International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.04, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Review of Face Recognition Method

Priyanka Rajendra Gaikwad[1], Professor V.N. Bhonge[2]

[1]*E&TC, Shri Sant Gajanan Maharaj College of Engineering Shegaon, (India)*

[2]*E&TC, Shri Sant Gajanan Maharaj College of Engineering Shegaon, (India)*

ABSTRACT

Face recognition is one of the critical unsolved problems in computer science, a lot of time and energy is spent to invent a robust solution for it. Face recognition can play a significant role in security, Biometric verification, auto detection of criminals in a crowd, etc. Researchers conclude that feature extraction based approach and holistic are the two widely used methodologies for face recognition. This paper provides a detailed review of different methodologies used for face recognition.

Keywords: Biometric Verification, Deep Learning, Face Recognition, Face Detection, Image Processing,

I. INTRODUCTION

We all are gifted with an incredible ability to recognize a human face. A field of computer science – Machine Learning, gives the computer the ability to self-learn based on the information gained in the training phase. One of the main focuses of Machine learning is to provide computers the incredible ability to recognize a human face. Face Recognition and Face Detection are frequently interchangeable words in this field but both have a distinct meaning. A computer technology that is able to identify human faces in a given digital image is called as Face Detection, whereas Face Recognition is one of the applications of Face Detection, it describes a biometric technology that attempts to identify the person in the image, count the number of human faces in the image. From past few years, Researchers [1] introduced several methods for face recognition. Earlier approach of Face Recognition extracts features (local) from an image for analysis but due to the non-availability of robust and distinctive local feature, this approach was deprecated and a holistic approach was developed which takes whole face region as an input to the recognition system. However, the holistic approach was nonperformance [2] for images that have a variation of the face due to pose and variation in the angle of taking an image. We would study different approaches to Face Recognition developed and used over these years in detail along with their advantages and disadvantages.

II. THE PROCESS OF RECOGNISING FACE

The face recognition process typically involves three processes:

i) Detect Face in Image

ii) Extraction of the Face Features

iii) Recognize the Face

Each of this process is explained in detail below:

2.1) Detect Face in Image

Authors L. R. Cerna, G. Cámara-Chávez, D. Menotti [3] mention various methods of face detection viz: Histogram of Oriented Gradients, Bag of features

2.1.1) Histogram of Oriented Gradients (HOG)

Histogram of Oriented Gradients are used in various field of Image Processing, computer vision etc. to detect the faces in the image. HOG descriptor is preferred for face recognition as it provides a robust feature set to distinguish and detect the face in a variety of image that has different lighting background, a wide range of pose, different locations etc.

HOG reminds us of other methods like SIFT descriptor, Shape Context mainly because they prefer using the dense grid of cells that overlap local contract histogram normalization of image gradient orientations to improve the detector performance [4]. HOG feature set performs well for face detection because it uses the same principle as used in above two methods [5].

HOG features are calculated by taking orientation histograms of edge intensity in a local region. We extract HOG features from 16×16 local regions. In this cell, gradient orientation is calculated. Sober filters are used to obtain the edge gradients and orientations. [6].

The steps for calculating HOG is explained in Fig:1

(a) Original pedestrian image scaled to 20x40 pixels,

(b) Gradient image,

(c) The image divided into cells of 5x5 pixels, resulting in 4x8 cells,

(d) Resulting HOG descriptor for the image showing the gradient orientation histograms in each cell [7].

2.1.2) Bag of Features

Bag of Feature [8-10], popularly known as Bag of Virtual Words, is inspired by the natural language processing application that represents text documents by the histogram of word occurrence in that document.

These natural language processing methods rely on the vocabulary of words which are readily available for words but the vocabulary of the image is not readily available, it needs to be generated by studying the set of training images. The image vocabulary is created by following steps:

i) The local features are extracted from the set of training images.

ii) K-means clustering is applied to these features to make them vector quantized.

iii) The calculated centers of these clusters are referred to as virtual words, and collectively they form a vocabulary.

Once we have the image vocabulary, the local features, extracted from the image under the study, are mapped to virtual words and each category too is represented by a virtual word. The vocabulary creation can be illustrated in Fig 2:

Each image is then represented by a histogram that contains the frequency of the visual word in the image, and this histogram is referred as Bag of Feature. Such representation not only allows us to compare the similarities in the image but also provides us a way to query the database to retrieve the similar images.
The simplicity and low computation complexity have made Bag of Feature successful in different applications viz. object or face detection [11], retrieval [13], classification [12].

2.1.3) Bag of Feature for Image classification

The Bag of Feature for Image classification follows the similar process as that of Bag of Words. The Bag of Feature represents each image as an orderless collection of local features [14], for face the local feature can be the mouth, eye, ears, eyebrow etc.

The steps involved in Image classification are as follows:

i) Extract the orderless collection of local facial features, these would be basic element candidates (can be compared to "words" in Bag of Words)
ii) Clustering process is applied to these features to get the clusters of different size.
iii) The center of each cluster is considered as "codeword" and is used to build the histogram based on the frequency of their appearances in the image.

Each feature in the image is mapped to these “codeword” using the clustering process, and these features are used to build the histogram.

The Fig. 3 is the graphical representation of the process explained above. For Face detection, the above process is executed on the input image, the feature vector is extracted for each sub-window and then these are classified as face or non- face [14], as represented in Fig.4.

2.2) Extraction of the Face Features

Once the face is detected in an image, the next logical operation is to extract the feature of the face. The face has around 25 invariant features viz –Left Eye, Right Eye, Nose, Mouth Left, Mouth Right, Left Eyebrow, Right Eyebrow Pupil etc. The various feature extraction technique is categorized into Holistic Approach, Local Approach, and Hybrid Approach [15]

2.2.1) Holistic Approach

A holistic approach is widely used in face recognition. In this approach, the whole image is taken into account for analysis and is represented as high dimensional vector space. The size of the dimensional vector is derived from the size of the image that is represented in a pixel unit, for example, the image of size 256 x 256 pixel would convert into 65536-dimensional vector space. One of the concerns when dealing with high dimensional vector space is the high computation cost. This concern is addressed by using Dimensionality reduction technique. In this technique, some transformations are applied on the image to reduce the dimensionality without losing their accuracy.

Various methods that use this approach are Support Vector Machine (SVM), Hidden Markov Model (HMM), Fisher faces etc. All these methods are based on Principal Component Analysis (PCA),

Karhunen-Lo`eve expansion:

Karhunen-Lo`eve expansion finds a small number of features in an image which is termed as Principal Component of a face. These components are found by first projecting the two-dimensional face vector space into a one-dimensional subspace, and then selecting the principal component which captures the highest variances among individual faces. Eigenvectors and eigenvalues are used to calculate the principal component of faces; the eigenvector consists of feature space that represents variations among the faces. The face is represented by finding the best feature among these feature space. [16].

2.2.2) Local Feature Extraction Approach

The local feature extraction approach considers a small portion of an image for analysis rather than considering the whole image as done in Holistic approach. The features are extracted using the transformation or measurement, and the geometric feature-based methods describe the local feature and their geometric relationship. Gaborwavelet transform based features, and discrete cosine transform DCT-based features are commonly used local feature extraction techniques.

2D Discrete Cosine Transform (DCT)

In DCT method, the image is divided into uncorrelated smaller images on which DCT transform is applied on a block by block basis [17], mathematically, it can be represented in: (1)

2.2.3) Hybrid Approach

The Hybrid Approach [18] is the combination of local and global feature extraction approaches. In this approach, DCT transformation is applied on both the small portions of the images (local feature approach) and on the image as a whole (global feature). The small sections of the face are eye, nose, mouth etc. on which the DCT transformation is applied to extract 50 coefficients. The transformation is also applied to the image as a whole, and again 50 coefficients are extracted. The Euclidian distance of 50 coefficients are calculated, and sum together to represent a particular feature. The rank of the coefficient with minimum sum is considered as 1. For identification of the person, the rank of both the global and local features are compared, if the rank of both is "1" then only the person's identification is confirmed else it is rejected. This approach has the excellent result; false acceptance rate is zero with this approach.

2.3) Recognize the Face

There are various Face recognition methods developed in recent times, they can be broadly classified into following sections:

i) Geometric Feature-Based Methods
ii) Feature-Based Methods
iii) Neural Network-Based Methods

2.3.1) Geometric Feature-Based Methods

In Geometric Feature Based methods, the facial features are identified, and then the Feature Vector is formed by joining together the geometric relationship among the features. The training images are studied beforehand, and their results are stored in the database. For the test image, the minimum distance between the feature vector of the test image and that of the training image is calculated and based on the result the identification is done.
The performance of this method is a concern when compared to other methods. In [19], Brunelli and Poggio explain that the template-based method has significant performance over Geometric based method.

2.3.2) Feature-Based Methods

The Feature-Based Methods uses non-linearity feature pattern distribution. Kernel Direct Discriminate Analysis Algorithm and SIFT comes under Feature-Based Methods.

2.3.2.1) Kernel Direct Discriminate Analysis Algorithm:

This method uses non-linearity feature pattern distribution [20] to recognize the face in the image. Small set features only are taken into consideration; as a result, this method has a minimum error rate as compared to other methods like Kernel-PCA and GDA - Generalized Discriminant Analysis.

2.3.2.2) Scale Invariant Feature Transform (SIFT)

In [21], describes the SIFT algorithm which is widely used in face recognition. SIFT algorithm has been divided into 4 procedures:

i) Scale-space extrema detection: The first stage of computation searches overall image locations and scales, it uses the difference-of-Gaussian function to identify potential interest points that are invariant to scale and orientations. The scale space function is produced from a convolution of a variable-scale Gaussian: (2)

ii) Accurate key point localization: In this step, the value of Laplacian function at each candidate key point is evaluated. The key point will be removed if the value of the function is found to be below the set threshold value as this indicates that the structure has a low contract. In case of poorly denned peaks in the scale-normalized Laplacian of Gaussian operator, the ratio of principal curvature for each candidate key point is calculated, and if the ratio is found to be below the set threshold value the key point is retained.

iii) Orientation assignment: Based on local image gradient directions, one or more orientation is assigned to each key point.

iv) Key-point descriptor: The image gradient and orientation are measured around each key point. The feature descriptor is calculated as a set of orientation histogram on 16x16 pixels around key point. Each of this histogram contains 8 bins, and each descriptor contains a 4x4 array of histogram around each key point. Thus for each key point, the feature vector is 4x4x8=128 dimensions.

2.3.3) Neural Network Based Methods

The Neural Network methods are as follows:

i) Training Feed forward Networks with the Marquardt Algorithm: In [22], Marquardt algorithm is used for non-linear least square and is build-in the back propagation algorithm for training feed-forward neural network. When the neural network contains few hundredweights, this method gives the best result.

ii) Detection using Polynomial Neural Network (PNN): In [23], the PNN takes the binomials of the projection of a local image onto a feature subspace which is evaluated from the PCA. The distance calculated from the feature space, together with the PNN improves the performance of face detection.

iii) The depth and Curvature Feature Based Recognition: Instead of Convention based features, in [24] Depth and curvature features are used for recognition as it is the best descriptor for describing the face regions that are most affected by pose variation viz. cheeks, forehead etc.

iv) Detection and Localization of Faces Using MLP: In [25], Machine learning is used for face detection and recognition. The recognition is carried out by multiresolution analysis of digital images. In machine learning technique, the computer is trained by analysis set of training images, the result of the analysis is stored in the database, and the same is used for face recognition by comparing the analysis result of an image with the results stored in the database.

III. INDENTATIONS AND EQUATIONS

3.1) Equation (1):

$$\mathbf{I(u,v)} = \alpha(u)\alpha(v)cos\left[(2x+1)\frac{\pi u}{2N}\right]cos\left[(2y+1)\frac{\pi u}{2M}\right]\mathbf{I(x,y)}$$

Here,

I(x, y) = Original image pixel intensity value

I (u, v) = Transformed coefficient,

u = ranges from 0 to M-1,

v = ranges from 0 to N-1,

M*N = size of images

3.2) Equation (2):

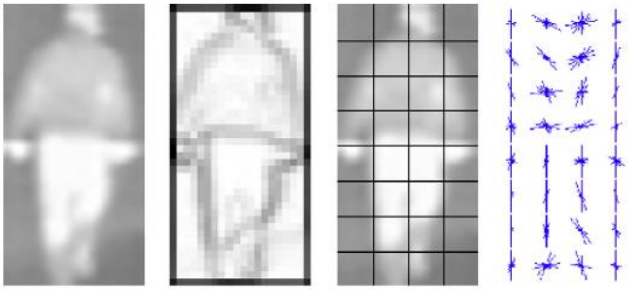
$$L(x, y, \sigma) = G(x, y, \sigma) * I(x, y)$$

where $I(x, y)$ is the given image and

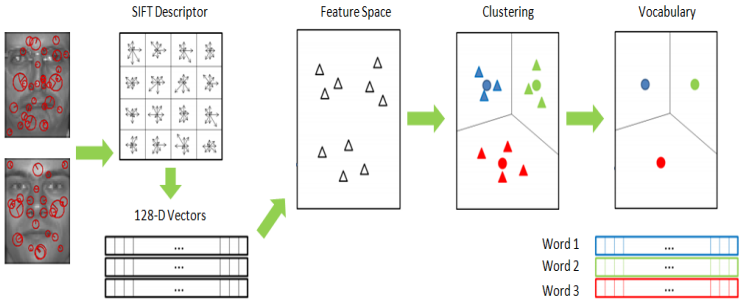
$$G(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{\sigma^2}}$$

IV. FIGURES AND TABLES

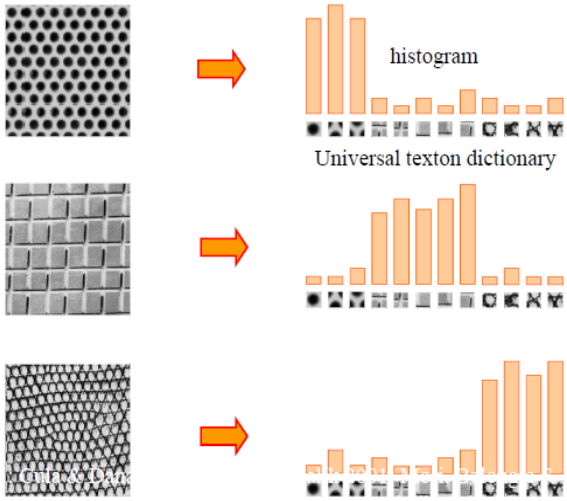
4.1) Fig. 1: images from the various stages of generating a Histogram of Oriented Gradients feature vector



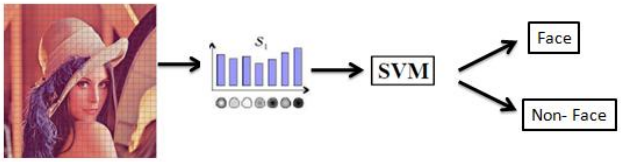
4.2) Fig. 2: Steps for Vocabulary Creation.



4.3) Fig. 3: Bag of Feature – Image classification



4.4) Fig. 4: Bag of Feature – Face, Non-Face classification



V. CONCLUSION

In 90's the traditional linear feature extraction methods were used. Since then there has been a lot of innovation and new techniques for non-linear feature extraction were used. These days machine learning is taking computer more closely to the way the human brain recognizes the faces. The main purpose of this paper is to provide details of various methods and their technique to carry out face recognition.

REFERENCES

[1] W. Zhao, R. Chellappa, P.J. Phillips, and A. Rosenfeld, "Face recognition: A literature survey," *ACM Computing Surveys*, vol. 35, no. 4, pp. 399–458, 2003.

[2] Q. Yang and X.O. Tang, "Recent advances in subspace analysis for face recognition," in Advances in Biometric Person Authentication, pp. 275–287. 2005.

[3] L. R. Cerna, G. Cámara-Chávez, D. Menotti. Face Detection: Histogram of Oriented Gradients and Bag of Feature Method.

[4] O. Déniz, G. Bueno, J. Salido, and F. De la Torre. Face recognition using histograms of oriented gradients. Pattern Recognition Letters, 32(12):1598–1603, 2011.

[5] N. Dalal and B. Triggs. Histograms of oriented gradients for human detection. In Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on, volume 1, pages 886–893. IEEE, 2005.

[6] Histograms Of Oriented Gradients For Human Detection Navneet Dalal And Bill Triggs

[7] R. O0Malley, E. Jones, and M. Glavin. Detection of pedestrians in far-infrared automotive night vision using region-growing and clothing distortion compensation. Infrared Physics & Technology, 53(6):439 449, 2010.

[8] G. Csurka, C. R. Dance, L. Fan, et al., Visual Categorization with Bags of Keypoints, ECCV Workshop on Statistical Learning in Computer Vision, Prague, Czech Republic, 2004.

[9] J. Sivic and A. Zisserman, Video Google: A Text Retrieval Approach to Object Matching in Videos, Proceedings of the IEEE International Conference on Computer Vision (ICCV), Nice, France, pp. 1470 - 1477, 2003.

[10] F.-F. Li and P. Perona, A Bayesian Hierarchical Model for Learning Natural Scene Categories, Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), San Diego, CA, United States, pp. 524-531, 2005

[11] S. Lazebnik, C. Schmid, and J. Ponce, Beyond Bags of Features: Spatial Pyramid Matching for Recognizing Natural Scene Categories, Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), New York, NY, USA, pp. 2169-2178, 2006

[12] J. Sivic and A. Zisserman, Video Google: A Text Retrieval Approach to Object Matching in Videos, Proceedings of the IEEE International Conference on Computer Vision (ICCV), Nice, France, pp. 1470 - 1477, 2003

[13] Z. Li, J. Imai, and M. Kaneko, Robust Face Recognition Using Block-Based Bag of Words, Proceedings of the International Conference on Pattern Recognition (ICPR), Istanbul, Turkey, pp. 1285-1288, 2010

[14] L. Fei-Fei and P. Perona. A Bayesian hierarchical model for learning natural scene categories. In Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on, volume 2, pages 524–531. IEEE, 2005.

[15] A Survey On Face Detection Methods And Feature Extraction Techniques Of Face Recognition -Urvashi Bakshi, Rohit Singhal, International Journal Of Emerging Trends & Technology in Computer Science 2014.

[16] Kirby, M. & Sirovich, L. (1990), 'Application Of The Karhunen-Lo`Eve Procedure For The Characterization Of Human faces', Ieee Transaction. PatternAnalysis And Machine Intelligence 12(1), 103–108.

[17] Face Recognition Using Block-Based Dct Feature Extraction K Manikantan, Vaishnavi Govindarajan, V V S Sasi Kiran, S Ramachandran Journal Of Advanced Computer Science And Technology, 2012.

[18] "Face Recognition Using Discrete Cosine Transform for Global and Local Features" Aman R. Chadha, Pallavi P. Vaidya, M. Mani Roja Proceedings at the 2011 International Conference on Recent Advancements in Electrical, Electronics and Control Engineering, 2011

[19] R.Chellappa.C. Wilson and S.Sirohey; "Human and Machine recognition of face", Proceedings of IEEE, vol 83,pp.705-741,1995.

[20] Anastasios N. Venetsanopoulos " Face Recognition Using Kernel Direct Discriminant Analysis Algorithms"; IEEE Transactions On Neural Networks, Vol. 14, No. 1, pp.117-126,2003.

[21] T. Ojala, M. Pietikinen, and T. Menp, Multiresolution grayscale, and rotation Invariant texture classification with local binary patterns, IEEE Trans. Pattern Analysis and Machine Intelligence, vol.24, no.7, pp.971-987, 2002

[22] Martin T. Hagan and Mohammad B. Menhaj, "Training Feedforward Networks with the Marquardt Algorithm" IEEE Transactions On Neural Networks, VOL. 5, NO. 6, pp.986-993, 1994.

[23] Yoshihiro Hagihara, Lin-Lin Huang, Akinobu Shimizu, "Face detection from cluttered images using a polynomial neural network", Neurocomputing Elsevier Science, pp.197-211,2003.

[24] Gaile G. Gordon," Face Recognition Based on Depth and Curvature Features" International journal of pattern recognition, vol 16,pp808-810,1992.

[25] Gilles BUREL & Dominique CAREL," Detection and localization of faces on digital images", Pattern Recognition Letters, Vol. 15, no 10, pp.1-9, 1994.