

Review of Face Recognition Techniques

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ABSTRACT

Face Recognition is used for real time application. So reliability is the more important matter for security. Facial Recognition is rapidly becoming area of interest. Face biometrics is useful for authentication that recognizes face. This paper represents review of face recognition methods and discusses their advantages and disadvantages. The purpose of this paper is to provide a survey of face recognition methods that appeared in the literature over the past decade which was not discussed in the previous survey and also categorize them into meaningful approaches.

General Terms

Image Processing

Keywords

Face Recognition, Knowledge-based, Feature-invariant, Template matching, Appearance-based, PCA, LDA

1. INTRODUCTION

A system requires reliability to recognition the identity of an individual entity. The purpose is to ensure that the services are accessed only by a authorized user and not else others. In Biometric, face recognition is based on their physiological and/or behavioral characteristics of individuals. A biometric recognition system consists of four main modules:[26]

- (i) Image captures of a biometric trait
- (ii) Feature extraction module that extracts certain features from the biometric data
- (iii) System database that stores the features extracted from biometric data.
- (iv) Matcher module that matches the features extracted from the biometric imputed data with

the features stored in the system database.

2. FACE RECOGNITION PROBLEM

However, the major drawbacks of any facial recognition algorithms are

2.1 Illumination Problem

Illumination problem happens when same image with condition. So person have to keep with fix lighting condition, fixed distance, same facial expression and also same view point. It can emerge extensively different when lighting condition is different. [8] [45]

2.2 Pose Problem

Face recognition with different facial poses that is called pose problem. If face rotation made very large changes in face appearance it reduce recognition rate. If person try to match same image with different facial pose, it show the different result.[8] [46]

3. REVIEW OF FACE RECOGNITION METHODS

Face recognition methods divided into categories [29][7][11][35][2]

- Knowledge-based methods
- Feature-invariant methods
- Template matching methods
- Appearance-based methods

3.1 Knowledge-based methods

Knowledge-based methods are encoding our knowledge of human faces. These are rule-based methods. They try to capture our knowledge of faces, and translate them into a set of rules. It's easy to guess some simple rules. For example, a face usually has two symmetric eyes, and the eye area is darker than the cheeks. Facial features could be the distance between eyes or the color intensity difference between the eye area and the lower zone. The big problem with these methods is the difficulty in building an appropriate set of rules. There could be many false positives if the rules were too general. On the other hand, there could be many false negatives if the rules were too detailed. A solution is to build hierarchical knowledge-based methods to overcome these problems. These methods show themselves efficient with simple inputs. But, what happens if a man is wearing glasses? There are other features that can deal with that problem. For example, there are algorithms that detect face-like textures or the color of human skin. [7][29]

3.2 Feature-invariant methods

Feature-invariant methods that try to find invariant features of a face despite its angle or position. Facial recognition utilizes distinctive features of the face – including: distinct micro elements like: Mouth, Nose, Eye, Cheekbones, Chin, Lips, Forehead, Ears, Upper outlines of the eye sockets, the areas surrounding the cheekbones, the sides of the mouth, and the location of the nose and eyes. The distance between the eyes, the length of the nose and the angle of the jaw. [29]

3.3 Template matching methods

These algorithms compare input images with stored patterns of faces or features. Template matching methods try to define a face as a function. One can try to find a standard template of all the faces. Different features can be defined independently. For example, a face can be divided into eyes, face contour, nose and mouth. Also a face model can be built by edges. But these methods are limited to faces that are frontal. A face can also be represented as a shape. Other templates use the relation between face regions in terms of brightness and darkness. These standard patterns are compared to the input images to detect faces. This approach is simple to implement, but it's insufficient for face detection. It cannot achieve good results with variations in pose, scale and shape. However,

deformable templates have been proposed to deal with these problems. [29]

3.4 Appearance-based methods

A template matching method whose pattern database is learnt from a set of training images. In general, appearance-based methods rely on techniques from statistical analysis and machine learning to find the relevant characteristics of face images. [29,35,11]

3.4.1 Eigenface based Methods - PCA Algorithm

Principal Component Analysis (PCA) is well-organized method for face recognition. It is one of the most usable methods for a face image. It is used to reduce the dimensionality of the image and also holds some of the variations in the image data. It is projecting face image data into a feature space that covers the significant variations among known facial images. Those significant features are known as “Eigen faces”, because they are the eigenvectors or Principal Component of the set of faces. That is not necessary to correspond to the features such as eyes, ears, and noses. The projection operation characterizes an individual face by a weighted sum of the Eigen faces features. So to recognize a particular face, it is necessary only to compare these weights to those individuals. The Eigen Object Recognizer class applies PCA on each image, the results of which will be an array of Eigen values. To perform PCA several steps are undertaken: [8][20][19] [2][21]

Stage 1: Subtract the Mean of the data from each variable (our adjusted data)

Stage 2: Calculate and form a covariance Matrix

Stage 3: Calculate Eigenvectors and Eigenvalues from the covariance Matrix

Stage 4: Chose a Feature Vector (a fancy name for a matrix of vectors)

Stage 5: Multiply the transposed Feature Vectors by the transposed adjusted data

3.4.2 Distribution based Methods – LDA

Algorithm

LDA also known as Fisher’s Discriminant Analysis, is another dimensionality reduction technique. It is an example of a class specific method i.e. LDA maximizes the between – class scattering matrix measure while minimizes the within – class scatter matrix measure, which make it more reliable for classification.[37][38]. Lih-Heng Chan [15] proposed a framework of facial biometric was designed based on two subspace methods i.e., Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). First, PCA is used for dimension reduction, where original face images are projected into lower-dimensional face representations. Second, LDA was proposed to provide a solution of better discriminant. Both PCA and LDA features were presented to Euclidean distance measurement which is conveniently used as a benchmark. LDA-based methods outperform PCA for both face identification and verification. Fisher faces are one the most successfully widely used method for face recognition. It is based on appearance method. In 1930 Fisher developed linear/fisher discriminant analysis for face recognition which shows successful result in face recognition process [16]. The disadvantage of LDA is that within the class the scatter matrix is always single, since the number of pixels in images is larger than the number of images so it can increase detection of error rate if there is a variation in pose and lighting condition within same images. So to overcome this problem many algorithms has been proposed. Because the fisher faces technique uses the advantage of within-class information so it minimizes the variation within class, so the problem with variations in the same images such as lighting variations can be overcome [17].

4. OVERVIEW, ADVANTAGE AND DISADVANTAGE OF DIFFERENT FACE RECOGNITION METHODS

Table 1. Overview, Advantage and disadvantage of different face recognition methods

| Methods | Knowledge-based methods | Feature-invariant methods | Template matching methods | Appearance-based methods | |
|----------|---|--|---|---|--|
| | | | | Eigenface-based Methods | Distribution based Methods |
| Overview | <ul style="list-style-type: none"> Capture our knowledge of faces, and translate them into a set of rules Ruled-based methods | <ul style="list-style-type: none"> Distinctive features of the face like Mouth, Nose, Eye, Cheekbones, Chin, Lips, Forehead, Ears | <ul style="list-style-type: none"> Compare input images with stored patterns of faces or features Different features can be defined independently for example; a face can be divided into eyes, face contour, nose and mouth. Also a face model can be built by edges | <ul style="list-style-type: none"> Based on Principal Component Analysis (PCA reduces the dimension of the data) Create an image subspace (face space) which best discriminates between faces like faces occupy near points in face space. It Compare two faces by projecting the images into faces space and measuring the | <ul style="list-style-type: none"> Based on Fisher’s Linear Discriminant Analysis (LDA maximizes the between-class scatter LDA minimizes the within-class scatter) Fisherface Uses ‘within-class’ information to maximise class separation. |

| | | | | | |
|-----------------|--|--|---|---|--|
| | | | | distance between them. | |
| Characteristics | <ul style="list-style-type: none"> • Easy to implement | <ul style="list-style-type: none"> • find invariant features of a face anyway of it's angle or position | <ul style="list-style-type: none"> • simple to implement | <ul style="list-style-type: none"> • Relatively simple • Fast • Robust • Work well with high dimension. | <ul style="list-style-type: none"> • Faster than eigenfaces, in some cases • Has lower error rates • Works well even if different illumination • Works well even if different facial express |
| Drawback | <ul style="list-style-type: none"> • easy to guess some simple rules • difficulty in building an appropriate set of rules • false positives if the rules were too general • false negatives if the rules were too detailed • hierarchical knowledge-based methods used for this but it detect face based on textures or the color of human skin | <ul style="list-style-type: none"> • Facial expression | <ul style="list-style-type: none"> • Limited to faces that are frontal. • A face can also be represented as a shape. • Other templates use the relation between face regions in terms of brightness and darkness. • This approach is simple to implement, but it's insufficient for face detection. • It cannot achieve good results with variations in pose, scale and shape. | <ul style="list-style-type: none"> • Different head pose • Different alignment • Different facial expression | <ul style="list-style-type: none"> • Small databases • The face to classify must be in the DB • Can't work well with high dimension |

5. BENEFITS OF BIOMETRIC FACIAL METHODS [10][11]

No More Time Fraud –

One of the big benefits of using face biometric systems in your company is that you won't have to worry about time fraud. It will be impossible for buddy punching to occur, since everyone has to have their face scanned to clock in.

Better Security –

You'll also enjoy better security with a facial biometrics system. Not only can you track employees, but any visitors can be added to the system and tracked throughout the area too. Anyone that is not in the system will not be given access.

Automated System –

Many companies like the fact that biometric imaging systems are automated. You won't have to worry about having someone there to monitor the system.

Easy Integration –

Biometric facial systems are also easy to integrate into your company. Usually they will work with existing software that you have in place.

High Success Rate –

Facial biometrics technology today has a high success rate, especially with the emergence of 3d face recognition. It is extremely difficult to fool the system, so you can feel secure knowing that your system will be successful at tracking time and attendance while providing better security.

6. CONCLUSION

This paper has attempted to review a significant number of papers to cover the recent development in face recognition field. Present study exposes that face recognition algorithm can be enhanced using hybrid methods for better performance. The list of references to provide more detailed understanding of the approaches described is enlisted. We apologize to researchers whose important contributions may have been overlooked. In future scope, one can implement hybrid method to get better result of face recognition.

7. REFERENCES

- [1] "Comparitive Study on Face Recognition Using HGPP, PCA, LDA, ICA and SVM", Global Journal of Computer Science and Technology Graphics & Vision Volume 12 Issue 15 Version 1.0 Year 2012 Type: Double Blind Peer Reviewed International Research Journal Publisher: Global Journals Inc. (USA) Online ISSN: 0975-4172 & Print ISSN: 0975-4350 By Hardik Kadiya , Merchant Engineering College.
- [2] "Improved PCA Algorithm for Face Recognition", World Applied Programming, Vol (2), Issue (1), January 2012. 55-59 Special section for proceeding of International e-Conference on Computer Engineering (IeCCE) 2012 ISSN: 2222-2510 ©2011 WAP journal. www.waprogramming.com, Vinay Rishiwal, Ashutosh Gupta

- [3] “REAL TIME FACE RECOGNITION BY VARIING NUMBER OF EIGENVALUES”, International Journal of Advanced Scientific and Technical Research Issue 3 volume 1, January-February 2013 Available online on <http://www.rspublication.com/ijst/index.html> ISSN 2249-9954, Prof. B.S PATIL1 Prof. A.R YARDI2, ,Dr Mrs Patil S B3
- [4] Chapter 15 CLUSTERING METHODS Lior Rokach Department of Industrial Engineering Tel-Aviv University liorr@eng.tau.ac.il Oded Maimon Department of Industrial Engineering Tel-Aviv University maimon@eng.tau.ac.il.
- [5] “Blind Authentication: A Secure Crypto-Biometric Verification Protocol” Maneesh Upmanyu, Anoop M. Namboodiri, Kannan Srinathan, and C. V. Jawahar”, IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, VOL. 5, NO. 2, JUNE 2010
- [6] “Very Low Resolution Face Recognition Problem” Wilman W. W. Zou, Student Member, IEEE, and Pong C. Yuen, Senior Member, IEEE, IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 21, NO. 1, JANUARY 2012
- [7] “Color Local Texture Features for Color Face Recognition” Jae Young Choi, Yong Man Ro, Senior Member, IEEE, and Konstantinos N. Plataniotis, Senior Member, IEEE, IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 21, NO. 3, MARCH 2012
- [8] “Multibiometric Cryptosystems Based on Feature-Level Fusion” Abhishek Nagar, Student Member, IEEE, Karthik Nandakumar, Member, IEEE, and Anil K. Jain, Fellow, IEEE, IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, VOL. 7, NO. 1, FEBRUARY 2012.
- [9] A Framework for Analyzing Template Security and Privacy in Biometric Authentication Systems” Koen Simoens, Julien Bringer, Hervé Chabanne, and Stefaan Seys, IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY, VOL. 7, NO. 2, APRIL 2012
- [10] “A Review Paper on Biometrics: Facial Recognition” Sakshi Goel1, Akhil Kaushik2, Kirtika Goel3, International Journal of Scientific Research Engineering & Technology (IJSRET) Volume 1 Issue 5 pp 012-017 August 2012 www.ijsret.org ISSN 2278 – 0882
- [11] Face Recognition: A Literature Review by Thomas Heseltine DPhil Research Student University of York ,2012
- [12] “ Face Recognition Based on Principal Component Analysis” Ali Javed Faculty of Telecom & Information Engineering, University of Engineering & Technology, Taxila, I.J. Image, Graphics and Signal Processing, 2013, 2, 38-44 Published Online February 2013 in MECS (<http://www.mecspress.org/>) DOI: 10.5815/ijgisp.2013.02.06
- [13] “ Face Recognition: Some Challenges in Forensics” Anil K. Jain, Brendan Klare and Unsang Park Department of Computer Science and Engineering Michigan State University East Lansing, MI, U.S.A {jain, klarebre, parkunsa}@cse.msu.edu
- [14] “Towards a Practical Face Recognition System: Robust Alignment and Illumination by Sparse Representation” Andrew Wagner, Student Member, IEEE, John Wright, Member, IEEE, Arvind Ganesh, Student Member, IEEE, Zihan Zhou, Student Member, IEEE, Hossein Mobahi, and Yi Ma, Senior Member, IEEE
- [15] Lih-Heng Chan, Sh-Hussain Salleh and Chee-Ming Ting. “Face Biometrics Based on Principal Component Analysis and Linear Discriminant Analysis.” J. Computer Sci., 6 (7): 693-699, 2010.
- [16] R. A. Fisher. “The Use of Multiple Measurements in Taxonomic Problems.”1936.
- [17] Jyoti S. Bedre, Shubhangi Sapkal. “Comparative Study of Face Recognition Techniques: A Review.” Emerging Trends in Computer Science and Information Technology – 2012(ETCSIT2012) Proceedings published in International Journal of Computer Applications® (IJCA) 12.
- [18] A.L. Yuille, D.S. Cohen, and P.W. Hallinan (19889) Feature extraction from faces using deformable templates proc. CVPR, San Diego, CA, June 1989.
- [19] Improved PCA Algorithm for Face Recognition, Vinay Rishiwall Ashutosh Gupta2, World Applied Programming, Vol (2), Issue (1), January 2012. 55-59, Special section for proceeding of International e-Conference on Computer Engineering (IeCCE) 2012, ISSN: 2222-2510 ©2011 WAP journal. www.waprogramming.com
- [20] “REAL TIME FACE RECOGNITION BY VARIING NUMBER OF EIGENVALUES” ,Prof. B.S PATIL1 Prof. A.R YARDI2, ,Dr Mrs Patil S B, International Journal of Advanced Scientific and Technical Research Issue 3 volume 1, January-February 2013 Available online on <http://www.rspublication.com/ijst/index.html> ISSN 2249-9954
- [21] AN EFFICIENT METHOD FOR FACE RECOGNITION USING PRINCIPAL COMPONENT ANALYSIS (PCA) Gunjan Dashore, Dr. V.Cyril Ra, International Journal of Advanced Technology & Engineering Research (IJATER), ISSN NO: 2250-3536 VOLUME 2, ISSUE 2, MARCH 2012.
- [22] “Eigenvectors of Covariance Matrix using Row Mean and Column Mean Sequences for Face Recognition ”International Journal of Biometrics and Bioinformatics (IJBB), Volume (4): Issue (2), Dr. H. B. Kekre, SAKshay Malooudeep D. Thepade, 2013
- [23] “Biometric Template Security” By Abhishek Nagar A Dissertation Submitted to Michigan State University in partial fulfillment of the requirements for the degree of Doctor of Philosophy Computer Science 2012
- [24] E. Mordini and S. Massari. Body, biometrics and identity. Bioethics, 22(9):488– 498, 2008.
- [25] J.D. Woodward. Biometrics: privacy’s foe or privacy’s friend? Proceedings of the IEEE, 85(9):1480 – 1492, 1997.
- [26] Mrs. Kamini H. Solanki, Dr. Prashant P. Pittalia. Novel Approach for Robust Face Recognition using Principle Component Analysis (PCA) with Skewness, International Journal of Computer Engineering and

Applications, Volume VI, Issue I April.14
www.ijcea.com ISSN 23213469.

- [27] “A complete and fully automated face verification system on mobile devices”, Jianfeng Ren a,n, XudongJiang b, JunsongYuan b, Pattern Recognition, www.elsevier.com/locate/pr
- [28] Face Recognition Performance: Role of Demographic Information, Brendan F. Klare, Member, IEEE, Mark J. Burge, Senior Member, IEEE, Joshua C. Klontz, Richard W. Vorder Bruegge, Member, IEEE, and Anil K. Jain, Fellow, IEEE
- [29] “Face Recognition Algorithms”, Proyecto Fin de Carrera , June 16, 2010 Ion Marques
- [30] Face Recognition using Neural Networks, P.Latha, Dr.L.Ganesan & Dr.S.Annadurai, Signal Processing: An International Journal (SPIJ) Volume (3) : Issue (5)
- [31] <http://www.journals.elsevier.com/image-and-vision-computing/call-for-papers/multibiometrics-and-mobile-biometrics/>
- [32] Face Recognition Algorithms, Proyecto Fin de Carrera , June 16, 2010 Ion Marques
- [33] A tutorial on Principal Components Analysis by Lindsay I Smith February 26, 2002
- [34] COMPARATIVE ANALYSIS OF FACE RECOGNITION ALGORITHMS by Mukesh Gollen , IJREAS Volume 2, Issue 2 (February 2012) ISSN: 2249-3905 International Journal of Research in Engineering & Applied Sciences. <http://www.euroasiapub.org>
- [35] 3D Face Recognition on GAVAB Dataset” by Kiran K. Panchal International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 www.ijert.org Vol. 2 Issue 6, June – 2013
- [36] Vapnik N. (1995): The Nature of Statistical Learning Theory, Springer.
- [37] Zhang Baochang and et al (2007): Histogram of Gabor Phase Patterns (HGPP). A Novel Object Representation Approach for Face Recognition, IEEE Transactions on Image Processing, vol. 16, No.1, pp 57-68.
- [38] An Efficient LDA Algorithm for Face Recognition Jie Yang, Hua Yu, William Kunz School of Computer Science Interactive Systems Laboratories Carnegie Mellon University Pittsburgh, PA 15213
- [39] On the Euclidean Distance of Images Liwei Wang, Yan Zhang, Jufu Feng Center for Information Sciences School of Electronics Engineering and Computer Sciences, Peking University Beijing, 100871, China {wanglw, zhangyan, fjf}@cis.pku.edu.cn
- [40] Automatic analysis of facial expressions: the state of the art, Pantic, M. ; Dept. of Media Eng. & Math., Delft Univ. of Technol., Netherlands ; Rothkrantz, L.J.M., Pattern Analysis and Machine Intelligence, IEEE Transactions on (Volume:22 , Issue: 12)Dec 2000
- [41] J. Li, Y. Wang, T. Tan, and A.K. Jain. Live Face Detection Based on the Analysis of Fourier Spectra. In Proceedings of SPIE Conference on Biometric Technology for Human Identification, volume 5404, pages 296–303, Orlando, USA, March 2004.
- [42] K. Kollreider, H. Fronthaler, and J. Bigun. Evaluating Liveness by Face Images and the Structure Tensor. In Proceedings of Fourth IEEE Workshop on Automatic Identification Advanced Technologies, pages 75–80, Buffalo, USA, October 2005.
- [43] H.-K. Jee, S.-U. Jung, and J.-H. Yoo. Liveness Detection for Embedded Face Recognition System. International Journal of Biomedical Sciences, 1(4):235– 238, 2006.
- [44] A. Lanitis, C. J. Taylor, and T. F. Cootes, “Towards automatic simulation of ageing effectson face images,” IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 24, no. 4, pp.442–455, 2002.
- [45] N. Senthilkumaran and R. Rajesh, “A Study on Edge Detection Methods for ImageSegmentation”, Proceedings