Recent Advances in Face Recognition: A Survey of Techniques and Applications

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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. Face Recognition plays a major role in Biometrics. Feature selection is a measure issue in face recognition. This paper proposes a survey on face recognition. There are many methods to extract face features. In some advanced methods it can be extracted faster in a single scan through the raw image and lie in a lower dimensional space, but still retaining facial information efficiently. The methods which are used to extract features are robust to low-resolution images. The method is a trainable system for selecting face features. After the feature selection procedure next procedure is matching for face recognition. The recognition accuracy is increased by advanced methods.

KEYWORDS: Face features, feature selection, local binary pattern. Face features, feature selection, local binary pattern.

I. INTRODUCTION

The goal of this effort is to develop new algorithms for a robust pose-invariant face recognition that overcome many of the limitations found in existing facial recognition systems. Specifically, we are interested in addressing the problem of detecting faces in color images in the presence of various lighting conditions and complex backgrounds as well as recognizing faces under variations in pose, lighting, and expression. This work is separated into two major components (i) Face detection and (ii) Face recognition. Specific tasks include developing modules for face detection, pose estimation, face modeling, face matching, and a user interface.

We have developed a robust, real-time face detection system from color images using a skin-tone color model and facial features. Major facial features are located automatically and color bias is corrected

by a lighting compensation technique that automatically estimates the reference white pixels. This technique overcomes the difficulty of detecting the low-luma and high-luma skin tones by applying a nonlinear transform to the color space. We have also developed a robust face detection module to extract faces from cluttered backgrounds in still images The system is easily extended to work with video image sequences The proposed system not only detects the face, but also locates important facial features, such as eyes and mouth. These features are crucial to the performance of the face recognition.

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

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.

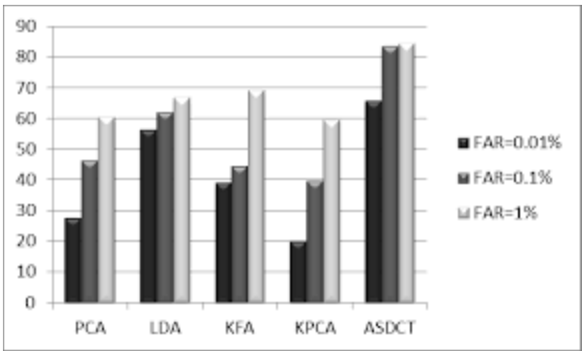


Figure 1: Summary of approaches to face recognition with FAR analysis

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. Liposcak, 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.1.

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.

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. FEATURE EXTRACTION TECHNIQUES FOR FACE RECOGNITION

Face Recognition is non-nosy strategy for distinguishing singular appearances by the element extraction and characterization of countenances. Facial component extraction is a standout amongst the most critical and endeavored issues in PC vision. This paper thinks about the distinctive facial component extraction methods like geometry-based element extraction (Gabor wavelet change), appearance based procedures, shading division based systems and format based element extraction. These systems give differing execution different variables, for example, brightening variety, face appearance variety clamor and introduction. [3]

Feature Extraction Technique

Some picture handling methods separate element focuses, for example, eyes, nose, and mouth and after that utilized as info information to application. Different methodologies have been proposed to remove these facial focuses from the pictures. The fundamental methodologies are as per the following. [4]

A. Geometry –based Technique

In this method highlight are removed utilizing the size and the relative position of critical segments of pictures. In this strategy under the main technique firstly the course and edges of imperative part is recognized and after that building highlight vectors from these edges and heading. Vigilant channel and inclination investigation typically connected in this course. Second, strategies depend on the grayscales distinction of irrelevant parts and vital segments, by utilizing highlight squares, set of Haar-like component piece in Adaboost technique [8] to change the grayscales conveyance into the element. In LBP [9] strategy, each face picture separates into squares and every piece has its comparing focal pixel.

B. Format Based Techniques

This system will remove facial component taking into account the beforehand planned formats utilizing proper vitality capacity and the best match of layout in facial picture yield the base vitality. Strategies have been proposed by Yuille et al. [12], distinguishing and portraying elements of confronts utilizing deformable formats. In deformable formats the component of interest, an eye for instance, is portrayed by a Parameterized layout. These parameterized layouts empower from the earlier information about the normal state of the elements to manage the recognition procedure [12].

C. Appearance –based approach

This methodology procedure the picture as two dimensional examples. The idea of "highlight" in this methodology is not quite the same as straightforward facial elements, for example, eyes and mouth. Any separated trademark from the picture is alluded to an element. This technique bunch discovered best entertainer in facial component extraction since it keep the vital data of picture and reject the excess data. Strategy, for example, foremost part examination (PCA) and free segment investigation are utilized to extricate the component vector. The principle reason for PCA is to decrease the substantial dimensionality of watched variable to the littler natural dimensionality of free variable without losing much data. This procedure would be later the establishment of the proposition of numerous new face recognition calculations [5]. In PCA investigation high request conditions exist and this is the detriment of this technique since much data may contain in the high request relationship.

D. Shading –based approach

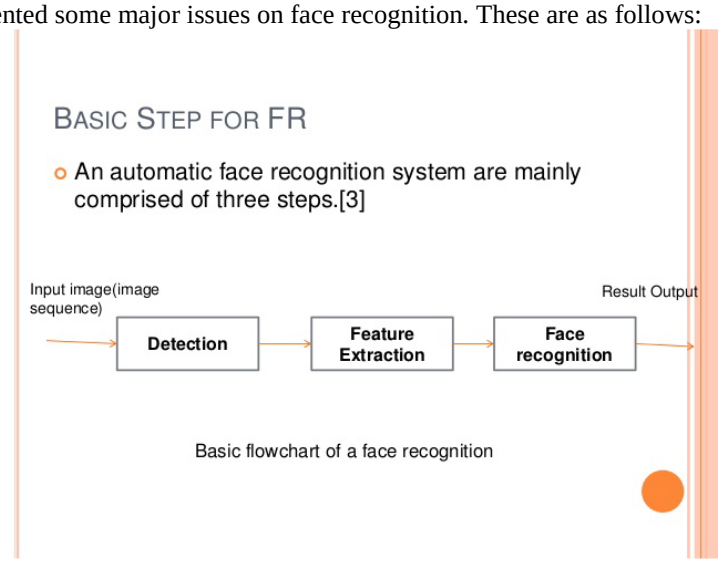
This methodology utilizes skin shading to confine the face region from the non face zone in a picture. Any non-skin shading area inside the face is seen as a contender for eyes or mouth [7]. The execution of such methods on facial picture databases is fairly restricted, because of the differences of ethnical foundations [6].

E. Color Based Feature Extraction

With the assistance of various shading models like RGB skin district is distinguished [4], [8]. The picture acquired in the wake of applying skin shading insights is subjected to binarization. Firstly it is changed to dark scale picture and after that to a twofold picture by applying appropriate edge. This is done to dispose of the shading and immersion values and consider just the luminance part. After this luminance part is changed to parallel picture with some limit on the grounds that the elements for face are darker than the foundation hues. In the wake of thresholding clamor is expelled by applying some opening and shutting operation. At that point eyes, ears, nose facial elements can be extricated from the parallel picture by considering the limit for zones which are darker in the mouth than a given threshold.

IV. DISCUSSION AND REMARKS

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



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.

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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