

# Comparative Analysis of Facial and Fingerprint Biometric Identification Systems through Soft Computing Techniques

<sup>1</sup>Jyoti Rajharia, <sup>2</sup>P. C. Gupta

<sup>1</sup>Jaipur National University, Jaipur, Rajasthan, India

<sup>2</sup>Dept. of Computer Science and Informatics, University of Kota, Kota, Rajasthan, India

## Abstract

Biometric identification refers to the automatic recognition of individuals based on their physiological and behavioral characteristics. A biometric system is essentially a pattern recognition system which has been used to identify a person. Fingerprint and face recognition are two different approaches through which a person can be recognized. This paper mainly aims how these approaches can be used and what are the limitations of each.

## Keywords

Biometric, Identification, Pattern Recognition

## I. Introduction

Biometric is the science of measuring human's characteristics for the purpose of authenticating or identifying the identity of an individual person. Two types of characteristics are measured in biometric identification namely, physiological characteristics and behavioral characteristics [1]. Physiological characteristics measure human body parts while behavioral characteristics measure the actions produced by human such as sound, signature. Physiological characteristics used in biometric are appearance of face, hand geometry, fingerprint, iris and palm print. A biometrics-based identification system consists of the six major components depicted in Figure 1. The first component of an automated biometric identification system is a data acquisition component that acquires the biometric data in digital format by using a sensor. For fingerprints, the sensor is typically a scanner; for face pictures, the sensor is typically a camera. The quality of the sensor has a significant impact on the accuracy of the comparison results. The second and third components of the system are optional. They are the data compression and decompression which are designed to meet the data transmission and storage requirements of the system.

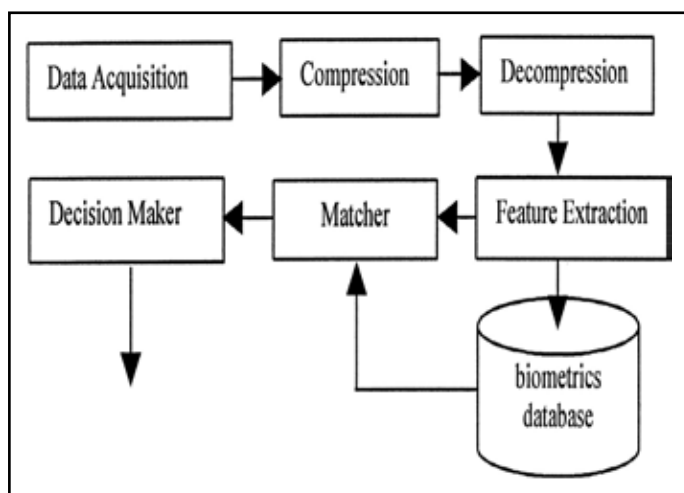


Fig. 1: A Biometric-Based System

The fourth component is of great importance, the feature extraction algorithm. It produces a feature vector, in which the components

are numerical characterizations of the underlying biometrics. The fifth component of the system is the “matcher,” which compares feature vectors obtained from the feature extraction algorithm to produce a similarity score. The sixth component of the system is a decision-maker. Among all the biometric techniques, fingerprint-based identification is the oldest method and most widely used form of biometric identification. Today it is one of the most popular and reliable biometric techniques which are used in a personal identification [2]. Fingerprint recognition has been widely adopted for user identification due to its reliable performance and usability. Every person has its own unique, immutable fingerprint. So, finger print has being used for identification and forensic investigation for a long time. Face recognition is another popular biometric identification approach for personal identification. It is the most common biometric characteristics used by humans to make a personal recognition and also the primary focus of attention in the society, playing a major role in conveying identity of a person. There are many ways that humans can identify each other, and so is for machines. Being different from other types of biological characteristics, the human face can be gained through a direct and natural way. Face recognition can be accepted easily by the users. There are many different identification technologies available, many of which have been in commercial use for years. The most common person verification and identification methods are password or PIN systems. The problem with these techniques that they are unique and it is possible for some body to forget or loose. These problems were overcome by developing considerable interest in biometric identification system, which use pattern recognition techniques to identify people using their characteristics. Some of those methods are face and fingerprint recognition.

## II. Literature Review

### A. Face Recognition Techniques

The research on fully automated face recognition has been started from 1960s, in which feature (such as eyes, ears, nose, and mouth) from face image was located. W. Zhao [3], provides an up-to-date survey on face recognition and discusses two types of face recognition task which is based on still images and video. Turk [4] used standard linear algebra technique to calculate the eigenfaces. This method enabled real-time automated face recognition system. L. Liao [5], Used Fast Fourier Transform algorithms for the input face image before applying recognition. The FFT algorithm transform input face images into “Whitenedfaces” then perform face recognition using Principal Component Analysis (PCA) and Independent Component Analysis (ICA) coding strategies, respectively. Experimental result shows that the whitening processing will bring better recognition performances for both PCA and ICA based face recognition system. G. Jarillo [6] used different image transformations (such as contrast enhancement and edge detection). The experimental results shown that such transformations can provide unique discriminatory information useful for face classification, namely PCA, LDA (Linear

Discriminate Analysis. For experiment YALE and FERET database are used. G. K.Lin [7] proposed Hausdroff distance in recognition step instead of Euclidian distance. Experiments showed satisfactory results in terms of recognition accuracies and processing speed. A. Eleyan [8] used wavelet transform along with PCA. Two methods have been proposed first is Multi resolution Feature Concatenation (MFC), where PCA is used for dimensional reduction on each subband and resulting each subband together for performing classification, second is Multi resolution Majority Voting (MMV) where PCA and classification are done separately on each subband. Experimental result showed that both techniques promising the results and NMV approach outperforms the MFC approach. Shermina.J [9] used DCT for minimizing the illumination problem in face recognition. DCT applied image later is used in recognition step and for this step PCA approach is used. Result shows illumination normalized image provides more accurate result.

### B. Fingerprint Recognition Techniques

G. Sambasiva Rao et al., [10] proposed fingerprint identification technique using a gray level watershed method to find out the ridges present on a fingerprint image by directly scanned fingerprints or inked impression. M. R. Girgisa et al., [11] proposed a method to describe a fingerprint matching based on lines extraction and graph matching principles by adopting a hybrid scheme which consists of a genetic algorithm phase and a local search phase. Experimental results demonstrate the robustness of algorithm. Duoqian Maio et al., [12] used principal graph algorithm by kegl to obtain principal curves for auto fingerprint identification system. From principal curves, minutie extraction algorithm is used to extract the minutiae of the fingerprint. The experimental results shows curves obtained from graph algorithm are smoother than the thinning algorithm. Alessandra Lumini, and Loris Nanni [13] developed a method for minutiae based fingerprint and its approach to the problem as two - class pattern recognition. The obtained feature vector by minutiae matching is classified into genuine or imposter by Support Vector Machine resulting remarkable performance improvement. Mohamed et al., [14] presented fingerprint classification system using Fuzzy Neural Network. The fingerprint features such as singular points, positions and direction of core and delta obtained from a binarised fingerprint image. The method is producing good classification results. Ching-Tang Hsieh and Chia-Shing – Hu [15] has developed anoid method for Fingerprint recognition. Ridge bifurcations are used as minutiae and ridge bifurcation algorithm with excluding the noise-like points are proposed. Experimental results show the humanoid fingerprint recognition is robust, reliable and rapid. Haiping Lu et al., [16] proposed an effective and efficient algorithm for minutiae extraction to improve the overall performance of an automatic fingerprint identification system because it is very important to preserve true minutiae while removing spurious minutiae in post-processing. The proposed novel fingerprint image post-processing algorithm makes an effort to reliably differentiate spurious minutiae from true ones by making use of ridge number information, referring to original gray-level image, designing and arranging various processing techniques properly, and also selecting various processing parameters carefully. The proposed post processing algorithm is effective and efficient. Prabhakar S, Jain. A.K. et al., [17] has developed filter-based representation technique for fingerprint identification. The technique exploits both local and global characteristics in a fingerprint to make identification. Each fingerprint image is filtered in a number of directions and a 640-

dimensional feature vector is extracted in the central region of the fingerprint. The feature vector is compact and requires only 640 bytes. The matching stage computes the Euclidian distance between the template finger code and the input finger code. The method gives good matching with high accuracy. Ballan M [18] introduced Directional Fingerprint Processing using fingerprint smoothing, classification and identification based on the singular points (delta and core points) obtained from the directional histograms of a fingerprint. Fingerprints are classified into two main categories that are called Lasso and Wirbel. The process includes directional image formation, directional image block representation, singular point detection and decision. The method gives matching decision vectors with minimum errors, and method is simple and fast.

### III. Comparision of Fingerprint and Face Recognition Techniques

The main goal of fingerprint and facial identification system is to find out the identity of a person and to identify a person different method has been used. This section gives an overview of human face and fingerprint recognition methods.

#### A. The Methods Considered in Fingerprint Recognition Techniques are as follow:

##### 1. Fast Fourier Transform and Gabor Filters

This method is used to enhance and reconstruct the information of the fingerprint image, as well as to extract two fundamental types of minutiae, ending points and bifurcations. Finally the extracted features are used to perform the fingerprint recognition [19].

##### 2. Fusion and Context Switching Frameworks

Fusion and Context Switching framework approach is implemented in forensic science application to match two latent fingerprints. In this approach unlike matching latent with inked or live fingerprints, proper analysis and attention is made.

##### 3. Segmentation Algorithm

Segmentation is one of the first and most integral pre-processing steps for any fingerprint verification and it determines the result of fingerprint analysis and recognition. Different segmentation algorithms have been used which are described as below:

##### (i). Gauss Filtering

In this process of collecting the fingerprints, noises are usually drawn into the fingerprint image for many reasons, such as inhalation of dust and spots on the sensor surface [20]. Therefore, the Gaussian filter is used to weaken this effect and improve the quality of the images. The two-dimensional Gaussian function is given as follows:

$$G(x,y) = A e^{-x^2+y^2/2\delta^2} \quad [21]$$

Where x is the distance from the origin in the horizontal axis and y is the distance from the origin in the vertical axis.

##### (ii). Histogram Processing

Histogram manipulation can be used effectively for fingerprint image enhancement. Histograms are simple to calculate in software and also lend themselves to economic hardware implementations, thus making them a popular tool for real-time image processing.

## B. The Methods Considered in Facial Recognition Techniques can be Divided Into Two Categories [22]:

### 1. Holistic Matching Technique

Holistic matching technique also called template matching. In this technique input image compare with a set of templates and these templates can be constructed using statistical tools like Principal Component Analysis (PCA), Linear Discriminate Analysis (LDA), and Independent Component Analysis (ICA). Constructed templates also called extracted feature and form the basis of any recognition task.

### B. Feature –Based Matching Technique

Feature-based (structural) matching methods analyze local facial features such as eyes, nose, mouth and chin and their geometric relationships. This set of features is then matched with the features of known individuals. A suitable metric such as Euclidean distance (finding the closest vector) can be used to find the closest match. The advantage of using geometrical features is that recognition is possible even at very low resolution and with noisy images (images with many distorted pixel intensities). Table 1. shows the face recognition approaches and techniques for implementation of these.

Table 1: Face Recognition Techniques

S.no.	Face Recognition Approaches	Technique
1.	Holistic Matching	Principal Component Analysis (PCA) or Eigenfaces  Linear/Fisher Discriminate Analysis (FLD/LDA) or Fisher faces  Independent Component Analysis(ICA)
2.	Feature based (structural) matching	Elastic Bunch Graph Matching Algorithms (EBGM)

## IV. Conclusion

In this paper we have discussed facial and fingerprint identification system. It is also considered, how these can be implemented in individual applications and what are the advantages and limitations of each. The focus of the study in our future research work is to propose an identification method which will be better in terms of identify a person.

## References

- [1] David Zhang, "Palmprint Authentication", Kluwer Academic Publishers, 2004.
- [2] P.Porwik, "The Biometric Passport. The technical requirements and possibilities of using", IEEE International Multi-conference on Biometrics and Kansei Engineering, 2009, Cieszyn, Poland , pp. 65-75.
- [3] W.Zhao, R.Chellappa, P.J..Phillips, A. Rosennfeld, "Face Reconition: A literature Survey", ACM Comput.Surv., 35(4), pp. 399-458, 2003.
- [4] M.A.Turk, A.P. Pentaland, "Face Recognition Using Eigenfaces", IEEE conf. on Computer Vision and Pattern Recognition, pp. 586-591, 1991.
- [5] Ling-Zhi Liao, Si-Wei Luo, Mei Tian, "Whitenedfaces", Recognition With PCA and ICA", IEEE Signal Processing Letters, Vol. 14, No. 12, pp. 1008-1011, Dec. 2007.
- [6] G. Jarillo, W.Pedrycz, M. Reformat, "Aggregation of classifiers based on image transformations in biometric face recognition", Machine Vision and Applications (2008) Vol. 19, pp. 125-140, Springer-Verlag 2007.
- [7] Kwan-Ho Lin, Kin-Man Lam, Wan-Chi Siu, "A New Approach using ModiGied Hausdorff Distances with EigenFace for Human Face Recognition", Seventh international Conference on Control, Automation, Robotics And Vision (ICARCV'02), Singapore, Dec 2002.
- [8] A.Eleyan, H. Demirel, "Face Recognition using Multiresolution PCA", IEEE International Symposium on Signal Processing and Information Technology-2007.
- [9] Shermina.J, "Illumination Invariant Face Recognition Using Discrete Cosine Transform And Principal Component Analysis", International conference on Emerging Trendes in Electrical and Computer Technology(ICETECT)-2011.
- [10] G.Sambasiva Rao, C. NagaRaju, L. S. S. Reddy, E. V. Prasad, "A Novel Fingerprints Identification System Based on the Edge Detection", International Journal of Computer Science and Network Security.
- [11] Eric P. Kukula, Christine R. Blomeke, Shimon K. Modi, Tephenn J. Elliott, "Effect of Human Interaction on Fingerprint Matching Performance, Image Quality, and Minutiae Count", International Conference on Information Technology and Applications, pp. 771-776, 2008.
- [12] Luping Ji, Zhang Yi, "Fingerprint Orientation field Estimation using Ridge Protection", The Journal of the Pattern Recognition, Vol. 41, pp. 1491-1503, 2008.
- [13] Duresuoquian Miao, Qingshi Tang, Wenjie Fu, "Fingerprint Minutiae Extraction Based on Principal Cures", the Journal of the Pattern Recognition Letters, Vol. 28, pp. 2184 -2189, 2007.
- [14] L. Lam S W Lee, C Y Suen, "Thinning Methodologies-A Comprehensive Survey", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 14, pp. 869-885, 1992.
- [15] Mohamed. S. M and Nyongesa.H, "Automatic Fingerprint Classification System using Fuzzy Neural techniques", IEEE International Conference on Artificial Neural Networks, vol. 1, pp. 358-362, (2002).
- [16] Manvjeet Kaur, Mukhwinder Singh, Akshay Girdhar, Parvinder S. Sandhu, "Fingerprint Verification System using Minutiae Extraction Technique", Proceedings of World Academy of Science, Engineering and Technology, Vol. 36, pp. 497-502, 2008.
- [17] Haiping Lu, Xudong Jiang, Wei-Yun Yau, "Effective and Efficient Fingerprint Image Post processing", International Conference on Control, Automation, Robotics and Vision, Vol. 2, pp. 985- 989, 2002.
- [18] Prabhakar, S, Jain, A.K, Jianguo Wang, Pankanti S, Bolle, "Minutia Verification and Classification for Fingerprint Matching", International Conference on Pattern Recognition, Vol. 1, pp. 25-29, 2002.
- [19] Gualberto Aguilar, Gabriel Sanchez, "Fingerprint Recognition", IEEE, 2007.

- [20] Jun Ma, Xiaojun Jing, Yuanyuan zhang, "Simple effective fingerprint segmentation algorithm for low quality images", IEEE 2010.
- [21] Hao Li, Xi Fu, "Proficient in Visual C++ and Algorithms Implement of Fingerprint Pattern Recognition System; Posts and Telecom Press", Bei Jing, 2008.
- [22] W.Zhao, R.Chellappa, P.J. Phillips, A. Rosenfeld, "Face Reconition: A literature Survey. ACM Comput.Surv., 35(4), pp. 399-458, 2003.
- [23] Saurabh P. Bahupuri, Dr. D.S. Choudhary, "A Study of Face Recognition Technique", International Journal of Electronics and Soft Computing Science and Engineering (IJESCSE), Vol. 1, Issue 1.



Jyoti Rajharia has obtained her masters degree in computer science from JNVU, Jodhpur, Rajasthan. She is pursuing Ph.D. in Computer Science from School of computer and system sciences, Jaipur National, University, Jaipur, Rajasthan, India. She also has many publications in National and International Journal. Her area of interest includes Artificial Intelligence and Neural Networks.



Dr.. P.C. Gupta received Ph.D Computer Science from Bundelkhand University, Jhansi. He is working as Associate Professor, Department of Computer science, University of Kota, Kota, Rajasthan, India. He is guiding a number of Ph.D Research Scholars. He has published many research papers in National and International Conferences and Journals. His research interest lies in Artificial Intelligence and Neural

Networks.