric. In this paper, a combination framework is proposed in which principal component analysis (PCA) and linear binary pattern (LBP) are applied on both face and palm print to generate a unique score that is used to authenticate the human. For validation of the framework two different databases, ORL (Olivetti Research Laboratory) and PolyU (Hong Kong Polytechnic University) are used. The framework achieved an accuracy of 99.8%, which is far better as compared to the unimodal system.

**Keywords** Multimodal biometric · PCA · LBP · ORL · PolyU · Face recognition · Palm recognition

## 1 Introduction

The biometric framework is utilized for authentication and acknowledgment framework. The framework utilizes the data of an individual to recognize dependent information, which is novel and explicit to their natural characteristics. The biometric is utilized in businesses, associations, and governments for security reasons. A biometric framework is ordered into unimodal/single modular and multimodal. The unimodal utilize a single characteristic, for example, a face, finger, and palm print for the acknowledgment [1]. The unimodal do not satisfy the degree of execution and

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has less exactness due to which the multimodal framework is an assurance to create a superior outcome. The multimodal uses more characteristics, for example, finger–face, face–palm print, and palm–retina print. The multimodal biometric framework shows a few favorable circumstances in numerous angles when contrasted with that of a unimodal biometric framework because of different sources. Multimodal biometric has amazing precision and accuracy than unimodal [2]. The multimodal biometric framework combination methods consolidate at least two distinctive biometric modalities (feature, matching score, or decision) into another space to produce another combination esteem [3].

Data combination is a significant technique in numerous images preparing the application. The combination can be separated into two classes, which are before matching and after matching. In multimodal biometric, combination is a significant stage to deliver higher segregation power in the component space. The combined features now and then has high separation power and required component determination calculation to lessen the dimensionality. A wide range of combination images can be actualized in the spatial or recurrence space. The term of spatial area alludes to the typical space of the image. The information image straightforwardly works at pixel level depends on pixels' position understanding. The recurrence area term alludes to the change from spatial space to another space. The destinations of this exploration center to an improvement of combination procedure to upgrade the most elevated precision of the acknowledgment framework in the spatial space for face and palm print biometric.

## 2 Proposed Methodology

### *2.1 Preprocessing*

Image preprocessing is the most important stage in the biometric acknowledgment framework. The pre-handling process incorporates changing example images into grayscale, upgrade image quality, edge identification, and ROI trimming [4]. During the image catching procedure, numerous elements influence the information, for example, brightening, differentiation, etc. It responds to the acknowledgment framework exactness, instantaneity, and strength [5, 6]. Before the preparation procedure, the information must be handled and converted into the appropriate organization, for example, size, grayscale, and direction. A trimming strategy is then required for the palm print image to catch the focal point of the palm image (Fig. 1).

*Local Binary Pattern (LBP)*: Feature extraction gives the effect to the presentation and exactness of the framework. The element vector of the example images removed utilizing the particular strategy permits the framework to perceive the extraordinary example in the element space [7–9]. Feature extraction dependent on LBP is the basic structure that speaks to the histogram and has shown predominant outcome on

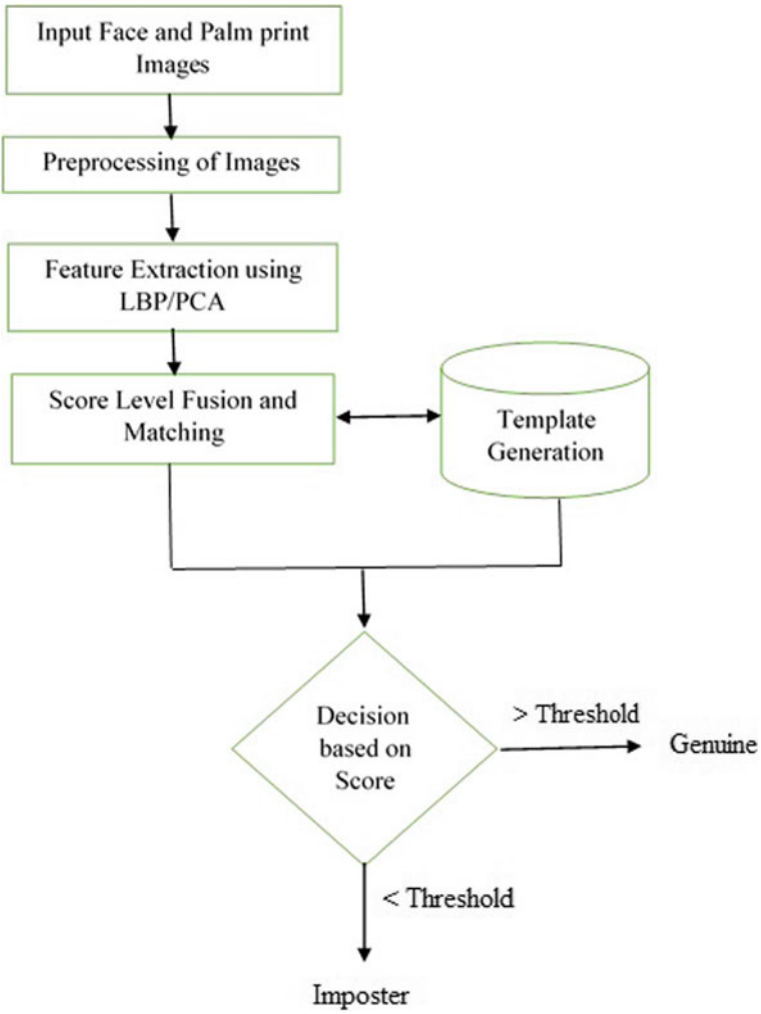


**Fig. 1** Proposed framework

the component arrangement execution. LBP separates the image on the pixel esteem with it's neighbourhood in a grayscale image.

The pixel estimation of the neighborhood is deducted with the middle pixel esteem. The deduction is performed utilizing a limit and incentive. The edge esteem utilizes the standard if neighborhood pixel higher than focus pixel offered 1 to that area, and in any case given 0 [10]. The aftereffect of the limit is changed over into a decimal incentive to supplant the middle worth. The outcomes for all pixels in the images speak to the histogram of LBP.

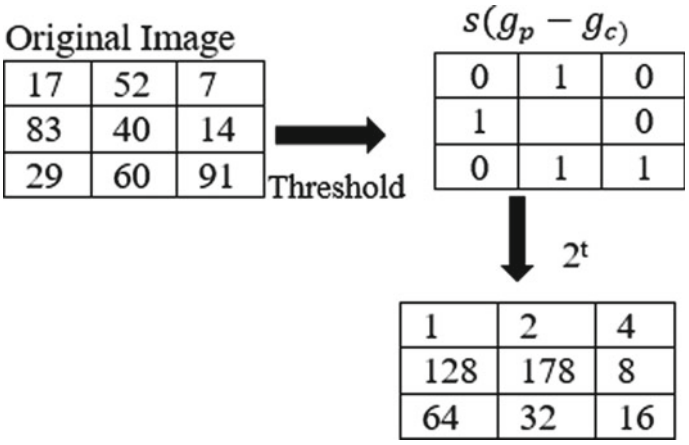


**Fig. 2** LBP process

$$\mathrm{LBP}_{\mathrm{p1\ p2}} = \sum_{\mathrm{p=0}} S\left(g_p - g_c\right)2^{\mathrm{t}} \tag{1}$$

In the Eq. 1, $g_p$ and $g_c$ are the pixel power of the middle pixel with range $R$, and $P$ is the absolute number of the neighboring pixel. LBP process appeared in Fig. 2.

In this procedure, the palm print images are isolated into 8 squares and the LBP window is $3 \times 3$ pixel. The clockwise strategy is applied to create all an incentive in each square to include the extraction process. The LBP surface can be portrayed by utilizing a histogram of 256 codes.

## 2.2 *Principal Component Analysis (PCA)*

The yield of LBP feature extraction is the new vector speaking to the histogram in 256 measurements. Straight projection technique, for example, principal component analysis (PCA) [3, 11–13], is a reasonable and viable answer for diminishing the element of this feature. The quantity of head parts in terms of information measurement is not exactly the first information. The main part is arranged dependent on the most noteworthy Eigen esteem speaking from the most significant information to less significant information. The most significant information in the eigenvector is situated in initial barely any columns of the grid [14].

The calculation of the most significant eigenvector is executed in both the preparation stage and the testing stage as follows:

- Prepare the wellspring of information with a similar size.
- Rearrange the 2D grid into a 1D framework.

- Calculate a mean of information and normalization utilized zero scores (Z-score) method, as in:

$$Z_S = D - a \tag{2}$$

- In the equation, $D$ is 1D grid information and a is mean (normal vector of information).
- After normalization utilizing Z-score, at that point covariance is determined as:

$$\text{Cov} = Z^t \times Zs \tag{3}$$

- Calculate the Eigenvector of covariance grid above as in:

$$[V, \text{d}] = \text{Eig}(\text{cov}) \tag{4}$$

- Calculate the principal components of data as shown in the equation, where $Zs$ is Z-score data and $V$ is variance.

$$Pc = (Zs \times V) \tag{5}$$

In this process, PCA is used to reduce the feature vector dimensionality by choosing a relevant high variance of data. PCA observing correlated data then produces the uncorrelated data by removing all redundant and noise that exist in the data.

## *2.3 Fusion Method*

In multimodal biometric, the combination is utilized to expand segregation power in the element space. There are four phases of combination, which are sensor level, feature level, score level, and decision level. Few strategies of combination have been utilized in each level, for example, whole principle, weight sum rule [1], and rule. In these trials, the combination at matching score level is performed utilizing weight aggregate standard.

## 3 Experimental Results

The calculation in this process is demonstrated utilizing MATLAB (R2014a). The investigation of each face and palm print is discussed in detail in the following section.

### *3.1 ORL Database*

The investigation of face images is led utilizing Olivetti Research Laboratory (ORL), Cambridge. In the ORL database, there are 40 subjects comprising 10 unique images of each subject. The image is captured on various levels, outward appearance, changing the lighting, and detail in facial (wearing glasses and not wearing glasses). A sample image from the ORL database is presented in Fig. 3.

Every pixel comprises 256 Gy levels. The process of feature extraction is as follows:

1. The preparing information is arbitrarily chosen from 40 subjects. They have a few varieties.
2. Read the preparation image and preprocess every one of them.
3. Crop each image into 78 × 81 pixels and convert it into a single vector.
4. PCA strategy is utilized to extricate the neighborhood feature from the yield of preprocessing stage and develop the element vector as follows:

    - Transform 2D information into a 1D long vector.

**Fig. 3** Sample ORL face images

- The entire of preparing information is standardized with the Z-score (zero scores) procedure.
- Calculate the mean image.
- Find the covariance lattice of preparing information.
- Compute the Eigenvalue and Eigenvector of the preparation information. Each Eigenvector connects to Eigenvalue.

5. The figuring of preparing and testing coordinating score utilizing Euclidean separation classifier.

## *3.2 PolyU Database*

The palm print images are taken from the PolyU (Hong Kong Polytechnic University) database. The images comprise 250 palm images gathered from the volunteer. The images are separated into 55 females and 195 males. In this examination, 40 subjects of palm print images are utilized and each subject comprises 10 unique images. The size of each image is 191 × 131 pixels, and every one of them is reshaped into 80 × 80 pixels. A sample image from the PolyU database for palm print is depicted in Fig. 4.

In this work, a similar strategy as face investigation was additionally applied on palm print images. For the palm print image, the nearby element is extricated utilizing the LBP technique, and afterward, the PCA strategy is utilized to decrease include measurements.

LBP is utilized to remove the palm print image surface. The histograms are built from a surface element. The test result of the palm print utilizing LBP-PCA is 89% acknowledgment rates.

*Fusion of two modalities:* A mix of palm print and face matching scores from the past investigation can accomplish a better outcome. Weight aggregate method is

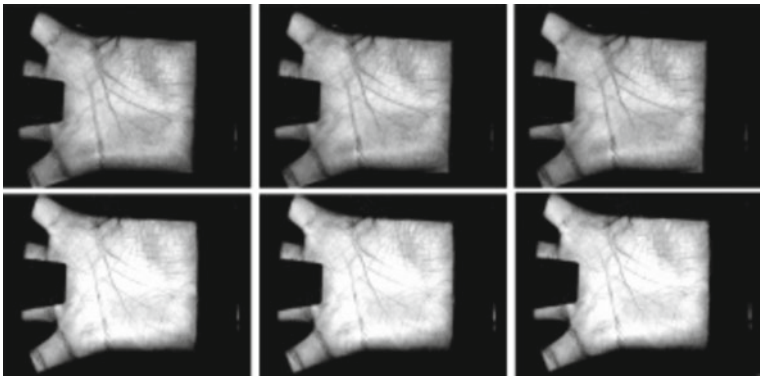

**Fig. 4** Sample Palm print images from PolyU database

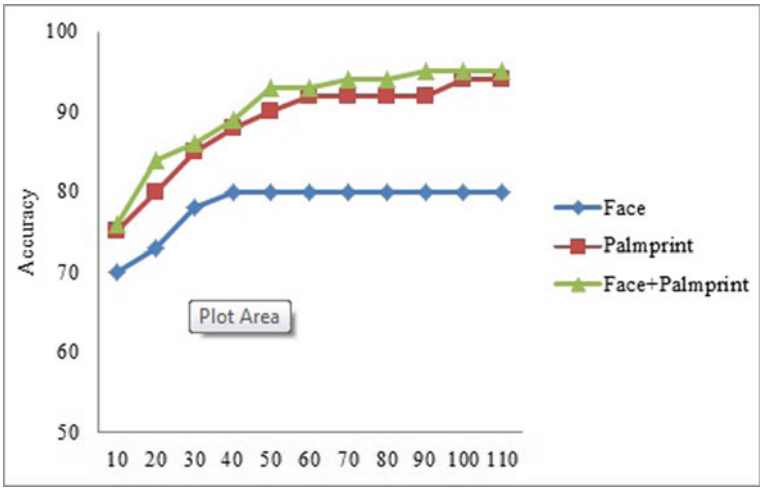


**Fig. 5** Accuracy plot of both modalities

utilized to coordinate both methodologies at matching score by utilizing this standard: new_score = a.face + fJ.palm, where a + fJ = 1. The accuracy of the trial result is depicted in Fig. 5.

Face acknowledgment precision utilizing PCA produces 98.5% acknowledgment rates, while palm print acknowledgment is 99%. The palm print acknowledgment produces a better outcome contrasted with face acknowledgment after utilizing the proposed technique. The combination of the two modalities has the most noteworthy exactness of 99.8%. The combination can increment the acknowledgment rates contrasted with the normal precision of the face and palm print. The examination between face, palm print, and the combination appears in Fig. 6.

## 4 Conclusion

A framework design is proposed based on the combination of Face and Palm print Biometrics which gives high accuracy in Human authentication. Score level fusion strategy is applied for generating the final scores from the input images of Face and Palm print. The input images are preprocessed, and then a combined strategy of PCA (principal component analysis) and LBP (linear binary pattern) is applied on the processed image to remove surface features and reduce feature level calculations. The Gaussian dissemination of feature vector in the element space produces a Euclidean separation classifier to compute the matching score. Matching based on weighted sum rule is used to compute the matching score. If the value of the score generated is above threshold, then the authentication is successful and the user is said to be Genuine otherwise Imposter. The rate of accuracy obtained by the combination of

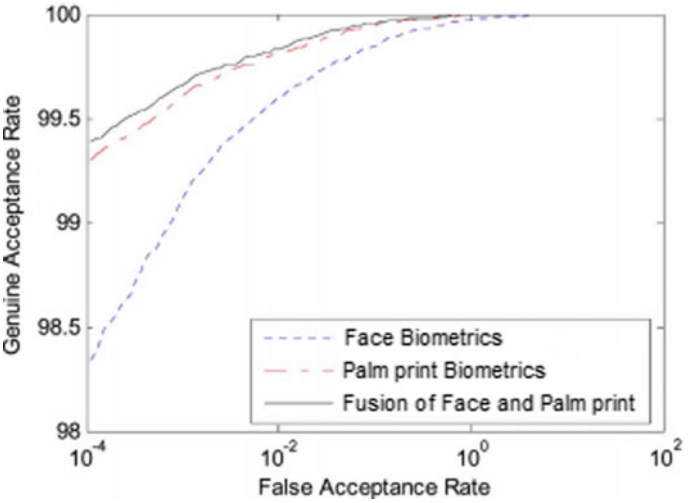


**Fig. 6** Comparison of face, Palm print, and their fusion

face and palm print biometrics is 99.8% which is extremely high compared to the single use of face and palm print alone as unimodal biometrics.

## References

1. Kumar Y, Nigam A, Tiwari K, Gupta P (2015) A mechanized multimodal biometric framework and combination. In: IEEE workshop computational intelligence biometrics identity management CIBIM, January, vol 2015, pp 16–21
2. Mondal A, Kaur A (2016) Relative study of feature level and decision level fusion in multimodal biometric recognition of face, ear, and iris. 5(5):822–842
3. Morris C, Rajesh RS (2015) An epic and improved spatial space combination strategy utilizing simple—PCA strategies. In: 2014 international conference communications networks technology ICCNT 2014, vol 2015, March, pp 90–94
4. Bounneche MD, Boubchir L, Bouridane A, Nekhoul B, Ali-Cherif A (2016) Multi-phantom palmprint acknowledgment dependent on arranged multiscale log-Gabor channels. Neurocomputing 205:274–286
5. Jain AK, Nandakumar K, Ross A (2016) 50 years of biometric research: accomplishments, difficulties, and openings. Pattern Recognit Lett 79:80–105
6. Zuo W et al (2017) Palmprint recognition based on complete direction representation. IEEE Trans Image Process 26(9):4483–4498
7. Xiao-Qiang Y, Xiao-bing Z (2017) Face recognition research based on the fusion of layered LBP feature. In: IEEE workshop computational intelligence biometrics identity management CIBIM, pp 75
8. Ali MMH, Yannawar PL, Gaikwad AT (2017) ScienceDirect multi-algorithm of Palmprint recognition system based on fusion of local binary pattern and two-dimensional locality preserving projection. Proc Comput Sci 115:482–492

9. Skillet Z, Wu X, Li Z (2019) Focal pixel choice procedure dependent on neighborhood dim worth circulation by utilizing angle data to upgrade LBP for surface order. Expert Syst Appl 120:319–334
10. Srivastava R (2020) Score-level multimodal biometric authentication of humans using retina, fingerprint, and finger vein. Int J Appl Evol Comput (IJAEC) 11(3). https://doi.org/10.4018/IJAEC.2020070102
11. Luo YT et al (2016) Neighborhood line directional example for Palmprint acknowledgment. Pattern Recognit 50:26–44
12. Meher B, Agrawal S, Panda R, Abraham A (2019) A study on area-based image combination strategies. Inf Combination 48:119–132
13. Moutafis P, Kakadiaris IA (2015) Rank-based score standardization for multi-biometric score combination. In: 2015 IEEE international symposium technology homeland security, HST 2015, pp 1–6
14. Moi H, Asmuni H, Hassan R, Othman RM (2014) Master systems with applications multimodal biometrics: weighted score level combination dependent on non-perfect iris and face images. Expert Syst Appl 41(11):5390–5404
15. Khodadoust J, Khodadoust AM, Li X, Kumari S (2018) Plan and usage of a multibiometric framework dependent available's characteristics. Expert Syst Appl 97:303–314
16. Jain MP, An Alad Manoj Peter M (2016) Combination of PalmPrint and Iris for multimodal biometric. Int J Scient Res Publ 6(5):221–227
17. Srivastava R, Srivastava P (2019) A multimodal based approach for face and unique mark based combination for confirmation of human. Int J Bus Anal 6(3). https://doi.org/10.4018/IJBAN.2019070102
18. Srivastava R (2020) A score level fusion approach for multimodal biometric fusion. Int J Scient Technol Res. ISSN: 22778616
19. Zhou LF, Du YW, Li WS, Mi JX, Luan X (2018) Posture strong face acknowledgment with Huffman-LBP improved by divide-and-rule procedure. Pattern Recognit 78:43–55
20. Modak SKS, Jha VK (2019) Multibiometric combination technique and its applications: a survey. Inf Combination 49:174–204