FACE RECOGNITION TECHNIQUES: A REVIEW

Prasanta Pratim Bairagi[1], Assistant Professor, Department of Computer Science and Engineering, Assam down town University, Guwahati, Assam

Nijara Kalita[2], Assistant Professor, Department of Computer Science and Engineering, Assam down town University, Guwahati, Assam

Abstract:

Identifying or verifying a person from a frame has been popularized through a mass media. Nowadays identifying a person as through a system has become more interesting and popular as well as more researches are going on to improve the system which can be a great used in the future. This project deals with the development of a system which provides the information of the faces which need to identify at present time. To recognize the face in a frame, we need to check whether the human face is available in the frame. In modern days to make a system secure many features are equipped with various biometric security options like password, fingerprint, face detection etc. It protects the privacy, personal information of a person. When such software like real time face detection and recognition is equipped in the system as a security, a system must detect the face of a person. If the face is identified by the system, the system will allow to get accessed or else it will not. Thus this make every person to feel more secured with their data in the system. It is also very useful in surveillance areas which help the military forces for official works.

Key words: Face Detection, Face Recognition, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Eigenfaces, Fisherface, Local Binary Pattern Histogram (LBPH).

1. Introduction

A real time face detection and recognition system is capable of recognising or identifying an individual from a video frame or through a camera or webcam or from a photograph. Nowadays face detection is used world-wide for the security and safety of the people. It can be as a biometric in the system of any electronic devices like Smart phones, PC, laptops etc. for example device must detect the right face to get unlock. In surveillance areas face detection plays a vital role in detection faces which is a great helps for the military forces to find the criminals especially in crowded places. The initial work related to face detection and recognition was started in early 1950s [1] and in early 1997, the first automated system for face detection was introduced by Kanade [2].

There are multiple methods in which facial recognition systems work, but in general, they work by comparing selected facial features from given image with faces within a database. Face

recognition systems use different techniques to pick out specific, distinctive details about a individuals face. These details, such as distance between the eyes or shape of the chin, are then converted into a mathematical representation and compared to data on other faces collected in a face recognition database. To recognize the face in a frame, first we need to check whether the face is present in the frame or not. OpenCV (*Open Source Computer Vision Library*) is a library of programming functions which mainly aimed to use at real-time computer vision in order to detect any object [3, 4].

A face recognition system can be divided into three major steps:

a) Face Detection/ localization: Face detection is the necessary first step in a face recognition system. The main aim of this phase is to determine whether a human face appears in a given image.

b) Features Extraction: The main aim of this phase is to extract features of different face elements like eyes, nose, mouth, etc from human face image. This process is very much important to initiate other techniques like face tracking, facial expression recognition or face recognition. Feature extraction involves several ways - dimensionality reduction, feature extraction and feature selection. Dimensionality reduction is an essential task in any pattern recognition system.

c) Face Recognition: The main aim of face recognition phase is to identify a face from the images in the database.

2. Literature Review

a. In [5], author introduced the Principal Component analysis (PCA) for feature extraction. It is one of the oldest and most popular methods of feature detection and extraction. Using PCA recognition of individual faces was first done by Turk and Pentland [6] which was considered as a major milestone in technology and reconstruction of human faces was done by Kirby and Sirovich [7].

b. In [8], author introduced Local Binary Pattern analysis for texture recognition which was improved for facial recognition later by incorporating Histograms (LBPH). LBP has been used for facial representation in different tasks, which include face detection [19], [20], [21], face recognition [22], [23], facial expression analysis [24], [25], demographic (gender, race, age, etc.) classification [26], [27], and other related applications [28], [29].

c. In [9], author introduced Linear Discriminant Analysis (LDA) for dimensional reduction which can identify faces in different illumination conditions, which was a biggest problem in Eigenfaces method. A subspace analysis method for face recognition called kernel discriminant

locality preserving projections (MMDLPP) was proposed in [18] based on the analysis of LDA, LPP and kernel functions.

d. In [10], author introduced a recursive algorithm for calculating the discriminant features of PCA-LDA procedure. This algorithm includes four steps- Preprocessing, Dimension Reduction Using PCA, Feature Extraction Using LDA and Classifications using Neural Network.

e. In [11], author introduced a face detection technique using HAAR cascades and ADABoost. HAAR cascades are also used for face detection and Eigenfaces, Fisherface and LBPH are used for face recognition.

f. In [12, 13], author introduced a face detection technique using Gabor Jets which are similar to mammalian eyes. The basic idea behind the DGJ-based face detection is to first detect fiducial points such as eye corners and mouth corners and then to detect faces by verifying the relative positions of fiducial points with a reference graph.

3. Face Recognition Techniques

The following sections describe some of the most popular face recognition method like Eigenfaces, Fisherface, and Local binary pattern histogram. They are-

a. Eigenfaces face recognizer: It is also known as Karhunen- Loève expansion, eigenpicture, eigenvector, and principal component. References [30, 31] used principal component analysis to efficiently represent pictures of faces. This algorithm considers the fact that a person can be recognized by his distinct features, like the eyes, nose, cheeks or forehead and how they vary respect to each other. It extracts all the components which are useful from the images of the people and discard the rest. These important features are called principal components. The important features represent the faces of the people.

Thus a new image is introduced it repeats the same process as follows:

i. Extract the principal components from the new picture.
ii. Compare those features with the list of elements stored during training.
iii. Find the ones with the best match.
iv. Return the ‘person’ label associated with that best match component.

Eigenfaces also considers illumination as an important feature i.e., it picks anything having two eyes, a nose, and a mouth that resemble a face. Lights and shadows are picked up by Eigenfaces, which classifies them as representing a face. To avoid such issue we can do it by tuning Eigenfaces so that it extracts useful features from the faces of each person separately instead of extracting them from all the faces combined. In this way, even if one person has high illumination changes, it will not affect the other people's features extraction process

b. Fisher face recognizer: Fisherface technique builds upon the Eigenface and is based on LDA derived from Ronald Fishers' linear discriminant technique used for pattern recognition. However, it uses labels for classes as well as data point information [9]. This algorithm is an improved version of the Eigenfaces. Eigenfaces looks at all the training faces of all the people at once and finds principal components from all of them combined. This technique concentrates on the ones that represent all the faces of all the people in the training data, as a whole.

Since Eigenfaces also finds illumination as a useful component, it will find this variation very relevant for face recognition and may discard the features of the other people's faces, considering them less useful. In the end, the variance that Eigenfaces has extracted represents just one individual's facial features.

Fisherface face recognizer algorithm extracts principal components that differentiate one person from the others. In this process, an individual's components do not dominate over the others. Fisherface only prevents features of one person from becoming dominant, but it still considers illumination changes as a useful feature.

c. Local Binary Pattern Histograms: Local binary patterns were proposed as classifiers in computer vision and in 1990 By Li Wang [14]. The combination of LBP with histogram oriented gradients was introduced in 2009 that increased its performance in certain datasets [8]. The effect of light is a major issue in Eigenfaces and Fisherfaces and LBPH overcome this issue. LBPH find its local structure by comparing each pixel to the neighbouring pixels and extract a histogram from every region of the grid to give a combined result.

LBPH have the pattern of the faces and during recognition, the process is as follows:

i. Feed a new image to the recognizer for face recognition.
ii. The recognizer generates a histogram for that new picture.
iii. It then compares that histogram with the histograms it already has.
iv. Finally, it finds the best match and returns the person label associated with that best match.

d. Support Vector Machine: SVM is a face recognition technique which is considered an effective method for face recognition because of its high performance without the need to add other knowledge [32]. SVM can also be considered as a train polynomial neural networks or Radial Basis function classifier. This technique is very much useful in average size face recognition system due to its training set. In SVM, the face recognition process has been divided into two particular categories [33]. They are:

i. Dissimilarities between faces of the same person.
ii. Dissimilarities between faces of different person.

e. Neural Networks: The use of Neural Network in the face recognition system is very much popular due to its nonlinearity characteristics in the network which gives more accurate results in the feature extraction. The first artificial neural networks (ANN) based techniques used for face recognition is a single layer adaptive network called WISARD which contains a separate network for each stored individual [34]. Later a new approach has been introduced in which face detection was done by using the Gabor wavelets & feed forward neural network [35].

4. Applications Of Face Recognition System

There are many useful applications that can be used. Here some of the following uses:

a) **Face Identification:** Face recognition system can be used to identify and verify anyone ids, voter id's etc. using face rather than check the validation, passwords or PINs.

b) **Access control:** To get accessed in the system one's have to do many ways like typing of passwords or PINs, answering question, using any other recourses and so.

c) **Security:** Today most people are aware of all fraud and illegal things in which mischievous person tried to trick other for their own benefit. Most people have many IDs including the illegal so that they can hide their identities. So face detection and reorganization is very important to identify the person face as a person cannot have many faces. This system is used everywhere for the protection of the people like airport, military force, banks.etc and also in the devices like smart phones, laptops.etc

d) **Image database Investigations:** Through this system information of the people is stored in the database, so license, ids, can be identified and verified easily. It is also used by the military force in search of a person or to identify a person before entering to any place.

5. Conclusion

Real time face detection and recognition system have been considered as a very powerful security technique which provides top class security in different applications. It is very useful for places that required more security like banks, military etc. as well as for all modern devices like smart phones, laptops etc. In surveillance it provides an easy way in finding a person which is always used by the military force to catch the criminal. Every device has its own features like some can use only as security, others can more do more like editing the faces and many application just for fun. In this paper, we have tried to review a significant number of papers to analysis some mostly used faced recognition techniques and also tried to cover the recent development in the field of face recognition.

REFERENCES

[1] Bruner, I. S. and Tagiuri, R. *The perception of people. In Handbook of Social Psychology*, Vol. 2, G. Lindzey, Ed., Addison-Wesley, Reading, MA, 634–654.1954

[2] Takeo Kanade. Computer recognition of human faces, volume 47. Birkh¨auser Basel, 1977.

[3] Facial Recognition using OpenCV, Shervin EMAMI1, Valentin Petruț SUCIU2., www.jmeds.eu.

[4] Ammar Anuar, Khairul Muzzammil Saipullah, Nurul Atiqah Ismail, Yewguan Soo "OpenCV Based Real-Time Video Processing Using Android Smartphone" , IJCTEE, Volume 1, Issue 3

[5] Lawrence Sirovich and Michael Kirby. Low-dimensional procedure for the characterization of human faces. Josa a, 4(3):519–524, 1987.

[6] M. Turk and A. Pentland, "Eigenfaces for recognition," *J. Cognitive Neuroscience,vol*. 3, 71-86., 1991.

[7] D. L. Swets and J. J. Weng, "Using Discriminant eigenfeatures for image retrieval", *IEEE Trans. PAMI.*, vol. 18, No. 8, 831-836, 1996.

[8] X. Wang, T. X. Han, and S. Yan. An hog-lbp human detector with partial occlusion handling. In 2009 IEEE 12th International Conference on Computer Vision, pages 32–39, Sept 2009.

[9] P. N. Belhumeur, J. P. Hespanha, and D. J. Kriegman. Eigenfaces vs. fisherfaces: recognition using class specific linear projection. IEEE Transactions on Pattern Analysis and Machine Intelligence, 19(7):711–720, Jul 1997.

[10] Issam Dagher,‖Incremental PCA-LDA algorithm‖, *International Journal of Biometrics and Bioinformatics (IJBB)*, Volume (4): Issue (2)

[11] P. Viola and M. Jones. Rapid object detection using a boosted cascade of simple features. In Proceed- ings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. CVPR 2001, volume 1, pages I–511–I–518 vol.1, 2001.

[12] John G Daugman. Uncertainty relation for resolution in space, spatial frequency, and orientation optimized by two-dimensional visual cortical filters. JOSA A, 2(7):1160–1169, 1985.

[13] S Marˆcelja. Mathematical description of the responses of simple cortical cells. JOSA, 70(11):1297– 1300, 1980. S Marcelja. Mathematical description of the responses of simple cortical cells. JOSA, 70(11):1297– 1300, 1980.

[14] Dong chen He and Li Wang. Texture unit, texture spectrum, and texture analysis. IEEE Transactions on Geoscience and Remote Sensing, 28(4):509–512, Jul 1990.

[15] Rainer Lienhart and Jochen Maydt. An extended set of haar-like features for rapid object detection. In Image Processing. 2002. Proceedings. 2002 International Conference on, volume 1, pages I–I. IEEE, 2002.

[16] John P Lewis. Fast template matching. In Vision interface, volume 95, pages 15–19, 1995.

[17] N. Revathy, T. Guhan, "Face recognition system using back propagation artificial neural networks", International Journal of Advanced Engineering Technology, vol.3, no. 1, 2012.

[18] Rongbing Huang , Changming Su a, Fangnian Lang a, Minghui Du,‖ Kernel Discriminant Locality Preserving Projections for Human Face Recognition‖, *Journal of Information & Computational Science* 7: 4 (2010)

[19] Hadid, M. Pietikainen, and T. Ahonen, "A discriminative feature space for detecting and recognizing faces," in Proc. Int. Conf. Comput. Vis. Pattern Recog., 2004, pp. 797–804.

[20] W. Ali, F. Georgsson, and T. Hellstrom, "Visual tree detection for autonomous navigation in forest environment," in Proc. IEEE Intell. Veh. Symp., Jun. 2008, pp. 560–565.

[21] H. Zhang and D. Zhao, "Spatial histogram features for face detection in color images," in Proc. Adv. Multimedia Inform. Process., Pacific Rim Conf. Multimedia, 2004, pp. 377–384.

[22] T. Ahonen, A. Hadid, and M. Pietikainen, "Face description with local binary patterns: Application to face recognition," IEEE Trans. Pattern Anal. Mach. Intell., vol. 28, no. 12, pp. 2037–2041, Dec. 2006.

[23] J. Zhao, H. Wang, H. Ren, and S.-C. Kee, "LBP discriminant analysis for face verification," presented at the IEEE Workshop Face Recog. Grand Challenge Exp., San Diego, CA, Jun. 2005

[24] C. Shan, S. Gong, and P. W. McOwan, "Facial expression recognition based on local binary patterns: A comprehensive study," Image Vis. Comput., vol. 27, no. 6, pp. 803–816, May 2009

[25] T. Gritti, C. Shan, V. Jeanne, and R. Braspenning, "Local features based facial expression recognition with face registration errors," presented at the IEEE Int. Conf. Autom. Face Gesture Recog., Amsterdam, The Netherlands, Sep. 2008

[26] N. Sun, W. Zheng, C. Sun, C. Zou, and L Zhao, "Gender classification based on boosting local binary pattern," in Proc. Int. Symp. Neural Netw., 2006, pp. II: 194–201.

[27] Z. Yang and H. Ai, "Demographic classification with local binary patterns," in Proc. Int. Conf. Biometrics, 2007, pp. 464–473

[28] X. Gao, S. Z. Li, R. Liu, and P. Zhang, "Standardization of face image sample quality," in Proc. Int. Conf. Biometrics, 2007, pp. 242–251.

[29] B. Ma, W. Zhang, S. Shan, X. Chen, and W. Gao, "Robust head pose estimation using LGBP," in Proc. Int. Conf. Pattern Recog., 2006, pp. 512–515.

[30] L. Sirovich and M. Kirby, "Low-Dimensional procedure for the characterisation of human faces," J. Optical Soc. of Am., vol. 4, pp. 519-524, 1987.

[31] M. Kirby and L. Sirovich, "Application of the Karhunen- Loève procedure for the characterisation of human faces," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 12, pp. 831-835, Dec. 1990.

[32] V.N. Vapnik, "*The nature of statistical learning theory*," New York: Springverlag, 1995.

[33] P.J. Phillips, "Support vector machines applied to face recognition," *Processing system* 11, 1999.

[34] T.J. Stonham, "Practical face recognition and verification with WISARD," *Aspects of Face Processing*, pp. 426-441, 1984.

[35] Avinash Kaushal, J P S Raina,‖ Face Detection using Neural Network & Gabor Wavelet Transform‖ *IJCST* Vol. 1, Issue 1, September 2010