

FACE RECOGNITION TECHNIQUES AND APPROACHES: A SURVEY

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ABSTRACT: Face recognition is a necessity of the modern age as the need for identification of individual has increased with the globalization of the world. Personal authentication through face has been under research since last two decades. The performance of the face recognition system has been enhanced using various algorithms. A generic facial authentication method contains three major steps i.e. face detection, facial features segmentation and face recognition. There are many commonly used algorithms used for this purpose. This paper provides an overview of different face recognition approaches. These approaches are categorized into four classes in this paper. These are holistic based approach, model based approach, hybrid based approach and feature based approach. Various techniques introduced in each of these categories are discussed.

Key words: Face Detection, Face Recognition, Eigen Faces, Hybrid method, PDA.

INTRODUCTION

A facial recognition methodology is a way to automatically verify person by matching his digital image with the database of images. Nowadays the security of person, information or assets is becoming more difficult and important. The crimes like credit card misuse and computer hacking or security breach in organizations are increasing day by day. The face recognition technology is a branch of biometrics through which the humans are identified [1].

In 1960s First face recognition algorithms was introduced in which geometric features were used for detection of face and recognition of a person [2]. First automated face recognition system was proposed by Kanade in 1973 [3; 4] whereas the traditional technique in face recognition is Template Matching [5]. Turk and Pentland gave the concept of eigen face in 1991 based upon the “principal component analysis” (PCA) [6]. Eigen face was further improved by Belhumeur et al. and Frey et al. [7; 8]. Intensity images of the face are usually used in face recognition systems and most of the research, which is referred as “2D images”. While adding the depth of the face, nose, and eyes etc. represents “3D image” of the face or three-dimensional shape. An extensive survey on 3D and 2D face recognition is given in [9].

From last two and a half decade, “Face Recognition” remain very active area and has been studied enthusiastically, computers are becoming more and more intelligent and number of applications have been produced including HCI (Human Computer Interface), security, robotics, entertainment, games etc.

There are three operations involved in Face Recognition:

- a. Face Detection
 - b. Features Segmentation.
 - c. Face Recognition
- **Face Detection** is one of the essentials and first step to all facial analysis.
 - **Feature Segmentation** is a simultaneous process, sometimes face detection suit comparatively difficult and require 3D Head Pose, facial expression[10], face relighting, Gender, age and lots of other features.
 - **Face Recognition** is less reliable and its accuracy rate is still not up to the mark [11].

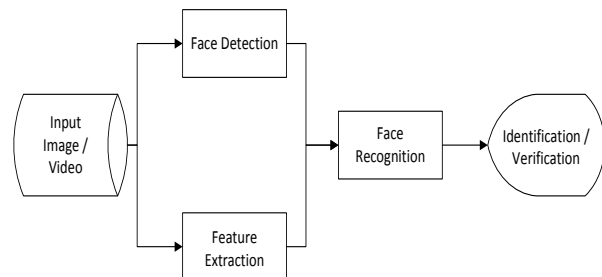


Fig. 1 Block Diagram of a general face recognition system

Nevertheless extensive work on Face Recognition have been done, but still it is not up to the mark for implementation point of view, more techniques are being invented each year to get better and realistic results.

ALGORITHMS

The most traditional and extensively used algorithms in the research of face recognition are PCA [12; 13] and Linear Discriminant Analysis (LDA) [14; 15]. A.M. Martinez and A.C. Kak [16] Shows that PCA is better than LDA with small dataset.

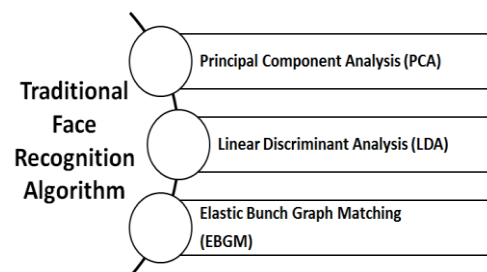


Fig 2: Traditional Face Recognition Algorithms

Principle Component Analysis (PCA)

PCA is a most commonly used method in the area of image and signal processing [17]. It has been used with different variations especially when solving single sample per person problems [18], instead of using general features [19]. PCA is also called as *Eigen faces*[13]. Eigen faces are set of orthogonal vectors used for human face recognition. Eigen vectors are also referred to as eigen faces [20].

Linear Discriminant Analysis (LDA)

LDA is most commonly used for dimensionality reduction and feature extraction [21; 22]. Its variation, 2D LDA has

also been used in different applications for image recognition [23]. LDA is also known as Fisherfaces. In this technique data are linearly projected among the regions in such a way that each region can easily be separable [24].

Elastic Bunch Graph Matching (EBGM)

EBGM was introduced by Wiskott et al. [25]. EBGM is based on Gabor filter coefficient [26]. In this technique fiducial points are manually located on images and from each point 'Jet' Gabor filter coefficients are extracted [27].

FACE RECOGNITION APPROACHES

Face as a biometric feature is less reliable due to variations in illumination conditions, poses, and expressions. 3D facial recognition methods resolved the reliability issues like pose change and lighting. Image based face recognition approaches can be classified as under:

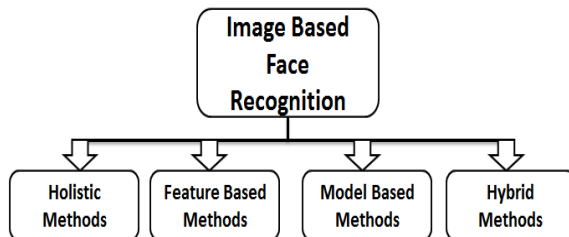


Fig 3. Classification of Face Recognition approaches

Holistic Approach

In this approach, the complete face is considered as a single feature for detection and recognition [28]. It compares the similarities of whole face, ignoring individual features like eyes, mouth, nose etc. These schemes are characterized into two parts as shown in Figure 4:

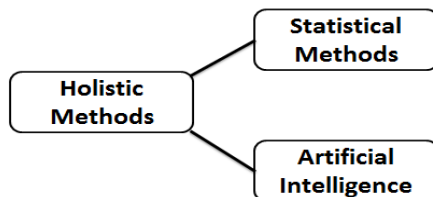


Fig 4: Holistic Face Recognition Methods

Statistical Approach: The face image density is calculated and the density set values are compared with the density values of database images [29]. This calculation is very expensive and directly suffering under the usual gaps pathways, such as face orientation scaling and illuminations. To cope with this problem, dimensions, it has been suggested that many other diagrams, use ways to reduce the size and statistical stay ahead of the most obvious dimensions before recognition performance. Some of them are as follows:

Sirovich and Kirby [30] were first get the benefit of PCA for economically represent face images. They represent facial images. They showed that in any particular, can effectively represent time eigen pictures coordinate space, and that each region can modernized with only a small photos own collection and appropriate expectations ("Transactions") along each Eigen pictures.

A. Pentland et. al. [31] expanded the Turk and Pentland capabilities of the system in several ways and proposed "Multiple Observer" technique to deal with pose variations.

Sharif M. et. al. [32] Proposed another technique for illumination normalization, results shows that proposed technique produced better recognition accuracy. Hashing technique is used in [33] for fast face recognition.

Artificial Intelligence Approach: Artificial Intelligence approach with tools such as neural networks and automatically recognizes the faces of learning techniques.

Samaria and Harter [34] applied one-dimensional HMM and get 87% accuracy rate on ORL database. Sharif et al [35] produced a survey on HMM, Eigen face, geometric based and template matching approach. Nefian and Hayes III [36] also used the same database and recorded 98% recognition and compared the results with embedded HMM [37] and also claimed that their mechanism was much intelligent than that of Samaria.

Feature based Approach

Opposite to holistic, feature based approach consider individual feature of the face like eyes, nose, mouth, mole, ears and match the similarity between the images [38]. Another approach in the domain of face recognition includes face recognition by means of hexagonal features detection. The approach works on the bases of edge detection for the sake of face detection and recognition using the hexagonal facial features [39]. Face recognition by means of using the heuristic parameters and storing them in the database before searching can be analyzed in [40]. This approach mainly focused on nose portion of the acquired images followed by gray scale conversion and transformation of intensity. Another research work in which the face recognition is done by the help of edge information refined by the help of reduced sample size. Low dimension space for face images is done by DCT [41].

The color feature in terms of HSV color space of the images of the facial portion is considered. The skin region is detected using the hue and saturation attributes in [35]. The SVD (single value decomposition) method is used in the face recognition in which the DWT (discrete wavelet transform) and DCT (discrete cosine transform) [42]. Skin feature of the face is used in [43], this research methodology uses the techniques like block approach and the RGB color space. Fiscal features like eyes, nose and mouth were taken as point [44] and Gabor filter applied for feature extraction. Another method [45] introduced mid frequency values method for feature extraction, covariance matrix was computed on the basis of DCT & PCA. Distinct feature vector computed and compared with ORL, Yale, PIE and MSRA resulting better accuracy rate than the traditional methods.

Similarly [46] proposed a part based methods using PCA, LDA, NMF, LNMF, ICA etc under partial occlusion[47] considering facial features for recognition.To overcome the 3S problem within a class and high computational cost.

A method called AFMC [48] was proposed which not only eliminated SSS problem but also the results shows that the algorithm is effective, efficient and reduced the

computational cost. Further pose variation and SSS problems was taken in account by [49] and proposed a framework, that depict fine performance against pose variation and SSS problem. In another research work [50], researchers have used eye region of the face for recognition, the results were encouraging.

Model Based Approach

Model based facial recognition is another approach. 3D facial model can be acquired using both active and passive means [51]. Extensively used active 3D image acquisition technique is infrared input which project laser beam onto an object and records its reflection [52] resulting best and accurate 3D models recognition.

Stereo Imaging is the passive technique for the acquisition of 3D model [53] in which two or more cameras simultaneously capture a scene from different angles. Depth information is acquired using disparity information from different angles.

In [54] 3D to 2D face recognition method was presented, using SRC and CCA for face recognition, results shows a better performance with low computational cost. A new model "Associate-Predict" (AP) was introduced by [55] to eliminate pose, illumination and expression variations. AP method effectively handled the personal variations.

[56] presented a discriminative model to overcome age variation problem in face recognition, using scale invariant feature transform (SIFT) and multi-scale local binary patterns for local descriptors and introduced multi-features discriminant analysis (MFDA) algorithm to analyze the local descriptors, resulting face recognition improvement in aging factor.

Patch based, image quality assessment algorithm was proposed by [57] and tested in a video based settings.

Hybrid Approach

Hybrid approaches are considered as the best approaches. The modern hybrid techniques for face recognition, a face identification method is presented in [58].

Face recognition by means of using the nose tip for the main attribute of feature extraction phase. Then a hybrid 3D model is used for the recognition purpose [44]. A research work is done on the face recognition with the help of the Gabor filter approach and the normalization approach in [59]. With the combination of holistic and feature based, a hybrid method was proposed in [60] using Markov Random Field, in which facial images were sub divided into patches. The IDs were allocated and compared using BP algorithm.

A research work done in [61], introduced a much faster method of face recognition using basis coordinates of nose tip, its slope and fusion of different dependent regional classifier with the 3D face classifier. Results show 99% identification and 94.6% verification rate [62]. Proposed LSP descriptor to overcome the problems of illumination and pose variations. Further SRC was applied to extract 3D depth information. Color image used and concept of tensor discriminant color space (TDCS) was introduced in 2D fast Face recognition approach based on wavelet network was proposed by [63]. The technique is the combination of training algorithm of face image and comparing it from training set. Moreover to increase performance, Levenberg-Marquardt method was implemented.

Another novel face recognition method Sp-Tensor was proposed by [64] using sub-pattern technique. The performance of the Sp-Tensor has better recorded than the Tensor Face. For 3D face recognition, [65] proposed an Insensitive to noise and resolution invariant based method.

DISCUSSION

Face recognition is used for the identification and authentication of an individual. The different approaches used for the face recognition are holistic based approach, model based approach, hybrid based approach and feature based approach. In holistic approach, whole face is considered as a single feature. Statistical and AI approaches are further classes of holistic approach. Unlike holistic approach the feature based approach considers [66] individual feature of the face like eyes, nose, mouth, mole, ears and match the similarity between the images. Popular method is hexagonal features detection. In model based face recognition approach the facial model is acquired using both active and passive means. It includes extensive use of active image acquisition technique which is mostly the infrared laser beam. In hybrid approach, features [67] matching and holistic approach are used.

CONCLUSION

In this survey different approaches of face recognition are discussed and it is concluded that the hybrid approach is comparatively best approach as it uses two approaches so hybrid approach is considered as best approach. Recent research works are based on the hybrid approach.

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