FACE RECOGNITION

PRINCIPAL COMPONENTS ANALYSIS

(PCA)

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Introduction

- The wide spreading of Technology lead to the necessity of applying more Security Procedures.
- Such Security Procedures can be implemented through Pattern Recognition.

Introduction (Cont)

- Pattern Recognition Applications include:
  1. Face Recognition
  2. Finger Print Recognition
  3. Voice Recognition
  4. Speech Recognition
- In fact, Face Recognition Application is one of the most applications widely used nowadays.

Applications and Usage

Applications	Advantages	Disadvantages
Credit Card, Driver's License, Passport, and Personnal Identification:	Controlled image Controlled segmentation Good quality images	No existing database Large potential database Rare search type
Bank / Store Security:	High value Geographically localised search	Uncontrolled segmentation Low image quality
Witness Face Reconstruction:	Witness search limits	Unknown similarity
Expert Identification:	High value Enhancement possible	Low image quality Legal certainty required

Face Recognition Technique

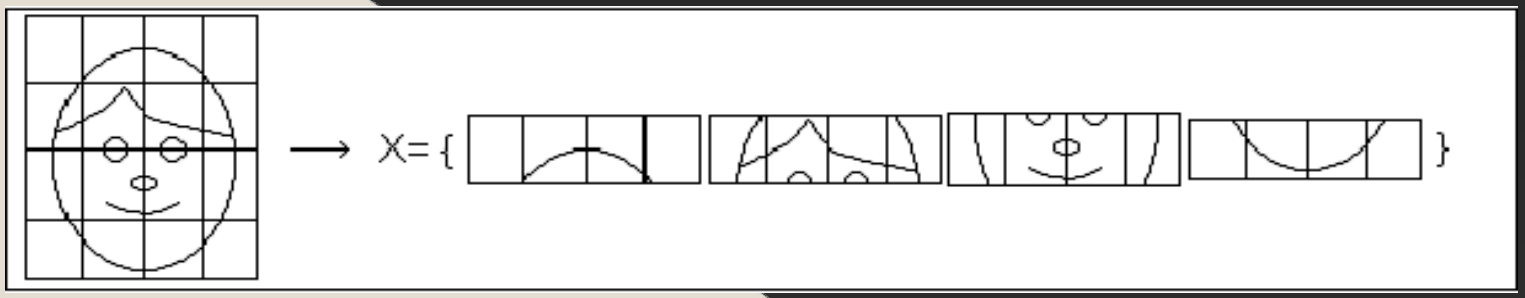
- FRT is formulated as follows:
  - Given still or video images of a scene
  - identify one or more persons in the scene using a stored database of faces
- This can be done through three stages:
  1. segmentation of scenes from cluttered scenes
  2. extraction of features from the face region
  3. decision

FRT (Cont)

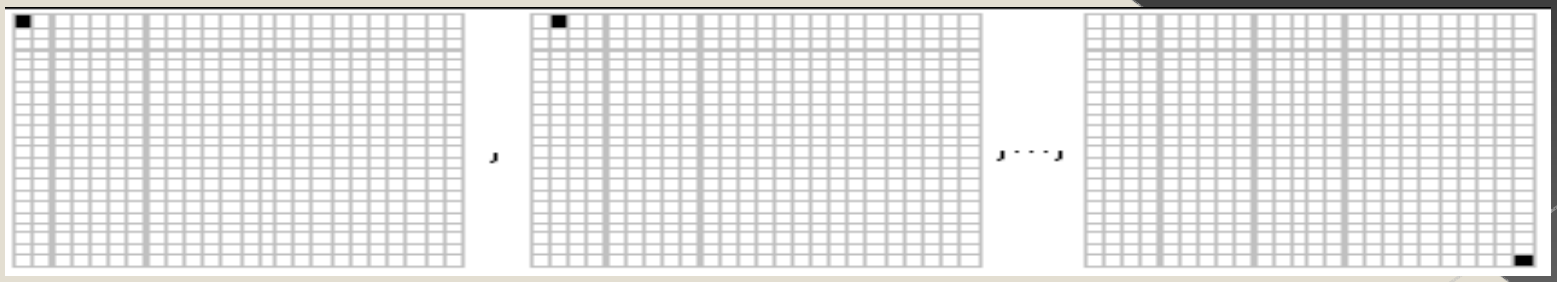
- At The Third Stage Three Types of decisions can be achieved depending on the application :
  1. *Identification:* in which labels of individuals must be obtained
  2. *recognition* of a person: where it must be decided if the individual has already been seen
  3. *Categorisation:* in which the face must be assigned to a certain category

Material And Method

- Face viewed as a vector



- Image Space
  - The basis of the image space is composed of the following vectors :



  - The basis vectors of this face space are called the principal components

Principal Components Analysis (PCA)

- It is a way of identifying patterns in data, and expressing the data in such a way as to highlight their similarities and differences
- Since patterns in data can be hard to find in data of high dimension, PCA is a powerful tool for analysing data
- PCA aims to catch the total variation in the set of the training faces, and to explain this variation by a few variables

PCA (Cont)

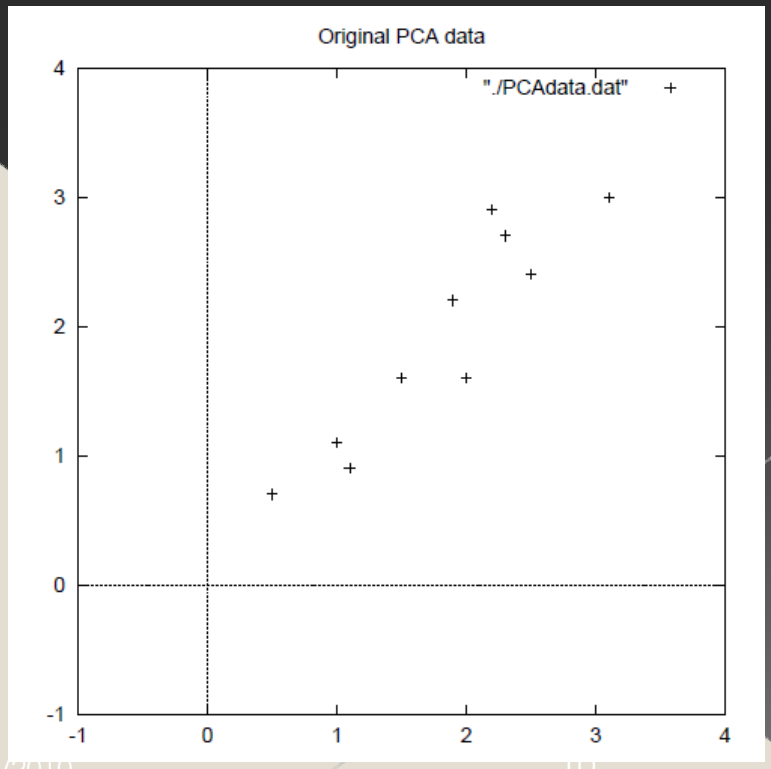
- Step 1: Get some data
- Step 2: Subtract the mean

Data =

x	y
2.5	2.4
0.5	0.7
2.2	2.9
1.9	2.2
3.1	3.0
2.3	2.7
2	1.6
1	1.1
1.5	1.6
1.1	0.9

DataAdjust =

x	y
.69	.49
-1.31	-1.21
.39	.99
.09	.29
1.29	1.09
.49	.79
.19	-.31
-.81	-.81
-.31	-.31
-.71	-1.01



PCA (Cont)

- Step 3: Calculate the Covariance Matrix

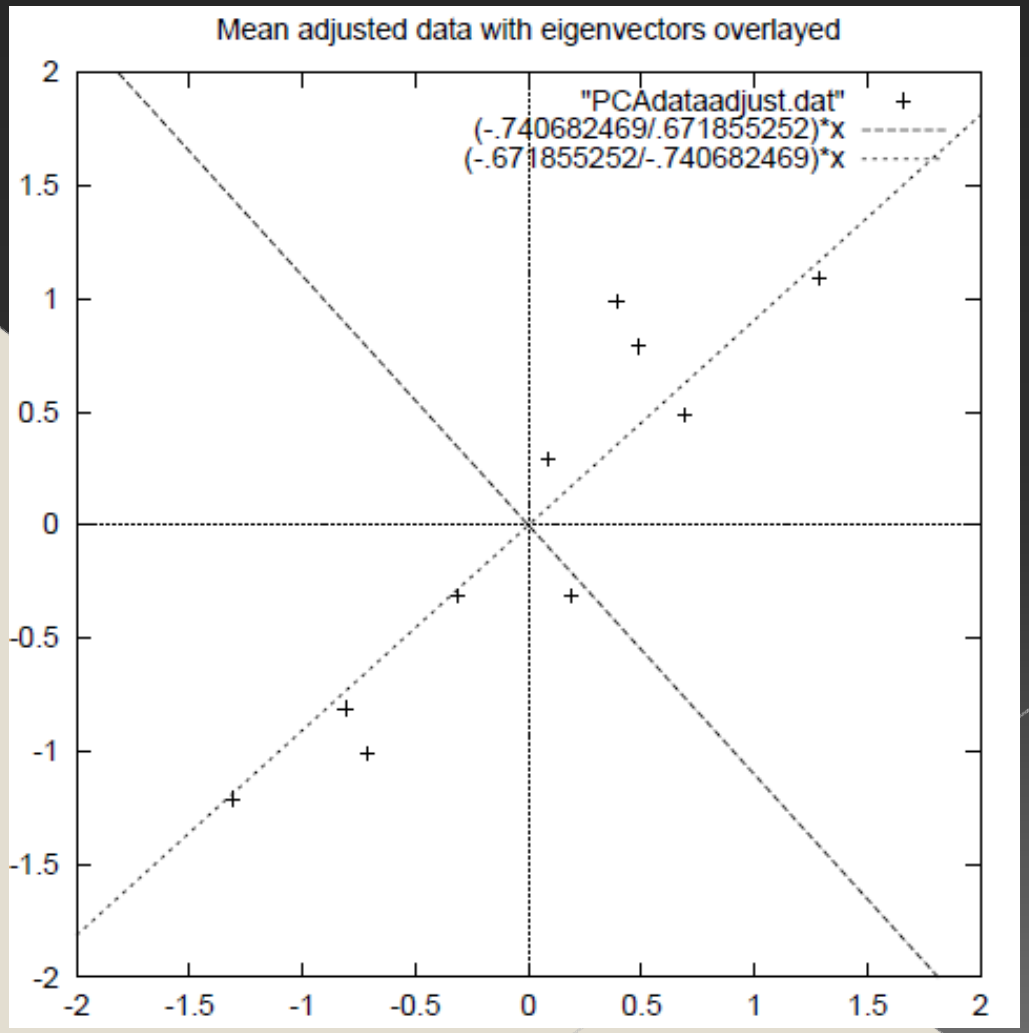
$$var(X) = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(X_i - \bar{X})}{(n-1)}$$

$$cov(X,Y) = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{(n-1)}$$

$$cov = \begin{pmatrix} .616555556 & .615444444 \\ .615444444 & .716555556 \end{pmatrix}$$

PCA (Cont)

- Step 4: Calculate the EigenVectors and EigenValues of the Covariance Matrix

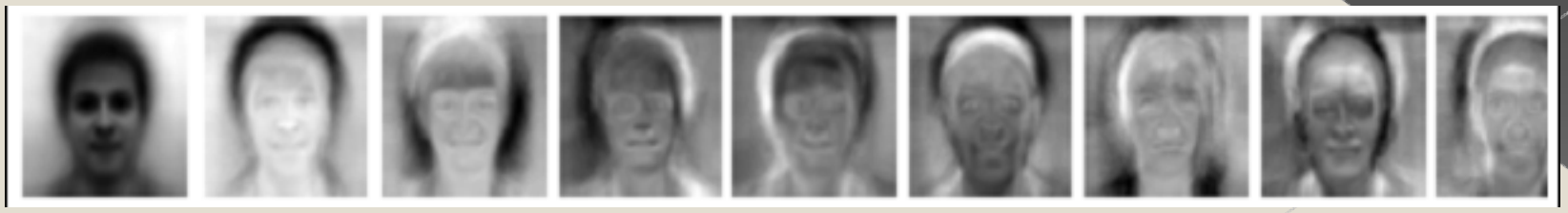


$$eigenvalues = \begin{pmatrix} .0490833989 \\ 1.28402771 \end{pmatrix}$$

$$eigenvectors = \begin{pmatrix} -.735178656 & -.677873399 \\ .677873399 & -.735178656 \end{pmatrix}$$

PCA (Cont)

- First Eigen Faces:
  - The first eigenface is the average face, while the rest of the eigenfaces represent variations from this average face
  - The first eigenface is a good face filter
  - The first eigenface accounts for the maximal variation, the second one accounts for the second maximal variation, etc.



PCA (Cont)

- Step 5: Choosing Components and forming a Feature Vector
  - Here's where the notation of Data Compression
  - In fact, it turns out that the eigenvector with the highest eigenvalue is the principle component of the data set

$$FeatureVector = (eig_1\ eig_2\ eig_3\ ....\ eig_n)$$

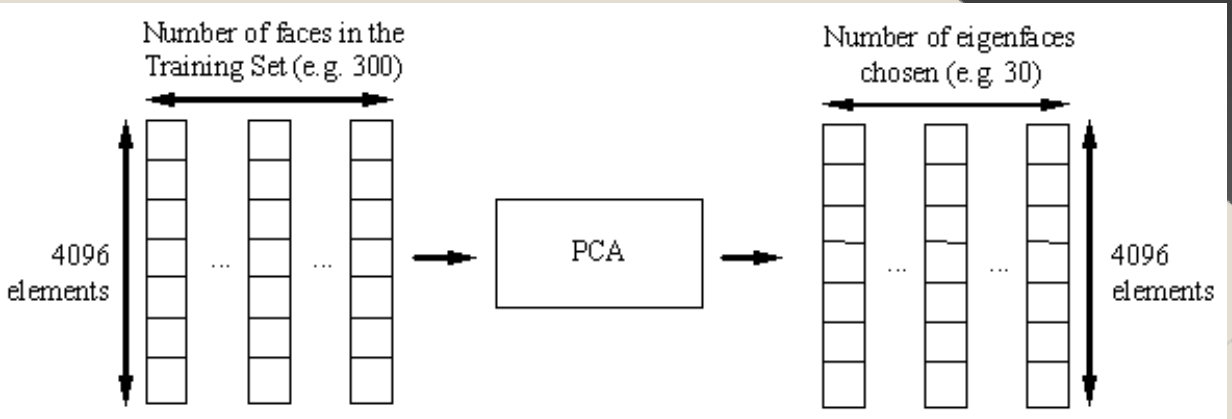
PCA (Cont)

- Step 5: Deriving the new data set
  - This the final step in PCA, and is also the easiest
  - Once we have chosen the components (eigenvectors) that we wish to keep in our data and formed a feature vector, we simplytake the transpose of the vector and multiply it on the left of the original data set, transposed

$$FinalData = RowFeatureVector \times RowDataAdjust$$

Conclusion

- Finally, That's what the PCA does
  - Define the training set
  - Define the faces to reconstruct
  - Define the faces to meet (which stores the components of the faces in order to be able to recognise them afterwards)
  - Define the faces to recognise
  - Define the face to classify



Thanks for Listening