A Technique for Face Recognition Using Approach based on Artificial Neural Network and Principal Component Analysis

تقنية لتمييز صور الوجوه باستخدام اسلوب يعتمد على الشبكة العصبية الاصطناعية وتحليل المكونات الاساسية

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Authorization

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Dedication

This dissertation is dedicated to:

To my Holly God,

To my Family,

To my Friends and To my Future.

Acknowledgements

It is a pleasure to thank those who made thesis achievable:

This thesis would not have been possible unless the professional supervision, Encouragements, Guidance and supporters of my supervisor

Prof. Dr. Alaa Al-Hamami

The respectable members of my thesis committee.

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Abbreviations

Abbreviations	Meaning
ANN	Artificial Neural Network
BP	Back Propagation
BPNN	Back Propagation Neural Network
CBIR	Content Based Image Recovery
CT	Computed Tomography
EER	Equal Error Rates
EOD	Even-Odd Decomposition
FAR	False Acceptance Rates
FRR	False Rejection Rates
GA	Genetic Algorithm
ICP	Iterative Closest Point
IR	Information Retrieval
IT	Information Technology
KDD	Knowledge Data Discovery
KNN	Knowledge Neural Network
LDA	Linear Discriminate Analysis
MARI	Mining Association Rule in Image Database
MDC	Minimum Distance Classifier
MLP	Multi Layer Perceptions
MPL	MDC+PCA+LDA
NN	Neural Network

ORL	**Olivetti Research Laboratory**
PCA	**Principal Component Analysis**
PNN	**Probabilistic Neural Network**
SVD	**Singular Value Decompositions**
TIMIT	**Texas Instruments(TI)+Massachusetts Institute of Technology(MIT)**

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Abstract

This study presents a hybrid technique (Principal Component Analysis and Artificial Neural Network) in order to get faster recognition system. One sub-problem will consider the problem of recognition face is different face features and the second problem is reducing the images dimension for enhancement recognizing faces.

The proposed system consists of two models, system with PCA and system without PCA.

Proposal algorithm will use system with PCA to reduce the dimensions in the images and this process is to find the correlations or patterns in the images to get low- dimensional without losing information from the images.

The Proposal method to enhance the accuracy of recognizing faces of people is available in (ORL) database.

The process of extracting the features from the images in the (ORL) database by using eigen vector function works to extract features of the images mathematically process of transforming the matrix values

for each image to eigen values, where eigen vector take special features of images by using the projection process; this calculation is ready in Mat Lab program.

All the operations here are based on convert images to matrices and extract the values, which are the features of the face in the pictures.

After the process of extracting the features and the initialize and classification of data using PCA then take features values to neural network for training and testing to achieve meaningful learning and get predictable results.

Neural network used to predict outcomes after the training process and taken knowledge during learning and the type of learning used in this network is supervised learning with back propagation algorithm to modify the weight for the input data to the network to get the optimum weight compared with the specific target of the Network.

The prediction gives us the correct number of results and a number of false results and the difference between them is the accuracy rate of system and the results derived from this network is face recognition.

Also, the technique of face recognition and related studies will be presented in literature review.

At the end, the attained outcomes from the tests will be demonstrated and analyzed. These tests are based on gray level pictures with one face background. A comparison will be done to NN with PCA and NN without PCA to accomplish good precision and get high performance and accepted accuracy.

Arabic summary

الملخص

تقدم هذه الرسالة تقنية هجينة هي (تحليل المكونات الاساسية و الشبكة العصبية الاصطناعية) من اجل الحصول على نظام تمييز اسرع.

مشكلة فرعية ستطرح هنا هي اختلاف صفات الوجه ستعتبر مشكلة في تمييز الوجوه والمشكلة الثانية هي الحد من ابعاد الصور لتحسين التعرف على الوجوه.

ويتكون النظام المقترح من نموذجين ، النظام باستخاد تحليل المكونات الاساسية و النظام بدون استخدام تحليل المكونات الاساسية.

الخوارزمية المقترحة سوف تستخدم النظام مه تحليل المكونات الاساسية للحد من الابعاد في الصور وهذه العملية هي العثور على الارتباطات او الانماط في الصور للحصول على ابعاد منخفضة دون فقدان الكثير من المعلومات من الصور.

الطريقة المقترحة لتحسين دقة التعرف على الوجوه باستخدام قاعدة بيانات لوجوه اشخاص متاحة في قاعدة البيانات (ORL).

عملية استخراج الصفات من الصور باستخدام دالة رياضية هي eigen vector حيث تعمل على استخراج الصفات من الصور بطريقة رياضية بتحويل قيم المصفوفة لكل صورة الى قيم ذاتية eigen values حيث ان eigen vector تأخذ الصفات المهمة من الصور وتستغني عن باقي القيم الغير مرغوب بها بواسطة عملية الاسقاط وهذه العملية الحسابية جاهزة في برنامج Mat LAB و تستند جميع العمليات هنا لتحويل الصور الى مصفوفات واستخراج القيم من المصفوفات وهذه القيم هي صفات الوجه للشخص.

بعد عملية استخراج الصفات وتهيئة وتصنيف البيانات باستخدام تحليل المكونات الاساسية نأخذ قيم الصفات الى الشبكة العصبية للتدريب والاختبار لتحقيق تعلم ذات معنى والحصول على نتائج يمكن التنبؤ بها.

الشبكة العصبية تستخدم للتنبؤ بالنتائج بعد عملية التدريب واخذ المعرفة خلال التدريب ونوع التعلم المستخدم في هذه الشبكة هو التعلم بأشراف باستخدام خوارزمية الانتشار الخلفي لتعديل اوزان البيانات المدخلة الى الشبكة للحصول على الوزن المثالي مقانة مع الهدف المحدد للشبكة.

التنبؤ يعطينا عدد من النتائج الصحيحة وعدد من النتائج الخاطئة والفرق بينهما هو معدل الدقة للنظام والنتائج المتأتية من هذه الشبكة هو تمييز الوجوه.

سوف تقدم تقنية تمييز الوجوه والدراسات المتعلقة بها في مراجعة الدراسات السابقة.

في النهاية النتائج التي تحققت من الاختبارات سيتم شرحها وتحليلها حيث تستند هذه الاختبارات على صور ذات مستوى رمادي مع خلفية وجه واحد وسيتم بعد ذلك المقارنة مع الشبكة العصبية باستخدام تحليل المكونات الاساسية والشبكة العصبية بدون استخدام تحليل المكونات الاساسية لتحقيق الدقة الجيدة والحصول على اداء عالي ودقة مقبولة للنظام.

Chapter one
Introduction

Chapter one is considered as an introduction about the system. It presents an overview about neural networks, data mining, and principal component analysis and face recognition. In addition, it talks about the methodology that will be applied, aims and objectives of the system and the problem statement, which will be solved.

Recently, Information Technology (IT) appeared in most regionslike government, business and science, due to that; the significance of computers for remote observing has been increased, which is the base for control schemes. Due to the great amount of databases, variety and heterogeneity of information resources need a new idea of evaluating them. In these areas, the information mining finds out inherent knowledge in a dataset which depends on several methods that could be executed separately or together. These methods try to discover information to illustrate their texts and take out the data more significant.

Also, these methods are not restricted to digital information and verification, since great amount of the data that exists in associations is familiar and formless, thus it should address the textual and multimedia. In the latest years, the production, acquirement, accumulation and processing of information in computers and communication above networks had made a remarkable development, which had effects on the appearance of the internet and the primary

web browser that developed the allocation of data [Moudani. et al, 2011].

The face recognition system is the advanced method of card access; in this the person is identified just by means of various other resources like the image is getting stored in the database.Data mining and PCA are the process of finding correlations or patterns among dozens of fields in large relational databases.In data mining, PCA are useful for analyzing and predicting customer behavior.

In this case, the process gets increased and gets the rate of quality picture and the one get acted as the captured member. In this, the person can be the one who involved in the valuable membership processed functions and finally get circulated.These are highly got qualified into various other processes and fundamental assurance gets damaged due to other quality picture function.These types of behavior get collaborated and finally the attachments get spoiled the various technology here used are to be functioning as per the other terminologies and functions that are matched and got other process to be found.

The implementation of the recognition system comprises the image pre-processing phase and the neural network arbitration phase. Image pre-processing is required prior to presenting the training or testing images to the neural network[Moudani. et al, 2011].

These are the aims of reducing the computational cost and providing a faster recognition system while presenting the neural network with sufficient data is a representation of each face to achieve meaningful learning.

1.1.Neural Networks and Back Propagation Algorithm

[Andrej Krenker, JanezBešter and Andrej Kos, 2011], an Artificial Neural Network (ANN) is a mathematical model that tries to simulate the structure and functionalities of biological neural networks. Basic building block of every artificial neural network is artificial neuron, that is a simple mathematical model (function). Such a model has three simple sets of rules: multiplication, summation and activation, as shown in fig. 1.1. At the entrance of artificial neuron, the inputs are weighted which means that every input value is multiplied with individual weight. In the middle section of artificial neuron is sum function that sums all weighted inputs and bias. At the exit of artificial neuron the sum of previously weighted inputs and bias is passing through activation function that is also called transfer function [Andrej Krenker, Janez Bester and Andrej Kos, 2011].

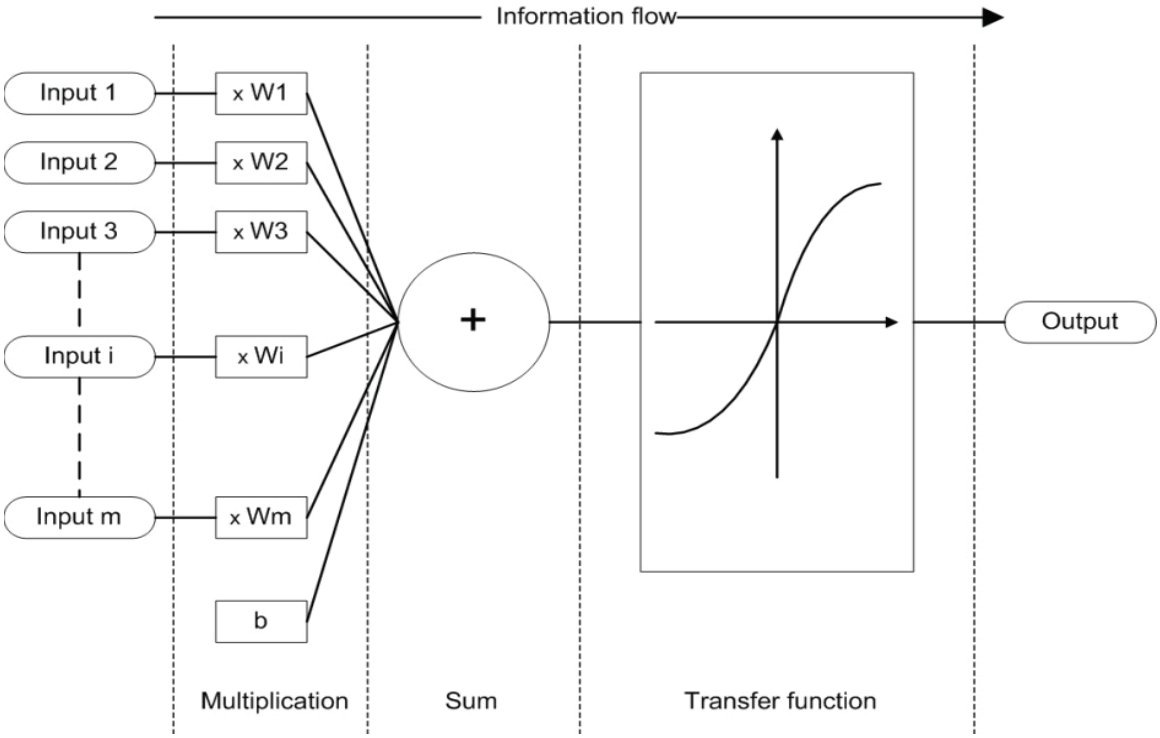

Figure1.1: simple artificial neural network[Andrej Krenker, JanezBester and Andrej Kos, 2011]

Artificial neural network with the recurrent topology is called recurrent artificial neural network. It is similar to feed-forward neural network with no limitations regarding back loops.

Benefit of artificial neuron model simplicity can be seen in its mathematical description below:

$$y(k) = F\left(\sum_{i=0}^{m} w_i(k) \cdot x_i(k) + b\right) \qquad (1)$$

Where:

- $x_i(k)$ is input value in discrete time k where i goes from 0 to m,
- $w_i(k)$ is weight value in discrete time k where i goes from 0 to m,
- b is bias,
- F is a transfer function,
- $y_i(k)$ is output value in discrete time k.

[Andrej Krenker, Janez Bester and Andrej Kos, 2011], in these cases information is no longer transmitted only in one direction but it is also transmitted backwards. This creates an internal state of the network which allows it to exhibit dynamic temporal behavior. Recurrent artificial neural networks can use their internal memory to process any sequence of inputs. Fig.1.2 Shows small fully recurrent artificial neural network and complexity of its artificial neuron interconnections.

The most basic topology of recurrent artificial neural network is fully recurrent artificial network where every basic building block (artificial neuron) is directly connected to every other basic building block in all direction. Other recurrent artificial neural networks such as

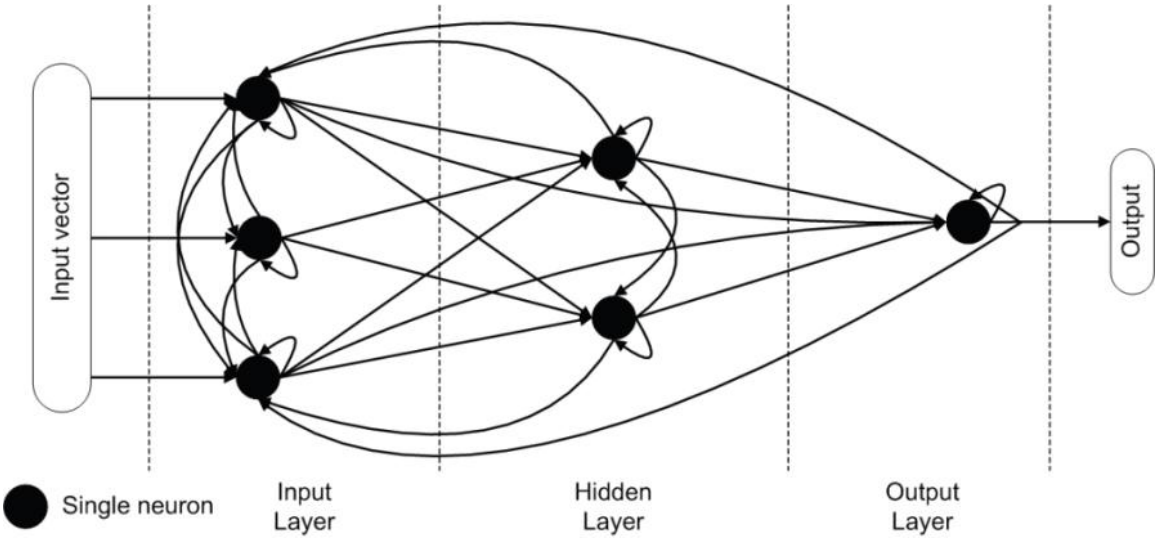

Figure 1.2 : Fully recurrent artificial neural network[Andrej Krenker, JanezBester and Andrej Kos, 2011]

When combining two or more artificial neurons we are getting an artificial neural network.

[Andrej Krenker, Janez Bester and Andrej Kos, 2011], if single artificial neuron has almost no usefulness in solving real-life problems the artificialneural networks do have it. In fact, artificial neural networks are capable of solving complexreal-life problems by processing information in their basic building blocks (artificialneurons) in a non-linear, distributed, parallel and local way.The way that individual artificial neurons are interconnected is called topology, architectureor graph of an artificial neural network. The fact that interconnection can be done innumerous ways results in numerous possible topologies that are divided into two basic classes. Fig. shows these two topologies; the left side of the figure represent simple feedforwardtopology (acyclic graph) where information flows from inputs to outputs in onlyone direction and the right side of the figure represent simple recurrent topology (semicyclicgraph) where some of the information flows not only in one direction from input tooutput but also in opposite direction.

[Dave Anderson and GeorgeMCneil, 2003], another type of connection is feedback. This is where the output ofone layer routes back to a previous layer. An example of this is shown inFig.1.3.

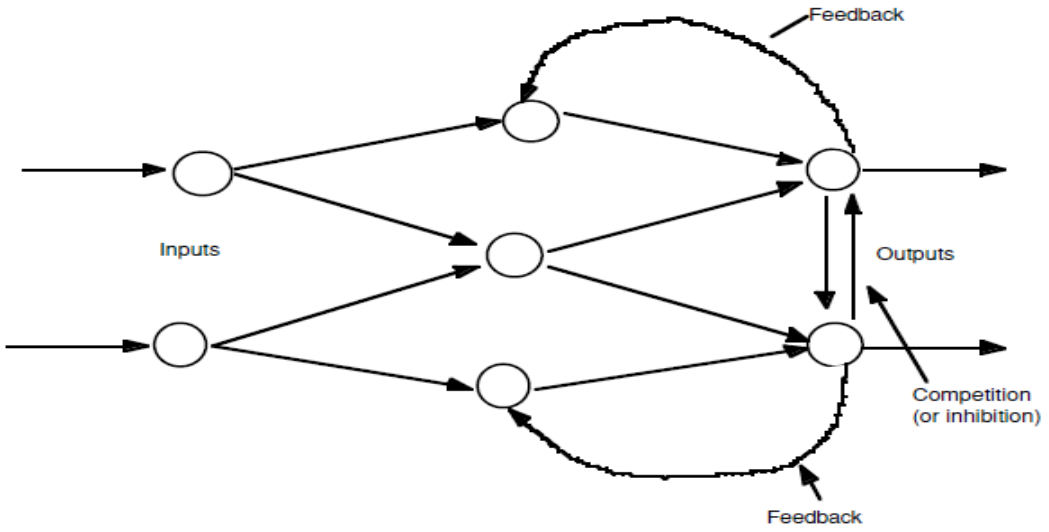

Figure 1.3 :simply network with feedback and competition[Dave Anderson and George MCneil , 2003]

[Dave Anderson and GeorgeMCneil, 2003], supervised learning is a machine learning technique that sets parameters of an artificialneural network from training data. The task of the learning artificial neural network is to setthe value of its parameters for any valid input value after having seen output value. Thetraining data consist of pairs of input and desired output values that are traditionallyrepresented in data vectors. Supervised learning can also be referred as classification, wherewe have a wide range of classifiers, each with its strengths and weaknesses.

Choosing asuitable classifier (Multilayer perceptron, Support Vector Machines, k nearest neighbor algorithm, Gaussian mixture model, Gaussian, naive Bayes, decision tree, radial basisfunction classifiers,…) for a given problem is, however, still more an art than a science.In order to solve a given problem of supervised learning various steps has to be considered. In

the first step, we have to determine the type of training examples. In the second step, weneed to gather a training data set that satisfactory describe a given problem. In the third, stepwe need to describe gathered training data set in form understandable to a chosen artificialneural network. In the fourth, step we do the learning and after the learning we can test theperformance of learned artificial neural network with the test (validation) data set. Test data set consists of data that has not been introduced to artificial neural network while learning[Dave Anderson and GeorgeMCneil, 2003].

1.2 .Face recognition and face features

It is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected facial features from the image and a facial database.

Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies Face detection is used in biometrics, often as a part of (or together with) a facial recognition system. It is also used in video surveillance, human computer interface and image database management. Some recent digital cameras use face detection for autofocus.Figure1.4 shown the basic Algorithm for face detection [Ponce, 2006].

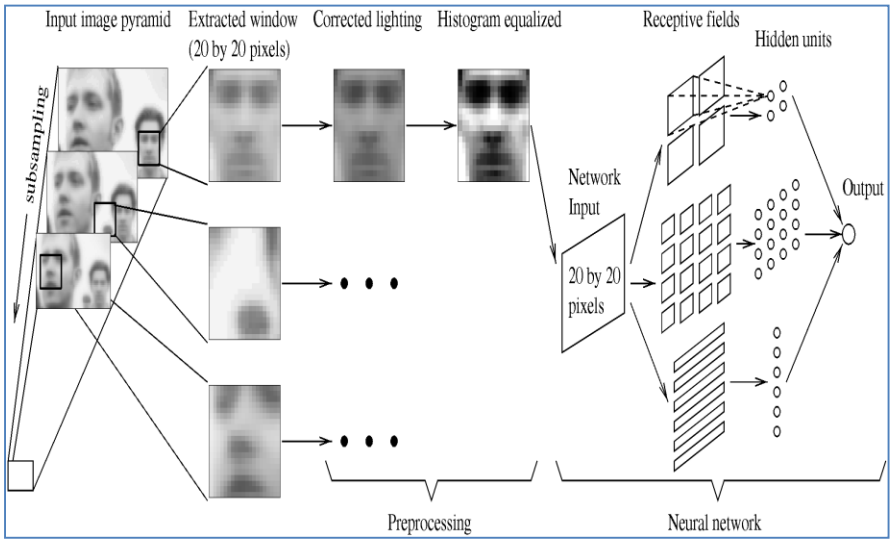

Figure1. 4: The Basic Algorithm used for Face Detection(Ponce, 2006)

[Harold, 2009]Facial feature dots are usually related to as facial significant dots for example the curves of the eyes, curves of the eyebrows, bends and external mid dots of the lips, bends of the nostrils, top of the nose, and the top of the chin. Recognition of facial characteristic points is regularly the first stage in computer vision appliances for example face recognition, facial appearancedetection, facesfollowing and lip reading. For instance localization of facial points is the firststage of “Active Shape and Active Appearance Models algorithms”.

[Adams. et al, 2010]Facial features are classified into three levels: Level 1, Level 2, and Level 3.

Level 1, contains features that form of disgusting facial features that are simplyvisible in a face, for example face,color and gender, in addition to the commonlook of the face.

Level 2,characteristics consist of restricted face data that needs particular cortex processing, for example the configuration of the face, the connectionamid facial elements, and the specificform of the face.

Level 3,characteristics consist of irregularities in the facial skin, which contains micro characteristics for example facial marks, skin staining, as well as moles.

1.3.Data mining

[Aberer, 2007], Sometimes called data or knowledge discovery, which is the process of analyzing data from different perspectives and summarizing it into useful information. This information can be used to increase revenue, cuts costs, or both. Data mining software is one of a number of analytical tools for analyzing data. It allows users to analyze data from many different dimensions or angles, categorize it, and summarize the identified relationships. Technically, data mining is the process of finding correlations or patterns among dozens of fields in large relational database.

[Hand. et al, 2001], the proposed in digital information achievement as well as store knowledge has effected in the expansion of enormous databases. This has happened in all fields of human being attempt, starting the ordinary (for example supermarket business statistics, credit card handling records) to the further unusual (for instance pictures of astronomical bodies, molecular databases, in addition to medicinal records). Data mining is considered as the investigation of observational statistics sets in order to discover unsuspicious

correlations as well as to sum up the information in original methods that are together comprehensible as well as helpful to the information holder. Correlations plus summaries obtained during a data mining work out are frequently known as models or patterns.

The description above named as "observational statistics," as countered to "investigational statistics." Data mining normally copes with information that has previously been gathered for some reason except the data mining examination. This denotes that the purposes of the data mining don't take part in the statistics gathering policy. This is one approach in which data mining is different from much of statistics where information is frequently gathered by means of professional methods to respond precise questions. For this cause, data mining is frequently named as "minor data investigation".
[Moudani. et al, 2011], proposed that the skin recognition is considered as a vital element in a diversity of appliances for example face recognition, mature image filtering in addition to gesture detection. A number of explanations regarding digital imaging and as well the "several image preprocessing" plus normalization are presented. Two sub-difficulties which is the skin recognition and face recognition are shown. Skin recognition technique in addition to some understood works in this field is proposed.

[Moudani. et al, 2011], concerning the appliance of face recognition, one of the major disadvantages of the technique is the implementation time which is vital since the browse of pixels in the image multiple times for every area is very expensive in calculating time.

They attain, supporting outcomes with dissimilar arrangements; they as well provide the likelihood to differ the factors as wanted to consumers. They also present such chances, the integration of visual content investigation, founded on skin color, for categorization and filtering of Web locations that are becoming gradually more visual and multimedia. Lastly, as they affirmed, the face recognition is the first phase of the scheme of face detection. A viewpoint that results is the integration of their stage in a biometric product. As well one of vital points is to support developers to work on developing behavior regarding calculating time of the utilized techniques.

[Sudhir, 2011], demonstrated that a developed image mining method is suggested for brain growth categorization utilizing reduced association rule with MARI algorithm. The suggested technique formulates utilization of association rule mining method to categorize the CT scan brain pictures within three groups explicitly typical, benevolent and malign. This suggested technique joins the low-stage characteristics mined from pictures and high stage knowledge from professionals. The suggested technique categorizes the brain CT scan pictures within three groups: typical, benevolent and malignant. The improved algorithm could provide a hand to the physicians for well-arranged categorization with several keywords per picture to obtain improved the precision. The investigational outcome on pre-analyzed database of brain pictures demonstrated 96% sensitivity and 93% precision.

Data mining is the investigation of great examinational information groups in order to discover un-suspected relations in addition to review the information within narrative methods, which are in cooperation comprehensible as well as practical for the information proprietor. Data mining gives techniques that permit to extort from great information sets unidentified relations in the midst of the information thing, which are practical for assessment creation. Consequently, data mining produces narrative, un-suspected explanations of information [Aberer, 2007].

The actual data mining task is the automatic or semi-automatic analysis of large quantities of data to extract previously unknown interesting patterns such as groups of data records (cluster analysis), unusual records (anomalydetection) and dependencies (association rule mining). This usually involves using database techniques such as spatial indices. These patterns can then be seen as a kind of summary of the input data, and may be used in further analysis or, for example, in machine learning and predictive analytics. For example, the data mining step might identify multiple groups in the data, which can then be used to obtain more accurate prediction results by a decision support system. Neither the data collection and data preparation, nor result interpretation and reporting, are part of the data mining step, but do belong to the overall Knowledge Data Discovery (KDD) process as additional steps.

1.3.1Principal Component Analysis

The principal component analysis in Data Mining: Basically, PCA is a method that reduces data dimensionality performing a covariance analysis between factors. The original data will be turned into a new coordinate system based on the variance in the data. PCA applies a mathematical procedure for transforming a number of (possibly) correlated variables into a (smaller) number of uncorrelated variables called principal components. The first principal component accounts for as much of the variability in the data as possible, and each succeeding component accounts for as much of the remaining variability as possible [Gargand Gulshan, 2005].

[Garg and Gulshan, 2005], demonstrated that PCA attempts to recognize the ways of utmost discrepancy in the preparationdata. by the SVD decomposition the first k-vectors whoseparticular charges are the biggest can be found. They essentially get the greatest projection ofthe preparation images onto a sub-space. The images when characterized in thissub-space have highest discrepancy (in the coordinates).

[Sharma et al, 2006], several pattern classifiers give high classification accuracy but their storage requirements and processing time are severely expensive. On the other hand, some classifiers require very low storage requirement and processing time but their classification accuracy is not satisfactory.

In either of the cases the performance of the classifier is poor. In this paper, they have presented a technique based on the combination of Minimum Distance Classifier (MDC), class-dependent Principal Component Analysis (PCA) and Linear Discriminate Analysis (LDA) which gives improved performance as compared with other standard techniques when experimented on several machine learning corpuses.

[Sharma et al, 2006], presented MPL technique which is a linear combination of MDC, class-dependent PCA and LDA techniques. The performance of the classifiers was measured in terms of classification accuracy as a function of storage and processing time. It was observed that the proposed combination of classifiers provided improved performance over all the other presented techniques. MPL technique on Sat-Image dataset produced maximum classification accuracy of 86.1% at 10 3.2 total parameter requirement and at 3.77 s. NN and KNN techniques also produced higher classification accuracy but the total parameter requirement and processing time were severely expensive. Similarly on TIMIT database, MPL produced the best performance with 86.1% classification accuracy at 10 3.723 total parameter requirement and at 13.28 s of processing time. On the other hand, in Multiple Feature-Digit class-dependent, PCA produced best performance among the presented techniques followed by MPL.

However, it was noted that MPL could produce better performance if a different combination was utilized.

[Mittal and Walia, 2008], illustrated the Principal Component Analysis (PCA) is one of the mainly effective methods that is utilized to identifyfaces in pictures. On the other hand, high arithmetical price as well as dimensionality is a chief difficulty of this method. There is proof that PCA can do better than over a lot of other methods at what time the dimension of the database is tiny. A quick PCA based face detection algorithm is suggested. In the suggested algorithm the database is sub-divided by some characteristics of attention in faces. Just one of the gained sub-groups is given to PCA for detection. The behavior of the suggested algorithm is examined on Indian face database, and the gained outcomes demonstrate a development in behavior of the suggested algorithm as contrasted to the similar with PCA technique.

[Luh and Hsieh, 2009], Principal Component Analysis (PCA) is an extensively applied dimensional decrease and characteristic removal method based on removing the favored numeral of main components of the multidimensional information. It engages an arithmetical process to change a number of probably connected changeable into a lesser digit of uncorrelated main components. And then least square method is used to approximate the parameters of the replica with these code constituents .

[Luh and Hsieh, 2009], proved that:

Allow X= ($x_1, x_2, \dots, x_i, \dots, x_N$) characterizes the n × N information matrix;

$x_i$is a face vector with length n, concatenated from a p ×q face image. As well, n indicates the whole numeral of pixels (p, q) in the face image

and N is the number of face images in the preparation set. The PCA is regard as a linear conversion from the original image vector X to a protuberance characteristic vector Y,

$$\mathrm{Y} = W^T \mathrm{X}$$

Y is the $m \times \mathrm{N}$ characteristic vector matrix, m is the dimension of the characteristic vector, and conversion matrix W is an n × m conversion matrix, whose columns are the eigenvectors matching to the m major eigen values calculated according to this equation,

$$\lambda \mathrm{e_i} = \mathrm{S e_i}$$

The scatter matrix S and the mean image of every sample are described as:

$$\mathrm{S} = \sum_{\mathrm{i=1}}^{\mathrm{N}} (\mathrm{x_i} - \mu)\,(\mathrm{x_i} - \mu)^{\mathrm{T}}$$

$$\mu = \frac{1}{\mathrm{N}} \sum_{\mathrm{i=1}}^{\mathrm{N}} \mathrm{x_i}$$

Subsequent to applying the linear conversionW^T , the scatter of the transformed feature vectors$\{x_1, x_2, \ldots, x_N\}$ will be W^TSW, in PCA the projection $\mathrm{W_{opt}}$is accepted to make the most of the determinant of the whole scatter matrix of the predictable tasters as subsequent

$$=\mathrm{W_{opt}} = \arg\max \left\| \mathrm{W^T S W} \right\| [\mathrm{w_1\ w_2 \ldots w_m}]$$

Where$\{\mathrm{w_i} | \mathrm{i} = 1,2, \ldots \mathrm{m}\}$ the set of m-dimensional eigenvectors,
S is related to the m main Eigen values. In further expressions, the face vector in an n-dimensional space is compact to a characteristic vector in an m-dimensional subspace [Luh and Hsieh, 2009].

1.4 MATLAB Software Techniques

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include:
(http://www.mathworks.com/products/matlab/)

- Math and computation.
- Algorithm development.
- Modelling, simulation, and prototyping.
- Data analysis, exploration, and visualization.
- Scientific and engineering graphics.
- Application development, including Graphical User Interface building.

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar noninteractive language such as C or FORTRAN.

The name MATLAB stands for matrix laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects, which together represent the state-of-the-art in software for matrix computation.
MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool

for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis(MathWorks, 2013).

1.5 Database in Recognizing Face

[M. S. El-Bashir, 2012],proposed a method to enhance the accuracy of recognizing faces of people available in Olivetti Research Laboratory (ORL) dataset.

ORL Database includes a set of face images taken amid April 1992 and April 1994. The database was utilized in the background of a face recognition task carried out in cooperation with the Speech, Vision and Robotics Group. There are ten dissimilar images of every of 40 separate topics. For a few topics, the images were taken at dissimilar instances, changing the lighting, facial appearances (closed /open eyes, not smiling / smiling) and facial features (glasses / no glasses). Every image was taken alongside dark uniform surroundings with the topics in a straight, forward location. The dimension of every image is 92x112 pixels, with 256 grey levels per pixel. The images are prearranged in 40 directories (one for every topic), which have names of the type sX, where X points to the topic digit (amid 1 and 40). In all of these directories, there are ten dissimilar images of that topic, which have names of the type Y.pgm, where Y is the image digit for that topic (amid 1 and 10).

1.6. Aims and Objectives

This thesis aims to use the neural network tactic in face recognition and apply PCA in the enhancement process in order to get better results, MATLAB software techniques are used in this thesis for this purpose too. In these areas, the data mining and PCA find out inherent knowledge in a dataset depends on several methods, which could be executed separately or together.

The main aim of this thesis can be achieved by applying the following objectives:

a. Deep study about Face recognition; Data mining; principle component analysis; and Neural Network.
b. Literature survey and study for the suggested project.
c. Training about MATLAB/SIMULINK in order to investigate the performance of face recognition.
d. Comparing the results and recommending further improvements.

1.7 Problem Statement

Due to the great amount of databases, variety and heterogeneity of information resources need a new idea of evaluating them. In these areas, the data mining and PCA find out inherent knowledge in a dataset depends on several methods, which could be executed separately or together. These methods try to discover information, to illustrate their texts and take out the more significant data and to reducing the dimensional for the images in database (ORL).

Feather extraction is an important issue for any pattern recognition problem.

One sub-problem that is differing features will consider the problem of recognition face and to reducing the images dimensional to enhancement recognizing faces.

The accuracy and the high performance are considered as another difficulties which will be addressed via MATLAB software techniques that are used in this thesis for this purpose, thus the need to simulate recognition artificially in our attempts to create intelligent autonomous machines. The training of the database and testing images will be done using neural network.

1.8 Methodology

In order to satisfy the main aim of this project, analyze the main concepts and the performance of Face Recognition system, two systems, which are with and without PCA, will be studied and the main steps that will be followed are as below:

1- Eigen vector method with EOD are presented to get main features and to eliminate unwanted pixels.
2- After that PCA is applied for classification to enhance training section.
3- Training images and testing images are saved in different variables.
4- Then training images by NN are applied to get main learn using back propagation method in order to get optimum weights at specific mean square error.
5- Finally recognition rate measurement for NN is applied with and without PCA.

1.9 Thesis Outline

The contents of this thesis will include five chapters combined with each other, the reminder of the following chapters organized as follows:

- Chapter 1: gives introduction and an overview of the overall thesis.

- Chapter 2: gives a Literature review to face recognition, Data mining, principal component analysis, and Neural Network concepts.

- Chapter 3: proposal design for the Methodology used for this thesis, requirements, and methods to perform face recognition.

- Chapter 4: discusses the work done along with the results achieved by using MATLAB software. Testing and evaluation of the performance will be also included.

- Chapter 5: contains the conclusion of the work and gives some potential future work.

Chapter two
Literature Review

Chapter two presents some literature work and a number of efforts that were executed regarding this project.

2.1. What is Face Recognition System

[Sridhar and Murali Krishna, 2012],proposed a new face recognition method based on Discrete orthogonal Tchebichef moments with Linear Discriminate Analysis and Probabilistic Neural Network is proposed. Tchebichef moments are having good energy compaction property that made them useful in image compression and dimensionality reduction operations. Moreover the translation and scale invariant properties of Tchebichef moments are very much useful in almost all pattern recognition applications. The proposed face recognition method consists of three steps, (i) Dimensionality reduction using Tchebichef moments (ii) Feature extraction using Linear Discriminate Analysis and (iii) classification using Probabilistic Neural Network. Linear Discriminate Analysis selects features that are most effective for class separability in addition to dimensionality reduction. Combination of Tchebichef moments and Linear Discriminate Analysis is used for improving the capability of Linear Discriminate Analysis when few samples of images are available(Sridhar and Murali Krishna, 2012).

Probabilistic Neural Network (PNN) is a promising tool and gives fast and accurate classification of face images. Evaluation was performed

on two face data bases. First database of 400 face images from Olivetty Research Laboratories (ORL) face database, and the second database of thirteen students are taken. The proposed method gives fast and better recognition rate when compared to other classifiers. The main advantage of this method is its high speed processing capability and low computational requirements[Sridhar and Murali Krishna, 2012].Figure 2.1shown the Architecture of probabilistic neural networks.

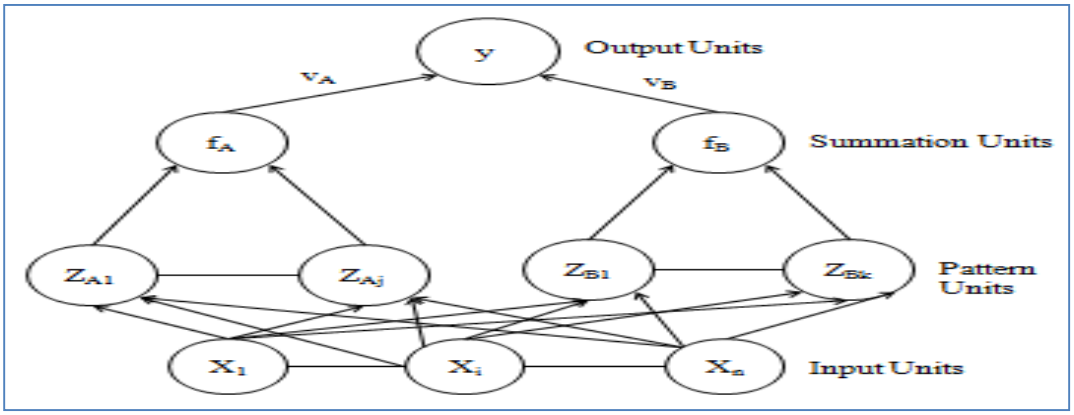

Figure 2. 1: Architecture of probabilistic neural networks(Sridhar and Murali Krishna, 2012)

According to [Sridhar and Murali Krishna, 2012], this new method is a combination of Discrete Tchebichef moments, Linear Discriminate Analysis and Probabilistic Neural Network. By using these algorithms an efficient face recognition method was constructed with maximum recognition rate of 100%. Simulation results using AT & T (ORL) face database and student's database demonstrated the ability of the proposed method for optimal feature extraction and efficient face classification. The new face recognition algorithm can be used in many applications such as security systems.

The ability of their proposal face recognition method is demonstrated on the basis of obtained results on AT & T face database and student's database. For generalization, the proposed method should achieve 100% Recognition rate on other face databases and also on other combinations of training and test samples.

[Amit Sharma and PrakashDevale,2012] work, today in Modern Society Face Recognition has gained much attention in the field of network multimedia access. After the 9/11 tragedy, the need for technologies for identification, detection and recognition of suspects has increased. One of the most common biometric recognition techniques is face recognition since face is the convenient way used by the people to identify each other.

[Amit Sharma and PrakashDevale, 2012] are going to study a method for representing face which is based on the features which uses geometric relationship among the facial features like mouth, nose and eyes .Feature based face representation is done by independently matching templates of three facial regions i.e. eyes, mouth and nose .Principal Component Analysis method which is also called Eigen faces is appearance based technique used widely for the dimensionality reduction and recorded a greater performance in face recognition.

According to [Amit Sharma and PrakashDevale,2012], face Recognition is a challenging as well as important recognition technique. It has great importance due to its friendliness. In this paper, they have given an introductory survey for the face recognition technology, discussing a generic frame work for face recognition.

The researchers discussed steps for PCA algorithm .The authors have covered basics of neural networks used in face recognition. The researchers hope this paper can provide the readers a better understanding about-face recognition. Face recognition can be applied in various fields like passport recognition, criminals list verificationetc.

2.1.1 Face Recognition Units

[HSU. et al, 2002], the improvements in area of image acquirement and accumulation method have demonstrated the approach for inconceivable development in widely great and featured picture databases. The pictures that are obtainable in these databases could supply precious data to the individual clients if they are tested. Image mining helps the mining of concealed data, picture information involvement, or other models not obviously gathered in the pictures. Image mining is an interdisciplinary exertion that supplies important purpose in the domain of apparatus studying, image processing, picture recovery, data mining, database, computer visualization, and simulated intelligence.

[Harold, 2009],The face recognition units are classified according to the concept of various units that are processing as like the means of each individual part of the face are marked to the various vocations and those are modified as like the means of other qualified functions and the processed to aware of the other technology.

In this unit the identifications are calculated due to the other functions and process as per the various unit recognition in the face that can be

identified and also be aware of various other terminologies that are varied for the aware of other functions and unit of the system that are modified. In this case, the various case cycles can be evaluated and process other terms and functions as possible as other units. Here the face marks are reduced toward the final way of around the other criteria and processing the functions that can be modular and identified which cannot be the one to other persons and finally those are not supposed to alter due to missing of some other units to be followed and varied [Harold, 2009].

[Harguess and Aggarwal, 2010], illustrated that modern study in the field of automatic apparatus recognition of human being faces have presented that there perhaps a benefit in using face dispute in order to develop recognition accurateness. Whilst promising, this effort has guided to a number of questions. What is a fine characteristic description or achieve of the dispute of the face? Is there an arithmetical importance amid face dispute and face detection? They showed novel dispute scores of the face and utilize the scores to contrast the dispute in a number of sub-groupings of a face database. A 3D face database is utilized to eliminate the results of illumination that should develop the consistency of the dispute score. They found a major dissimilarity in face dispute amid the men and women topics in the database. The database is then divided into mainly symmetric as well as smallest amount symmetric subjects founded on the dispute scores. The average-half-face is used in their face recognition experimentations to take into consideration the dispute of the face.

Face detection with eigenfaces utilizing the average-half-face is extensively superior than utilizing the complete face in all sub-groupings in spite of dispute score. Though, face detection utilizing the complete face does rely on the dispute score and usually supports the smallest amount symmetric topics.

[Jain et al, 2011], they illustrated that face detection has turn out to be an important as well as regular judicial mean utilized by criminal researchers. Contrasted with automatic face detection, judicial face detection is more challenging since it has to be capable to handle facial images taken below non-perfect situations and it has high legal responsibility for tracking lawful processes.

[Teja and Ravi, 2012],face recognition knowledge has obtained a huge amount of concentration over the decades in the area of image investigation and computer visualization. It has been learnt by scientists from diverse fields of psychophysical knowledge and those from diverse fields of computer knowledge. Psychologists as well as neuron-scientists mostly cope with the human being awareness part of the subject where as engineers learning on machine recognition of being faces cope with the computational features of Face Recognition. Face Recognition is a significant as well as natural human capability of a human being. On the other hand expanding a computer algorithm to do similar thing is one of the hardest jobs in computer vision. Investigation over the precedent some years allows alike recognitions mechanically. A variety of face recognition methods are symbolized throughout a variety of their work gave an evaluation of dissimilar face recognition methods offered as of today.

The concentration is on sub-space methods, demonstrating the utilization of image pre-processing executed as a beginning stage to decrease mistake rates. The PCA, Linear Discriminate Investigation and their developed techniques of face recognition are realized under sub-space methods; calculating “False Acceptance Rates (FAR)” as well as “False Rejection Rates (FRR)” on a typical experiment group of images that create classic complexities for recognition. By executing a variety of image processing procedures it is expressed that the behavior is extremely reliant on the kind of pre-processing stages utilized and that “Equal Error Rates (EER)” of the Eigenfaces and Fisher face techniques could be decreased by the technique suggested in their paper.

2.2. The Dimensional Surface Matching Method

[Phillips. et al, 2003], within the past years, the face recognition system which is part from the biometric systems worked with several applications like the authentication with the access control devices. Face recognition system deals with several reports that describe the problems of the commercial technologies of the face recognition. There are two problems with the commercial technologies of the face recognition; the inter class similarities (similarities between the twins and the similarities between the father and the son) which contain similarities with difficulties in the distinguishing people and the intra class variation which is affected by the changing in the light conditions, pose variation, and facial expression.

[Amor. et al, 2006], the system of face recognition can use the dimensional surface matching method. While the previous methods

are focused on the intensity of the images of the face, the dimensional surface matching method focuses on introducing information that describes the problems of the face recognition, such as the illumination and the facial expression variations. Also, this algorithm is used the ICP (Iterative Closest Point) which introduces the best posture of the probe. Also, this algorithm used the spatial deviation in the overlapped parts of the matched surface to provide the similarity of the metrics. The dimensional surface matching method deals with the 3D face gallery which uses laser based scanner (off line phase). In the online phase, the image of the face are captured by 2.5D and a set of 3D faces that are taken from the gallery and compare them to the 3D face model of the genuine. Finally, the 3D face database is used to make the important experiments.

2.3. Working of Recognition System

[Robert, 2000], accordingly they should think that the Gauss-Markov theorem only holds in the never-never land. However, it is important to understand the Gauss-Markov theorem on two grounds: We may treat the world of the Gauss-Markov theorem as equivalent to the world of perfect competition in micro economic theory. The mathematical exercises are good for your souls for performing this type of valuations and behavior functions to be laid. This can be good enough to do the process and identify the face and detect the areas.

The 3D function of the face how it gets recognized and formatted versions are carried out in case of face attitude first in this case the same image as like of the original picture is shown and that in case of

the next formatted functions it can be the same as original face function is possible here. These are similar in the way that the functions are carried and processed out in case of similar image and functions as look as possible and terms to be identified then the processing functions are carried out in case of the above figured function the ways and the ranges are calculated.

[Robert, 2000], there are many recognition systems that are used nowadays. The most commonly and the most preferred system is the face recognition system. The face recognition system has more advantages as mentioned. The face recognition system works on the principle of the Gauss-Markov theorem[Robert, 2000], this theorem deals with the function of how the face is detected and identify from the database. For that the formula used is given below.

$$Y_i = \sum \beta_j X_{ij} + €_l \qquad \text{.... .... (1)}$$

Here the i and j are the pixel rate of the parts of the face and those are calculated by the matrix functions and formulated based on the value of the functions in this the Yi value is calculated and process as the recognition of the face detected from the database. If the value is similar as of the value present in the database the process will continue and the functionality of the process would be barely good [Robert, 200]).

Markov theorem mainly explains the concept of various other terminologies in this case the images are categorized and those are circulated by the pixel and other range of functions and process also

the proper extension of various other functions are carried out by means of other functionality this arises the major cause of the adhere process functions and laid towards the other in terms of various nodes and pixel functions. Also the similar functions are lay down to their process [Robert, 2000].

[Ponce, 2006], as see in figure 2.2the shapes and reflectance can be calculated both together and in a single manner. These are functions calculated by Gauss-Markov by his theorem. They are able to say that by means of this theorem the process can be viewed towards the various calculations and the proper functions will be getting back to the function in which we are expecting the various function together to form a detected image.

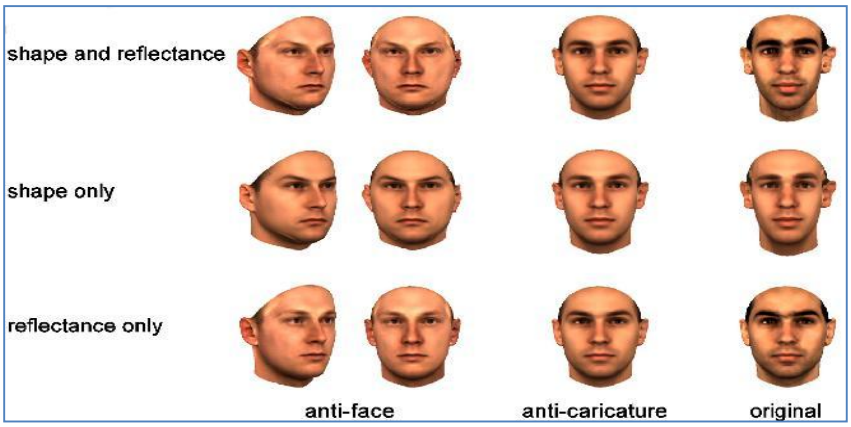

Figure 2. 2: Different Movement andthe ReactionsbyTheorem (Ponce, 2006).

2.4 The Concept of Image Retrieval

[Willy and Kufer, 2004],proposal identified the Content Based Image Recovery (CBIR) as a primarily suggested to defeat a difficulty caused by the bias of a user's observation. That bias outcomes in imprecise text stand keyword commented that may cause disregarded

mis-matchs in the presently picture recovery progression. Instead of creature physically explained, also they shown that the Content Based Image Recovery (CBIR) guides descriptions using their illustration stuffing such as color, surface and form.

[Zakariya et al, 2010], proved that theImage Retrieval is a performance of browsing, stabbing, and recovering the images from a representation data base. They demonstrated that there are two forms of diverse image recovery procedures that is text-based image recovery and satisfied based image recovery practices. Text-Based image recovery utilizes conventional record practices in order to control images. CBIR (Content Based Image Recovery) utilizes the Visual properties of an image such as form, color, spatial describe, and surface in order to symbolize and guide the image.

In addition to, they explained CLUE and CBIR within their paper. They described the Cluster Based Image Retrieval (CLUE) and shown that it was a well identified Content Based Image Recovery advance. In addition to that, Content Based Image Recovery (CBIR) system also recovers images by gathering just like CLUE. However, the planned system joins all the characteristics (form, color, and surface) with various proportion of all characteristics value for the intention. The planned is two methods of Content Based Image Recovery (CBIR) by Mixing a few fraction values of two characteristics that is Color surface characteristics and color form characteristics.

This mixture of characteristics grants a vigorous characteristic set for image recovery.

[Bhadoria and Dethe, 2010], showed that the image recovery is a deprived stepchild to further shapes of "Information Retrieval" IR. Also they demonstated that the image recovery became one of the mainly attractive and vibrant investigate regions in the pasture of computer visualization over the next decades. Image recovery for medicinal submissions was a constant further attractive, and was in advance a lot of concentration in modern years, with a huge numeral of medicinal images in digital configure produced by hospitals and medicinal associations daily. They showed that there was an omitted relation among investigate connected with computer technology and medicinal sections. The digital imaging insurrection in medicinal area of the preceding three decades had cemented the method for radiologists and physicians to image directed judgment and healing of illnesses.
[Ananth and Subbiah,2012], proposes a new approach for face recognition using discrete orthogonal moments. Two different databases have been used to evaluate the proposed method. The orthogonal moment features prove to be efficacious for the image retrieval task.

2.4. Feature Extraction

[Gupta and Sexton, 1999], demonstrated that their work contrasted the utilization of BP and Genetic Algorithms (GA) for developing ANN. For this messy time sequence difficulty, their experiential outcomes present that the GA is better than BP in efficiency, accessibility and

effectiveness in preparation of NNs. Even though the GA prepared fewer networks, it was discovered to supply a statistically better explanation over BP. Because the GA did not require getting best factor settings, its availability was greatly better than BP. This algorithm also discovered superior clarification in a lesser amount of time, which is a chief concern in NN investigation. Though BP is by far the mainly accepted technique of optimization for NNs, it is obvious from this examination that a GA may be further appropriate for preparation the NNs. By utilizing a worldwide explore method, for example the GA, for NN preparation, many if not all difficulties linked with BP can be defeat. A number of matters are valuable of future examinations. First, a complete study to contrast the behavior of GAs and gradient search methods throughout the utilizing of added multifaceted functions and actual statistics from the compound fields such as financials and economics will be helpful. Second, investigation studies to decide a best NN design to get the most excellent outcomes in the preparation of a known NN will be attractive and valuable. Finally, the improvement and testing of mixture algorithms, that utilize a mixture of GA, BP, and other met heuristics to improve the efficiency and effectiveness of preparation ANNs is equally attractive and perhaps essential.

Chapter three
Proposal Design

This chapter illustrates the designed systemin addition to the main methodologyand it presents how they will be applied together in order to achieve the main aim of this project.

3.1. Introduction

Face recognition is a chart model identification difficulty. A three dimensional face to unstable enlightenment, pretense, and appearance is to be recognized founded on its two dimensional representation. Generally, a face identification scheme consists of four units: detection, alliance, characteristic removal, and corresponding, where localization and normalization are dispensation steps before face identification is carried out (J.P .Ananth et al., 2012).

Face identification has haggard substantial attention and concentration from a lot of investigators for the last two decades. The identification of faces has received wide concentration because of its possible appliances in a lot of fields like detection for rule enforcement, corresponding of photographs on IDs or driver's certificates, right of entry manage to safe computer systems and amenities, verification for safe banking and monetary contracts, routine showing at airports for recognized terrorists, and video observation practice. Face identification has a number of benefits more than other biometric knowledge because it is normal, non invasive, thus the populace can contact it at ease. Furthermore, it can be utilized wherever and

employed in a variety of appliances. As a result, facial characteristics achieved the uppermost compatibility amid the six biometric qualities (J.P.Ananth et al., 2012).

Face identification end results depend extremely on characteristics that are removed to stand for the face prototype and categorization techniques used to differentiate amid faces. The face illustration was executed by utilizing two groups. The first group is worldwide approach or look-based that utilizes holistic texture characteristics and it is applied to the face or exactarea of it. The second one is characteristic-based or part-based, which utilizes the arithmetical connectionamid the facial characteristics like nose, mouth and eyes.

Amongst the look based approach, Principal Components Analysis (PCA) technique which is also called eigenfacesis utilized mainly over the earth. PCA based approaches characteristically contain two stages: preparation and categorization. In the preparation stage, an eigens pace is recognized from the preparation testers using PCA and the preparation face images are mapped to theeigenspace for categorization. As to the categorization stage, an input face is predictable to the identical Eigen space and classified bysuitable classifiers.

(Luh and Hsieh, 2009), In the field of prototype identification, the mixture of an assembly of classifiers can attain image categorization schemes with superior presentation in contrast with a solitary classifier in that the lacks of every classifier may be remunerated each other .Many image categorization schemes based on the mixture of outputs

of diverse classifier schemes have been planned. Diverse arrangements for joining classifier schemes can be grouped in three patterns: cascade, parallel and hybrid. The identification apparatus consists of two stages: the PCA characteristic removal stage, and the immune network categorization stage. The Immune networks are used as person classifiers.

3.2 Main Methodology

Two main systems will be proposed; Figure 3.1 illustrates the first one which contains Data mining (PCA+N.N).

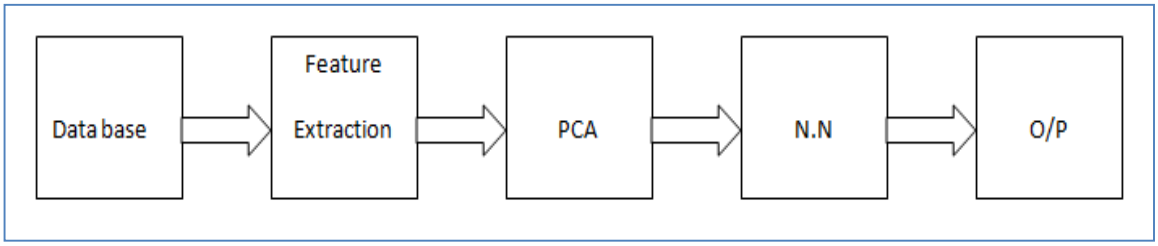

Figure3.1:System with PCA

And the other system has shown in Fig. 3.2.This system doesn't contain the PCA block.

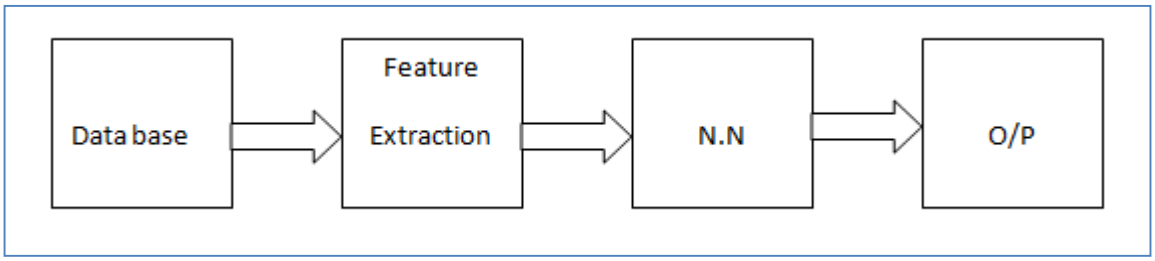

Figure3. 2: System without PCA

3.3The Steps for Proposal Design

Step 1- Database:

The Database which was used in the system is the ORL Database; [http://www.cl.cam.ac.uk/Research/DTG/attarchive:pub/data/att_faces .tar.Z].

ORL Database includes a set of face images taken amid April 1992 and April 1994. The database was utilized in the background of a face recognition task carried out in cooperation with the Speech, Vision and Robotics Group. There are ten dissimilar images of every of 40 separate topics. For a few topics, the images were taken at dissimilar instances, changing the lighting, facial appearances (closed /open eyes, not smiling / smiling) and facial features (glasses / no glasses). Every image was taken alongside dark uniform surroundings with the topics in a straight, forward location. The files are in PGM set-up. The dimension of every image is 92x112 pixels, with 256 grey levels per pixel. The images are prearranged in 40 directories (one for every topic), which have names of the type sX, where X points to the topic digit (amid 1 and 40). In all of these directories, there are ten dissimilar images of that topic, which have names of the type Y.pgm, where Y is the image digit for that topic (amid 1 and 10).

Step 2 - Feature Extraction:

The job of the feature extraction and assortment techniques is to get the majorityapplicabledata from the original data and symbolize that data in a lower dimensionality space. The aim is to choose, amongst all the obtainable characteristics that will execute better. The following 15 features will be introduced in the form of distance.

Width of nose.

- Left eye to right eye.
- Width of mouth.
- Left eye to left side of nose.
- Right eye to right side of nose.
- Left side of nose to right side of mouth.
- Right side of nose to left side of mouth.
- Left eye to middle of nose.
- Right eye to middle of nose.
- Vertical distance from mouth to nose.
- Horizontal distance from left edge of face to left side of nose.
- Horizontal distance from right edge of face to right side of nose.
- Horizontal distance from left edge of face to left side of mouth.
- Horizontal distance from right edge of face to right side of mouth.
- Vertical distance from eye to nose.

The value of feature vector characterizes absolute spaceamid feature points. For example, let the left eye (X_1, Y_1) and middle of nose (X_2, Y_2). Then, their absolute distance is computed by

$$fe(8) = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}$$

A high-qualitycharacteristic extraction will raise the performance of face recognition scheme. A variety of methods has been suggested in the literature for this reason and is mostly categorized in four groups.

(1) Arithmetical characteristic-based technique group: the characteristics are removed by utilizing relative positions and sizes of the significantelements face like eyes, nose, mouth and other significantelements of face. The benefit of these techniques is the attentiveness on vital components of face like eyes, nose, and mouth but the difficulty is not to stay face global construction.

(2) Template-based technique Group: based on a template function and suitable energy function, this technique group will remove the characteristic of significantelements of face such as eyes and mouth, or face form. A picture region is the best suitability with template (eyes, mouth, etc.) which will reduce the energy. Benefits of this group technique are using template and determining parameter for significant components of face, but difficulty is not to reproduce face global structure.

(3)Unicolor segmentation-based technique group.

(4)Appearance-based technique group: The objective of this technique group is utilizing linear transformation and arithmetical techniques to discover the basic vectors to symbolize the face.

Step 3- PCA-Immune System

The algorithm utilized for principal component analysis is as follows:

(i) Obtain a first set of M face images (the training set) and compute the Eigen-faces from the teaching set, remaining only M' Eigen-faces that match to the highest Eigen-value.

(ii) Compute the matching allocation in M'-dimensional weight space for every identified individual, and compute a set of weights based on the input image

(iii) Categorize the weight model as either an identified person or as unidentified, consistent with its space to the neighboring weight vector of an identified person.

The antigen space is distinct as the information set of *m*-dimensional eigenvectors $\{v_i | i = 1,2, \dots N_{Ag}, v_i \in R^m\}$; N_{Ag} will show the numeral of antigens/preparation face images. For the reason of professionally neutralizing the antigen, diverse antigens need qualitatively diverse immune replies. The antigenic background has become connected with the linked suitable kinds of immune reply. Here the antibody's receptor is described as $\{P_j | j = 1,2, \dots N_{Ab}, P_j \in R^m\}$; N_{Ab} shows the numeral of antibodies in every immune system classifier. The similarity $\mathrm{m_{ij}}$ described as the corresponding relative amount amid the i^{th} antigen epitope and the j^{th} antibody receptor, is described as a Boltzmann-Gibbs distribution function.

$$m_{ij} = \frac{e^{-\beta_j d_{ij}}}{Z}$$

Where β_j is a factor managing the allocation form, and $d_{ij}=\|v_i - P_j\|$ is the Euclidean space amid the i^{th} antigen epitope vector and j^{th} antibody receptor vector. The normalizing factor

$$Z = \sum_{i=1}^{N_{Ab}} e^{-\beta_i d_{ij}}$$

Is named the divider function

The reply of the whole immune systems is derived from forming a set of similarities connected with the receptors and the structural resemblance among antigen and antibody described as quantification of the space in antigen hole. The communal immune reply function for the i^{th} antigen/preparation image of the immune system is signified as the subsequent equation,

$$f(v_i) = \sum_{j=1}^{N_{Ab}} m_{ij}$$

For the PCA-IN, the i^{th}immune classifier attempts to make the most of the immune reply of the self antigen whilst reduce the replies to non-self antigens. The factors of the i^{th} immune classifier contain the antibody's receptor P_j and the allocation coefficient β_j.

Crossover operative recombines hereditary data of two persons to create the progeny for the subsequently age group.

The major reason of crossover is to swap hereditary data amid parent couples without losing any significant schema. In brief crossover operative can be observed as a two-step procedure.

In the first step, the persons of mating couples are selected from the mating pool of inhabitants, after that contract of chromosome sections amid mating couples is executed in the second step. Diverse crossover operatives have been suggested to reduce the possibility of disturbance of powerfully fixed schema throughout the seek procedure. The reason of alteration is to initiate hereditary variety into the inhabitants. An arbitrary numeral is produced and it is verified with the possibility of alteration. If the arbitrary numeral is fewer than the possibility of alteration, the chosen chromosome has to suffer alteration. Characteristically, the alteration speed lies in 0.001 to 0.01. Together the crossover and alteration operatives are the resources of examination. They will disturb a number of the schema on which they work. In the procedure of hereditary seek; there is a tradeoff amid utilization and examination. The complexity of hereditary algorithms is seeking the equilibrium amid utilization and examination that decide the junction and variety of the best seek.

The strength function of the i^{th}immune classifier is described as follow,

$$\mathrm{fit_i} = \mathrm{w_1}.\frac{\sum_{j=1}^{N_{self}} m_{ij}}{N_{self}} + \mathrm{w_2}.\frac{1}{\sum_{k=1}^{N_{non-self}} m_{ik} \Big/ N_{non-self}}$$

Where N_{self} and $N_{non-self}$ symbolize the numeral of preparation images of the j^{th} being and that of the outstanding being, correspondingly. Factors w_1 and w_2 are the weighting charges, w_1+w_2=1.

Step4- Neural network:

The Algorithm for Face recognition by neural classifier is as follows:

1. Pre-processing step –Images are made of zero-mean and unit-variance.

2. Dimensionality decrease step: PCA - Input data is summarized to a lower dimension tofacilitate classification.

3. Categorization step - The reduced vectors from PCA are applied to train back propagation neural network classifier to get the recognized image.

An artificial neural network is a nonlinear and adaptive arithmetical module enthused by the working of a human brain. It consists of simple neuron factors operatingin parallel and communicating with each other during weighted interconnections.

There are basically three layers in Neural Networks that are: input layer, hidden layer and output layer. All these layers are connected through nerves. This could be simulated in artificial intelligence, and happens in following manner.

First, the input layer which is connected to hidden layer. Hidden layer is a layer where actual processing takes place. It is basically back end

processing and what we realize is the input and output layer thus it is known as input layer. This input layer then connects with the output layer where the desired results could be seen out. Now let us see how this model is applicable in face recognition which is an integral part of home based security software.

Second, this neural network needs some amount of training so that it could give good and desired results. For this purpose, the database in form of faces and non faces could be given and training could be started at desired level of learning rate. Hidden layers would be trained on the basis of these inputs where it would identify pictures on basis of faces and non faces. After getting training, it would be able to detect whether image is a face or not. This face identification is an important and impertinent step before face recognition or identification.

During the training of the neural network, the error function can be given as illustrated in the following equation:

$$\varepsilon = \sum_{X_i \epsilon E} (d_i - f_i)^2$$

Where; d_i: are the given desired output, and f_i: are the real output.

The value of εmainlydependsonthevaluesoftheweight.

The gradient descent: minimizing the value of the error through moving the weights along the decreasing slope of error. The main idea is to perform the training process by adjusting the values of the weights in order to reach the minimum value of the error gradient. Now, the assigning of

$$W_i^j \leftarrow W_i^j + c_i^j \delta_i^j X^{j-1}$$

Will be performed, where;

W_i^j: weightoftheithsigmoidinthejthlayer.

c_i^j: learningrateconstantoftheithsigmoidinthejthlayer.

X^{j-1}: systeminput, whichisalsotheprevious layeroutput.

δ_i^j: thenetworkoutputsensitivitytothechangeintheinputofthesystem.

The sensitivity of the network can be given as illustrated in the following equation:$\delta_i^j = (d-f)\frac{\partial f}{\partial s_i^j} = -\frac{1}{2}\frac{\partial \varepsilon}{\partial s_i^j}$

$\delta_i^j = \delta^k$, for the output layer

$$\delta_i^j = \delta^k = (d-f)\frac{\partial f}{\partial \delta^k}$$

$$\delta_i^j = (d-f)f(1-f) for sigmoid.$$

So, $W^k < -W^k + c^k(d-f)f(1-f)X^{k-1}$

While for the hidden layers,$\delta^k = (d-f)f(1-f)$, so;

$$\delta_i^j = f_i^j(1-f_i^j)\sum_{l=1}^{m_{j+1}} w_{il}^{j+1}$$

Weight equation for the output layer:

$$w_{ij}(t+1) - w_{ij}(t) = \eta\,\Delta_i(t)z_j(t) = \eta\big(d_i(t) - y_i(t)\big)g'\big(a_i(t)\big)\,z_j(t)$$

η: Learning rate
$g'(a_i(t))$: $activation\ function$
$d_i(t)$: desired or target output
$y_i(t)$: real output

$z_j(t)$: Output from the previous layer

$w_{ij}(t+1)$: Adjusted value of the weights

Weights for the hidden layers:

$$v_{ij}(t+1) - v_{ij}(t) = \eta\ \delta_i(t) x_j(t) = \eta\ g'(u_i(t)) x_j(t) \sum_k \Delta_k(t)\, w_{ki}$$

$$\Delta_i(t) = (d_i(t) - y_i(t)) g'(a_i(t))$$

$$\delta_i(t) = g'(u_i(t)) \sum_k \Delta_k(t)\, w_{ki}$$

These equations are used to calculate the values of the weights on the lines between neurons by firstly selecting random values of the weights and then adjusting them based on the error value.

Third,after face detection, there would be a database of images of people that would be considered as authorized users. This would help in identifying and enabling software to recognize whether the person is authorized or not. There would be a match of the input image with the face that has been given in the database so that all the fits can be given authorization and on other hand all the other mismatches could be considered as unauthorized thereby maintain the security.

Doing well face recognition method depends greatly on the particular option of the characteristics used by the model classifier .The Back-Propagation is the most excellentrecognized and extensivelyutilized learning algorithm in teachingMultiLayer Perceptions (MLP). The MLP refer to the network consisting of a set of sensory units (source nodes) that comprise the input layer, one or additionalconcealed layers of calculation nodes, and an output layer of calculation nodes. The input signal broadcasts during the network in aheadway, from left to right and on a layer-by-layer basis.

Back propagation is a multi-layer feed forward, managed learning network based on gradient drop learning law. This back propagation neural networkgives a computationally competenttechnique for altering the weights in feed ahead network, by differentiable start function units, to learn a teaching setof input-output data. Being a gradient droptechnique reduces the whole squared error of the output calculated by the net. The intent is to teach the network to attainequilibriumamid the capability to reactproperly to the input patterns that are utilized for teaching and the capability to givehigh-qualityreply to the input that are alike.

A classic back propagation network with Multi-layer, feed-forward supervised learning is as shown in the Figure. 3.4. Here learning procedure in Back propagation needs couples of input and goal vectors. The output vector ‘o ‘is contrasted with goalvector’t ‘. In case of dissimilarity of ‘o’ andt‘vectors, the weights are adjusted to reduce the dissimilarity. At firstarbitrary weights and thresholds are allocated

to the network. These weights are updated each iteration with the intention ofreducing the mean square error amid the output vector and the goal vector.

Number of Hidden Units: If the start function can differ with the function, then it can be seen that an n-input, output function needs at most 2n+1 hidden unit. If additional number of hidden layers is present, then the computation for the δ's are replicated for every extra concealed layer present, summing all the δ's for units present in the preceding layer that is fed into the present layer for which δ is being computed.

Fourth, selection of training parametersfor the competent process of back propagation network it is essential for the suitable collection of the factors used for teaching.

Training a Net:The incentive for applying back propagation net is to attain equilibrium amid memorization and generality; it is not of necessity beneficial to go on teaching waiting the error arrives at a smallest amount value. The weight alterations are based on the teaching patterns. As long as error the for corroboration decreases training continues. When the error starts to rise, the net is starting to remember the teaching patterns. At this point teaching is finished.

Fifth,initial weightsthis first weight will pressure whether the net achieves a global or local minima of the error and if so how quickly it meets. To obtain the most excellent product the initial weights are set to arbitrary numbers between -1 and 1.

Step 5- O/P:

It is well recognized that the training BP can be observed as theoptimization of the error depends on the weights. A local optimization method isapproximately for all time used for training as well as a result the training algorithmfrequently attains a local minimum.

In addition, the exacting local minimum will decide the quality of the neuralnetwork result. If theminimum is near to the worldwide one the behavior will be satisfactory and the training unbeaten. Conversely, thereare minima that consequence in badly trained networks and failed convergence.The issues that decide the last local minimum are mostly the exacting weightinitialization and the training algorithm.In addition, the weight initialization affects the rate of convergence, thelikelihood of convergence and the generality.

Chapter four
Implementation and Results

In this chapter face recognition system model is constructed using MATLAB software and using feature extraction and neural networks, in order to satisfy the main aim of this project, analyze the main concepts and the performance of face recognition system to obtain results and compare them with PCA system.

1. Load database that contains different images as training and tasting.
2. Apply eigen vector method with EOD to get main features and to eliminate unwanted pixels.
3. Save training images and testing images in different variables.
4. Apply PCA for classification to enhance training section.
5. Apply training images of NN to get main learn using back propagation method in order to get optimum weights at specific mean square error.
6. Apply recognition rate measurement for NN with and without PCA.

4.1. System without PCA

To obtain the results many steps must be performed:

1. Extract the files under MATLAB software.
2. To run the program, neural networks and image processing tool boxes should exists.

3. Then form main. file within the command window

After these steps, the program will be generated as figure 4.1.

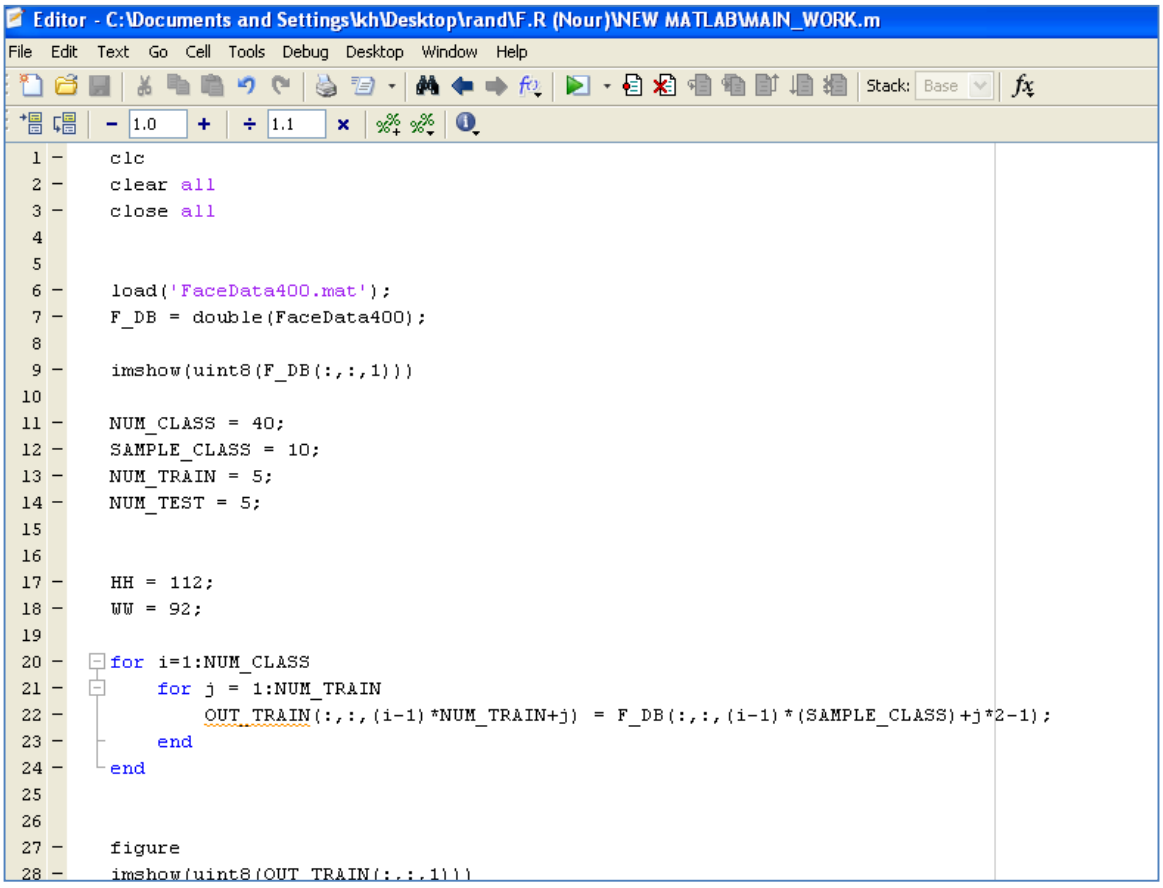

Figure 4.1 : Face Detection Steps- MATLAB software

First Step: Database

In this step all database will be created automatically by design, and it will be ready to do the next step that is Initialize network.The extraction of the images is performed at this step. The recognized face will be considered as the database that will be used latterly in the testing process. To start with this step, the images will be firstly read on MATLAB software using the function (Imread), after that some image processing that includes converting the image to the grey scale and binary representation is performed, some of noise removal may be also

performed in order to achieve the best quality after finishing the image processing on the image, the image will be stored as database using the function save. By these steps the read image is saved as a database. This process will be repeated to include all recognized faces.

Second Step: Train Network

The second step is the training of the neural network. This is an essential step that will be used as a way to enhance the ability of the neural network to recognize the faces. In general, the neural network consists of input layer, hidden layer and output layer. In each layer there are a set of neurons, each one of these neurons are connected to all neurons in the next layer.

Set of features that are essential to recognize the face, such as the iris will be used as input of the neural network. at each line between the neurons there is a weight value , the main idea of the training lies in giving these weights a random values at the first time and then adjust their values to minimize the error function between the real output and the desired output. An important idea is when increasing the number of epochs, which is how much the training of the neural network is performed, and then better results will be achieved.

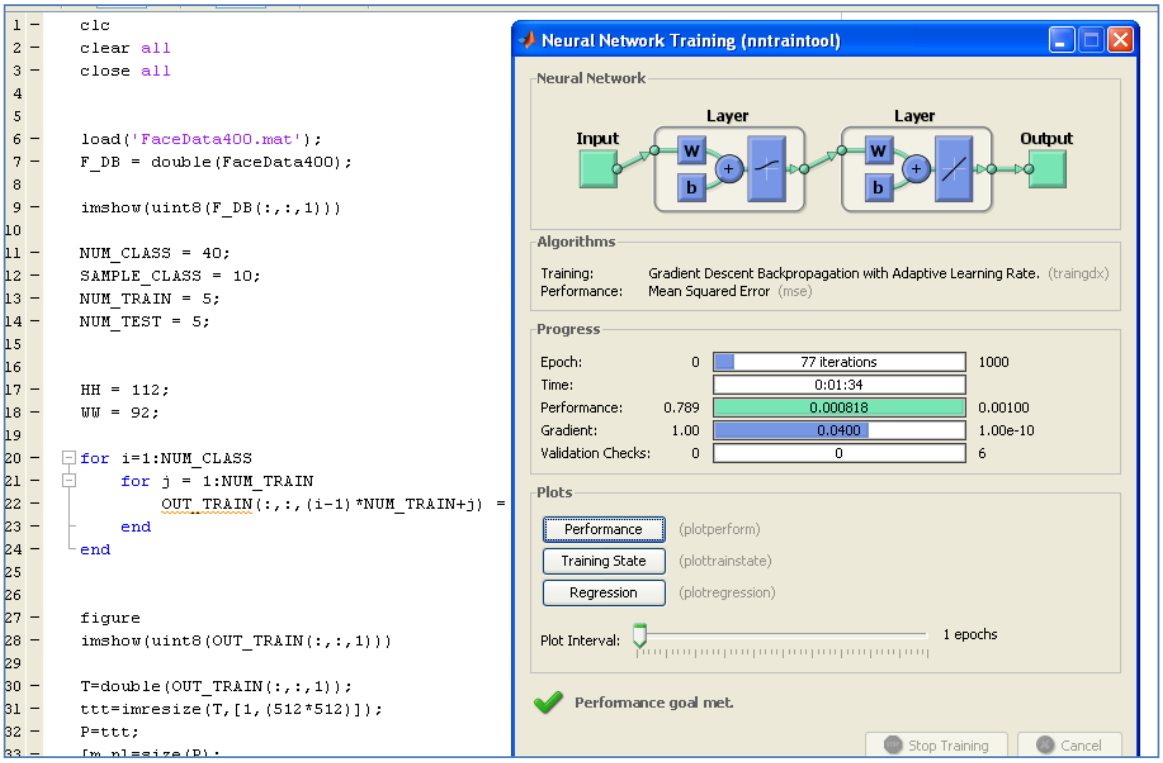

Figure 4.2: Train Network- MATLAB software

The figure 4.2 has shown the second step of face detection, which is train Network, Neural Network demonstration in this step as figure 4.3:

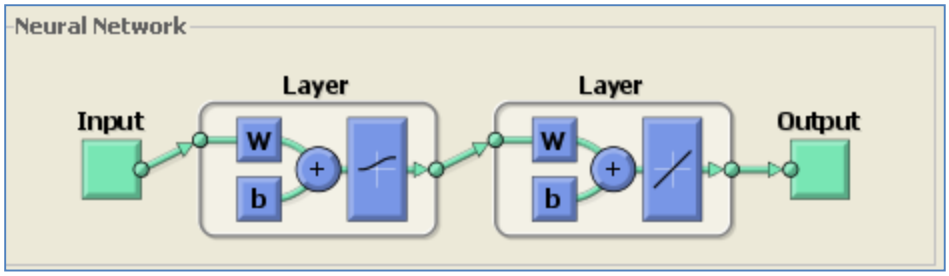

Figure 4.3: Neural Network

Neural network as Figure 4.3 shown consists of an input, output and two layers. Also in this step the algorithm and the progress of the face recognition are demonstrated as figure 4.4 shows:

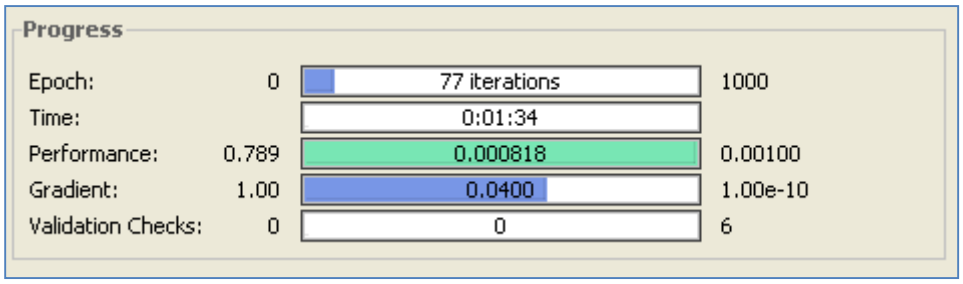

Figure 4.4: Train Network Step

Figure 4.4 demonstrates the progress of the face recognition algorithm, the performance which desired in this code is equal to 0.00100, in addition to that the gradient is equal to 1.00*e^{-10}.

The learning rate results of the proposed system can be summarized as illustrated below in figure 4.5.

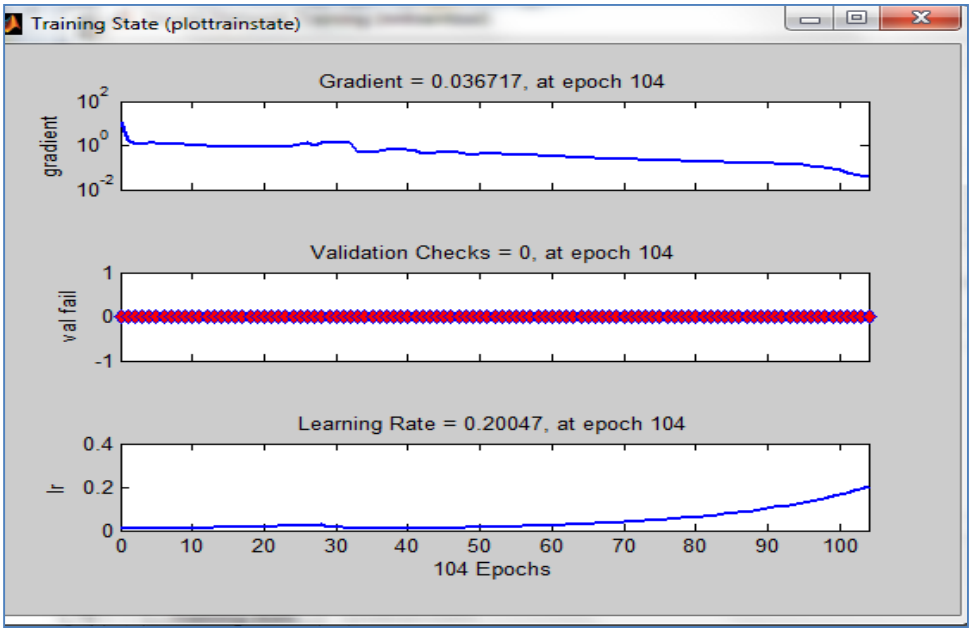

Figure 4.5: Learning rate results.

The above figure shows the values for the learning rate at epochs 104 which is 0.20047.

Last Step: Test Network

At this stage, the data base is already stored in MATLAB and the training process of the neural network is performed. The testing will be achieved by selecting the image that is required. The testing is performed by using some image, for which the output is already known, to ensure the ability of the neural network of performing the process as much accurate as possible.The results of face detection are obtained after this step is completed.

In order to perform this step:

1. Select Image Scanning from the menu
2. Choose one of the images in order to show the result, the program is able to identify faces just concerning [27 18] pixels within the image and this number of pixels was obtained by trial and error it was found that this number offer the optimum solution.
3. A test is done on the data base of the images as figure 4.6.

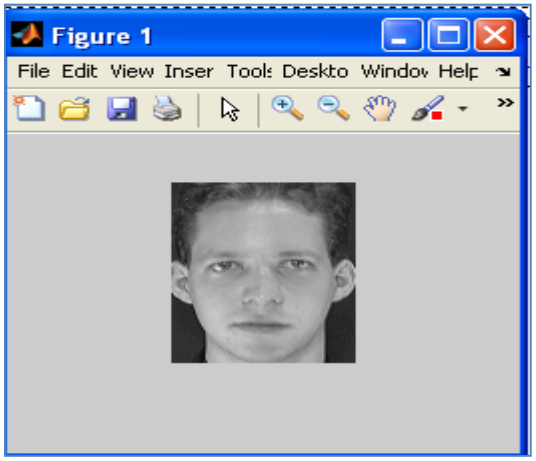

Figure 4.6: test 1 for face detection

Figure 4.7 illustrates face recognizing view for the face.

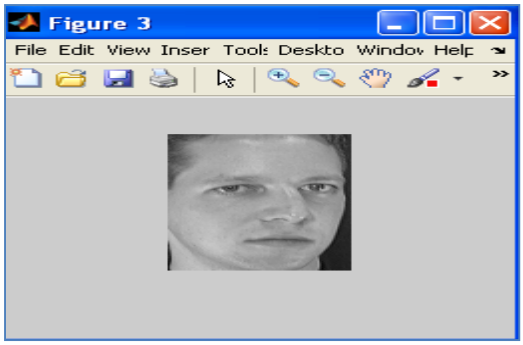

Figure 4.7: the recognize face from database

There are two processes which are applied on the data base. They are testing and training and for each image there is more than one view saved in the data base, so when the above picture was tested, another view for the same image was detected through the detection process.

For the first view of the image above, theface data was found by the MATLAB code which means the values of the matrix for the detected image.

The function X= F_DB (:, :, 1) which is shown in the workspace of the MATLAB code below characterizes the face data for the first image.

Another test is done on another face, and the result was as figure follow 4.8:

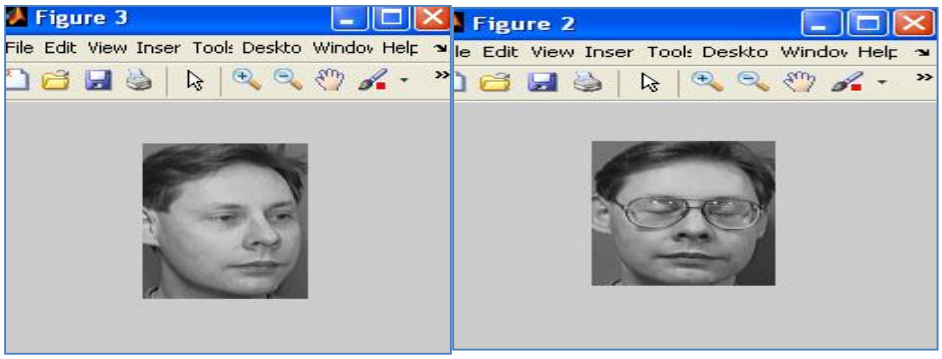

Figure 4.8: test 2 for face recognition

Alltestsare performed on the set of imagesas see in figure 4.9:

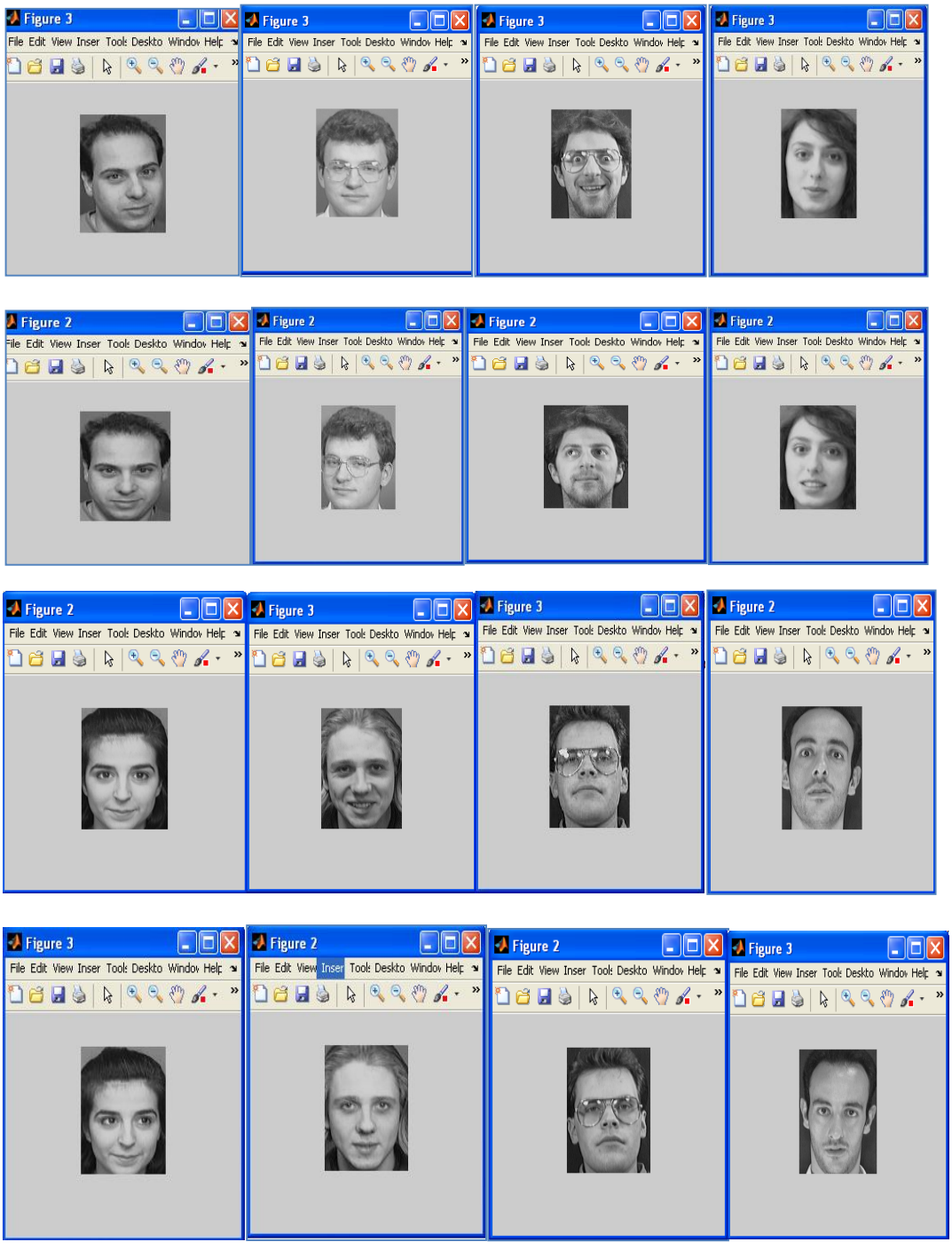

Figure 4.9 : test for face recognition

4.2. The results of the System with PCA

A pattern recognition method called PCA was developed using MATLAB as the best pattern recognition algorithm. In addition, PCA algorithm is based on categorizing the image dataset into classes, minimize the in-class distance and maximize the between-class distance. As a result, PCA will provide higher performance than the other pattern recognition methods.

ORL database was exploited to test the proposed algorithm and compare it to other previous algorithms. ORL database involves images of forty persons (classes), ten sample images per person of different expressions. On the other hand, all of the images of both databases are of size 112 * 92, with 256 grey levels per pixel.

The files are in PGM format. The images are organized in 40 directories (one for each subject), which have names of the form sX, where X indicates the subject number (between 1 and 40). In each of these directories, there are ten different images of that subject, which have names of the form Y.pgm, where Y is the image number for that subject (between 1 and 10).

The same steps are done for the system with PCA in MATLAB; on the other hand the results show that there is a difference in the recognition rate since the recognition rate for the system with PCA is higher than that without PCA. Figure 4.10 presents the recognition rate difference between PCA system and system without PCA.

The relation between the number of iteration and the recognition rate is direct, when the number of iterations increase, the accuracy of the recognition rate will increase too.

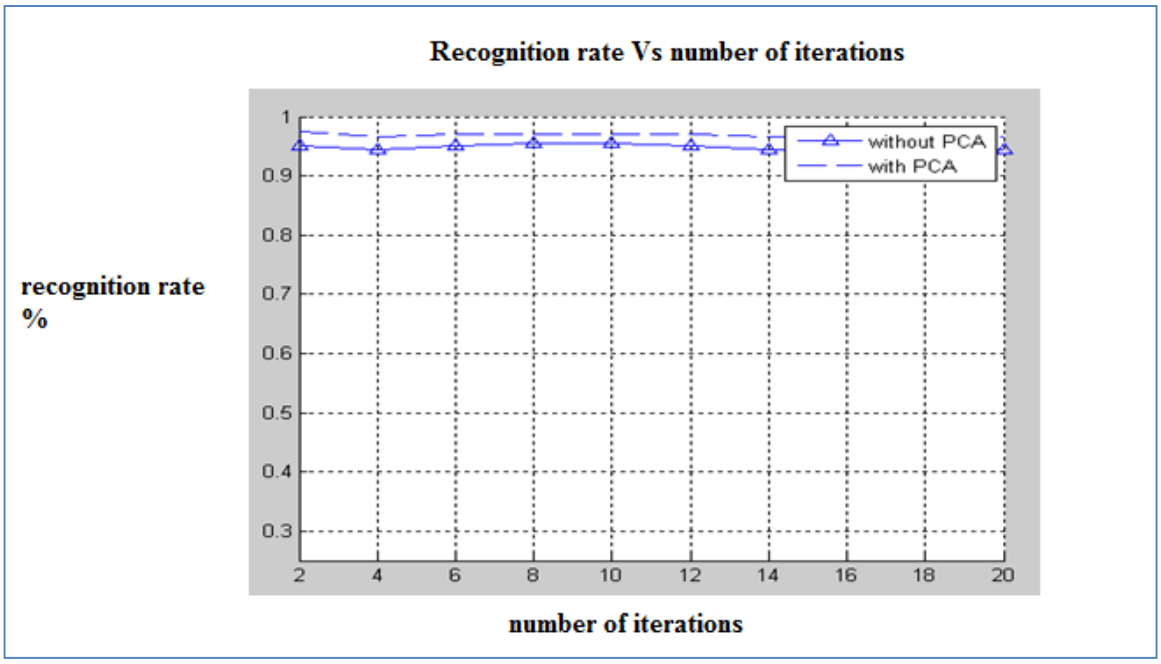

Figure 4.10: recognition rate comparison

The horizontal axis represents thenumber of iterations.

The vertical one represents the recognition rate.

4.3. Evaluation of the proposed technique

Related to the Recognition Rate (RR) curve, it shows that the RR with PCA enhance the overall system by 2% related to the main database, that means the accuracy which is calculated by dividing the recognition rate value by the maximum value which is 100 and then multiplying the result with 100% increase by 2% which provides more accuracy and high recognition using PCA.

The recognition rate is calculated by dividing the number of recognized images by the number of testing images which are 10 tests in this research. The following table 4.1 shows the recognition rate before and after using the proposed PCA technique.

Table 4.1: recognition rate comparison

RR without PCA	RR with PCA	Enhancement
95%	97.5%	2.5%
94.5%	96.5%	2.0%
95%	97%	2.0%
95.5%	97%	1.5%
95%	97%	2.0%
94.5%	97%	2.5%
94.5%	96.5%	2.0%
94.5%	96.5%	2.0%
94.5%	96.5%	2.0%
94.5%	96.5%	2.0%

4.4. Constraints and Difficulties

The main difficulties encountered the proposed system is the use of technology hybrid consists of neural network technology with the principal component analysis technique, as a complex techniques and contain many calculations and processors.

Use of static data base is one of the difficulties faced by the proposal system, so we will put these difficulties and addressed in future work.

Chapter Five
Conclusion and Recommendations

5.1.Conclusions

In this thesis, the process in face recognition is based on using both the neural network with and without PCA technique in combination with the Even-Odd Decomposition (EOD) technique is proposed. This process starts with dividing a known face images dataset into two databases; training and testing databases, applying the even odd decomposition technique on each database, evaluating the row-row and column-column covariance matrices of even and odd parts, applying PCA technique, finding both the in-class and between-class scatter matrices of each part and combining the scatter matrices of each part in order to find the projection matrices, compute the even-odd Eigen vectors and extract the feature matrix based on Eigen value and Eigen vector.

The developed algorithm can be used in order overcome the main restrictions of using the traditional PCA algorithm, which are: the dependency on a one-dimensional vector only, the need for converting the image matrices into vectors and the huge dimensions of the resultant image matrices. Results show that there is a match between both the recognition rate and the success values of the algorithm and the resultant maximum recognition rate is 95.5%. In addition, both the Eigen values and the success values are directly related to the number

of sample classes, in which when the number of sample classes increases, both the accuracy and recognition rate of the system are enhanced.

5.2. Future Work

In future, many solutions can be used in order to overcome the disadvantages that faces our project, for example some enhancement steps can be appliedon the algorithm to decrease its complexity as well as develop the accurateness of the model in addition to the efficiency of the retrieval, another environment of the database also can be used which is the dynamic database environment that is permits the addition and removal of images in order to use database in an easy and simple way than that used with static database.

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