International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Face Recognition Using Principal Component Analysis for Security Based System

Madhuri M. Ghodake[1], Parul S. Arora[2]

[1]Savitribai Phule Pune University, G.H.Raisoni College of Engg & Management, Domkhel Road, Wagholi, Pune

[2]Assistant Professor, G.H.Raisoni College of Engg & Management, Domkhel Road, Wagholi, Pune, Savitribai Phule University, Pune

Abstract: ***Security is generally a state or feeling of being saved and protected, it is an assurance that something of value will not be taken which is protected. This system is mainly designed for getting access in the strong rooms of the Military system by recognizing the face. This proposed system consist of two of the emerging artificial intelligence technologies that are: Facial Recognition and Eigen Face approach using Principal Component Analysis algorithm for developing a secure keyless door where authentication of authorized faces is the only guarantee for entry in the strong rooms of the Military security system . This mechanically built door, has an interface with the PC for capturing and processing images. A facial recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. Proposed System uses face recognition technique for verification in Military security System. For face recognition, there are two types of comparisons are done. The first step is the verification, in this this verification step the system compares the given individual with who that individual says they are and gives a yes or no decision. The next one is of the identification, in the identification the system compares the given individual to all the other individuals in the database and gives a ranked list of matches of the images. Principal component analysis (PCA) is the simplest of the true eigenvector based multivariate analysis. Mathematically, it is an orthogonal linear transformation that transforms the data to a new coordinate system. The use of Eigen faces is commonly called as Principal Component Analysis. With PCA, the image which are used for verification and the identification they should be of same size and they are normalized to line-up the eyes and mouth of the subjects within the image. Using PCA, dimension of data using data compression basics is reduced and precisely decompose the face structure into orthogonal and uncorrelated components know as Eigen faces.***

Keywords: Face Recognition, Verification,Eigen faces, Principal Component Analysis (PCA).

1. Introduction

In many real time applications the human face recognition is most important. This system has the various applications in the various fields. For identifying the person from the digital images or from the video input this system is used. Based on the physiological characteristics. Face recognition systems is the part of facial image processing applications. The significance of the face recognition system as a research area is increasing recently now a days. In the face Recognition system it uses the biometric information of the humans for recognizing the face and it is applicable easily instead of fingerprint, iris, signature etc. There are various applications of this system. Such as it can be used for prevention of the crimes, for video surveillance system, for person verification, and similar security activities. This proposed Face recognition system is a combination of face detection technique and face recognition techniques in the image analyzes. The face detection application is used for finding the position of the faces in the given image. Here we are using the Principal Component Analysis algorithm for Recognition of the Faces. This Face recognition Principal component analysis algorithm is used to classify given images with known structured properties, these known structured properties are used commonly in most of the computer vision applications. All these images which we are referring for the recognition they are having some known properties like; same resolution of the images, including same of the facial feature components, and similar alignment of eye etc. All these images which we are using for verification and identification they are referred as the, "standard image" in the further sections. In the Face Recognition applications we are using these standard images and also we are using the detection algorithms for detecting the faces and for extract acting the face images feature which include eyes, eyebrows, nose, and mouth etc. In the proposed face recognition system there are various steps are involved. The first step for face recognition system is to acquire an image from an image database.

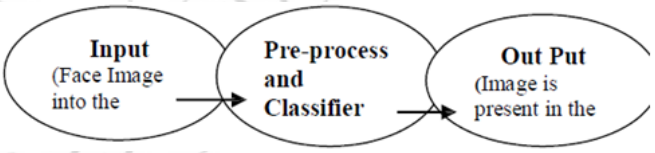


Figure 1: Generic Representation Of The Face Recognition System

In the proposed system the first step is of acquiring the input image from the images database, once an image is acquired from the image database, detection of the face from the acquired image by extracting the features of the input images is the second step in the proposed system. And the final and the third step is the face recognition. In this step the face is recognized.The PCA method was first developed in the in the 1991 by the Karl Pearson. For the reduction of the dimension of the images this method is used . This Eigen face technique have been used for recognition of the images of the faces and the compression of the images. We can do the prediction of the images with the help of Principal Component Analysis algorithm , similarly the redundancy is removed from the images, feature extraction and the data compression of the images is done with the help of PCA. In the PCA method the number of variables are reduces in the face recognition . Mathematically in this Principal Component algorithm the

set of the correlated variables is converted in to the linearly uncorrelated variables. PCA decomposes the face structure in to the uncorrelated components which are the Eigen face. In the Principal component analysis algorithm when the new images is recognized then the eigenvalue and the weights of that images are calculated . These calculated weights are then compared with the weights of the known face images in the training set. . If the Euclidian distance which is calculated is minimum then the face is known and matching is done and if the Euclidian distance is maximum then the face is unknown and matching of the two faces not found. .Here By cumulatively summing the calculated Euclidian distance between the stored database and the test face images and the Face recognition is carried out .

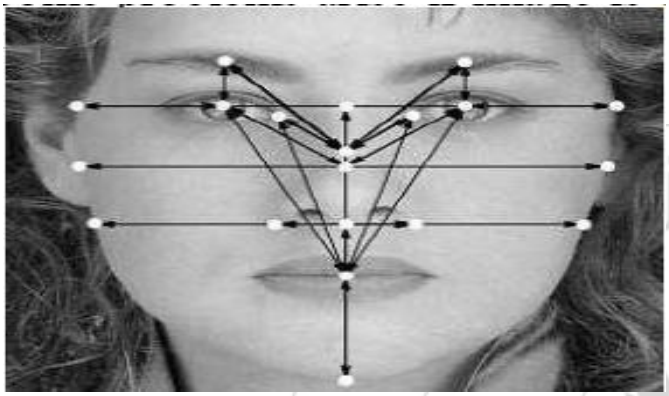


Figure 2: Some Facial points and distance between them is used are used in the face Recognition

2. Literature Survey

Although face recognition systems are known for decades, there are many active research work has been done on this topic.

AbinAbrahamOommen1,C.SenthilSingh,M.Manikandan,
[1] have proposed the principal component analysis algorithm for recognizing the faces from an input image database. Principal Component Analysis algorithm is the most flexible and efficient method for recognition of the faces. For this they have taken all the images in training set as a linear combination of weighted Eigen vectors. This system receives the input face from the database image and it is recognized from the training set. For the recognition the Euclidean distance is calculated between the input face and our training set . They have simulated this whole system using Matlab and it shows appreciable result and faster detection rate. The approach is definitely simple, easy and faster to implement. Guodong Guo,[8], have studied the problem of face recognition with cosmetic changes. He collected the database of about 500 pairs of face images to facilitate the study. For dealing with the facial changes with makeup, he has proposed to use correlation mapping between the makeup and non-makeup faces on features extracted from local patches. The learned correlation bases can be used to project faces in different appearances separately, and the transformed features for faces belonging to the same identity are moved closer in the new feature space. We have found that the correlation has to be executed on extracted features, rather than on raw images. The local patch-based feature extraction and correlation mapping are crucial, which can tolerate the diversity of users who apply cosmetic products with different styles or degrees. Wilman W. W. Zou, [7] in 2012 presented the Very Low Resolution face recognition problem of the face image. To solve the problem of the Very low Resolution, a piecewise linear regression model was used, and a novel relationship-based SR was proposed. Based on this idea, for good visual quality applications, a new data constraint that measures the error in the HR image space was developed, and RLSR was proposed. For machine-based face recognition applications, a discriminative constraint was designed and integrated with the new data constraint, and DSR was proposed. Finally the Experimental results show that the proposed method outperforms the existing SR algorithms in terms of visual quality and recognition performance.

3. Proposed Face Recognition System

There are typical three main steps of the structures of face recognition system consist of, that are, the first step is the acquisition of face data, the second step is of extracting feature of the face and third and the final step is of recognition zing the face. Above shows typical structure of face recognition system in which subject under consideration given to the system for the recognition purpose this is consider to be acquisition of face image. First the Acquisition of the image/Face Data is done. Later on in the next second step from the image the features are extracted and finally in the third step recognition of the given image is done. All these three steps are elaborated as follows.

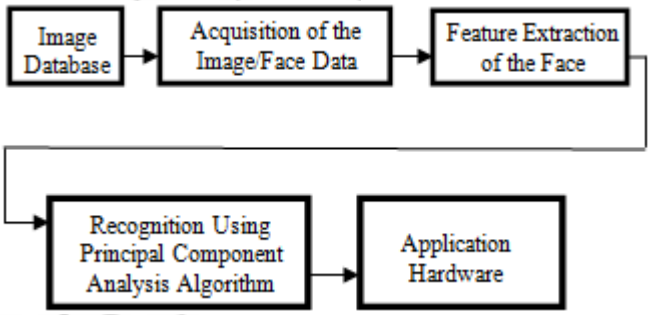


Figure 3: Proposed System Block Diagram

3.1Acquisition of the Image/Face Data

Acquisition and processing of the Image/Face is the first step for the Face recognition system. Here in this first step we are collecting these images from the image database for the acquisition purpose. The images which we have collected from the image database it should contain the different pose, different expression and illumination for checking the accurate performance of the proposed face recognition system under the different conditions. Due to the change in the pose, illumination and variance, background, lighting conditions, due to the change in orientation and size of the head, all these thing are affecting the accurate performance of the proposed Face Recognition system. So the processing of the Face image is important step, otherwise all these changing conditions will cause the serious effect on getting the accurate performance of the Face Recognition system. In

This step first the normalization of the input image is done. After normalizing the input image some of the image transformation methods are applied on it. Images which are available on the website,it collected images contains various expressions.

3.2 Extracting the Features of the Face

Extracting the features of the face is the second step in the face recognition system. Feature. In this process the relevant information from a face image is extracted. Whatever features we will extract in this step that we will use later on for the recognition of the face in the third step. The image which we are representing mathematically, a mathematical representation of original image called as a biometric template or biometric reference biometric template or biometric reference is generated in this step of feature extraction,. In the database this biometric reference or template which is generated is stored and will form the basis (vector) of any recognition task. The First initial feature which we are considering is the gray scale pixel.

3.3 Recognition of Face

Once we select and extract the features in the second step, the third step in the proposed face recognition system is of classification the image for the recognition purpose. Principal Component Analysis algorithm is most widely used algorithm for the recognition of the face. In the step of the classification, the similarity between faces from thesame individual and different individuals after all the face images in database are represented with relevant features. Sometimes feature extraction of the face image & recognition of the face images, these two process are done simultaneously. Once the image processing part of the recognition of the Face is done the recognized image is applied to the application Hardware. Here we are developing the face recognition system for the strong room of Military Security System, to get the entry in that strong room to only authorized person of that strong room. The application Hardware Consist of AVR Microcontroller AT mega 16 A, Motor driver, GSM Module, etc.

4. Application Hardware

4.1AVR Microcontroller ATmega16 (A)

AVR AT mega 16 (A) controller is a 8 bit controller which is mostly used in the world. It is a 8 bit on chip system with Reduced Instruction set command system. It contains the 32 general purpose registers. The ATmega16 is a low-power controller. It is a CMOS 8-bit microcontroller. It is based on the AVR enhanced RISC architecture. It executes the powerful instructions in a single clock cycle. In a single clock cycle powerful instructions are executed. The ATmega16 achieves throughputs approaching 1 MIPS per MHz Power consumption versus processing speed is optimized. This controller has some of the Features such as it has 16K bytes of In-System Programmable Flash Program memory, which has the read capabilities as well as the write capabilities. It contains the 512 bytes EEPROM. It also includes the 1k byte SRAM. It contains the 32 general purpose I/O lines. It has the 16-bit Timer/Counter this 16 bit Timer/Counter unit allows accurate program execution timing (event management), also this unit allows the wave generation, as well as the signal timing measurement. With a full suite of program and system development tools this AVR AT mega 16A controller is supported. The different development tools with which it is supported are C compilers tool, tool of the macro assemblers, tools for program debugger or the program simulators, also it is supporting in-circuit emulators, and evaluation kits etc. The most of the commands in this controller are performed in the single clock cycle. During the execution of the previous command the reading of the next instruction is done on this controller.so in this controller overall number of commands in 1 second is almost equal to the working frequency. It differs from the other microcontroller that is it requires the less power in the higher frequencies. It has the more advanced architecture than the other microcontroller that allows to run one instruction per clock cycle while PIC microcontrollers run one instruction in 4 clock cycles.

4.2 Sim900A

There are various features of this SIM900 like it has the GPRS multi- slot class 10/ class 8 (optional) and it also supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 24mm x 24mm x 3mm. SIM900 can meet almost all the space requirements in User's applications, like the application such as M2M, smart phone, PDA and other mobile devices.

4.3 Dc Motor

A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings.

4.4 Liquid Crystal Displays (LCD)

It is a low cost display. It is easy to interface with the microcontroller. Because of an embedded controller. This controller is standard across many displays (HD 44780) which means many micro-controllers have libraries that make displaying messages as easy as a single line of code. It is a 16 x 2 LCD display. It is used to display the message for the entry if the face is getting matched then this message is get displayed on the LCD.

5. Principal Component Analysis Algorithm

Principal component analysis (PCA) was invented in 1901 by Karl Pearson. It is one of the most popular method used for the recognition of the Faces. It reduces the number of the variables in the face recognition. The main task of the Principal Component Analysis algorithm is that it can do that are prediction, redundancy removal, feature extraction, data

compression, etc. There are various steps that are involved in the recognition of the faces using the PCA algorithm. First it compares the input image/face with images/faces that are stored in the data-base with fixed background such as white in color. The images/faces that are present in the database are called authorized images/faces and the input image/face is called as un-known/unauthorized image/face. Then images are stored in our database for testing purpose. In the recognition steps of the face using Principal Component Analysis first the Eigen vectors are calculated from the images and then its threshold values are determined. By using Euclidian distance between threshold values of authorized and unauthorized faces corresponding images are compared and persons will be identified accordingly.

A] Training Set

It is a set which is formed by combining the different set of the images. From the different type of sources these images are collected. These collected images contains the different pose and expressions. These images are used for the recognition.

B] Eigen Face

These are set of the features in the form of the vectors. It denotes the variations between the different faces. It is weighted combination of some component of base faces. Each image in the training set has its own contribution on making the Eigen faces . Facial expression which occurs in the Eigen faces are deviates from the original images. Eigen vectors are formed by converting the image matrix into the vector form. These Eigen vector should satisfy the Eigen value equation .The size of this eigenvector is less but there is no loss of data in these eigenvector.

C] Weight Vector

For the recognition of the face, the weight of the largest Eigen face is calculated. When the new face image is to be recognized then the weight associated with that Eigen face is calculated. By comparing these calculated weighs with the weights of the known face images we can recognize the whether the face is known face or unknown face

D] Euclidian Distance

Euclidian Distance is a ordinary distance between the two points. By using the Pythagorean formula we can calculate this Euclidian distance. The Euclidian distance between two points is a length of the segment connecting these two points .Here we are calculating the Euclidian distance between the input image and the training face. If the Euclidian distance is less than the threshold then the face which is determined in known face or if this distance is above the threshold then the determined face is unknown.

5.1Benefits of the Principal Component Analysis Algorithm

1) Due to the Principal Component Analysis algorithm there is a the reduction in the dimension of the data.
2) There is no any data redundancy as all the components are orthogonal.
3) Due to this algorithm there is the reduction in the complexity of grouping the images.
4) There are different applications of this algorithm in recognition of the faces like for, Entrance control in Building, for getting control to computers, for Automated Teller Machines, at the post office, For the passport verification, and identifying the faces in a given database.

5.2Steps of the Principal Component Algorithm

1) Get database set of images and then find mean of the images
2) Find the difference between mean image and each of database images.
3) Find covariance matrix of the matrix obtained from step 2 for this covariance matrix.
4) Find Eigen values and Eigen vectors, and then we will find the Eigen faces with larger Eigen values.
5) Find out weight vector using this Eigen faces
6) For new/unknown image also the process will be echoed from step 1to3 and then find out weight vector for test image.
7) Now find Euclidian distance between weight vectors of unknown image and database images.
8) If this distance is less than threshold then test image is considered to be in database and hence authorized, otherwise unauthorized

5.3 Flowchart of the Principal Component Analysis Algorithm

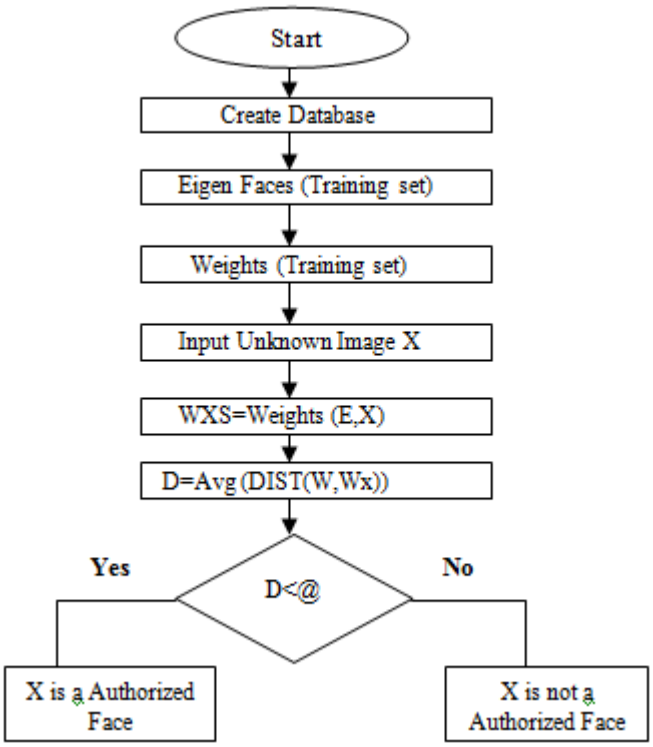
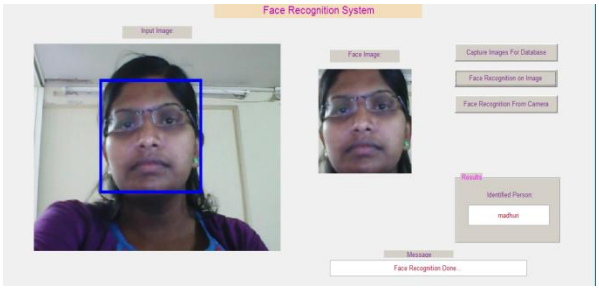


Figure 4: Flowchart of the Principal Component Analysis Algorithm

6. Results



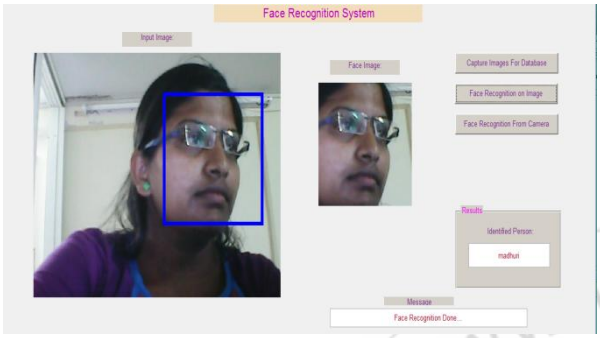


Table 1: Result Table of Face Recognition

Input Images	*Training Images*	*Testing Images*	*Images Matched*	*% Accuracy*
1	10	10	8	80%
2	10	10	7	70%
3	10	10	8	70%

Here we have taken 60 face images of three different person with different expressions. Out of that 60 images of face of each person 10 images are placed as the training images and 10 images are placed as the testing images of each person. And the face recognition is done on the testing images by using Principal Component Analysis Algorithm. The accuracy achieved in recognizing the first person faces of different expression is 80%. The accuracy achieved in recognizing the faces of second person with different expression is 90%.And the accuracy achieved in recognizing the faces of third person with different expression is 80%. The Face recognition result we got by using principal component analysis algorithm is compaired with other algorithm results.The result table of different algorithm is as follows.

Table 2: Results of Face different Recognition algorithm and Their Comparision

	PCA	ICA	KCPA	Bayes[21]
Accuracy	77%	77%	87%	95%
Uniqueness	Yes	No	Yes	Yes
Projections	Linear	Linear	Nonlinear	Linear

The results we got in Face Recogntion by using Principal Component Analysis Algorithm is compaired with other algorithm. The results are as shown in the above table. The benefits of Principal Component Analysis Algorithm over other algorithm is that Due to the Principal Component Analysis algorithm there is a the reduction in the dimension of the data and there is no any data redundancy as all the components are orthogonal. Due to this algorithm there is the reduction in the complexity of grouping the images.There are different applications of this algorithm in recognition of the faces like for, Entrance control in Building, for getting control to computers, for Automated Teller Machines, at the post office, For the passport verification, and identifying the faces in a given database.

7. Applications of the Face Recognition System

1) Security system for ATM.
2) For the Automatic face recognition.
3) For the security system of the Airport.
4) The automatic recognition of handwritten postal codes on postal envelopes.
5) For the security system of the industry.
6) Automatic recognition of images of human faces.

8. Conclusion

Face recognition is a both challenging and important recognition technique. Face recognition technique is user-friendliness and this is one of the great advantage of this technique among all other biometric technique. In this paper the PCA algorithm for recognizing the faces from an input is proposed. From the training set images are taken as a liner combination of weighted Eigen vector. By finding the Euclidian distance between the input face and the training set images the recognition of the face is done.

References

[1] Abin Abraham Oommen, C.Senthil Singh," Design Of Face Recognition System Using Principal Component Analysis", International Journal of Research in Engineering & technology, Volume 03, Issue 01, March-2014 ISSN 2321-7308
[2] O.T.Arulogun, E.O.Omidiora," Development of security system using Facial Recognition", Pacific Journal of Science & technology, Volume 03, Issue 01, March-2014 ISSN 2321-7308
[3] Chengjun Liu , "Capatilize On Dimensionality Increasing Technique For Improving Face Recognition Grand Challenge Performance", IEEE Transaction on pattern analysis and machine intelligence, vol.28,No 5, May 2008.
[4] Xlaogang wang and xlaoou Tang, Fellow, "Face Photo-sketch synthesis and Recognition", IEEE Transaction on pattern analysis and machine intelligence, vol.31, No 11, November 2009.
[5] Harin Sellahewa and Sabah A.jassim,"Image Quality-Based Adaptive Face Recognition", IEEE Transaction on Instrumentation And Measurement , vol.59,No 4, April 2010.
[6] Younghwan Kim, Jang-Hee Yoo, "A Motion and Similarity-Based Fake Detection Method for Biometric Face Recognition Systems", IEEE Transaction on Consumer Electronics, Vol. 57, No. 2, May 2011.
[7] Wilman W. W. Zou, "Very Low Resolution Face Recognition Problem", IEEE Transaction on Image Processing, VOL. 21, NO. 1, January 2012.

[8] Guodong Guo , "Face Authentication With Makeup Changes ", IEEE Transaction on Circuit And Systems For Video Technology, vol.24,No 5, May 2014.