

A Survey paper for Face Recognition Technologies

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Abstract- The biometric is a study of human behavior and features. Face recognition is a technique of biometric. Various approaches are used for it. A survey for all these techniques is in this paper for analyzing various algorithms and methods. Face recognition is emerging branch of biometric for security as no faces can be defeated as a security approach. So, how we can recognize a face with the help of computers is given in this paper.

Index Terms- Face features, feature selection, local binary pattern.

I. INTRODUCTION

Humans often use faces to recognize individuals and advancements in computing capability over the past few decades now enable similar recognitions automatically. Early face recognition algorithms used simple geometric models, but the recognition process has now matured into a science of sophisticated mathematical representations and matching processes. Major advancements and initiatives in the past ten to fifteen years have propelled face recognition technology into the spotlight. Face recognition can be used for both verification and identification (open-set and closed-set).

In face recognition system it identifies faces present in the images and videos automatically. It is classified into two modes:

1. Face verification (or authentication)
2. Face identification (or recognition)

In face verification or authentication there is a one-to-one matching that compares a query face image against a template face image whose identity is being claimed. In face identification or recognition there is a one-to-many matching that compare a query face image against all the template face images in the database to determine the identity of the query face image. Another face recognition scenario involves a watch-list check, where a query face is matched to a list of suspects (one-to-few matches). The performance of face recognition systems has improved significantly since the first automatic face recognition system was developed by Kanade (T.Kanade, 1973). Furthermore, face detection, facial

Feature extraction, and recognition can now be performed in real-time for images captured under favorable (i.e. constrained) situations. Although progress in face recognition has been encouraging, but still there are some unconstrained tasks where viewpoint, illumination, expression, occlusion, accessories, and so on vary considerably. It is natural, nonintrusive, and easy to use. There are many biometric systems but among the six famous biometric attributes considered by Hietmeyer (R. Hietmeyer, 2000), In a Machine Readable Travel Documents (MRTD) system facial features scored the highest compatibility, such as enrollment, security system, machine requirements, renewal, surveillance system and public perception, shown in Figure1.

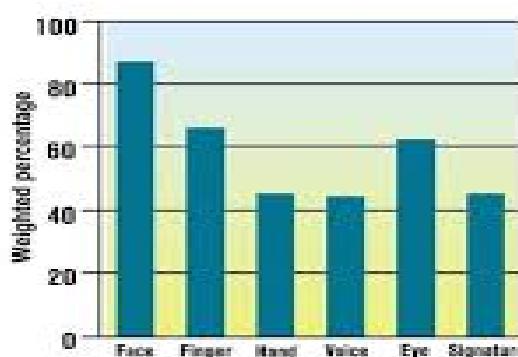


Figure 1: A comparison of various biometric features based on MRTD compatibility (R Hietmeyer, 2000).

Face Recognition Processing

Face recognition is a visual pattern recognition problem. There, a face as a three-dimensional object subject to varying illumination, pose, expression and so on is to be identified based on its two-dimensional image (three-dimensional images e.g., obtained from laser may also be used). A face recognition system generally consists of four modules as depicted in Figure 2:

detection, alignment, feature extraction, and matching, where localization and normalization (face detection and alignment) are processing steps before face recognition (facial feature extraction and matching) is performed. Face detection segments the face areas from the background. In the case of video, the detected faces may need to be tracked using a face tracking component. Face alignment is aimed at achieving more accurate localization

and at normalizing faces thereby whereas face detection provides coarse estimates of the location and scale of each detected face. Facial components, such as eyes, nose, and mouth and facial outline, are located; based on the location points, the input face image is normalized with respect to geometrical properties, such as size and pose, using geometrical transforms or morphing. The face is usually further normalized with respect to photometrical properties such illumination and gray scale. After a face is normalized geometrically and photo-metrically, feature extraction is performed to provide effective information that is useful for distinguishing between faces of different persons and

stable with respect to the geometrical and photometrical variations. For face matching, the extracted feature vector of the input face is matched against those of enrolled faces in the database; it outputs the identity of the face when a match is found with sufficient confidence or indicates an unknown face otherwise. Face recognition results depend highly on features that are extracted to represent the face pattern and classification methods used to distinguish between faces whereas face localization and normalization are the basis for extracting effective features. These problems may be analyzed from the viewpoint of face subspaces or manifolds, as follows.

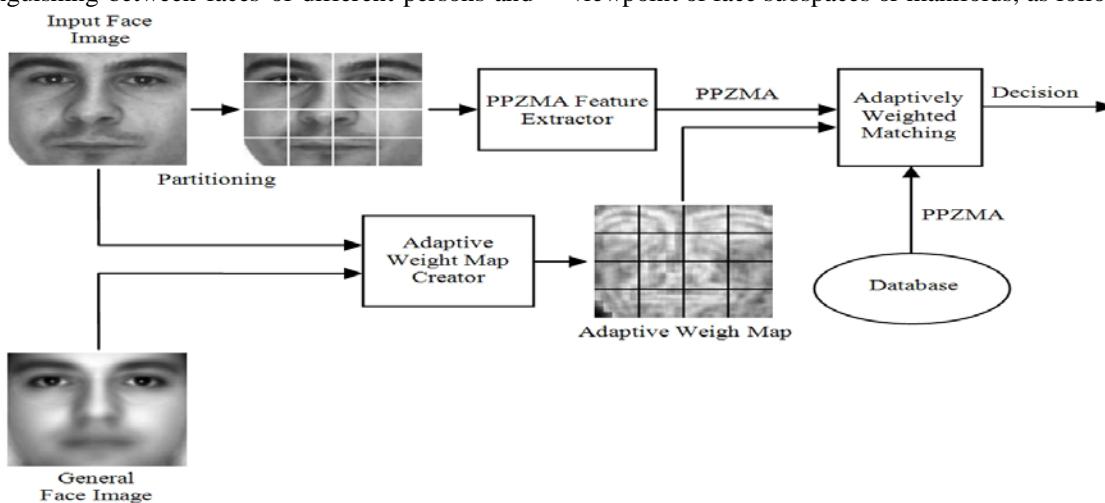


Figure 2: Face Recognition processing flow.

II. LITERATURE SURVEY

Face recognition has been an active research area over last 40 years. The face recognition research has several disciplines such as image processing, machine learning approach, pattern recognition, computer vision, and neural networks. Classification is the main problem. In the process of face recognition it includes, to train the face images from the known individuals and then to classify the newly coming test images into one of the classes. The problem of face recognition is easily solved by Humans where limited memory can be the main problem. The problems or limitations for a machine learning face recognition system are:

1. Facial expression change
2. Illumination variation
3. Ageing
4. Pose change
5. Scaling factor (i.e. size of the image)
6. Frontal vs. profile
7. Presence and absence of spectacles, beard, mustache etc.
8. Occlusion due to scarf, mask or obstacles in front.

In automatic face recognition system the main complicated task is that it involves detection of faces from a cluttered background, facial feature extraction, and face recognition. A complete face recognition system has to solve all sub-problems, where each one is a separate research problem. Image template based and geometry feature-based are the two classes of face recognition system algorithms. In template based method it (Robert J. 1981) compute the correlation between a face image and one or more model of face image templates to estimate the face image identity from the database. Brunelli and Poggio (R. Brunelli, 1993) suggest the optimal strategy for face recognition system which is holistic and corresponds to template matching. The statistical tools such as Support Vector machines (SVM) (E. Osuna, 1997), (Vladimir N, 1995) Independent component Analysis, Principal Component Analysis (PCA) (L. Sirovich, 1987), (Matthew Turk, 1991), Linear Discriminant Analysis (LDA) (Peter N.Belhumeur et.al, 1997), kernel methods (Bernhard Scholkopf et.al, 1998), (M. H. Yang, 2002), and neural networks (A. Jonathan, 1995), (Steve Lawrence, 1998), (T. Poggio, 1994) used to construct a suitable database of face image templates.

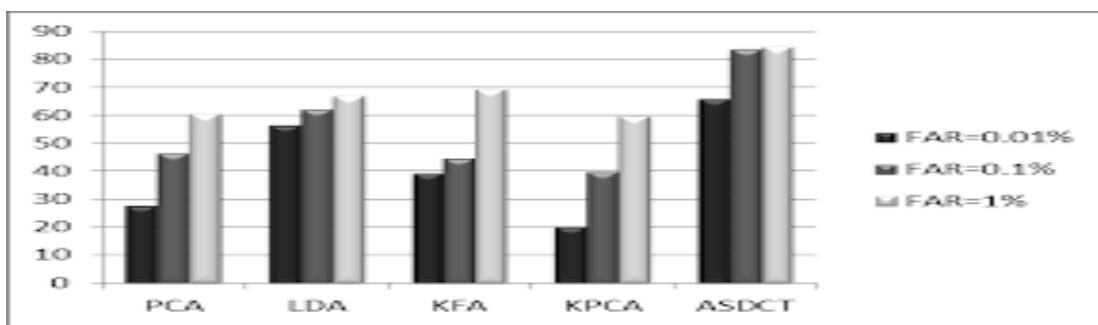


Figure 3: Summary of approaches to face recognition with FAR analysis

Other than neural network approach and statistical approach there are other approaches known as hybrid approaches which are the combination of both statistical pattern recognition techniques and neural network systems. Examples for hybrid approaches include the combination of PCA and Radial Basis Function (RBF) neural network (M.J. Er, 1999), (C. E. Thomaz et. al, 1998). Among other methods, people have used range (R. Chellappa, 1995), infra-red scanned (Y. Yoshitomi et. al, 1997) and profile (Z. Liposzak, 1999) images for face recognition. While templates can be viewed as features, they mostly capture global features of the face image. Facial occlusion (Face images with goggles, specs, scarf etc) and low resolution is often difficult to handle in these given approaches.

In the geometry feature based methods the explicit local facial features are found, and their geometric relationships. Cootes et al. (Andreas Lanitis et.al, 1997) have presented an active shape model which was the extending approach by Yuille (Alan L, 1991). Wiskott et al.(aurenz Wiskott, 1997) developed an elastic bunch graph matching algorithm for face identification. Penev et al. (P. Penev, 1996) developed PCA into Local Feature Analysis (LFA). This technique is one of the most successful and useful commercial face recognition systems, Face It. The summary of approaches to face recognition is shown in Fig. 3.

Template based Methods

Template matching is conceptually related to holistic approach which attempts to identify faces using global representations (J. Huang, 1998). These types of methods approach the face image as a whole and try to extract features from the whole face region and then classify the image by applying a pattern classifier. One of the methods used to extract features in a holistic system, is based on statistical approaches which are discussed in the following section.

Statistical Approaches

There are some techniques that identify, parameterize and analyze linear subspaces. Other than linear subspaces there are some statistical face recognition techniques which are based on non-linear subspaces (like kernel-PCA and kernel-LDA), transformation (like DCT, DCT & HMM and Fourier Transform) and Support Vector Machine (SVM). Appearance-based approaches for face recognition like PCA, LDA, and probabilistic subspace view a 2D face image as a vector in image space.

Neural Network based Approaches

Artificial Neural Network (ANN) (B. Yegnanarayana, 1999) is a most successful tool for pattern recognition problems. In Kohonen's associative map (T. Kohonen, 1998), one of the earliest demonstrations of neural network for face image recall applications is reported. Using a small set of face images, accurate recall was reported even when input image is very noisy, low resolution and dimension or when portions of the images are missing. A few NN based face recognition techniques are discussed in the following.

Single Layer adaptive NN:

A single layer adaptive NN (one for each person) for face recognition, expression analysis and face verification was reported in (T. J. Stonham, 1984). A system named Wilke, Aleksander and Stonham's recognition devise (WISARD) was devised. It needs typically 200-400 presentations for training each classifier where the training patterns included translation and identification in facial expressions. One classifier was constructed corresponding to one subject in the database.

Multilayer Perceptron (MLP):

Most of the present literatures on face recognition system with neural networks present results with a small number of classes (often below 20). In (D. Demers, 1993) the first 50 principal components of the face images were extracted and reduced to five dimensions using auto associative neural network. The resulting representation was classified using a standard multilayer perceptron (MLP).

Self-Organizing map (SOM):

The self-organizing map describes a quantization of the face image samples into a topological space are also nearby in the output space, it provides dimensionality reduction and invariance to minor changes in the face image sample. The convolutional neural network provides partial invariance to translation, rotation, scale and deformation.

Hop-field memory model:

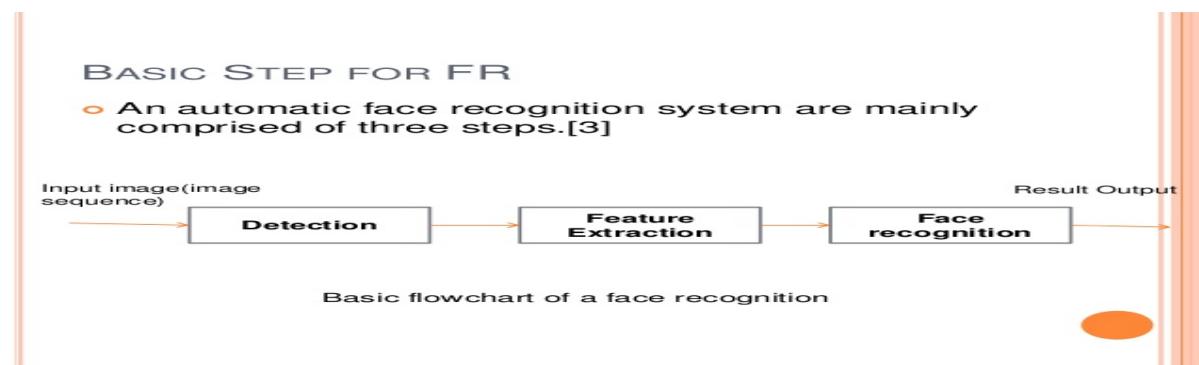
In (Y. Dai, 1998), a Hop-field memory model for the facial images is organized and the optimal procedure of learning is determined. A method for face recognition using Hop-field memory model combined with the pattern matching is proposed. It shows better performance of database having 20 faces of 40 subjects.

Others:

A hierarchical neural network is grown automatically and not trained with gradient descent was used for face recognition or identification by Weng (J. Weng, 1995). They found good and more accurate results for discrimination of ten subjects. The ability of the compression networks was demonstrated by Cottrell and Fleming in (G. W. Cottrell, 1990).

In (Vladimir N, 1995) linear auto associative networks, non-linear auto-associative (or compression) and/or hetero-associative back propagation networks are explored for face processing. In (Shang-Hung, 1997) Lin et al. proposed a face recognition technique based on Probabilistic Decision based Neural network (PDBNN). It adopts a hierarchical network structures with non-linear basis functions and competitive credit assignment scheme. It demonstrated a successful application of PDBNN on FERET and ORL databases. The mixture consists of ensembles of radial basis functions (RBFs). Inductive Decision Trees (IDTs) and SVMs implement the “gating network” components. Experimental results yield good results on gender, ethnic and pose classification, which can be effectively used in face recognition.

Hybrid Approaches



Face detection:

For the constrained conditions, many face detection methods for static image are not directly suitable to the task in video. We classified current approaches into groups, and summarized their pros and cons.

Face tracking:

In face tracking head rotation and pose variations are measure issues. Face tracking is a significant procedure in face recognition. It usually exploits statistical model, example-based model, and skin color information to accomplish the tracking task. In addition, for these methods it also exploits CAMSHIFT, condensation, adaptive Kalman filter algorithms.

Face recognition:

Since the spatio-temporal information plays a significant role in face recognition, how to fully exploit redundancy information in the video sequence is a key issue for video based recognition. One of the chief advantages of video over still frames is that fact accumulation over multiple frames can provide better face recognition performance.

The hybrid approaches use both statistical pattern face recognition techniques and neural networks.

PCA and RBF:

The use of RBF on the data extracted by discriminated Eigen-features suggested by Er et al. They used a hybrid means the combination of learning algorithm to decrease the dimension of the search space in the gradient method, which is very complicated for optimization of high dimension problem in face images. Firstly, they tried to extract the face image features by principal component analysis, Independent component analysis and linear discriminated analysis methods. Secondly, they developed hybrid learning algorithm to train the RBF Neural Networks, so the dimension of the search memory space is significantly decreased in the gradient method. Thomaz et al. also studied on combining two methods PCA and RBF neural network.

III. DISCUSSION AND REMARKS

In this paper, we presented some major issues on face recognition. These are as follows:

Consequently, face recognition in video possesses more challenges to the current face recognition systems. Use of three dimensional face image models has been suggested as a way to compensate for low resolution, low dimension, poor contrast and non-frontal pose. By the way of constructing a 3D face model from multiple non-frontal frames in a video, and then generating a frontal view from the derived 3D model, and finally using a 2D face recognition algorithm to recognize the synthesized frontal view, the spatio-temporal information can be fully employed. Meantime, it will help solve the problem of occlusion, pose variance and illumination issues caused by video frame's poor quality.

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