University of AL Qadisiyah

Collage of computer science and

Information technology

Department of Multimedia

Detection and Identification of Human Faces by using Eigenface algorithm

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بسم الله الرحمن الرحيم

يرفع الله الذين أمنوا منكم والذين أوتو العلم درجات والله بما تعملون خبير"

صدق الله العلي العظيم

اهداء

أحمد الله عز وجل على منه و عونه لإتمام هذا البحث

إلى الذي وهبني كل ما يملك حتى أحقق له آماله، إلى من كان يدفعني قدما نحو الأمام لنيل المبتغى، إلى الإنسان الذي امتلك الإنسانية بكل قوة، إلى الذي سهر على تعليمي بتضحيات جسام مترجمة في تقديسه للعلم، إلى مدرستي الأولى في الحياة، أبي الغالي على قلبي أطال الله في عمره؛ إلى التي وهبت فلذة كبدها كل العطاء و الحنان، إلى التي صبرت على كل شيء، التي رعتني حق الرّعاية و كانت سندي في الشدائد، و كانت دعواها لي بالتوفيق، تتبعتني خطوة خطوة في عملي، إلى من ارتحت كلما تذكرت ابتسامتها في وجهي نبع الحنان أمي أعز ملاك على القلب و العين جزاها الله عني خير الجزاء في الدارين؛ إليهما أهدي هذا العمل المتواضع لكيّ أُدخل على قلبهما شيئا من السعادة إلى أخوتي و أخواتي الذين تقاسموا معي عبئ الحياة ؛ كما أهدي ثمرة جهدي لأستاذتي الكريمة الدكتورة: شروق جمعة الذي كلما تظلمت الطرق أمامي لجأت إليها فأنارتها لي و كلما دب اليأس في نفسي زرعت فيا الأمل لأسير قدما و كلما سألت عن معرفة زودتني بها و كلما طلبت كمية من وقتها الثمين وفرته لي بالرغم من مسؤولياتها المتعددة؛ إلى كل أساتذة قسم الوسائط المتعددة؛ و إلى كل من يؤمن بأن بذور نجاح التغيير هي في ذواتنا و في أنفسنا قبل أن تكون في أشياء أخرى...

الى كل هؤلاء أهدي هذا العمل

Abstract

An approach to the detection and identification of human faces is presented, and a working, near-real-time face recognition system which tracks a subject's head and then recognizes the person by comparing characteristics of the face to those of known individuals is described. This approach treats face recognition as a two-dimensional recognition problem, taking advantage of the fact that faces are normally upright and thus may be described by a small set of 2-D characteristic views. Face images are projected onto a feature space ('face space') that best encodes the variation among known face images. The face space is defined by the 'eigenfaces', which are the eigenvectors of the set of faces; they do not necessarily correspond to isolated features such as eyes, ears, and noses. The framework provides the ability to learn to recognize new faces in an unsupervised manner.

Chapter one

1.1 Introduction

Different aspects of human physiology are used to authenticate a person's identity . The science of ascertaining the identity with respect to different characteristics trait of human being is called biometrics. The characteristics trait can be broadly classified in to two categories i.e. physiological and behavioral. Face biometrics belongs to physiological characteristic and Face biometrics is used by everyone every day. The face is the first defining characteristic which, we use to identify persons. Face is only the characteristic which is used to recall person, when trying to remember what person looks like. We use it, and eventually come to depend on it, for recognition. We carry photo IDs that we show as proofs of identity. On the cards are pictures of our face. Our trust in our ability to judge if we know someone by his/her face can also fool us as well. We have all at one time or another thought we recognized person face, only to have it not be the person we thought. For many people, including parents, twins present a unique problem. Some twins can be so similar that even the parents may need to identify them by some other means. Human face recognition has been studied for more than twenty years. Face biometrics always surprisingly questionable biometrics for identified person. Face recognition is a non-intrusive method, and facial attributes are probably the most common biometric features used by humans to recognize one another.[1]

1.2 Background and related work of face recognition

The earliest work on face recognition can be traced back at least 1950s in psychology and the 1960s in the engineering literature. Some of the earliest studies include work on facial expression Darwin in 1972, and research on automatic machine recognition of faces started in 1970s. Over the 30 years extensive research has been conducted by psychophysicist, neuroscientist, and engineers on - various aspects by humans and machines . Many methods of face recognition have been proposed during the past 30 years. Face recognition is such a challenging yet interesting problem that it has attracted researchers who have different backgrounds: psychology, pattern recognition, neural networks, computer vision, and computer graphics. It is due to this fact that the literature on face recognition is vast and diverse. Often, a single system involves techniques motivated by different principles. The usage of a mixture of techniques. makes it difficult to classify these systems based purely on what types of techniques they use for feature representation or classification. To have a clear and high-level categorization, we instead follow a guideline suggested by the psychological study of how humans use holistic and local features. Specifically, we have the following categorization:

1. Holistic matching methods. These methods use the whole face region as the raw input to a recognition system. One of the most widely used representations of the face region is eigenpictures which are based on principal component analysis.

2. Feature-based (structural) matching methods. Typically, in these methods, and mouth are first extracted and their locations and local statistics (geometric and/or appearance) are fed into a structural classifier.

3. Hybrid methods. Just as the human perception system uses both local features and the whole face region to recognize a face, a machine recognition system should use both. One can argue that these methods could potentially offer the best of the two types of methods . History of still face recognition techniques according to applied approach and representative work. First, the holistic' methods using Principal Component Analysis (PCA) are Eigenfaces has done by direct application of PCA are Craw and Cameron in 1996,and recently methods. Second, using probabilistic eigenfaces with two class problem with measure problem by

Mohaddam and Pentland in 1997. Third, using fisher face/subspace LDA with FLD on eigenfaces by Beihurneur in 1997 and Weng in 1996b, Zhao et al., in 1998. Evaluation pursuit to enhance GA learning by Liu and Wechsler in 2000, feature lines with point-to-line distance based by Li and Lu in 1999, ICA-based feature analysis by Bartlett et al., in 1998. Two-class problem based on SVM in multiclass problem SVM with 2 layer data and multiclass .Theil, Smooth SYM based on Eigenfaces by Furqan M., et al., in 2009. The other representations methods are using LDAIFLD on raw image by Etemad and Chel1aPPa in 1997 and Probabilistic decision based NN or PBNN. The feature based methods are using pure geometry methods with earlier methods by Kanade in 1973, Kelly in 1970 and recent methods by Cox et al, in 1996 and Manjunath et al, in 1992. Using dynamic link architecture graph matching methods by Okada et al., in 1998, and Wiskott et al., in 1997. Using Hidden Markov model (HMM) methods by Nefian and Hayes in 1998, Samaria in 1994 .

Using SOM learning based CNN methods. The hybrid methods are Modular eigenfaces and eigen modules and hybrid LFA Local feature method by Penned and A tick in 1996 and shape-normalized Flexible appearance models by Laities et al, in 1995 and Component-based face recognition. The key issue and difficulty in detection is to account a wide range of variations in face images. There have been numerous innovative strategies proposed for solving this problem. Most of then used image invariants snake or spire templates or eigenfaces.Appropriate schemes should be chosen based on the specific. requirements of a given task. Most of the systems reviewed here focus on the subtask of recognition, but others also include automatic face detection and feature extraction, making them fully automatic systems .[2]

1.3APPLICATIONS OF FACE RECOGNITION

Face recognition is used for two primary tasks:

1. Verification (one-to-one matching): When presented with a face image of an unknown individual along with a claim of identity, determining whether the individual is who he/she claims to be.

2. Identification (one-to-many matching): Given an image of an unknown individual, determining that person's identity by comparing that image with a database of images of known individuals. There are many application regions in which face recognition can be exploited for these two purposes, a few of which are summarized below.

1. **Security :** access control to buildings, airports/seaports, ATM machines and border checkpoints, computer/ network security , email authentication etc.,

2. **Surveillance:** A large number of CCTVs can be monitored to look for known criminals, drug offenders, etc. and authorities can be notified when one is located.

3.**General identity verification:** Electoral registration, banking, electronic commerce, identifying newborns, national IDs, passports, drivers' licenses, employee IDs.

4. **Criminal justice Systems:** Mug-shot/booking systems, post-event analysis, forensics.

5.**Image database investigations:** Searching image databases of licensed drivers benefit recipients, missing children, immigrants and police bookings.

6. **"Smart Card" applications:** Maintaining a database of facial images, the face-print can be stored in a smart card, bar code or magnetic stripe, authentication of which is performed by matching the live image and the stored template. [3]

1.4 Advantages and disadvantages of face recognition:

1.4.1 Compared to other biometric systems

One key advantage of a facial recognition system that it is able to person mass identification as it does not require the cooperation of the test subject to work. Properly designed systems installed in airports, multiplexes, and other public places can identify individuals among the crowd, without passers-by even being aware of the system .[4]

However, as compared to other biometric techniques, face recognition may not be most reliable and efficient. Quality measures are very important in facial recognition systems as large degrees of variations are possible in face images. Factors such as illumination, expression, pose and noise during face capture can affect the performance of facial recognition systems. . Among all biometric systems, facial recognition has the highest false acceptance and rejection rates.thus questions have been raised on the effectiveness of face recognition software in cases of railway and airport security. **[2]**

1.4.2 FACIAL RECOGNITION PROS

1.The Improvement of Security Level

As we said in the first paragraph, a face biometric system greatly improves your security measures. All corporation's premises would be protected since you'll be able to track both the employees and any visitors that come into the area. Anyone who doesn't have access or permission to be there will be captured by the recognition system that alerts you instantly about the trespassing.[5]

2. Easy Integration Process

Most of the time, integratable facial recognition tools work pretty flawlessly with the existing security software that companies have installed. And they're also easy to program for interaction with a company's computer system.[5]

3.High Accuracy Rates

These days, the success level of face tracking technology became higher than ever before. Thanks to the assistance of 3D facial recognition technologies and infrared cameras the process of identification happens to be incredibly accurate and showing great results. It's possible but difficult to fool such system, so you can be sure that an FR digital security software will successfully track every aspect of attendances to provide a better level of protection for your facilities.[5]

4.Full Automation

Instead of manual recognition, which is done by security guards or the official representatives outside of company's premises, the facial recognition tech automates the identification process and ensures its flawlessness every time without any haltings. You won't even need an employee to monitor the cameras[5]

5. Forget the Time Fraud

One of the big benefits that facial recognition technology companies offer is the time attendance tracking that allows excluding the time fraud among the workers. No more buddy favours from securities for staff members, since everyone now has to pass a face scanning devices to check-in for work. And the paid hours begin from this moment till the

same check-out procedure. And the process will be fast due to the fact that employees don't have to prove their identities or clock in with their plastic cards[5]

1.4.3 FACIAL RECOGNITION CONS

Sure, it's all looking so appealing… but there is always a 'but'. There are still some problems with facial recognition systems, factors that limit the effectiveness of them. We'll review most common ones.

1. Processing & Storing

It requires a lot of space. Just like high-quality image. There is no need to handle all the picture frames because we only need the face. This is a waste of time

Professional agencies use a range of computers to reduce total processing time. But each added computer means data transmission over the network, which can be affected by input and output constraints that reduce processing speed[5]

2. Image Size & Quality

Obviously facial recognition requires high quality images captures facial face detection system in the picture. Then the relative size of that face image will be compared with one recorded size. Therefore, image quality here affects the whole face recognition process and how successful it is. Pretty hard to get a clear identity in such case. What's more, scanning a photo for varying face sizes is a processor-intensive task. Most systems allow identification of a face-size range to eliminate false recognition and speed up image processing.[5]

3. System deceived

There are also problems with things like facial hair or sunglasses. One can fool the face recognition system with a beard that has suddenly appeared or has been removed, the same applies to blocking facial parts with glasses or masks. To avoid these failures, you must update your databases regularly with the latest images.[5]

1.5 Eigenfaces

Eigenfaces is a well-studied method of face recognition based on principal component analysis (PCA), promoted by the pivotal work of Turk & Puntland. Though the method has now mostly been archaic, it is still often used as a level to compare the concert of other algorithms against, and serves as a good introduction to subspace-based methods to face **recognition**[١١]. PCA is a method of transforming a number of interrelated variables into a smaller number of uncorrelated variables. Similar to how Fourier analysis is used to rot a signal into a set of colorant orthogonal sinusoids of varying rates, PCA rots a signal (or image) into a set of colorant orthogonal basis vectors or eigenvectors. The main difference is that, while Fourier analysis uses a fixed set of basis functions, the PCA basis vectors are erudite from the data set via unverified training. PCA can be applied to the task of face recognition by converting the pixels of an image into a number of eigenface feature vectors, which can then be compared to measure the similarity of two face images.[6]

Eigenfaces are mostly used to:

a - Extraction of facial information is like, may or may not be directly linked to the human intuition of facial features such as eyes, nose and lips.. One way to do so is to capture the statistical variation between face images.

b. Represent face images capably. To reduce the computation and space complexity, each face image can be represented using a small number of dimensions. Typical structures of face recognition system consist of three major steps, acquisition of face data, extracting face feature and recognition of face. These steps are elaborated as follow:

A. Gaining of Face Data:

Acquisition and Processing of Face Data is first step in the face recognition system. In this step face images are collected from different sources. The sources may be camera or readily available face image database on the website. The collected face images should have the pose, illumination and expression etc. variation in order to check the performance of the face recognition system under these conditions. Processing of face database require sometimes otherwise causes serious effect on the performance of face recognition systems due changes in the illumination condition, background, lighting conditions, camera distance, and thus the size and orientation of the head. Therefore, input image is normalized and some image transformation methods apply on the input image.

B. Extracting Face Feature:

Feature extraction process can be defined as the process of extracting relevant information from a face image. In feature extraction, a mathematical representation of original image called a biometric template or biometric reference is generated, which is stored in the database and will form the basis (vector) of any recognition task. Later these extracted features used in recognition. A greyscale pixel is considered as initial feature.

C. Recognition of Face:

Once the features are extracted and selected, the next step is to classify the image. Presence-built face recognition algorithms use a wide variety of sorting methods Such as PCA, LDA. In sorting the similarity between faces from the same individual and different persons after all the face images in database are represented with related features. Sometimes feature extraction & recognition process done simultaneously .**[7]**

1.6 Upload photos

The first step is to download training images. You can get faces from a variety of face databases available to the public, and the main requirements are that faces images should be:

• Grayscale images with consistent accuracy. If you use color images, convert them to grayscale first with gray • rgb• 2.

• Crop to display the face only. If the images have a background, the face recognition will not work correctly, as the background will be merged into a workbook.

• Aligned facial features. Because PCA is a variable translation variable, the front faces must be aligned well on facial features such as eyes, nose and mouth. Most face databases are available on the ground so you do not need to categorize these features manually.

Some photo processing toolbox provides some useful functions for recording images. [8]

Each image is converted to a column vector, and the images are loaded in a matrix of size n × m, where n is the number of pixels per

image and m is the total number of images. The following code reads all PNG images from the directory specified by input_dir and measures all images to the size specified by image_dims.

1.7 Training:

1. find the average face images entered.

2. ask the rate of input images for medium offset images.

3. Electrical border account of the expected images with media and dotted values.

4. Order self Vectors through their own values corresponding, in descending order.

5. keep only self areas with greater self-values (major components).

6. Design your images with gradient in the intermediate eigenspace category using

distances presence retained.

Chapter two

2.1 Principal Components Analysis (PCA)

More than the past 25 years, a number of face recognition techniques have been proposed, motivated by the increasing number of real-world applications and also by the interest in modeling human cognition. One of the most versatile approaches is derived from the statistical technique called Principal Component Analysis (PCA) adapted to face images. In the context of face detection and identification, the use of PCA was first proposed by Kirby and Sirovich. They showed that PCA is an optimal compression scheme that minimizes the mean squared error between the original images and their reconstructions for any given level of compression.. Turk & Pentland (1991) popularized the use of PCA for face recognition. PCA is based on the idea that face recognition can be accomplished with a small set of features that best approximates the set of known facial images(show fig.1). Application of PCA for face recognition proceeds by first performing PCA on a set of training images of known human faces. From this analysis, a set of principal components is obtained, and the projection of the test faces on these components is used in order to compute distances between test faces and the training faces. These distances, in turn, are used to make predictions about the test faces.[7]

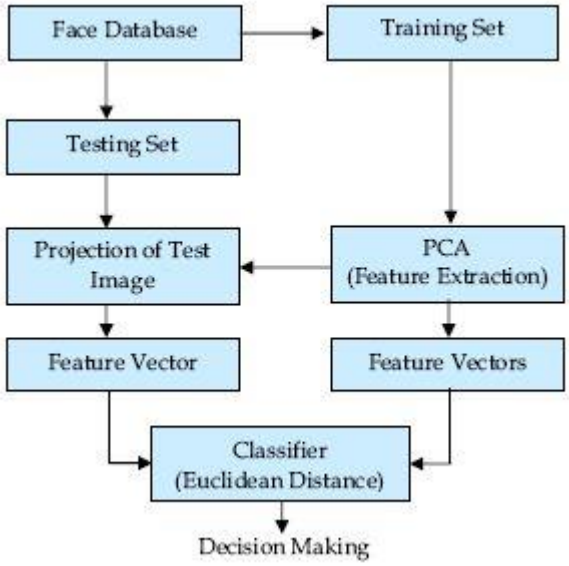

fig.1

PCA approach for face Recognition

2.1.1 Advantages of PCA

1. Recognition is simple and efficient compared to other matching approaches.

2. Data compression is achieved by the lowdimensional subspace representation.

3. Raw intensity data are used directly for learning and recognition without any significant low-level or mid-level processing low-level or mid-level processing.

4. No knowledge of geometry and reflectance of faces is required.[9]

2.1.2 Disadvantages of PCA

1. The method is very sensitive to scale, therefore, a low-level preprocessing is still necessary for scale normalization.

2. Since the Eigenface representation is, in a leastsquared sense, faithful to the original images, its recognition rate decreases for recognition under varying pose and illumination.

3. Though the Eigenface approach is shown to be robust when dealing with expression and glasses,

these experiments were made only with frontal views. The problem can be far more difficult when there exists extreme change in pose as well as in expression and disguise.

4. Due to its “appearance-based” nature. First, learning is very time-consuming, which makes it difficult to update the face database.[9]

2.2 Linear Discriminant Analysis (LDA)

Linear Discriminant Analysis is a well-known scheme for feature extraction and dimension reduction. It has been used widely in many applications such as face recognition, image retrieval, microarray data classification, etc. Classical LDA

projects the data onto a lower-dimensional vector space such that the ratio of the between-class distances to the with in class distance is maximized, thus achieving maximum discrimination. The optimal projection (transformation) can be readily computed by applying the Eigen decomposition on the scatter matrices Linear discriminant analysis (LDA) and the related Fisher's linear discriminant are methods used in statistics, pattern recognition and machine learning to find a linear

combination of features which characterize or separate two or more classes of objects or events [14]. The resulting combination may be used

as a linear classifier or more commonly, for dimensionality reduction before later classification(show fig.2)

Closing thoughts:

Though it employs a simple model structure, LDA has held up reasonably well, sometimes still besting more complex algorithms. When its assumptions are met, the literature records it doing better than logistic regression.

It is very fast to execute and fitted models are extremely portable- even a spreadsheet will support linear models (...or, one supposes, paper and pencil!) LDA is at least worth trying at the beginning of a project, if for no other reason than to establish a lower bound on acceptable performance.

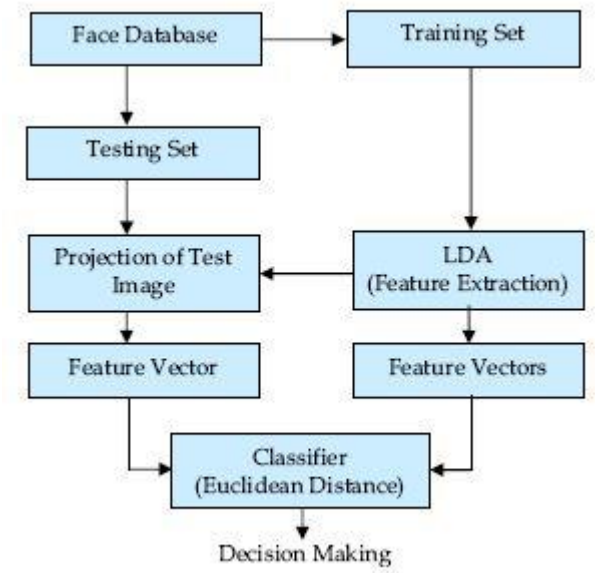

Fig.2

LDA approach for face Recognition

2.2.1Advantages of LDA

1. The Fisher face projection approach is aimed to solve the illumination problem by maximizing the ratio of between-class scatter to within-class scatter; however, finding an optimum way of projection that is able to simultaneously separate multiple face classes is almost impossible.

2. LDA based algorithms outperform PCA based ones, since the former optimizes the low dimensional representation of the objects with focus on the most discriminant feature extraction while the latter achieves simply object reconstruction.[12]

2.2.2 Disadvantages of LDA

1. An intrinsic limitation of classical LDA is the socalled singularity problem, that is, it fails when all scatter matrices are singular.

2. However, a critical issue using LDA, particularly in face recognition area, is the Small Sample Size (SSS) Problem. This problem is encountered in practice since there are often a large number of pixels available, but the total number of training samples is less than the dimension of the feature space. This implies that all scatter matrices are singular and thus the traditional LDA algorithm fails to use.[12]

2.3 COMPARISON OF PCA AND LDA

There has been a tendency in the computer vision community to prefer LDA over PCA. This is mainly because LDA deals directly with discrimination between classes. while PCA does not pay attention to the underlying class structure. When the training set is small, PCA can outperform LDA. When the number of samples is large and representative for each class, LDA outperforms PCA. Many works analyzed the differences between these two techniques, but no work investigated the possibility of fusing them. In our opinion, the apparent strong correlation of LDA

and PCA, especially when frontal views are used and PCA is applied before LDA, discouraged the fusion of such algorithms. However, it should be noted that LDA and PCA are not as correlated as one can think, as the LDA transformation applied to the principal components can generate a feature space significantly different from the PCA one. Therefore, the fusion of LDA and PCA for face recognition and verification is worth of theoretical and experimental investigation.[13]

2.4 Dataset Arrays

Statistics and Machine Learning Toolbox™ has dataset arrays for storing variables with heterogeneous data types. For example, you can combine numeric data, logical data, cell arrays of character vectors, and categorical arrays in one dataset array variable.

Within a dataset array, each variable (column) must be one homogeneous data type, but the different variables can be of heterogeneous data types. A dataset array is usually interpreted as a set of variables measured on many units of observation. That is, each row in a

dataset array corresponds to an observation, and each column to a variable. In this sense, a dataset array organizes data like a typical spreadsheet.

Dataset arrays are a unique data type, with a corresponding set of valid operations. Even if a dataset array contains only numeric variables, you cannot operate on the dataset array like a numeric variable. The valid operations for dataset arrays are the methods of the dataset class.[7]

Dataset Array Properties

In addition to storing data in a dataset array, you can store metadata such as:

- Variable and observation names
- Data descriptions
- Units of measurement
- Variable descriptions

This information is stored as dataset array properties. For a dataset array named ds, you can view the dataset array metadata by entering ds.Properties at the command line. You can access a specific property, such as variable names—property VarNames—using ds.Properties.VarNames. You can both retrieve and modify property values using this syntax.

Variable and observation names are included in the display of a dataset array. Variable names display across the top row, and observation names, if present, appear in the first column. Note that variable and observation names do not affect the size of a dataset array.[10]

Chapte three

3.1 PROPOSED ALGORITHM

Eigen face system based on Principal Component Analysis (PCA) to recognize faces.

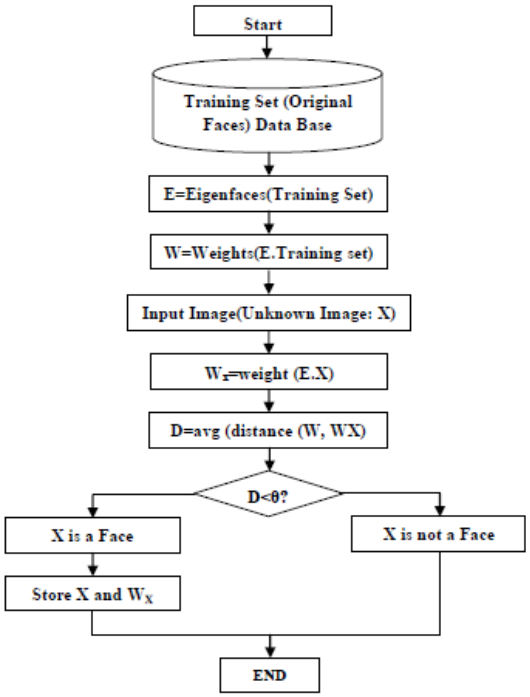

Fig.3 Flow Chart of the eigenface-based algorithm

Step 1 : Inserting a set of images into a database. These images are called as the training set.

Step 2 : Loading Database into matrix V

Step 3 : Randomly pick an image from database

Step 4 : Rest of images are used for training

Step 5 : Randomly selected image is used to test algorithm (show fig.3)

3.2 SOFTWARE DETAILS

This paper is completely based on MATLAB for face recognition. It is used in such a way that it is able to match the face from predefined database. and generate an output. MATLAB 2015a is utilized and its Image Acquisition and Image Processing toolbox are used(show fig.4).

Fig.4 Pictures from the Tarining Base

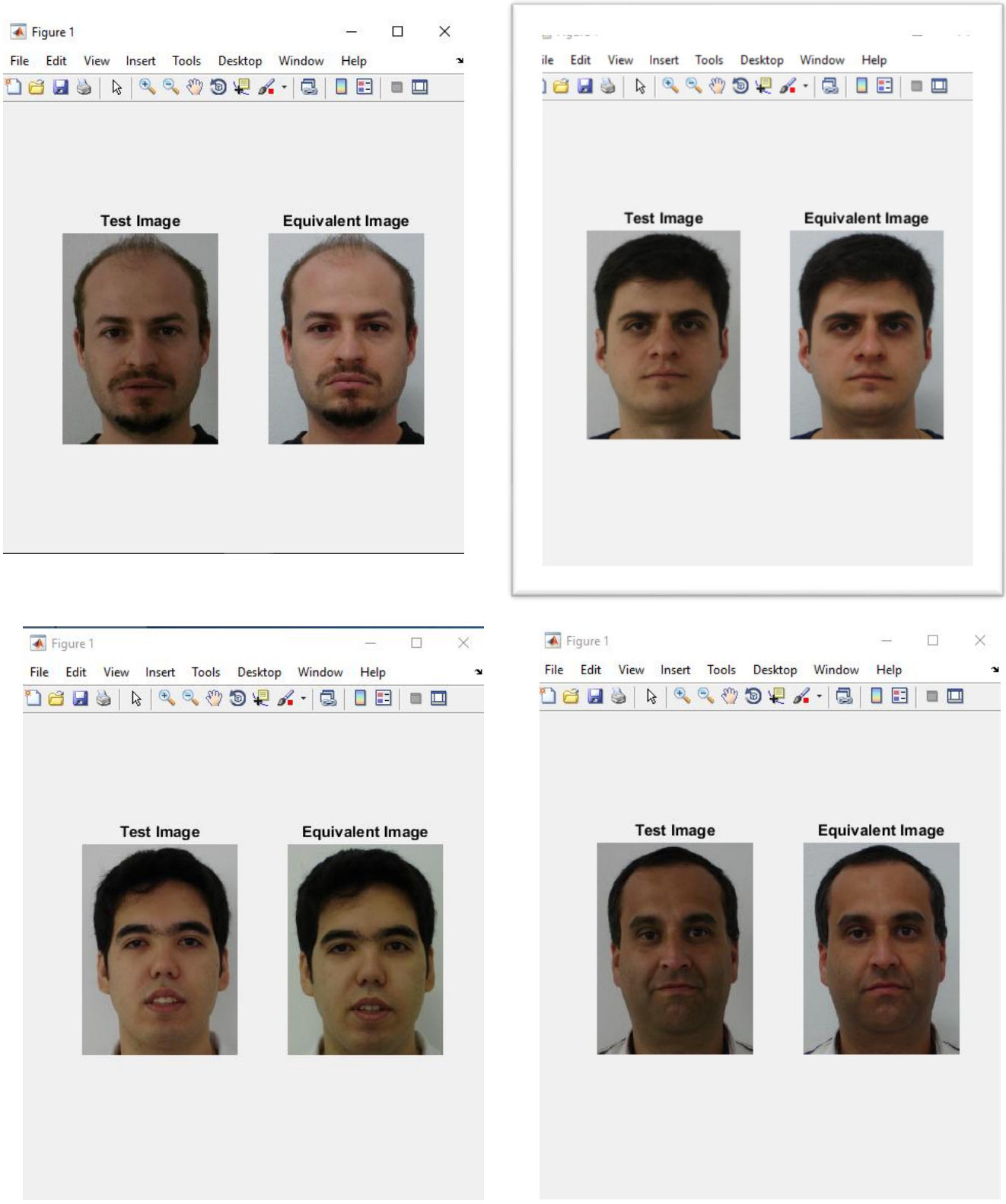

Fig.5 Test image and recognized image from the training base

Face recognition method using Eigen faces is proposed. We used database of face images which contains ٢٠images of ١٠different persons (٢ images per person). From the results, it can be concluded that, for recognition, it is

sufficient to take about 10% eigenfaces with the highest eigenvalues. It is also clear that the recognition rate increases with the number of training images per person. It is obvious that if the minimum distance between the test image and other images is zero, the test image entirely matches the image from the training base. If the distance is greater than zero but less than a certain threshold, it is a known person with other facial expression, otherwise it is an unknown person(show fig.5).

Chapter four

4.1 Testing

testing is carried out by following step.

1.select an image which is to be tested using open file dialong box.

2.image is read and normalize.

3.calculate the RPV of image using eingenvector of covariance matrix.

4.find the distance of theis input image RPV from average RPVs of all the persons.

5.find the person from which the distance is minimum.

6.if this minimum distance is less than the maximum distance of that

person calculated during training than the person is identified as this

person.

4.2 Conclusion

Among the objectives in the experiments test the performance of

the proposed method in a realistic practical environment, we decided

to build a three-dimensional database of the face of the face capture station

used It includes taking the image, defining the entire face, converting it to CREE,

then converting it to Binary, defining the features of the face, and then comparing it with the database, identifying the similarities and differences and knowing whether the person owns the images within the database or there is no picture of the person within the database.

4.3 Suggestions:

One of the important suggestions in distinguishing facial patterns is the use of a code that includes a camera that captures images and then compares them with a picture of database.

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