JOHAR – Journal of Hospitality Application & Research
16 (2) 2021, 01-16
http://www.publishingindia.com/johar/

BIOMETRIC FACE RECOGNITION: APPLICATION OF NEURAL NETWORKS AND FUZZY CONTROL IN HOSPITALITY INDUSTRY

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Abstract

The pattern detection device for biometric identification, which is discussed in the following paper, made use of mathematical modelling and descriptive statistics together with exploratory factor analysis i.e., Principal Component Analysis on the point of a function extraction technique. The proposed prestige gadget consisted of androgenic hair for the identification of biometric features with four hundred photographs for each database. A total of four-hundred pictures were gathered from each database. It was taken from a total of 25 respondents and sixteen snapshots from each respondent from hospitality industry. Performed with the highest accuracy, the system utilized a histogram equation with 2-fold cross-recognition, seventy-six. 68% of the average precision for the facial database and 19% mean accuracy for the androgenic hair database. Both means of accuracy are achieved using the 90 maximum large eigenvalues and their complementary eigenvectors within the principal component analysis attribute extraction technique.

Keywords: *Neural Network, Fuzzy Control, Principal Component Analysis, Factor Analysis, Artificial Intelligence, Biometric, Hospitality Industry*

Introduction

In the field of hospitality by comparing data with real customer faces, hotels and guesthouses can offer personalized services. Hotels can process payments in a more efficient and cost-effective way. Hotels, guest houses, restaurants, airports, and tourism companies can all use face recognition to make payment processes - from applying discounts to ending transactions without wasting time with your staff and customers. Face recognition technology can alert hotel staff if there are suspicious guests. In this way, problems can be easily identified and prevented. An example can be provided with access to face recognition and guest verification. If a visitor, wants to go to the gym, their hotel room or elsewhere, they can do so by examining their face.

Face recognition holds the promise of transforming the hospitality industry. It is already being used by airports, companies, and hotels around the world to improve safety and efficiency. The first to use technology can benefit from the growth process.

Facial recognition is a biometric application utility that is capable of uniquely identifying or confirming an individual's identity by evaluating and analyzing patterns based solely on an individual's facial figure. The popularity of the face is mainly used for security functions, even though applications are increasing in other areas of use.

(Jalled & Voronkov, 2016) Eigen's Faces use the Face Recognition Machine Vision System, Moscow Institute of Physics and Technology, Department of Radio Engineering and Cybernetics first discussed about the concept of Principal Component Analysis (PCA) and Normalized Principal Component Analysis (N) on experimental overall performance contrast of face recognition. Eigenfaces method is one of the most commonly used linear statistical techniques. It can be described as classifying a face as a known or unknown, after matching it with recognized individuals saved as a database.

(Yang et al., 2002) Reviewing the existing techniques for detecting faces in a single image. Face localization by using methods such as feature invariant approaches, template matching methods and other such rule driven methods. (Neth et al., 2009) The perception of facial expressions of emotions increased with the changed configurations w.r.t. norm (face prototype). (Sirovich et al., 1986) Fourier and Digital methods were elaborated since face recognition is an instantaneous process, it is plausible that we do it by processing optimum number of dimensions. (Teoh et al., 2004) Another stepping-stone in the

area of biometric face recognition wherein integral form of the biometric information is utilized to produce an array of random numbers, designated as Facehash.

(Aleksa et al., 2019) Various algorithms are used by the software but the output of biometric face recognition narrows down to the collation of input image with the one which is stored in the database. (Bouhou et al., 2016) Discussed about face variations from individual to individual and hybrid approach adopted to segregate two categories of objects from a mixed document. (Chang et al., 2005) Implementation of Principal component analysis methods for multimodal recognition. The major finding was that a combination of 2-D and 3-D face recognition gives the optimum results. (Chatfield et al., 2018) Provided a detailed insight into multivariate analysis, concepts like principal component analysis, factor analysis, cluster analysis and similar statistical terminologies. (Shivakumar & Vijaya, 2013) Classification of facial expressions into six basic categories - happy, sad, surprised, disgusted, anger and fright. Multiple iterative searching methods and edge detection methods are made use of.

NPCA is an extension on linear PCA, in which the normalization of Pix is first eliminated, to eliminate power variations and background results, and the use of singular cost decomposition (SVD) to replace Eigen cost decomposition (EVD). N-PCA includes features such as:

- Collection of Images to make the Database
- Checking whether the photograph is colored or grey
- Average value(μ) and Standard Deviation(σ) of Images are calculated
- Normalization
- Calculating Train Concentered Images: Subtracting the suggest from the column vector matrix of schooling photographs to be able to obtain the centered images
- Calculating Eigen Vectors along with complementary values
- Creating Eigenfaces
- Calculating Train Weights
- Store Train Weights in Sink for Further Comparison
- Euclidean distance Classifier
- Face Recognized

The experimental outcome confirmed that N-PCA gives a higher recognition price. The comparison suggests that the accuracy for Principal component analysis is 92.50%, at the same time as for N-PCA is 93. 75% on Indian face database (IFD) for 80/20 Ratio of teaching to test photographs (Fig. 1).

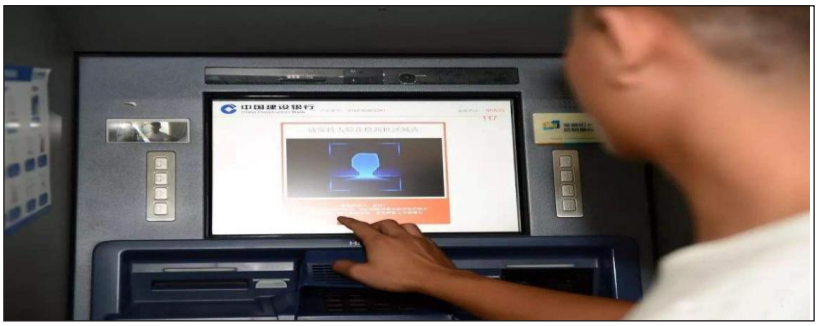

Fig. 1: Face Recognition

Objective

The goal of the proposed work is to perceive critical factors using PCA (Principal Component Analysis). The aim of the research is also to make the peregrination to face from a given picture. This is accomplished by the use of the PCA (Principal Component Analysis) Algorithm to extract the regulation dimensional characteristic vectors from input patterns.

Methodology

Delivery Targets

- *Privacy/Antiterrorism:* Access control, using the database information to track down terrorists/ sleeper cells.
- *Daycare:* Validating the identification of personnel taking possession of the children from daycare centers.
- *Net-Banking:* The application software can instantly verify a client's facial signature.
- *Voter ID Verification:* Voting is an essential procedure of democracies and ID verification is of utmost importance. Biometric face recognition is an improved procedure as compared to searching in electoral roll.
- *Smart Homes:* Alert residents of approaching trespassers.

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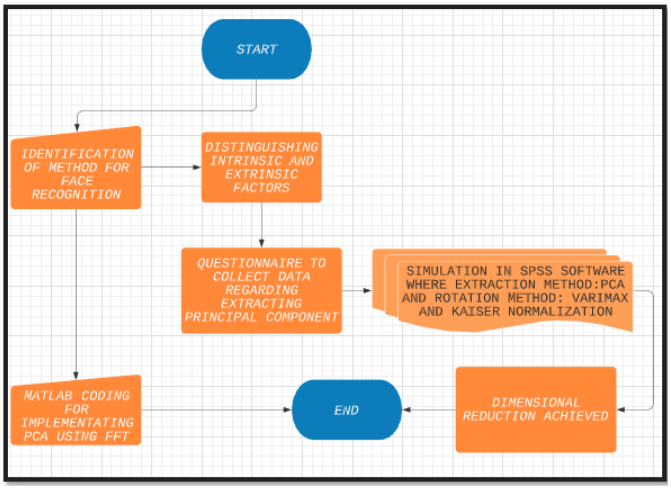


Fig. 2: Delivery Targets Process

Automatic Face Recognition using Neural Network: PCA

(Boualleg, Bencheriet & Tebbikh, 2016) Algeria proposed a new hybrid method for combining neural networks with principal component analysis for Face Recognition. Utilizing the geometric methodology, we make an underlying order of countenances by PCA before utilizing the neuronal procedure (PMC). The outcomes are contrasted alongside the PCA and PMC procedures.

- Collection of images to present the database.
- On the basis of geometric aspects, a miniaturized contour of the extracted face components is devised.
- The extraction of faces comprising nose, eyes, and mouth.
- By making a basic clearing of the lattice picture to investigate the situation of pixels having most extreme vitality to discover the positioning of the eyes.
- To distinguish different facial features, use space-time data to stamp the focuses that recorded the most variation intensity during the grouping process.
- In PCA, calculate the correlation coefficient eigenvalues, and eigenvectors and arranges them in descending order.
- PCA made use of two-hundred images with eight dimensions wherein each dimension represents a vector characterizing one of the face attributes.

- For improving the rate of recognition and rate of rejection, recalled the hybridization of PCA and NN.
- This instead of providing the 8 neurons distance, provided the 8 parameters of PCA.
- Comparing PCA with NN methods along with their hybridizations.
- The penultimate step involves validation done by the neural networks utilizing Back Propagation Network (BPN) and Radial Basis Function (RBF) networks.
- On the basis of performing the steps on several jpg files, the data is tabulated and further validated.

The experimental result showed that these hybrid methods (NN-PCA) are better as compared to those obtained by using one of two methods PCA or NN individually. Hence, in the hybrid method, the rate of recognition and rate of rejection for projection base is 99% and 1% respectively and for test base 94.5% and 5.5% respectively.

Most Basic Approach for Recognition

The basic approaches are shown in Fig. 3, Fig. 4 and Fig. 5.

Face Localisation

Fig. 3: Image Conversion

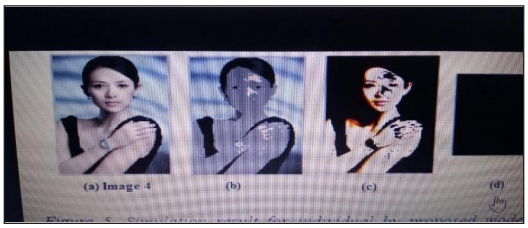


Fig. 4: Dilation

Fig. 5: Image Cropping

The Feature extraction technique is carried out by taking into consideration features such as mouth and eyes. Distance of the eyeball to eyeball and distance from mouth endings are taken. Distance between mouth endings and eyeballs are also taken. A total of six values are given to the Neural Network recognizer. For Neural Network as a Recognizer, Back Propagation Network (BPN) and Radial Basis Function Network (RBF) are used.

Back-propagation training is undergone in the following 3 stages:

- Feedforward of an input training pattern.
- Backpropagation of the associated error.
- Adjustment of weights takes place.

Principal Component Analysis (PCA)

PCA is an approach that statistically determines the extent of correlation for a set of variables (Wilks,1995, Storch & Zwiers,1999). The main purpose of PCA is to condense many variables into a lesser number of components. PCA facilitates in obtaining the principal components through a linear combination of the variables. Each of the variables with different factor loading leads to the formation of the principal component.

The original data is represented into a smaller dimension where the components are uncorrelated but have the maximal possible variance (Jolliffe, 2002). The working steps of the PCA are to determine the no. of principal components equal to the number of variables, to determine how many components are to be retained, rotating the components for better interpretation and interpretation of rotated solution (Suhr, 2005). In the analysis of PCA, the component is a combination of correlated variables (Kim & Mueller, 1978a; Tabachnick & Fidell, 2001). The procedure suggests that the components should be arranged in descending order. The component which has the greatest

variance of the original variables will be the first principal component and thereafter.

Sample Design

A self-designed questionnaire was developed to collect data regarding extracting the principal component of multi-dimensional data in biometric face recognition. The questionnaire was personally administered by students from various functional areas and institutions. The questionnaire consisted of 20 statements scaled on a 5-point Likert type scale. For the Likert questions for the five ordered response levels, an average score was calculated. Seven statements were eliminated by consensus of researchers and another ten by judge's expert in the area. The data was collected on 20 statements from faculty members of institutes of higher learning which was observed to be sufficient for scale development was used. Dimensional reduction is one of the key objectives of our analysis.

The intrinsic factors may be classified as:

- Aging
- Facial Expression
- Plastic surgery
- Facial Geometric Features
- Subject's race and gender
- Facial signature

The extrinsic factors may be classified as:

- Pose Variations
- Noise
- Illumination
- Low Resolution
- Occlusion
- Distance between your eyes
- Distance from forehead to chin
- Camera quality
- Light

- Database size
- Algorithm
- Distance
- The sensitivity of the sensor
- Environmental factors

Procedure Flow

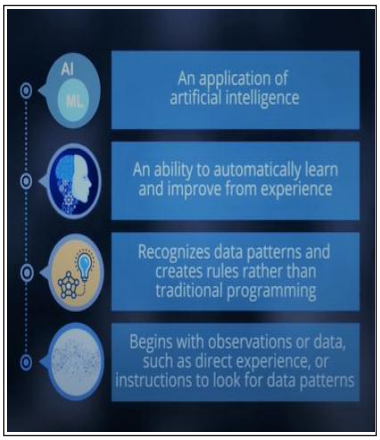


Fig. 6: Procedure Flow

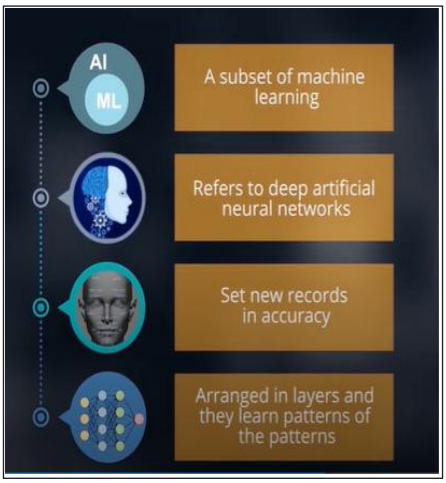
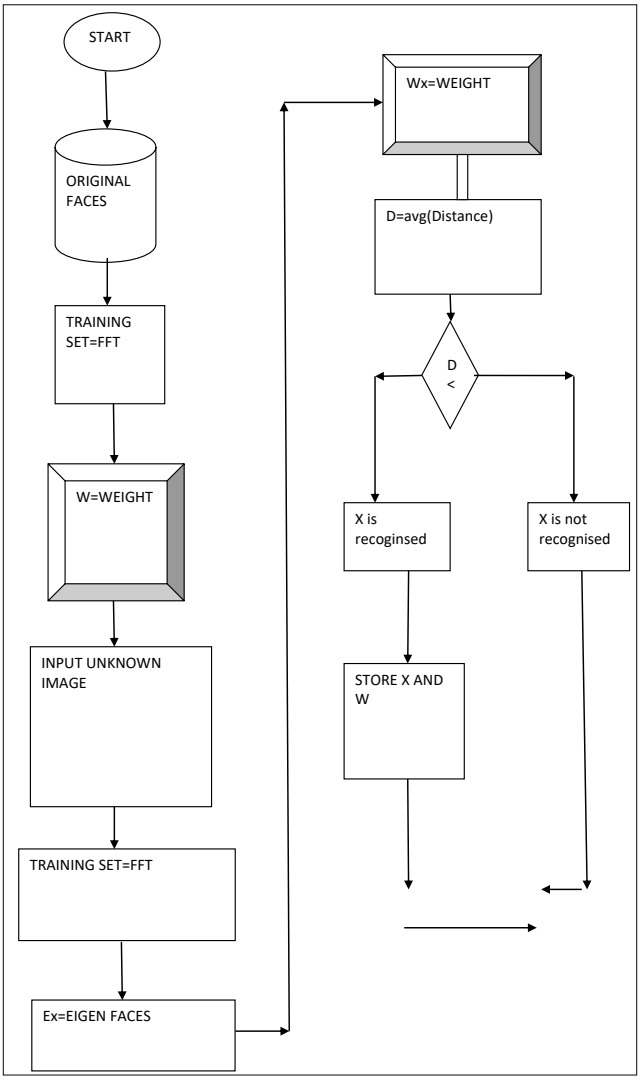


Fig. 7: Algorithm



Flowchart 1: Flowchart for Imlementing PCA using FFT

As far as facial recognition is concerned following a series of steps are followed in the procedural flow:

- A picture of the user's face has been extracted from a jpg or mp4 file. The criterion which has to be taken into consideration is that only the user should be visible without any external interference. The photo may either portray you forward or off the profile.

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- The facial recognition program learns your facial geometry(training). Important features to be taken into account include the Measurement Criterion, Subject's parameters, Micro-expressions, Methodology used, device precision, external factors and device precision. The program identifies facial features - one database identifies approximately sixty-eight of them - which is important to distinguish your face. Result is your facial signature.
- Your facial signature (basically a mathematical formula) is compared to a known face database. Considering the fact that at least one hundred seventeen million Americans have photos of their faces in multiple agency records. According to the May, 2018 report, the 'Federal Bureau of Investigation' was able to obtain 412 million face pictures in the search.
- Now, the process of verification takes place. We may end up with two cases wherein there is a match or no match with the facial signature stored in the database.

Inference: The neural network model can be made use of for effective recognition of frontal or almost frontal faces.

Data Analysis on SPSS

Table 1: Total Variance Explained

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.499	27.494	27.494	2.930	14.649	14.649
2	2.745	13.726	41.220	2.796	13.980	28.629
3	2.125	10.625	51.845	2.221	11.107	39.736
4	1.342	6.709	58.553	2.131	10.653	50.388
5	1.325	6.627	65.181	2.103	10.514	60.902
6	1.213	6.064	71.245	1.576	7.881	68.783
7	1.052	5.262	76.506	1.545	7.724	76.506
8	.921	4.607	81.114	Nil	Nil	Nil
9	.657	3.285	84.399	Nil	Nil	Nil
10	.541	2.706	87.105	Nil	Nil	Nil
11	.521	2.607	89.712	Nil	Nil	Nil
12	.436	2.181	91.893	Nil	Nil	Nil
13	.386	1.932	93.825	Nil	Nil	Nil

Compo-nent	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumul-ative %	Total	% of Variance	Cumul-ative %
14	.277	1.384	95.210	Nil	Nil	Nil
15	.248	1.239	96.449	Nil	Nil	Nil
16	.218	1.088	97.537	Nil	Nil	Nil
17	.170	.852	98.390	Nil	Nil	Nil
18	.139	.693	99.083	Nil	Nil	Nil
19	.105	.525	99.608	Nil	Nil	Nil
20	.078	.392	100.000	Nil	Nil	Nil

Extraction Method: Principal Component Analysis.

Table 1 shows us the actual factors that were extracted in the Factor Analysis. If we focus our attention on section labeled "Rotation Sums of Squared Loadings," it shows us that only those factors with eigen values > 1 have met the classical cutoff criterion (method of extraction). In this instance, there were seven factors whose eigenvalues turned out to be greater than 1. SPSS always extracts as many factors originally same as number of variables in the dataset, but the rest of these factors didn't make the criterion. The "% of variance" column tells you how much of the total variability (taking into account all the variables together) can be accounted for by each of these summary measures or factors. Factor 1 accounts for 14.649% of the variability in all the twenty variables as evident by first row of Table 1.

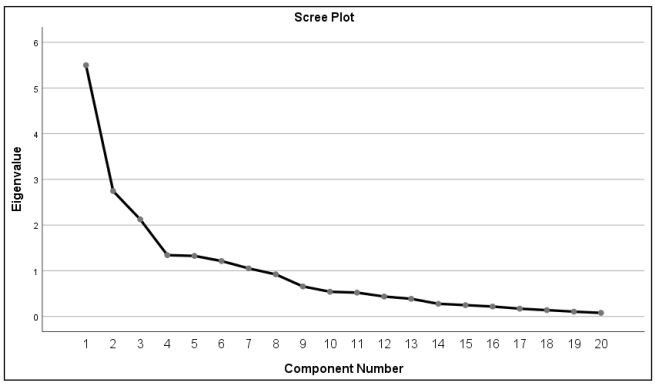

Fig. 8: Scree Plot

In the above scree plot shown in Fig. 8, the slope of the curve flattens after 7 factors alone. So, our objective is the extraction of the above 7 components. The assumption explains that the items which have an eigenvalue ≤ 1 should not be considered (Chatfield & Collin, 1980).

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Table 2: Rotated Component Matrix

	Component						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Pose variations	-.142	.647	.185	.298	.153	.041	.061
Noise	-.028	.125	-.076	.087	.101	.812	.168
Illumination	.302	-.098	.150	.044	.332	.057	.756
Low Resolution	.119	.100	-.050	.149	-.053	.223	.797
Occclusion	.109	.191	.305	.799	-.051	-.119	.172
Distance_eyes	.859	.124	-.054	.000	-.008	.066	.123
Distance_ forehead	.784	.197	.086	.288	.085	-.128	.146
Camera quality	-.088	.251	.078	-.096	.728	-.246	.248
Light	.085	.099	.120	.622	.596	.226	-.046
Database size	.617	.132	.050	.238	.506	.122	.076
Algorithm	.298	-.092	.040	.629	.223	.373	.098
Subject_Race_ Gender	.221	.679	-.142	.487	-.166	.024	.065
Aging	.240	.791	.003	-.132	.084	-.104	.017
Facialexpression	-.395	.499	.523	-.024	.221	-.071	.289
Plasticsurgery	.541	-.078	.305	-.028	-.119	.586	.178
Facial_geometric	.588	-.081	.544	.171	-.008	.291	.164
Distance	.013	.298	.855	.041	.133	-.043	-.071
Facialsignature	.155	-.126	.687	.357	.253	.015	.064
Sensitivity	.145	-.057	.366	.161	.757	.302	-.019
Environmental	.098	.834	.097	-.011	.055	.155	-.062

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Discussion

The rotated component matrix represents the factor loadings for each variable. We went through each row and emphasized the factor on which each variable is most strongly loaded. Based on these factor loadings, the factors can be represented as follows:

- The subtests distance between eyes, distance from forehead to chin, database size, and facial geometric features strongly biased on Factor 1 something which I will tag as Measurement Criterion.
- The subtests pose variations, subject's race and gender, aging, and environmental factors strongly biased on Factor 2 something which I will tag as Subject's parameters.

- The subtests facial expression, facial signature, and distance strongly biased on Factor 3 something which I will tag as Micro-expressions.
- The subtests occlusion, light, and algorithm strongly biased on Factor 4 something which I will tag as Methodology used.
- The subtests camera quality and sensitivity of sensor strongly biased on Factor 5 something which I will tag as device precision.
- The subtests noise and plastic surgery strongly biased on Factor 6 something which I will tag as external factors.
- The subtests illumination and low resolution strongly biased on Factor 7 something which I will tag as Light sensitivity.

Thereby we have narrowed down to 7 factors from 20 variables which is the principal application of Factor Analysis.

Table 3: Component Transformation Matrix

Component	1	2	3	4	5	6	7
1	.505	.325	.401	.446	.377	.247	.278
2	-.521	.755	.179	-.015	.150	-.302	-.107
3	.458	.532	-.498	-.037	-.506	-.012	.021
4	-.061	.097	-.286	-.567	.392	.177	.632
5	-.406	.001	-.554	.598	.128	.388	.058
6	-.295	.074	.412	-.075	-.590	.547	.291
7	.088	.159	-.017	-.339	.247	.606	-.651

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Conclusion

Completed the project that searches face from a given image. This is done by using PCA (Principal Component Analysis) Algorithm to extract the law dimensional feature vectors from input patterns. This research paper centers around keen control applications on biometric face confirmation. The real tangible data is digitized into picture lattice documents and afterward these information grids are examined utilizing propelled calculations. Along these lines, the genuine pattern of fingerprints will be caught. Plain-writings contain data about the signatures contained. In the wake of changing over the Plaintext information to ciphertext information, every one of the three RGB force parts of the Trimulus shading framework is determined and broke down exclusively. At that point Principal Component Analysis (PCA) and Split Half

Reliability are applied for dynamic decision-making. Its hypothesis is clear and very operative that advanced artificial intelligence technology can be used for effective identification of biometric fingerprints and facial signatures of individuals. Exploratory Factor Analysis turns out to be a very powerful tool for condensing the number of variables and eventually we are left with fewer factors which explain much of the original data. It is the need of the hour for companies to invest in data breach prevention, breach mitigation, and data protection advancement making use of methods like biometric face recognition, etc.

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