PERFORMANCE EVALUATION STUDY OF DATA SELECTION AND MATCHING CRITERIA IN FACE RECOGNITION FOR HUMAN SURVEILLANCE

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IJAZAH: DOCTOR OF PHILOSOPHY (COMPUTER ENGINEERING)

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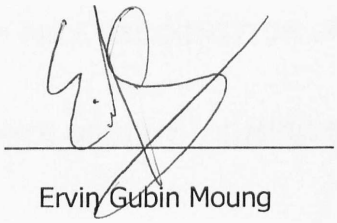
DECLARATION

I hereby declare that the material of this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.



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ABSTRACT

Face recognition is an important biometric in many fields, such as access control and surveillance. Currently there are many published reports in face recognition for surveillance application. However, there was no standard surveillance database, no standard evaluation criteria, and no standard method published for selecting training and testing data used by all researchers. Thus, a comparison between the various results reported is hard to be made. The aim of this work is to establish a standard training database selection method based on surveillance database suitable for face recognition for surveillance application and also to establish a test bed and test criteria for evaluating common reported approach. Two surveillance databases are used; ChokePoint Pre-processed Grayscale Database (PPG) and ChokePoint Manually Pre-processed Colour Images Database (MPCI). Three sessions are used to acquire the images in the database. The images in each session were equally divided into three classes: CLOSE, MEDIUM, and FAR. A commonly used PCA-based face recognition system has been selected for this work. The effect of the distance between the subject and the camera, the effect of the number of images per class, the effect of mean image, the effect of training database size, and the effect of database sessions on face recognition have been investigated. It was found that using images from the FAR class for training gives better performance compared to MEDIUM or CLOSE class. However, it was found that using one image from each class gives better recognition performance compared to using three FAR class images for training. It was also found that as the number of images per class increases, the recognition rate increases. Finally, it was found that using one mean image per class from all the available database sessions gives the best performance. The performance of YC_BC_R individual channels on face recognition has been investigated and compared with grayscale. It was found that grayscale performed better than all the individual YC_BC_R channels because grayscale has better quality of visual features. A fusion strategy using the individual YC_BC_R has been presented and compared to grayscale performance. It was found out that the fusion of C_BxC_R with any other channel outperforms the grayscale when three images of the same class from the same database are used for training (Case 1). For YC_BC_R individual channels, the best performance is achieved by using the C_BxC_R channel. It was also found that if the differences between individual channels performance vary significantly, the individual channel performance become an important criteria when selecting channels for fusion. In general, increasing the number of fused channels increases the performance of the system. A comparison of PPG and MPCI databases performance and also a comparison of Euclidean distance (ED) and Euclidean distance with SVM (ED+SVM) performance have been made. It was found that the recognition rate pattern stays the same regardless of the training database used and similarity matching method used. Processing time wise, ED is much more efficient compared to ED+SVM. The best recognition performance is achieved by PCA-based (ED) system using the MPCI database and ED matching method with Case 6 training database criteria, giving 100% average correct recall and reject rate, and uses 5.69 seconds process time for a single test person and 26.7 MB space for training data.

ABSTRAK

KAJIAN PENILAIAN PRESTASI PEMILIHAN DATA DAN KRITERIA PADANAN DALAM PENGESAHAN WAJAH UNTUK PENGAWASAN MANUSIA

Pengesanan wajah adalah aplikasi biometrik yang penting dalam banyak bidang, seperti kawalan akses dan pengawasan. Kini, terdapat banyak penerbitan laporan pengesanan muka untuk aplikasi pengawasan. Namun itu, tiada piawai untuk pangkalan data, kriteria penilaian, dan juga pemilihan data latihan dan ujian yang digunakan oleh penyelidik. Oleh itu, perbandingan antara hasil laporan sukar dibuat. Matlamat kerja ini adalah untuk menubuhkan satu kaedah pemilihan pangkalan data latihan berdasarkan pangkalan data pengawasan yang sesuai untuk pengesanan muka untuk aplikasi pengawasan dan juga untuk menubuhkan kriteria ujian untuk membandingkan hasil laporan. Dua pangkalan data pengawasan digunakan; "ChokePoint Pre-processed Grayscale Database" (PPG) dan "ChokePoint Manually Pre-processed Colour Images Database" (MPCI). Tiga sesi digunakan untuk memperoleh imej dalam pangkalan data. Imej setiap sesi dibahagikan kepada tiga kelas: CLOSE, MEDIUM, dan FAR. Sistem pengesanan wajah berasaskan PCA yang biasa digunakan telah dipilih untuk kerja ini. Kesan jarak antara subjek dan kamera, kesan bilangan imej setiap kelas, kesan imej purata, kesan saiz pangkalan data latihan, dan kesan sesi pangkalan data pada pengesanan wajah telah disiasat. Didapati penggunaan imej dari kelas FAR untuk latihan memberikan prestasi yang lebih baik berbanding kelas MEDIUM atau CLOSE. Namun itu, untuk latihan, penggunaan satu imej dari setiap kelas memberikan prestasi pengesanan yang lebih baik berbanding penggunaan tiga imej kelas FAR. Juga didapati bahawa apabila bilangan imej setiap kelas meningkat, kadar pengesanan meningkat. Akhirnya, didapati bahawa penggunaan satu imej purata dari setiap kelas dari semua sesi pangkalan data memberikan prestasi terbaik. Prestasi warna individu YC_BC_R atas pengesanan wajah telah disiasat dan dibandingkan dengan "grayscale". Didapati bahawa prestasi grayscale adalah lebih baik berbanding warna individu YC_BC_R kerana "grayscale" mempunyai ciri-ciri visual yang lebih baik. Strategi penggabungan menggunakan warna individu YC_BC_R telah dibentang dan dibandingkan dengan prestasi "grayscale". Didapati bahawa penggabungan C_BxC_R dengan warna lain mengatasi prestasi "grayscale" apabila tiga imej dari kelas yang sama dari pangkalan data yang sama digunakan untuk latihan (Kes 1). Untuk warna individu YC_BC_R, C_BxC_R memberikan prestasi terbaik. Juga didapati sekiranya perbezaan prestasi antara warna individu berbeza besar, prestasi warna individu menjadi kriteria penting apabila dipilih untuk penggabungan. Secara umum, penambahan warna untuk penggabungan meningkatkan prestasi sistem. Perbandingan prestasi pangkalan data PPG dengan MPCI dan juga perbandingan prestasi "Euclidean distance" (ED) dengan "Euclidean distance" dengan SVM (ED+SVM) telah dibuat. Didapati bahawa corak kadar pengesanan tetap sama tanpa mengira pangkalan data latihan dan kaedah padanan kesamaan yang telah digunakan. Dari segi masa pemprosesan, ED adalah lebih cekap berbanding dengan ED+ VM. Prestasi pengesanan terbaik dicapai oleh sistem berasaskan PCA (ED) dengan menggunakan pangkalan data MPCI dan kaedah pemadanan ED dengan kriteria pangkalan data Kes 6, memberikan kadar purata penerimaan dan penolakan, dan menggunakan masa pemprosesan 5.69 saat untuk ujian tunggal dan 26.7 MB ruang penyimpanan data latihan.

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LIST OF ABBREVIATIONS

1-D	-	One dimension
2D	-	Two dimension
3D	-	Three dimension
3D TEC	-	3D Twins Expression Challenge
3DMAD	-	3D Mask Attack Database
AAEN	-	Auto-Associative Elman Network
AAM	-	Active Appearance Model
AAMT	-	Adaptive Appearance Model Tracker
AdaBoost	-	Adaptive Boosting
AFIS	-	Automated Fingerprint Identification System
AFS	-	Adaptive Frame Selection
AMP	-	Advanced Multimedia Processing
APCA	-	Adaptive Principal Component Analysis
AR	-	Aleix Martinez and Robert Benavente
ARM	-	Advanced Reduced Instruction Set Computer Machines
ARTMAP	-	Adaptive Resonance Theory Map
ASLBP	-	Adaptive Soft Histogram Local binary Patterns
ASUMS	-	Alcorn State University Multi Spectral
AT&T	-	American Telephone & Telegraph
BFM	-	Basel Face Model
BOW	-	Bag-of-Words
BP4D	-	Binghamton-Pittsburgh 3D Dynamic
BU-3DFE	-	Binghamton University 3D Facial Expression (Static Data)
BU-4DFE	-	Binghamton University 3D Dynamic Facial Expression Database (Dynamic Data)
CAS-PEAL	-	Chinese Academy of Sciences-Pose, Expression, Accessories and Lighting
CASIA	-	Chinese Academy of Sciences
C_B	-	Chroma: Blue
CBCL	-	Center for Biological & Computational Learning
CC	-	Correct Classification
CCD	-	Charge-Coupled Devices
CCTV	-	Closed-circuit television
CMOS	-	Complementary Metal–Oxide–Semiconductor
CMU	-	Carnegie Mellon University
CMU+MIT	-	Carnegie Mellon University and Massachusetts Institute of Technology
CMU-PIE	-	Carnegie Mellon University Pose, Illumination, and Expression
CNN	-	Convolutional Neural Network
COTS	-	Commercial-Off-The-Shelf

COX - Chinese Academy of Sciences, OMRON Social Solutions, Xinjiang University
CPU - Central Processing Unit
C_R - Chroma: Red
CSU - Colorado State University
CUDA - Compute Unified Device Architecture
CWFP - Chained Weighted Feature Pairs
CVL - Computer Vision Laboratory
DA - Domain Adaptation
DAISY - Fast Local Descriptor for Dense Matching
DBH - Distance Based Hashing
DCT - Discrete Cosine Transform
DDR - Double Data Rate
DISFA - Denver Intensity of Spontaneous Facial Action
DPSO - Dynamic Niching Particle Swarm Optimization
DSP - Digital Signal Processor
DSR - Discriminative Super-Resolution
DT-CWT - Dual Tree Complex Wavelet Transform
DWT - Discrete Wavelet Transform
ECR - Equal Correct Rate
EM - Expectation–maximization
ENN - Elman Neural Network
ESRC - Economic and Social Research Council
FaceDPL - Face DPL: Detection, Pose Estimation, and Landmark
FAR - False Acceptance Rate
FDDB - Face Detection Data Set and Benchmark
FEI - Faculty of Industrial Engineering
FERET - The Facial Recognition Technology
FiA - Face-in-Action
FIA - Carnegie Mellon University Face in Action
FLD - Fisher's Linear Discriminant
FLD+CWFP - Fisher's Linear Discriminant and Chained Weighted Feature Pairs
FLDA - Fisher Linear Discriminant Analysis
FQA - Face Quality Assessment
FR_SURV - Outdoor Surveillance Dataset
FRAD - Face Recognition at a Distance
FRGC - Face Recognition Grand Challenge
FRR - False Rejection Rate
FPGA - Field Programmable Gate Arrays
G-2DFLD - Generalized Two-Dimensional Fisher's Linear Discriminant
GB - Giga Bytes
GHz - Giga Hertz
GPU - Graphics Processing Unit
HD - High Definition
HDFS - Hadoop Distributed File System

HMM	-	Hidden Markov Model
HOG	-	Histogram of Oriented Gradients
HP	-	Head Pose
HQfaces	-	High quality faces
HSV	-	Hue, Saturation, Value
ICA	-	Independent Components Analysis
ICB-RW	-	International Challenge on Biometric Recognition in the Wild
ICT	-	Information and Communications Technology
iCV	-	Intelligent Computer Vision
iFRD	-	iCV Face Recognition
ID	-	Identity Document
IIT-NRC	-	Information and Communication Technology- National Research Council Canada
IMFDB	-	Indian Movie Face database
IoT	-	Internet-of-Things
IFaVid	-	IVECS Face Video Database
IVECS	-	Industrial Vehicle Electronic Control System
JAFFE	-	Japanese Female Facial Expression
jpeg	-	Join Photographic Experts Group
KDEF	-	Karolinska Directed Emotional Faces
KLT	-	Karhunen-Loève transform
KNCN	-	K-Nearest Centroid Neighbour
KNN	-	K-Nearest Neighbour
KPCA	-	Kernel Principal Component Analysis
LBP	-	Local Binary Pattern
LBP-P	-	Pose Clustering Based LBP
LBP-S	-	Different Image Scales Based LBP
LBP-SRC	-	Local Binary Pattern and Sparse Reconstruction Classifier
LBPH	-	Local Binary Patterns Histogram
LDA	-	Linear Discriminant Analysis
LDHF-DB	-	Long Distance Heterogeneous Face Database
LFC	-	Light-Field Camera
LFW	-	Labeled Faces in the Wild
LG	-	Log-Gabor
LG-SRC	-	Log-Gabor and Sparse Reconstruction Classifier
LMKNCN	-	Local mean-based k-nearest centroid neighbour
LMKNN	-	Local Mean Based K-Nearest Neighbour
LPQ	-	Local Phase Quantization
LQfaces	-	Low quality faces
LR	-	Low-Resolution
LRPCA	-	Local Region Principal Component Analysis
LWF	-	Labeled Wikipedia Faces
MATLAB	-	Matrix Laboratory
MCS	-	Multiple Classifier Systems
MDS	-	Multidimensional Scaling

MIT	-	Massachusetts Institute of Technology
MIW	-	Makeup in the "Wild"
MixRes	-	Mixed-Resolution Biometric Comparison
MOBIO	-	Mobile Biometry Face and Speech Database
MOBO	-	Motion of Body
MPCI	-	Manually Pre-processed Colour Images
MRTD	-	Machine Readable Travel Documents
MSRA-CFW	-	Microsoft Data Set of Celebrity Faces on the Web
MUCT	-	Modified University of Cape Town
MultiPIE	-	Multi Pose, Illumination, and Expression
Multi-PIE	-	Multi Pose, Illumination, and Expression
NFOV	-	Narrow Field of View
NICTA	-	National ICT Australia
NLS-MLC	-	Nonlocal Similarity and Multi-Scale Linear Combination Consistency
NIST	-	National Institute of Standard and Technology
OpenCV	-	Open Source Computer Vision
ORL	-	Our Database of Faces
OVA	-	One-Versus-All
OVO	-	One-Versus-One
P1	-	Portal One
P1E	-	Portal One Entering scene
P1L	-	Portal One Leaving scene
P2	-	Portal Two
P2E	-	Portal Two Entering scene
P2L	-	Portal Two Leaving scene
PABM-G	-	Global Principal Angles Boosting
PABM-GL	-	Global and Local Principal Angles Boosting
PaSC	-	Point and Shoot Face and Person Recognition Challenge
pAUC	-	partial Area Under Curve
PCA	-	Principal Component Analysis
PCA+SVM	-	Principal Component Analysis and Support Vector Machine
PIE	-	Pose, Illumination, and Expression
POEM	-	Pattern of Oriented Edge Magnitudes
PolyU	-	Hong Kong Polytechnic University
PolyU-HSFD	-	Hong Kong Polytechnic University Hyperspectral Face Database
PPG	-	Pre-processed Grayscale
PR	-	Precision-Recall
PTZ	-	Pan-Tilt-Zoom
PubFig	-	Public Face Image
PUT	-	Poznań University of Technology
QIM	-	Quantile Interval Method
RBF	-	Radial Basis Function
RGB	-	Red, Green, And Blue
RIDN	-	Resolution-Invariant Deep Network

ROC	-	Receiver Operating Characteristic
RQC_R	-	Red quadrature Chroma: Red
RSIF	-	Resolution Scale Invariant Feature
S1	-	Session One
S2	-	Session Two
S3	-	Session Three
S4	-	Session Four
SCface	-	Surveillance Cameras Face
SDK	-	Software Development Kit
SDRAM	-	Synchronous Dynamic Random-Access Memory
SGMM	-	Sequential Gaussian Mixture Models
SIFT	-	Scale-Invariant Feature Transform
SPEVI	-	Surveillance Performance Evaluation Initiative
SQI	-	Self-Quotient Image
SR	-	Super-Resolution
SR by D-LH3	-	Super Resolution method based on the dictionary in the wavelet domain
SR5	-	three frames for SR
SR5	-	five frames for SR
SRC	-	Sparse Reconstruction Classifier
SSF	-	Smart Surveillance Framework
SVM	-	Support Vector Machine
TCM-kNN	-	Transduction Confidence Machine – k-Nearest Neighbor
TV	-	Television
TVC	-	Dataset Collected From Television
UBHSD	-	Indoor and Outdoor High and Standard Definition Video
UCSD	-	University of California San Diego
UFI	-	Unified Face Image
ULFDA	-	Uncorrelated Local Fisher Discriminant Analysis
USB	-	Universal Serial Bus
UTK-LRHM	-	Long Distances Face Video Database
VADANA	-	Vims Appearance Dataset for facial Analysis
VGG	-	Visual Geometric Group
VidTIMIT	-	Texas Instruments and Massachusetts Institute of Technology Multi-Modal Database
VLSI	-	Very-Large-Scale Integration
VMU	-	Virtual Makeup
WAF	-	Warped Average Face
WFOV	-	Wide Field of View
WIT	-	WhoIsIt
WVU	-	West Virginia University
XM2VTS	-	Multi Modal Face Database
XOR	-	Exclusive OR-operator
Y	-	Luminance
YaleB	-	Yale Face Database B

YC_BC_R	-	Luminance; Chroma: Blue; Chroma: Red
YMU	-	YouTube Makeup
YTF	-	YouTube Faces

LIST OF SYMBOLS

$++$	-	In Table 3.1, Cases where the exact number of conditions is not determined are marked with "++"
Φ	-	In PCA algorithm, this is the zero mean face vector, obtained by subtracting the Γ_i with Ψ
Γ	-	In PCA algorithm, this is an N by N dimension image
λ	-	In PCA algorithm, this is the eigenvalue of $\boldsymbol{A^TA}$
$\boldsymbol{\Omega}$	-	In PCA algorithm, this is the low dimension vector, a new representation of a training image
$\boldsymbol{\Omega^{PT}}$	-	In PCA algorithm, this is a PCA feature vector that belong to P_T
$\boldsymbol{\Omega^{PD}}$	-	In PCA algorithm, this is a PCA feature vector belong that to P_D
Ψ	-	In PCA algorithm, this is the mean face vector obtained from the training database set
$\boldsymbol{A}$	-	In PCA algorithm, this is the collection of Φ obtained from the training database set
$\boldsymbol{a}$	-	In PCA algorithm, this is the element of matrix I_i
Aprs	-	In SVM algorithm, this is the average *prs* that belong to the majority *prc* class label
APRS_COLLECTION	-	In SVM algorithm, this is a set that contain the average predicted class score for each for each $\boldsymbol{\Omega^{PT}}$ from P_T
avg_ECR	-	The average equal correct rate produced using a Case 4, Case 6, or Case 8 training database training database tested on S1, S2, and S3 testing database
avg_ECR_CLOSE_STN$_j$	-	The average equal correct rate produced using CLOSE class S_j training database tested on S1, S2, and S3 testing databases.
avg_ECR_FAR_STN	-	The average equal correct rate produced using FAR class S_j training database tested on S1, S2, and S3 testing databases.
avg_ECR_MEDIUM_STN$_j$	-	The average equal correct rate produced using MEDIUM class S_j training database tested on S1, S2, and S3 testing databases.

$avg\_ECR\_STN_j$	-	The average equal correct rate produced using a Case 4, Case 6, or Case 8 training database training database tested on S1, S2, and S3 testing database
C	-	In SVM, this is a class
cos	-	In similarity matching, this is a cosine distance
e	-	This is the minimum Euclidean distance score between every test feature vector, Ω^{PT}_{fi}, with all the training set feature vectors *in TB*
d		In Similarity Matching, this is the Euclidean distance between two vectors x and y
E	-	This is a collection of minimum Euclidean distance score, e_{fi} for all *fi* indexes
E_{av}	-	This is a Euclidean distance average score, denoted as E_{av}, of all the e_{fi} from E that has the same *fi* index as I_{fi} when I_{fi} is equal to P_{mode}
$ECR\_CLOSE\_STT_i$	-	The equal correct rate produced using CLOSE class S_j training database tested on S_i testing database
$ECR\_FAR\_STT_i$	-	The equal correct rate produced using FAR class S_j training database tested on S_i testing database
$ECR\_MEDIUM\_STT_i$	-	The equal correct rate produced using MEDIUM class S_j training database tested on S_i testing database
ECR_ST	-	The equal correct rate produced using a Case 4, Case 6, or Case 8 training database, tested on S_i testing database.
ECR_STT_i	-	The equal correct rate produced using a Case 4, Case 6, or Case 8 training database, tested on S_i testing database.
$edge$	-	A MATLAB function to calculate the edge of an image
E_{diff}	-	This is the differences in a Euclidean distance score format between P_T and P_D
E_L	-	In Data Pre-processing, this is the length between the right and left eye (the blue horizontal line shown in Figure 3.11)
$E_{largest}$	-	In PCA algorithm, this is the largest distance threshold value, t, boundary
$E_{smallest}$	-	In PCA algorithm, this is the smallest distance threshold value, t, boundary
fi	-	In PCA algorithm, each test person P_T has a total of *Ftotal* feature vectors Ω^{PT} and *fi* is the index of the feature vectors Ω^{PT}

Ftotal	-	This is the total number of video frames per person
i	-	In PCA algorithm, the maximum number of i is the total number of training images which is M In the formula for Best Score, this is the testing database's session number
I	-	In PCA algorithm, this is an N by N dimension image
j	-	In PCA algorithm, the maximum number of j is the total number of eigenvectors obtained. For the matrix $\boldsymbol{AA^T}$, the maximum number of j is N^2. For the matrix $\boldsymbol{A^TA}$, the maximum number of j is M. In the formula for Best Score, this is the training database's session number
K	-	In PCA algorithm, this is the number of eigenvector used in face recognition system with $K \leq M$
l	-	In PCA algorithm, this is person P_D from the training database TB which has its $\boldsymbol{\Omega}^{PD}$ giving the minimum Euclidean distance e_{fi} with a test feature vector $\boldsymbol{\Omega}^{PT}{}_{fi}$, is denoted as l_{fi}
L	-	In PCA algorithm, this is a set that contains all the P_D that gives minimum Euclidean distance e_{fi} with $\boldsymbol{\Omega}^{PT}{}_{fi}$ for all the fi indexes
L	-	In Data Pre-processing, this marked the right side of the face cropping template shown in Figure 3.11
M	-	In Data Pre-processing, this marked the center of the blue horizontal line shown in Figure 3.11
M	-	In PCA algorithm, this is the total number of images in the training database
mode	-	This is a function to calculate a mode
Mprc	-	In SVM algorithm, this is the prc value with the highest majority
MPRC_COLLECTION	-	In SVM algorithm, this is a set that contain the list of predicted class for each for each $\boldsymbol{\Omega}^{PT}$ from P_T
N	-	In PCA algorithm, this is the width or height of a square image in pixel unit
$OVO\_SVM\_C_1vsC_2\_Classifier$	-	This is an SVM function to calculate the predicted classifiers of two class and its score
P_D	-	A person from the training database
P_{mode}	-	In PCA algorithm, this is the highest occurrence of l_{fi} from the set L and P_{mode} is a person from the training database

P_{mode}**counter**	-	In Figure 4.6, this count the condition where I_{fi} is equal to P_{mode}
prc	-	In SVM algorithm, this is a predicted class label
prs	-	In SVM algorithm, this is a predicted class score of *prc*
Psvm	-	In SVM algorithm, this is the Majority class from *MPRC_COLLECTION*
P_T	-	A test person
q	-	In SVM algorithm, this is the number of classes available in the training database
R	-	In Data Pre-processing, this marked the left side of the face cropping template shown in Figure 3.11
rgb2gray	-	MATLAB built-in function to convert RGB format to grayscale format
S_{TC}	-	In SVM algorithm, this is the total number of SVM classifiers required
sum	-	In Figure 4.6, this is the sum of e_{fi}
Sum_Of_Edges	-	This is the total edges detected by MATLAB function *edge* in image $\boldsymbol{I}$
svmtrain	-	MATLAB built-in SVM classifier function
svmclassify	-	MATLAB built-in SVM classification function
t	-	In the distance threshold value setting algorithm, this is the distance threshold value
T	-	In Data Pre-processing, this marked the middle-top of the face cropping template shown in Figure 3.11
Tcpara	-	In PCA algorithm, this is the Tuning Threshold Parameter
TB	-	Training set
u	-	In PCA algorithm, this is the eigenvector of covariance matrix $\boldsymbol{C}$
v	-	In PCA algorithm, this is the eigenvector of $\boldsymbol{A^TA}$
w	-	In PCA algorithm, this is the weight value of Φ_I, when multiplying u_j^T with Φ_i
x	-	In Support Vector Machine, this is a test subject
x	-	In Similarity Matching, this is a vector
X_{all_images}	-	In Figure 3.13, this is the total images from all the three sessions
X_c	-	In face images classification, this is the number of frames per class
X_{client}	-	In testing database, this is the total number of persons in the Client test database

$X_{imposter}$	-	In testing database, this is the total number of persons in the Imposter test database
$X_{session\_images}$	-	In Figure 3.13, this is the total images per session
y	-	In Support Vector Machine, this is the label of a test subject
y	-	In Similarity Matching, this is a vector
Y_d	-	In face images classification, this is the the total number of frames per person
Y_{client}	-	In testing database, this is the total number of images in the Client test database
$Y_{imposter}$	-	In testing database, this is the total number of images in the Imposter test database
Z_{ipp}	-	In testing database, total number of images per person