ISSN: 2321-4708
RESEARCH REVIEW
The Academic Research Issue
Open Access, Peer-Reviewed & Refereed Journal
An International Multidisciplinary Journal
Vol.1, Issue: 153, May 2025
Paper ID: RRJ740265
www.researchreviewonline.com
Publishing URL: https://www.researchreviewonline.com/issues/volume-1-issue-153-may-2025

COMPARATIVE EVALUATION OF VARIOUS FACE RECOGNITION TECHNIQUES

By
Devansh Saxena
Class XI-F
City Montessori School, Kanpur Road, Lucknow
& Co-Author - Associate Professor, Dr. Pankaj Dixit

Abstract

A comparative analysis of facial recognition methods was offered in this paper. Features are categorized as phase congruency features, Gabor features, and holistic features. Principal Component Analysis, Linear Discriminate Analysis, Kernel Fisher Analysis, and Kernel Principal Component Analysis are used in experiments on the ORL database for identification (Correct Identification Rate) and verification (Equal Error Rate).

Introduction

Instead of using passwords, PINs, smart cards, tokens, and other methods to grant access to physical or virtual domains, biometric systems use physiological or behavioral traits to verify and identify the user. To get around the drawbacks of passwords and PIN numbers (which might be forgotten or lost), Jain et al. suggested biometrics. These days, biometric technologies are being used in numerous applications, such as banking, business, and attendance monitoring in educational institutions. According to Muhtahir et al., an individual's face, iris, palm print, finger print, ear, and hand geometry are examples of physiological characteristics. Speech, signature, keystroke, and gait are examples of the behavioral characteristics. Although the iris scan and hand geometry are highly costly The following benefits include non-intrusiveness, inexpensive equipment costs, no need for personal physical contact, and no health risks being transferred. Good algorithms can deal with noise and small changes in an image's lighting and orientation. Kalluri et al. suggested employing Gabor and WPLI features to identify palm prints.Ever since facial recognition provides the aforementioned benefits and has been used in applications such as smart card, security, surveillance, general identity verification, video indexing, image database analysis, and so on. Face detection (segmentation), feature traction, and face recognition are the three stages of a face recognition system.

Figure 1 displays the face recognition block diagram. Face detection's objective is to extract the

There are four key components to any image: 1. Visual features, which include areas, edges, curves, and textures. 2. Features of statistics 3. Features of the Transform Coefficient and 4. Features of algebra. Knowledge-based, mathematical transform, neural network, or fuzzy extractor are the methods used to extract features. One of the most widely utilized feature extraction methods is the Gabor Wavelet Transform because of its biological significance and computational characteristics. Visual characteristics like spatial localization, spatial frequency, and orientation selectivity are captured via gabor feature

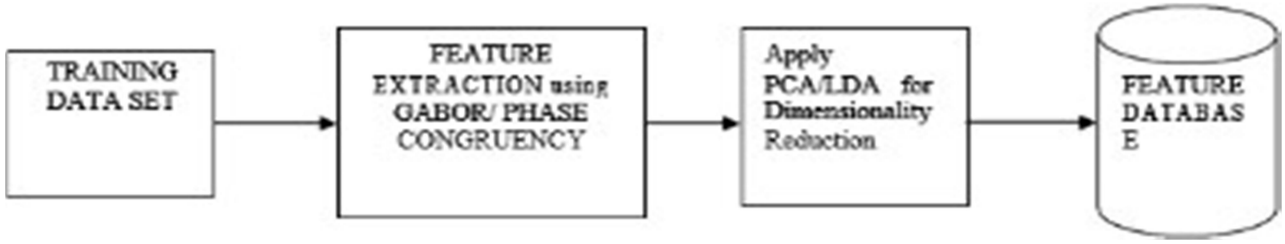
ISSN: 2321-4708
RESEARCH REVIEW
The Academic Research Issue
Open Access, Peer-Reviewed & Refereed Journal
An International Multidisciplinary Journal
Vol.1, Issue: 153, May 2025
Paper ID: RRJ740265
www.researchreviewonline.com
Publishing URL: https://www.researchreviewonline.com/issues/volume-1-issue-153-may-2025

extraction. Because the facial images it provides are coupled with the Gabor filter bank, the dimensionality of the Gabor feature space is quite vast. To lower the dimensionality, PCA is used. The Gabor Wavelet transform can be used to calculate phase congruency, which extracts the local features of the face. It is not affected by changes in lighting. Face recognition methods based on static photos were divided into feature- based and holistic-based methods by Lerato Masupha et al. Distinct facial features, such as the mouth, nose, and eyes, as well as other facial points, are identified using feature-based approaches. Next, they convert the image into geometrical representations by measuring the geometrical relationship between facial locations feature vector. There are two types of feature- based methods: Elastic bunch graph and geometric feature-based. Methods based on a holistic approach: These methods recognize faces by using all of the image's information. They are separated into two categories: artificial intelligence and statistics.

The full image is represented as a 2D array of intensity values in a statistically based method, after which the probing image is compared to every face in the database. LDA and Principal Component Analysis (PCA) are two instances of statistical methods. Neural network and machine learning ideas are used in artificial intelligence techniques to identify or verify faces. Examples of artificial intelligence techniques include neural networks, support vector machines, hidden Markov models, local binary patterns, and radial basic fuzzy (RBF). The remainder of the document is structured as follows: Section 2 provided an explanation of the suggested methodology. Section 3 discusses the experimental findings. Section 4 provides conclusions. Figures 2 and 3 display the block diagram for the suggested face recognition and identification system. Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), and other techniques are used in the suggested method. A quick description of PCA and LDA is provided below. We employed phase congruency features, holistic features, and Gabor features for feature extraction

Analysis of Principal Components

Principal component analysis is a linear projection method, according to Karim et al. with N being the total number of facial images, PCA finds the best linear least-square representation in (N-1) dimension space. The representation is described by a set of N-1 eigenvectors and eigenvalues. By normalizing the Eigen vectors, the orthogonal can be found. The greater percentage of training data that can be represented by lower-order eigenvectors, while a lesser percentage is altered by higher-order eigenvectors. PCA is incredibly simple and effective, and there is a strong correlation between the training and test images. A. Mir and A. G. Mir et al. demonstrated that lighting effects reduce PCA accuracy. LDA: It was suggested by Sharkas et al. that Fisher analysis, also known as linear discriminant analysis, maximized interclass differences but not data representation. When the sample size is tiny, the application of LDA runs into issues. The limited sample size issue was resolved by a strategy put forth by Chen et al. proposed a method that solves the small sample size problem.



ISSN: 2321-4708
RESEARCH REVIEW
The Academic Research Issue
Open Access, Peer-Reviewed & Refereed Journal
An International Multidisciplinary Journal
Vol.1, Issue: 153, May 2025
Paper ID: RRJ740265
www.researchreviewonline.com
Publishing URL: https://www.researchreviewonline.com/issues/volume-1-issue-153-may-2025

Face database

The AT&T Institute established the ORL database. The 400 photos in the ORL database feature 40 subjects, each of whom has ten distinct styles. Every image has a pixel size of 92x112 and is in PGM format. Each pixel contains 256 grey levels. Figure 4 displays a selection of the example photos.

Results

The following shows how well different face recognition algorithms perform on the ORL face database. The first three of each face's ten photos are used for training, while the remaining seven are used for testing. We regarded the first five photographs as train images and the remaining five as test images in the second run.

The identification rates for PCA are 66.07, LDA is 86.07, KPCA is 49.69, and KFA is 85.71 when there are three training images. For five training photos, PCA, LDA, KFA, and KPCA perform 70.83, 91.5, 88.5, and 52%, respectively. For three train images, the identification rates from Gabor-based PCA, KFA, KPCA, and LDA were 84.5, 93.33, 80, and 93.33, respectively. They generate 62.5, 95, 67.5, and 100% for five train photos, respectively. Table 1 presents the findings, and Figure 5 illustrates them.

Table 1: Results obtained for different face recognition algorithms

Algorithm	Correct Identification Rate	
	3 Training Images	5 Training Images
PCA	66.07	70.83
KPCA	49.29	52
KFA	85.71	88.5
LDA	86.07	91.5
Gabor PCA	84.5	62.5
Gabor KPCA	80	67.5
Gabor KFA	93.33	95
Gabor LDA	93.33	100
Phase Congruency PCA	60.83	57.5
Phase Congruency KPCA	71.67	57.5
Phase Congruency KFA	84.17	87.5
Phase Congruency LDA	82.5	92.5

Table 2: Results Equal Error Rate

Algorithm	Equal Error Rate	
	3 Training Images	5 Training Images
PCA	5.03	4.08
KPCA	9.29	7.03
KFA	7.22	6.13
LDA	4.28	2.5
Gabor PCA	5.01	0
Gabor KPCA	4.17	0
Gabor KFA	2.51	2.28
Gabor LDA	2.51	0
Phase Congruency PCA	5.85	2.5
Phase Congruency KPCA	6	2.5
Phase Congruency KFA	5.94	87.5
Phase Congruency LDA	5.19	2.5

ISSN: 2321-4708
RESEARCH REVIEW
The Academic Research Issue
Open Access, Peer-Reviewed & Refereed Journal
An International Multidisciplinary Journal
Vol.1, Issue: 153, May 2025
Paper ID: RRJ740265
www.researchreviewonline.com
Publishing URL: https://www.researchreviewonline.com/issues/volume-1-issue-153-may-2025

Conclusion

Phase congruency-based face recognition algorithms are found to perform worse than Gabor-based algorithms, according to experimental results. With five training images, Gabor PCA, Gabor KPCA, and Gabor LDA achieve 100% accuracy. Additionally, it has been noted that the Equal Error Rate is decreased when five training photos are used.

References

A. K. Jain, R. Bolle, and S. Pankanti,"Biometrics: Personal Identification in Networked Security," A. K. Jain, R. Bolle, and S. Pankanti, Eds.: Kluwer Academic Publishers, 1999.

M. O. Oloyede, and G. P. Hancke, Unimodal and Multimodal Biometric Sensing Systems: A Review, IEEE Access,pp:75327555, Vol.4, 2016.

R. Jafri and H. R. Arabnia : A survey of Face Recognition techniques, Journal of Information Processing Systems, pp. 4168, Vol.5, No.2, 2009.

H. K. Kalluri, M. V. N. K. Prasad, A. Agarwal,Palmprint Identification and verification based on wide principal lines through dynamic ROI, International Journal of Biometrics, pp. 1-30, Vol. 7, No. 1, 2015.

H. K. Kalluri, M V N K Prasad, Palmprint Identification based on Goabor and WPLI Features, Procedia Computer Science 93, 706 712,

2016.

L. Masupha, T. Zuva, S. Ngwira, O. Esan: Face Recognition Techniques, their Advantages, Disadvantages and Performance Evaluation, International Conference on Computing, Communication and Security (ICCCS), 2015.

T. F. Karim, M. S. H. Lipu, Md. L. Rahman, F. Sultana : Face Recognition Using PCA-Based Method, IEEE International Conference on Advanced Management Science, 2010.

A. Mir and A. G. Mir, "feature extraction methods(PCA fused with DCT)," International Journal of advances in engineering and technology, vol. 6, pp. 2145- 2152, 2013.

M. Sharkas, M. Abou Elenien, Eigenfaces vs. Fisherfaces vs. ICA for Face Recognition; A Comparative Study, 9thInternational Conference on Signal Processing, 2008.

L. Chen, H. Yuan, M. T. Ko, J. C. Lin, G. J. Yu : A new LDAbased face recognition system which can solve the small sample problem, Pattern Recognition, Vol. 33, No. 10, pp. 1713-1726, 2000.