ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

PCA Based Face Detection and Recognition system

Sherwan Abdullah[1], Burhan Argen[2]

MSc. Student, Department of Computer Engineering, Firat University, Turkey &Assistant Programmer in University of Zakho, Iraq.[1]

Associate Professor, Department of Computer Engineering, Firat University, Elazig, Turkey[2]

ABSTRACT: This paper presents face detection and recognition system using PCA (Principal Component Analysis) based technique with eigennface approach for detection and tracking to enhance the results of face recognition in different head position, face profile and head scale. This will be implemented with a data set that have only five images for each individual, images will have unconstrained background for different environments for any given image to find the face and recognize the person in the image, where unconstrained background increase the complexity of the detection and recognition process, that requires these condition must be solved for real time implementation.
Results have been showed that increasing number of training images can improve accuracy of the system. The number of training images per each individual, which is five for each sub-set group found as the optimal choice training for this approach. Results were fair and approving for developed work with good accuracy of detection and recognition.

KEYWORDS: Eigenfaces, Face Detection, Face Recognition, Principal Component Analysis.

I. INTRODUCTION

Facial recognition is an activity we all perform routinely and subconsciously in our everyday lives. Our capability to read the expressions of others with whom we interact is an imperative part of our social skills and, alongside associated abilities, has played an essential role on the evolution of the human race. How are humans able to conduct this activity so effortlessly, yet the task of face recognition still remains one of the most challenging computer vision problems to date.
Over past years of research in this area have introduced many theories and methods on how face recognition can be implemented using a computer system.
Usually, the detection and recognition systems needs a pre-defined database of known faces. However, if a new face has been considered the system has to decide whether it is a known face or not.
Using the pre-captured images database, the possibly of implementing a face recognition system based on the PCA Eigenfaces approach [1] is evaluated in this work. The focus lay on studying the algorithm, test and verify its performance with the database using a test setup especially created for this propose. The results found during the evaluation where promising enough to use the algorithm as a basis to design and implement a face recognition system. Identifying the strong points and weaknesses of the algorithm produced a clear view on how further improvements and future work could be conducted to improve the system's performance. Although video based recognition can common ground with the image based approach.
The problem of face recognition can be simply stated as:
"given an image of a scene identify or verify the identity of the face of one or more individuals in the scene from a database of known individuals" [2].
The problem can be broken down into three distinct stages:

1. Face detection and image pre-processing: Faces need to be detected within a given scene and the image cropped to give a smaller image containing just the detected face. Early approaches to face detection focused on

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

single face segmentation using methods such as whole-face templates and skin colour, whilst later developments have led to automatic computer based face detection procedures. Once segmented the face image needs to undergo certain image processing methods to be roughly aligned and normalised. This aims to take into account factors such as lighting, position, scale and rotation of the face within the image plane [4].

2. Feature Extraction: Key facial features need to be extracted to enable identification of the face. Various approaches exist including holistic methods, such as Principal Component Analysis [5] and Linear Discriminant Analysis [6] which use the whole face and are based on the pixels' intensity values, and feature-based methods that identify local features of the face, such as eyes and mouth [3].

3. Face Identification: Based on the features found from feature extraction, this step attempts to classify the unknown face image as one of the individuals known by the machine. Various approaches for identification have been developed including many eigenspace based approaches [8].

This paper going along all three stages of the problem, first the designed system detect face from selected image then it take it to other to stages namely that of feature extraction and then subsequent face identification based on these features. Furthermore, this image has then been segmented to give a smaller image just containing the detected face which then undergoes specified image preprocessing. We shall impose strict conditions on the images under investigation in that they are all of the same dimension.

II. RELATED WORK

Face detection and recognition had a huge number of researches due to itsimportant applications in all fields of human life. So it's impossible to review all literaturesrelated to it. So in this chapter the focus will be on the main research methodologies whichare most related to the proposed work.

In 1966, the first attempt to construct a semi-automated face recognition humancomputer system was made [9], [10]. The system was based on the extraction of the coordinates of a set of features from the photographs, which were then used by thecomputer for recognition. Later, feature extraction and pattern classification techniques[3] were employed for face recognition purposes. In [7] and [8], a template matchingapproach was developed and improved, using automatic feature measurements anddeformable templates which are parameterized models of face.

Early 1990s have witnessed the beginning of a new wave of developments for facerecognition, with considerable research endeavours made for enhancing recognitionperformance. These include principal component analysis (PCA) [11].

Abdullah, et al, in their research [13] tried to minimize the participatedeigenvectors which consequently decreases the computational time. They conduct a studyto optimize the time complexity of PCA (eigenfaces) that does not affects the recognitionperformance. Their algorithm was tested on standard dataset: face94 face databaseexperiments conducted using MatLab.

Arora in (2012) implemented eigenfaces recognition algorithm for real time facerecognition in [12] using laptop computer and web camera, Arora considered video frames as stillpicture, his experiment examined changing or variation in illumination and head size, heconsidered the experiment quite successful.Results of Arora's experiment where registered as following.

Face Condition	Recognition Accuracy	Recognition Error
Normal	83%	17%
Light Variation	61%	39%
Size of Face variation	55%	45%

Table 1: Results for eigenfaces algorithm for real time face recognition (Arora, 2012, 196)

Li and Tang in [14] studied the relationship between Eigen face recognitionperformance and different training data sets. Using the Multilevel Dominant EigenvectorEstimation (MDEE) method, they were able to compute eigenfaces from a large number oftraining samples. They focus more on the results of short feature lengths since theyillustrate how efficient the transformation compresses the large face vector. As the lengthof the feature vector increases, it becomes more like the original face vector. The effect ofthe transformation is largely lost if the original face image

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

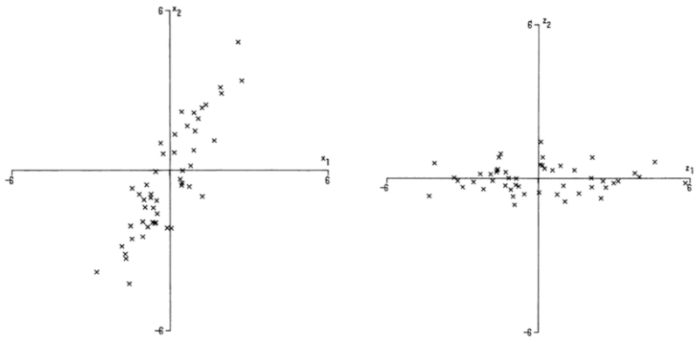
Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

directly was used for facerecognition, they got an accuracy of 74.9%; their experimental results show that increasingthe number of people benefits the recognition performance more than increasing thenumber of images per person. The gallery used for their research contains 72*10 faceimages of 72 different persons.
Zhang and Zhang (2009) [8]said that people from different raises have different skincolor nature, several studies have been done and found that the major difference lays in thevariation between their skin color intensity rather than their chrominance(page 110).
Tathe, Narote (2012) defined skin color based detection by: technique that used toseparate skin pixels from the rest of colors in a given image, this technique is simple andrequires less computation, but it is difficult to locate face in the presence of complexbackground and poor illuminations.

III. PRINCIPAL COMPONENT ANALYSIS

As stated, (PCA) or Principal Component Analysis aims to reduce the dimensionality of a data setconsisting of a large number of potentially correlated variables, whilst retaining as much as possibleof the total variation. This is achieved by an orthogonal transformation to a new set of uncorrelatedvariables, called the Principal Components (PCs) [10]. The first principal component is specified such that it accounts for as much of the variability in the original data variables as possible. Theneach succeeding component in turn, is constructed to have the highest variance possible, under theconstraint that it be orthogonal to the proceeding components. PCA thus can be simply thought ofas a coordinate rotation, aligning the transformed axes with the directions of maximal variance. Thisorthogonal transformation is shown in figure 1 which gives a plot of 50 observation on two highlycorrelated variables: x1 and x2 and a plot of the data transformed to the two PCs: z1 and z2. It isapparent that there is more variation in the direction of z1 than either of the original variables x1or x2. Also note there is very little variation in the second PC z2 which is orthogonal to z1.



(a) (b)

Figure 3.2: Orthogonal transformation to the principal components (a) Plot of 50 observations on two variables x1and x2 (b) Plot of 50 observations with respect to the two principal components z1 and z2.

IV. FACE/NO FACE DECISION AND IDENTIFICATION

The traditional eigenface-based face recognition algorithm can be briefly described as an algorithm that extracts certain features from a given training set, and makes use of these extracted features to identify new faces given a testing set. The algorithm operates on full size face images and is generally used to identify a group of previously authorized people among a large set. The identification process begins when an unknown face is present at the system input. Firstly the system projects this new face image onto the face space and computes its distance from all the stored faces. The face can be identified as the individual that is nearest to the new projection in the face space. However since the projection onto the face space is a many-to-one mapping, several images looking nothing like a face could be projected onto a stored face vector. Therefore, before trying to identify the subject in a test image we need to decide if the

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

presented test picture is a face image at all. We can decide if the input image is a face image by looking at the correlation (similarity measure) of the input face with the average face for the database in use. This process is depicted by Figure 2. If the computed correlation is equal or above a given threshold value Tc we assume we have a face image present at the input, otherwise we assume that the image present is not a face image.

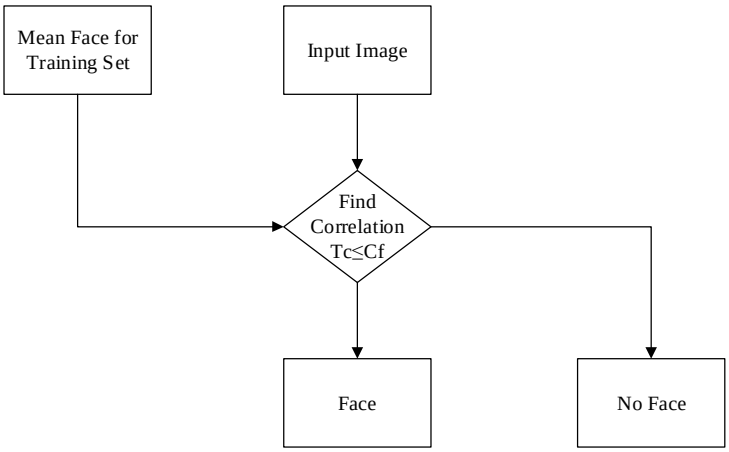


Figure 2: Face/No Face Decision flowchart

V. EXPERIMENTAL RESULTS

Software used for implementation is MatLab 2014a, training data set has images up to five training images for each individual, the number of individual is 11, the testing images for these individual is not included their training set. Recognition results are influenced by different training data sets. However, most researches simply choose a small number of training samples randomly for computation of the eigenfaces without much justification [14]; proposed dataset has no limtations or constraint on head position, head size or background, figure (3) shows a collection of images from training data set.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

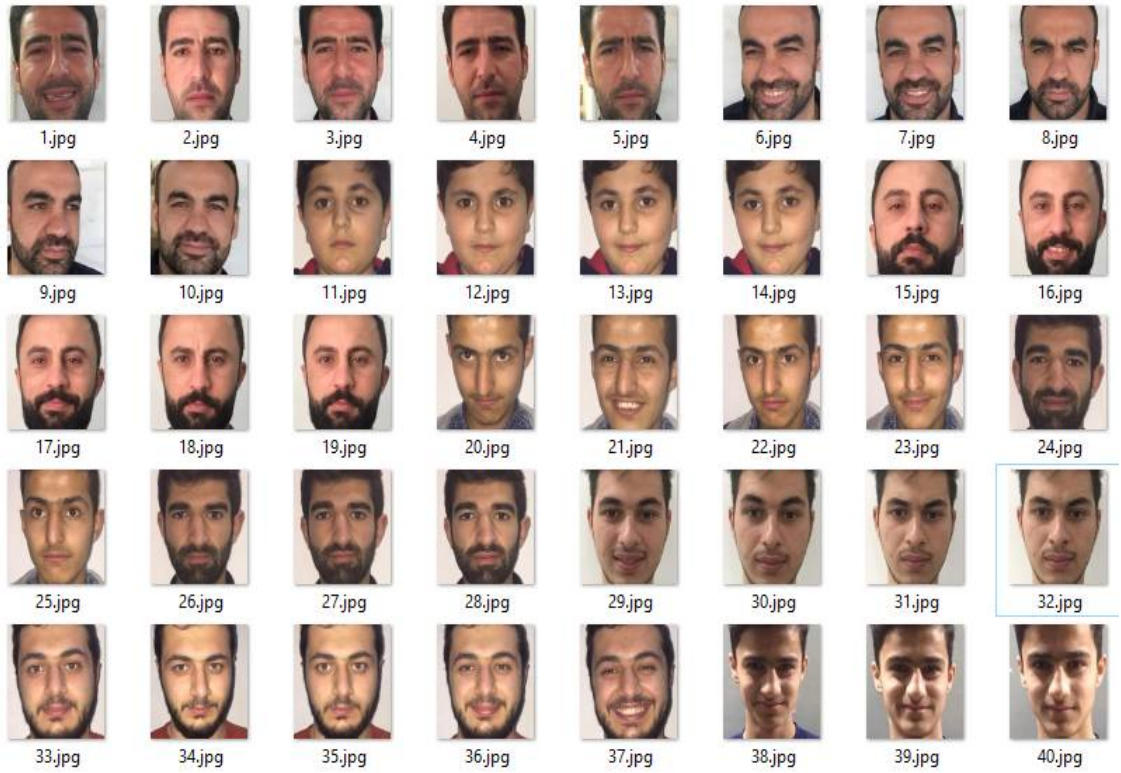


Figure3. Snapshot from training data set (the resolution of each image is 200x180)

Example is given for test on an image testing the accuracy to recognize individual with different view for the test image, the test scored true recognition. Figure 4 showing the equivalent image.

(a)

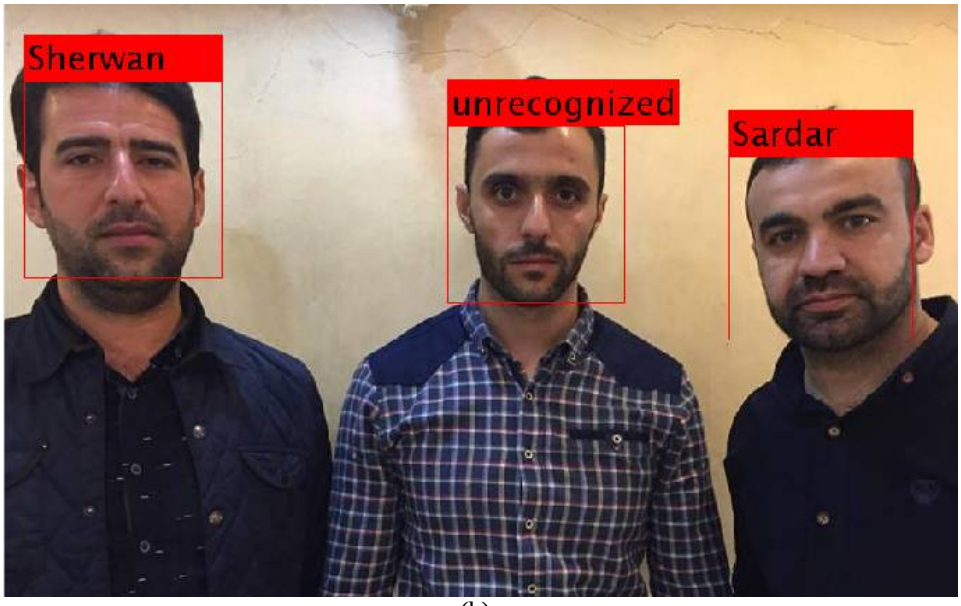
ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017



(b)

Figure 4. Face detection and recognition images (a) individual training images (b) Tested image result after executing

Then the test have been implemented in other phases as following: where the data set is available for 11 persons and dividing technique into sub-set for the training set is implemented, plus the aim of the proposed approach to decrease the number of the training images for each individual, this type of challenge need excessive testing.
This type of tests will find the effect of both factors:
First: decreasing the number of images for each individual, starting with minimum number of training images for each individual and increment this number (starting by 1 for each ending by 5) and observe the results.
Second: sub-setting training data set, in parallel with changing training images numbers sub-setting the training set will be tested also (starting by 1 individual in each subset ending by 11).
Detailed testing results are listed in table 2, tests have been categorized according to the number of training images for each individual, results ofrecognition are listed in tables with recognition result for each individual, correctrecognition result is marked with (✓) sign.

Image No.	Number of training images				
	1	2	3	4	5
1		✓	✓	✓	✓
2		✓			✓
3		✓	✓	✓	✓
4					
5				✓	✓
6	✓	✓	✓	✓	✓
7	✓	✓	✓	✓	✓
8				✓	✓
9	✓	✓	✓		✓
10			✓	✓	✓
11	✓			✓	✓

Table 2: testing training set with increasing in individual images

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

This results are followed by summarized table of results for easier observing recognition accuracy and analysing which is shown in table 3.

Result	Number of training images				
	1	2	3	4	5
Correct	4	6	6	8	10
False	7	5	5	3	1

Table 3. Summary of successful detection and recognition results

Summary for this test for the obtained tables is represented with recognition percentage for each case and it is shown in table 4.

Result	Number of training images				
	1	2	3	4	5
recognized	36.4%	54.5%	54.5%	72.7%	90.9%
Unrecognized	63.6%	45.5%	45.5%	27.3%	9.1%

Table 4.Percentage successes ratio of system

The results shows that by increasing the number of training images from 1 to 5 images for each individual increased the recognition results remarkably, but then from 2 to 3 it has less effect on the recognition. Although sub-setting the training data set solved the problem of having small number of training set for each person. The highest result from previous work with increasing both training images and the number of individuals in the sub-set group was (5 training images per each and 6 or 7 individual for each sub-set group) this is the optimal choice training for this approach.

VI. CONCLUSION

The work carried out in this work indicates that PCA as feature extraction method with eigenfaces algorithm is a good recognition tool when the database of face images are all about the same size, centered, and contain very little tilt. However the success of the Eigenface method is inhibited by the 3 key limitations occurring due to the use of PCA. The first being the assumption that large variances are important. This means the Eigenface method selects the most expressive features, which could include those due to lighting and pose variations. We saw, through our experimental investigations, how such features are not optimal for discriminatory purposes. The second being due to the non parametric nature of PCA. This is because PCA does not make any assumptions on the structure of the data set. This subsequently leads to data loss, as we do not account for class separability. The third limitation being due to the linear nature of the method. In using a linear projection we are unable to take into account any of the higher order pixel correlations present in face images . The Eigenface method consequently assumes that such non linear relations are not necessary to discriminate between different individuals. This limitations can be used as the motivation behind all further methods to be considered.

REFERENCES

[1] Abul-Kashem, M., & Akhter, M. N., & Ahmed, S., & Alam, M. M., (2011), Face Recognition System Based on Principal Component Analysis (PCA) with Back Propagation Neural Networks (BPNN),Canadian Journal on Image Processing and Computer Vision. 2(4), 36-45.
[2] Chakraborty, D. (2012). An Illumination invariant face detection based on human shape analysis and skin color information. Signal & Image Processing: An International Journal (SIPIJ), 3, 55- 62.
[3] Chitra, S., & Balakrishnan, G. (2012). Comparative Study for Two Color Spaces HSCbCr and YCbCr in Skin Color Detection, Applied Mathematical Sciences, 6(85), 4229 – 4238.
[4] Duda, R. O., & Hart, P,E. (1972).Use of the Hough Transformation To Detect Lines and Curves in Pictures, Communications of the ACM, 11-15.
[5] Georgescu, D. (2011). "A Real-Time Face Recognition System Using Eigenfaces", Journal of Mobile, Embedded and Distributed Systems, 3(4), 2067 – 4074.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

[6] Gottumukkal, R., & Asari, V.K. (2004). An improved face recognition technique based on modular PCA approach, Pattern Recognition Letters, 25, 429–436, 10.1016/j.patrec.2003.11.005
[7] Pathak, V., & Patwari, D.N., & Khanale, P.B., & Tamboli, N.M., &Pathak, V. M. (2011). Study and Comparison of Different Face Recognition Algorithms. BIOINFO Medical Imaging, 1(1), 05-09.
[8] Ramesha, K. (2009). Advanced Biometric Identification on Face, Gender and Age Recognition, IEEE journal, (978-0-7695-3845-7/09), 10.1109.
[9] Saudargare, P.V., & chaudhari, D.S. (2012). Facial expression recognition using neural network- An overview , International Journal of soft computing and engineering (IJSCE), 2(1),224-227.
[10] Slavkovic, M., & Jevtic, D. (2012). Face Recognition Using Eigenface Approach. Serbian Journal of Electrical Engineering, 9(1), 121-130. Süsstrunk, S., & Buckley R., &Swen, S. (1999).Standard RGB Color Spaces.
[11]Thepade, S., & Khandelwal, S., & Dhamejani, K., & Azmi, A. (2012). Improved Face Recognition with Multilevel BTC using Kekre's LUV Color Space, (IJACSA) International Journal of Advanced Computer Science and Applications, 3(1), 156-160.
[12] Arora, K. (2012). Real Time Application of Face Recognition concept, International Journal of Soft Computing and Engineering (IJSCE), 2 (5), 2231-2307.
[13] Abdullah, M., & Wazzan, M., & Bo-saeed, S. (2012). Optimizing face recognition using PCA, International Journal of Artificial Intelligence & Applications (IJAIA),3(2),(23-31), 10.5121/ijaia.2012.3203 23.
[14] Li, Z., & Tang, X. (2002). Eigenfaces recognition using different training data sizes. ACM. 1-58113-369-3.