A Review Paper on Face Recognition Techniques

[1]Gagandeep Jaswal and [2]Harjinder Singh

PG student ECE, Punjabi University, Patiala

Asst. Prof. ECE, Punjabi University, Patiala

Email: [1]gjaswal46@gmail.com, [2]hrjindr@gmail.com

Abstract: Face recognition presents a challenging problem in the process of image analysis and computer vision. Face recognition techniques can be broadly classified into three categories based on the face data acquisition methodology: methods that operates on intensity images; those that deal with video sequences; and those that requires other sensory data such as 3D information or infra-red imagery. High data dimensionality makes it challenging to distinguish the required discriminative information. In this paper, an overview of some well-known dimension reduction techniques is presented and some of the benefits and drawbacks of the schemes mentioned therein are examined. This paper also mentions the classification of dimension reduction techniques being developed and tries to give an idea of the state of the art of face recognition technology.

Keywords: Face recognition, image analysis, data acquisition, dimension reduction techniques

1. Introduction

Humans distinguish and identify faces based on location, size and shape of facial features, such as eyes, eyebrows, lips, nose, cheekbones, chin and jaw. The corresponding replaced approaches to face recognition are categorized as geometry feature-based methods. Other approaches are dependent on image templates and compute the correlation between a locally captured face and one or many model templates to estimate similarity. Most vendors of automated face recognition systems use proprietary (closed standard) algorithms to produce biometric templates. The algorithms are kept close and cannot be reverse-engineered to create a recognizable facial image from the template. Consequently, face recognition templates are not interoperable between vendors and thus the original captured photograph has to be retained, instead of a ready-to-use template. In the case of passports, the original captured photograph is stored on the RFID (radio-frequency identification) chip. When passing a immigration desk, the receiving state uses its own vendor algorithm to compare the passport bearer's facial image retained in real time with the data read from the chip. To be recognized accurately at many borders, it is significant that the template image on the chip makes visible a number of facial features and is captured under certain light and contrast conditions. Face recognition is a non-intrusive method and can be executed with digital cameras or in combination with closed-circuit television (CCTV), incorporating remote video surveillance cameras. However, modern technology may recognize accurately from full front faces or from images taken in small angles, with simple background and special illumination.

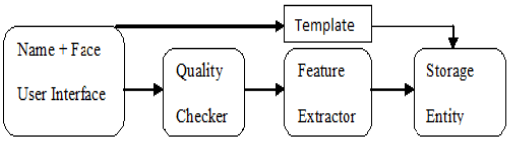

Fig.1 Enrolment Mode

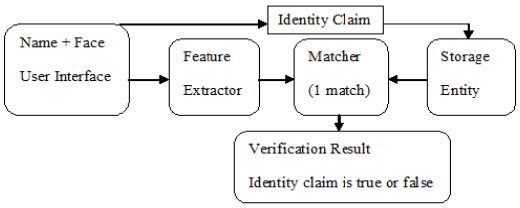

Fig.2 Verification Mode

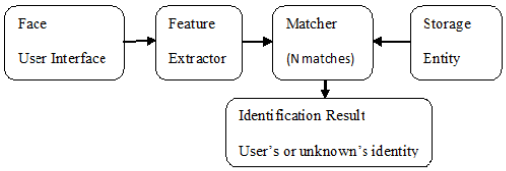

Fig.3 Identification Mode

2. Dimensionality reduction techniques:

a) Overview

The most significant problem in face recognition is the curse of dimensionality difficulty. The methods are beneficial to reduce the dimension of the considered space. When the system start to commit to memory the high dimensional information then it causes over fitting difficulty and also computational density becomes the significant task. This issue of dimensionality difficulty is reduced by dimensionality reduction techniques. Among those techniques some are linear methods while others are nonlinear. Linear technique is to amend statistics from high dimensional subspace into smaller dimensional subspace by linear map but it fails to work on the nonlinear statistics structure whereas non- linear methods are easily work on the compound nonlinear statistics structure. Associated to linear methods, nonlinear methods are very proficient while processing the problematic image like hairs addition, lighting state and so on. Principal constituent Analysis (PCA), Linear Discriminant Analysis (LDA) and Locality Protect Projections (LPP) are some recognized linear methods and nonlinear methods include Isometric Mapping (ISOMAP) & Locally Linear Embedding (LLE). According to the author [13], feature range is to explore a subset of the original variables. Two methods are filtered (e.g. Information gain) and wrap (e.g. Genetic algorithm) methods. It happens sometimes that data examination or classification can be done in the compact space extra accurately than in the unique space. Quality extraction is conveying a mapping of the multi-dimensional space into a liberty of fewer dimensions. This means that the unique feature space is changed by concern a linear transformation. The brief preface of feature extraction techniques is explained in the next section.

b) Linear Feature Extraction of Dimensionality Reduction Techniques

Generally the face recognition process is divided into 3 areas such as all-inclusive way use the unique image as an input for the face acknowledgement system. The examples of those methods are PCA, LDA and ICA and so on. In a feature based way, the local distinctive point such as eye, nose, and mouth are first taken out, then it will be sent to the classifier. Consequently, a cross method is used to recognize both the local feature and whole face region [3][4][5][13][15]. In dimensionality reduction, feature removal is a significant task to collect the set of features from a picture. The feature alteration may be a linear or nonlinear combination of original features. This review provides some of the significant linear and nonlinear methods are listed as follows:

i) Principal Component Analysis (PCA): PCA is one of the well-liked technique for both dimensionality reduction and face recognition since 1990's. Eigen faces [3] built with the PCA technique is presented by M. A. Turk and A. P. Pentland. It is an all-inclusive move toward where the input image directly used for the process. PCA algorithm can be used to determine a subspace whose basis vectors marks to the maximum variation directions in the original and dimensional freedom. PCA subspace can be used for entrance of data with minimum error involvement in original data. More research papers are providing the information for PCA techniques [8][13][15]. MPCA and KPCA are entirely based on the PCA technique.

ii) Linear Discriminant Analysis (LDA): LDA is one of the most prominent linear techniques for dimensionality reduction and data organization. The main objective of the LDA consists in the prediction of base of vectors providing the finest discrimination among the classes, trying to exploit the between-class difference, minimize the within-class differences by using spread matrices. It suffers from the small sample size concern which exists in higher dimensional pattern recognition task where the number of available models is fewer than the dimensionality of the samples. D- LDA, R-LDA, and KDDA are variations of LDA. This technique also discusses in more research papers [4][12][13].

iii) Singular Value Decomposition (SVD): SVD is a significant factor in the field of signal dispensation and statistics. It is the best linear dimensionality reduction technique based on the covariance medium. The main objective is to reduce the dimension of the information by discovering a few orthogonal linear combinations of the original variables with the largest variation [6]. Most of the researches have also cast-off this technique for face gratitude.

iv) Independent Component Analysis (ICA): ICA is a geometric and computational technique for revealing the concealed factors that underlie sets or chance variables, measurements, or signals. ICA is apparently related to principal component analysis and factors examination. The ICA algorithm targets at finding S component as self-governing as possible so that the set of experimental signals can be pronounce as a linear combination of statistically independent components. It uses cosine measures to perform the covariance matrix and also it is improved than the PCA and LDA performance.

v) Locality preserves Projections (LPP): LPP can be perceived as an option to PCA. When the high dimensional data deceit on a low dimensional manifold set in the ambient space, projections are attained by finding the optimal linear approximation for the Eigen purpose of the Laplace Beltrami operator on the various operations. Consequently, LPP shares many of the data symbol properties of nonlinear techniques like Laplacian Eigen Maps or Locally Linear Embeds [3].

vi) Multi - Dimensional Scaling (MDS): MDS is a good technique for dimensionality reduction. MDS generates low dimensional code putting prominence on preserving the couple wise distances between the data points. If the rows and the columns of the data matrix D both have mean zero, the prominence produced by MDS will be the same as that produced by PCA. Thus, MDS is a linear model for dimensionality reduction having the same limitations as PCA.

vii) Partial Least Squares: Partial least squares is a classical arithmetical learning method. It is widely used in chemo metrics and bioinformatics etc. In this modern era, it is also applied in face acknowledgment and human detection. It can eliminate the small sample size problems in linear LDA. Therefore partial least square is used as an alternative method of LDA.

c) Non Linear Feature Extraction of Dimensionality Reduction Techniques

Non-linear way can be broadly classified into two groups: a mapping (either from the high dimensional space to lower dimensional space or vice versa), it can be observed as a beginning feature extraction step and image is based on neighbor's data such as distance measurements. Research on nonlinear dimensionality reduction method has been going on in the last few years. A brief introduction to several non-linear dimensionality reduction techniques is given below:

i) Kernel Principle Component Analysis (KPCA): KPCA is the modification of customary linear PCA in a high-dimensional gap that is constructed using a kernel function. In recent existence, the modification of linear technique using the 'kernel trick' has led to the proposal of good techniques such as kernel ridge decay and support vector machinery. Kernel PCA calculates the principal eigen-vectors of the kernel matrix, slightly than those of the covariance matrix. The modification of usual PCA in kernel space is clear-cut, since a kernel matrix is analogous to the in product of the data points in the high dimensional gap that is constructed using the kernel function. The application of PCA in kernel space provides Kernel PCA the possessions of constructing nonlinear mappings.

ii) Isometric Mapping (ISOMAP): Frequently of the linear methods do not take the neighboring information end into an account. ISOMAP is a procedure that resolves this problem by exertions to preserve pairwise geodesic (or curvilinear) distance between data points. The estimation of geodesic distance divided into two classes. For, adjacent points, Euclidean distance in the input space providing a good approximation to geodesic distance and far away points, geodesic space can be estimated by adding up a sequence of "short hops" among neighboring points. ISOMAP shares some reward with PCA, LDA, and MDS, such as computational efficiency and asymptotic meeting guarantees, but with more liveliness to learn a huge class of nonlinear manifolds [15].

iii) Locally Linear Embedding: LLE is another technique which acknowledges the problem of nonlinear dimensionality reduction by computing low dimensional, neighborhood preserving embedding of high dimensional data. It is an approach that is similar to ISOMAP in that it also constructs a chart representation of the data points. It describes the local property of the manifold in the region of a data point by writing the data point as a linear combination (the so-called rebuilding weights) of its k nearest neighbors and attempts to retain the reconstruction weights in the linear combinations as proper as possible [15].

iv) Laplacian Eigen Maps: A directly related approach to locally linear embed is Laplacian Eigen Maps. Given t point in «- dimensional space, the Laplacian Eigen Maps Method (LEM) begins by constructing a biased graph with t nodes and a set of edges among adjacent points. Similar to LLE, the area graph can be constructed by finding the k nearest neighbors. The final objectives for both LEM and LLE contain the same form and change only in how the matrix is constructed [4].

v) Stochastic Neighbor Embedding: Stochastic Neighbor Embedding (SNE) is a probable move towards that maps high dimensional data tip into a low dimensional subspace in a way that preserve the relative distances to near neighbors. In SNE, alike objects in the high dimensional space will be put nearby in the low dimensional space, and dissimilar objects in the high dimensional space will usually be put distant apart in the low dimensional gap [4]. A Gaussian distribution centered on a point in the tall dimensional gap is used to define the probability sharing that the data point chooses other data points as its neighbors. SNE is better as compared to LLE in observance the relative distances between every two data points.

vi) Semi Definite Embedding (SDE): SDE can be seen as a variation of KPCA and an algorithm is based on semi definite training. SDE learns a kernel matrix by maximizing the variance in feature space while preserving the space and angles among nearest neighbors. It has some interesting property: the main optimization is convex and sure to preserve certain aspects of the local geometry; the system always yields a semi positive definite kernel matrix; the eigen spectrum of the kernel matrix allocates a guess of the basic manifold's dimensionality and the system does not depend on guess geodesic distances between far away points on the manifold. This dependable combination of restitution seems unique to SDE.

3. Discussion

As it is being cleared from the above comparison, face recognition is one of the vital fields of biometrics. Year by year many different modified techniques and algorithms are being implemented as discussed above. But still there are many chances of improvement in various algorithms. Since recognition rate is not yet as good as with manual intervention, since feature locating algorithm is not robust enough with illumination and expression changes. Thus, on this aspect work can be done.

References

[1] L.C.Jain, U.Halici, I.Hayashi, S.B.Lee, S.Tsutsui "Intelligent Biometric Techniques In Fingerprint And Face Recognition " The CRC Press International Series On Computational Intelligence, 2nd Edition, 2007, pp-217-221

[2] Anil K.Jain, Stan Z.Lee "Handbook Of Face Recognition "Springer Science + Business Media, Inc, 1st Edition, pp-3-12, 2005

[3] M. Turk and A. Pentland, "Eigen faces for recognition," Journal of Cognitive Neuroscience, vol.13, no. 1, pp. 71–86, 1991.

[4] R. Chellappa, C. L. Wilson, and S. Sirohey, "Human and machine recognition of faces: A survey," Proc. IEEE, vol. 83, no. 5, pp. 705–740, 1995.

[5] Yuan Chao, Zhang Changshui "Multiple Face Location Using Motion Information" Tsinghua Science and Technology ISSN 1007-0214 15/24 pp.183 – 186 Volume 5, Number 2, June 2000

[6] Hongcheng Wang, Narendra Ahuja "Facial Expression Decomposition" Proceedings of the Ninth IEEE International Conference on Computer Vision (ICCV'03) held in Nice (France), 2003

[7] Yehong Liao and Xueyin Lin "Blind Image Restoration With Eigen-Face Subspace" IEEE transactions on image processing, Vol. 14, no. 11, November 2005

[8] Haitao Zhao, Pong Chi Yuen and James T. Kwok "A Novel Incremental Principle Component Analysis and Its Application for Face Recognition" IEEE Transactions on Systems, Man, and Cybernetics—Part b: Cybernetics, Vol. 36, No. 4, August 2006

[9] Liya Ding and Aleix M. Martinez "Precise Detailed Detection of Faces and Facial Features" IEEE transactions on image processing, Vol. 16, no. 11, December 2008

[10]Wang Liting , Ding Xiaoqing, Fang Chi "Face Live Detection Method Based on Physiological Motion Analysis" Tsinghua Science and Technology ISSN 1007-0214 02/16 pp.685-690 Volume 14, Number 6, December 2009

[11]Maurício Pamplona Segundo, Luciano Silva, Olga Regina Pereira Bellon and Chauã C. Queirolo "Automatic Face Segmentation and Facial Landmark Detection in Range Images" IEEE Transactions on Systems, Man, and Cybernetics—Part b: Cybernetics, Vol. 40, No. 5, October 2010

[12] Shi Dongcheng and Jiang Jieqing "The Method of Facial Expression Recognition Based on DWT-PCA/LDA" 2010 3rd International Congress on Image and Signal Processing held in Yantai (China), 2010

[13] S.Sakthivel, Dr.R.Lakshmipathi, Enhancing Face Recognition using Improved Dimensionality Reduction and feature extraction Algorithms_An Evaluation with ORL database ‖ , Internationa of Engineering Science and Technology Vol. 2(6), 2010

[14] ZuoYuanyuan, Zhang Bo "Robust Hierarchical Framework for Image Classification via Sparse Representation" Tsinghua Science and Technology ISSNl l1007-0214l l03/17l lpp.13-21Volume 16, Number 1, February 2011

[15] Shylaja S S, K N Balasubramanya Murthy and S Natarajan, "Dimensionality Reduction Techniques for Face Recognition", International Journal of Advanced Computer Science and Applications, 2011

[16] Xavier P. Burgos-Artizzu, Pietro Perona, Piotr Dollar "Robust face landmark estimation under occlusion" IEEE International Conference on Computer Vision held in Sydney (Australia), 2013

[17] Jing Wang, Guangda Su, Ying Xiong, Jiansheng Chen, Yan Shang, Jiongxin Liu, and Xiaolong Ren "Sparse Representation for Face Recognition Based on Constraint Sampling and Face Alignment" Tsinghua Science and Technology, ISSNl 1007-0214l l08/12l lpp.62-67Volume 18, Number 1, February 2013

[18] Gee-Sern (Jison) Hsu, Yu-Lun Liu, Hsiao-Chia Peng, and Po-Xun Wu "RGB-D-Based Face Reconstruction and Recognition" IEEE Transactions on Information Forensics and Security, Vol. 9, No. 12, December 2014

[19] Gurjeet Singh and Er. Harjinder Singh "Design A New Algorithm For Image Edge Detection To Find Surface Defects" Published in International Journal of Innovative Research and Studies, ISSN 2319-9725, Vol. 3, No. 5, May 2014

[20] Priya Sharda, Harjinder Singh "Image Segmentation Techniques: A Review" International Journal of Research in Electronics and Computer Engineering, PP 15-21, VOL. 2 No. 4, ISSN: 2348-2281, December 2014.