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A Survey on Face Recognition and Facial Expression Identification

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Abstract **— In this paper, to write a survey of face recognition such as, first to provide the review the existing history, second is to describe the technical details like as methods, approchases, algorithms, etc., third is research opportunity in face recognition field.**

We started from the psychophysical studies that how human being perform that work. Then introduced description of techniques and we tried to explain some pre-processing difficulty and its explanation for the face recognition systems.

Keywords **- Face Recognition, Principle Component Analysis, Independent Component Analysis, Linear Discriminant Analysis, Support Vector Machine.**

I. INTRODUCTION

The physiological study of face recognition divides into two slightly different topics. First there are projects that focus on the recognition of faces preciously unfamiliar to subjects. Second there is a large literature on process underlying recognition of familiar faces.

Psychologically a face is a rich source of information about human behaviour. Facial displays indicate emotion, regulate social behaviour, reveal brain function and signal developmental transitions in infants. Geometrically a face is 3D spaces sum of large no polygons that can be represent by pixel and facial features are related to face geometry.

Face is a complex multidimensional structure and needs good computing techniques for recognition. The face is our primary and first focus of attention in social life playing an important role in identity of individual. We can recognize a number of faces learned throughout our lifespan and identify that faces at a glance even after years. There may be variations in faces due to aging and distractions like beard, glasses or change of hairstyles.

Face recognition is an integral part of biometrics. In biometrics basic traits of human is matched to the existing data and depending on result of matching identification of a human being is traced. Facial features are extracted and implemented through algorithms which are efficient and some modifications are done to improve the existing algorithm models[1][4][6][7].

In this paper, we will review the survey on face recognition work in previous section.

II. REVIEW

In [1], author presents a number of typical algorithms being categorized into appearance based and model-based schemes. For appearance-based methods, three linear subspace analysis schemes are presented, and several non-linear manifold analysis approaches for face recognition are briefly described. The model-based approaches are introduced, including Elastic Bunch Graph matching, Active Appearance Model and 3D Morphable Model methods.

In [2], author presents the feasibility of these algorithms for human face identification is presented through experimental investigation. It provides user authentication via facial features. These proposed systems of face recognition may be applied in identification systems, document control and access control.

In [3], author presents a template matching approach to address the pose problem in face verification, which neither synthesizes the face image, nor builds a model of the face image. Template matching is performed using edginess-based representation of face images. The edginess-based representation of face images is computed using one-dimensional (1-D) processing of images. It verifies the identity of a person using score obtained from template matching.

In [4], author presents a review of face recognition new algorithm has to evolve using hybrid methods of soft computing tools such as ANN, SVM, SOM may yields better performance. Attempt is made to review a wide range of methods used for face recognition comprehensively. This include PCA, LDA, ICA, Gabor wavelet soft computing tool like ANN for recognition and various hybrid combination of this techniques. This review investigates all these methods with parameters that challenges face recognition like illumination, pose variation, facial expressions.

In [5], authors present an overview of face recognition and discuss the methodology and its functioning. Thereafter we represent the most recent face recognition techniques listing their advantages and disadvantages. Some techniques specified here also improve the efficiency of face recognition under various illumination and expression condition of face images.

III. FACE RECOGNITION

Let us now describe the development of these systems in more detail by considering the following:

- The typical recognition steps performed by a facial recognition algorithm
- The different types of facial recognition algorithms
- The different types of image data used in the facial recognition process.

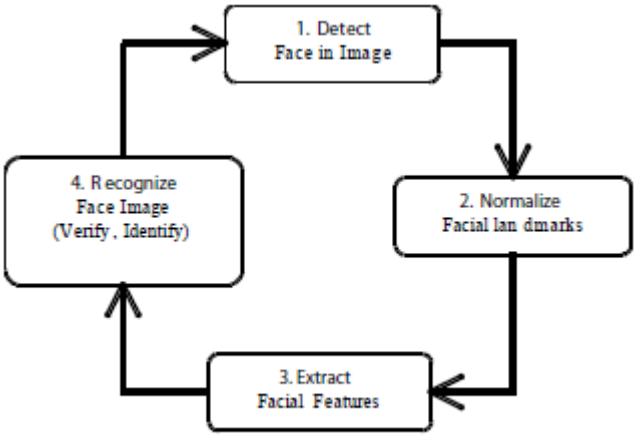

Fig.1 Steps in Facial Recognition Systems

Let us for the moment assume that we have a probe image with which to work. The facial recognition process normally has four interrelated phases or steps. The first step is face detection, the second is normalization, the third is feature extraction, and the final cumulative step is face recognition. These steps depend on each other and often use similar techniques. They may also be described as separate components of a typical FRS. Nevertheless, it is useful to keep them conceptually separate for the purposes of clarity. Each of these steps poses very significant challenges to the successful operation of a face recognition system.

The above steps is said that,

- When an identification application, the device read sample images and compare image from database systems
- When verification application, the generated image is only compared with one image in database systems.

IV. DIFFERENT TECHNIQUES FOR FACE RECOGNITION

Different Approach

Face recognition can be done in both a still image and video which has its origin in still image face recognition. Different approaches of face recognition for still images can be categorized into tree main groups such as:

- Holistic approach.
- Feature based approach.
- Hybrid approach.

Holistic Approach

In holistic approach, the whole face region is taken into account as input data into face detection system. They are all based on principal component analysis (PCA) techniques that can be used to

simplify a dataset into lower dimension while retaining the characteristics of dataset.

Feature Based Approach

In feature based approaches, local features on face such as nose, and then eyes are segmented and then used as input data for structural classifier. Pure geometry, dynamic link architecture, and hidden Markov model methods belong to this category.

Hybrid Approach

The idea of this method comes from how human vision system perceives both local feature and whole face. There are modular Eigenfaces, hybrid local feature, shape normalized, component based methods in hybrid approach.

Methods

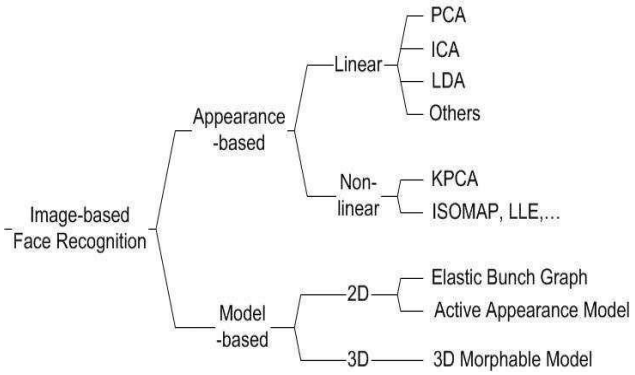

Fig.2 : Some Face Recognition methods

Principal Component Analysis (PCA)

Derived from Karhunen Loeve's transformation. Given an s dimensional vector representation of each face in a training set of images, Principal Component Analysis (PCA) tends to find a t dimensional subspace whose basis vectors correspond to the maximum variance direction in the original image space. This new subspace is normally lower dimensional (t<<s). If the image elements are considered as random variables, the PCA basis vectors are defined as eigenvectors of the scatter matrix.[1][2][3][4][5].

The Eigenface algorithm uses PCA for dimensionality reduction to find the vectors which best account for the distribution of face images within the entire image space. These vectors define the subspace of face images and the subspace is called face space. All faces in the training set are projected onto the face space to find a set of weights that describes the contribution of each vector in the face space. To identify a test image, it requires the projection of the test image onto the face space to obtain the corresponding set of weights. By comparing the weights of the test image with the set of weights of the faces in the training set, the face in the test image can be identified. The key procedure in PCA is based on KarhumenLoeve transformation. If the image elements are considered to be random variables, the image may be seen as a sample of a stochastic process. The PCA basis vectors are defined as the eigenvectors of the scatter matrix *ST*,

$$S_T = \Sigma^N_{i=1} (x_i - \mu) (x_i - \mu)^T$$

Independent Component Analysis (ICA)

Independent Component Analysis (ICA) is similar to PCA except that the distributions of the components are designed to be non Gaussian. ICA minimizes both second order and higher order dependencies in the input data and attempts to find the basis along which the data (when projected onto them) are statistically independent. Bartlett et al. provided two architectures of ICA for face recognition task:

- Architecture I statistically independent basis images,
- Architecture II factorial code representation.

Linear Discriminant Analysis (LDA)

Both PCA and ICA construct the face space without using the face class (category) information. The whole face training data is taken as a whole. In LDA the goal is to find an efficient or interesting way to represent the face vector space. But exploiting the class information can be helpful to the identification tasks.

Linear Discriminant Analysis (LDA) finds the vectors in the underlying space that best discriminate among classes. For all samples of all classes the between class scatter matrix SB and the within class scatter matrix SW are defined. The goal is to maximize SB while minimizing SW, in other words, maximize the ratio det|SB|/det|SW|. This ratio is maximized when the column vectors of the projection matrix are the eigenvectors of (SW^1 × SB).

Support Vector Machine (SVM)

Given a set of points belonging to two classes, a Support Vector Machine (SVM) finds the hyper plane that separates the largest possible fraction of points of the same class on the same side, while maximizing the distance from either class to the hyper plane. PCA is first used to extract features

of face images and then discrimination functions between each pair of images are learned by SVMs.

V. CONCLUSIONS

This paper has attempted to review a significant number of papers to cover the recent development in the field of face recognition. The following is a concise summary with conclusions representing the main topics from this paper: Face detection is currently a very active research area and the technology has come a long way since the survey of face recognition. Many methods have been proposed in this section and are successfully applied. But all these methods have their own advantages and disadvantages. The choice of method should be on the specific requirements of any given task.

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