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Effective Method of Age Dependent Face Recognition

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Effective Method of Age Dependent Face Recognition

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Abstract - This Automatic age dependent face recognition system is developed. This approach is based on the Principle Component Analysis (PCA). Eigen face approach is used for both age prediction and face recognition. Face database is created by aging groups individually. The age prediction is carried out by projecting a new face image into this face space and then comparing its position in the face space with those of known faces. After that we find the best match in the related face database, the Eigen face representation of an input image is first obtained. Then it is compared with the Eigen face representation of face in the database. The closest one is the match. It will be reduced the time complexity using this approach. The proposed method preserves the identity of the subject while enforcing a realistic recognition effects on adult facial images between 15 to 70 years old. The accuracy of the system is analyzed by the variation on the range of the age groups. The efficiency of the system can be confirmed through the experimental results.

Keywords- *age prediction; face recognition; Eigen face; age dependent face recognition.*

I. INTRODUCTION

Face recognition includes one of the biometric systems. Some examples of biometric features of humans are: Signature- studies the pattern, speed, acceleration and pressure of the pen when writing ones signature. Fingerprint- studies the pattern of ridges and furrows on the surface of the fingertip. Voice- studies way humans generate sound from vocal tracts, mouth, nasal cavities and lips. Iris- studies the annular region of the eye bounded by the pupil and the sclera. Retina- studies the pattern formed by veins beneath the retinal surface in an eye. Hand Geometry- measures the measurements of the human hand. Ear Geometry- measures the measurements of the human ear. Facial thermo gram- concerns the heat that passes through facial tissue. Among them face is the most natural and well known biometric.

Age prediction is concerned with the use of a training set to train a model that can estimate the age of the facial images. Among the first to research age prediction were, Kwon and Vitoria Lobo who proposed a method to classify input face images into one of the following three age groups: babies, young adults and senior adults [6]. Their study was based on geometric ratios and skin wrinkle analysis. Their method was tested on a database of only 47 high resolution face images containing babies, young and middle aged adults. They reported 100% classification accuracy on these data. Hayashi focused their study on facial wrinkles for the estimation of age and gender [8]. Skin regions were first extracted from the face images, followed histogram equalization to enhance wrinkles. Then, a special Hough transform, DTHT (Digital Template Hough Transform) was used to extract both the shorter and longer wrinkles on the face. Their experiments were not very successful on the age classification task though, achieving only 27% accuracy of age estimation and 83% on gender classification. It is important to note that they did not mention the size or source of their test to generate their accuracy values. Hayashi also noted the difficulty of extracting wrinkles from females' ages between 20 and 30 due to presence of makeup [8].

Lanitis empirically studied the significance of different facial parts for automatic age estimation [9]. The algorithm is based on statistical face models. Lanitis claims that introduction of the hairline has a negative effect on the results [9].His study was limited to subject ranging from 0 to 35 years old, and contained 330 images, of which only 80 were used for testing purposes. Evidently, faces with more wrinkles weren't used, leaving in doubt his ability to estimate the age of subjects older than 35 years. Some researchers have focused on particular age groups only, while others use an extremely wide classification range. Primarily, due to the lack of a good database, a global age prediction function, covering an extensive range of ages has yet to be developed.

J . R . Scolar and P . Navarreto [3] proposed an face recognition algorithm based on Eigen space. J.Yang and et al.[4] introduced the a new approach to appearance-based face representation and recognition. Most of the research in this area is very limited by the size and quality of the database used.

In this paper, age dependent face recognition system based on the diagonal PCA Method is presented. Face database contains the thirteen individual age groups as 15-20, 21-25, 26-30, 31-35, 36-40, 41-45, etc. First, the age of the input face is predicted. Then the matching process is performed for input face and the predicted age group of faces. It means that only age group is used. It is clear that the twelve times of processing times and complexities will reduce than the examining face using all faces in database. Furthermore, the feature points are extracted the specific part of face instead of the whole face. Finally, the record of the matched person is appeared as output. The detail discussions are described in the following sections.

II. SYSTEM OVERVIEW

Face region is extracted from a real image. Firstly, noise filtering and image adjusting processes are performed for image enhancing. Thirteen age individual groups are included in a face database. Within a given database, all weight vectors of the persons within the same age group are averaged together. This creates "a face class". When a new image comes in, its weight vector is created by projecting it onto the face space. The face is then matched to each face class that gives the minimum Euclidean distance. A 'hit' is occurred if the image nearly matches with its own face class. And then the age group that gives the minimum Euclidean distance will be assumed as the age of the input image. The record of the corresponding person is obtained by comparing with the estimated age group. The over view of the proposed system is illustrated in figure 1.

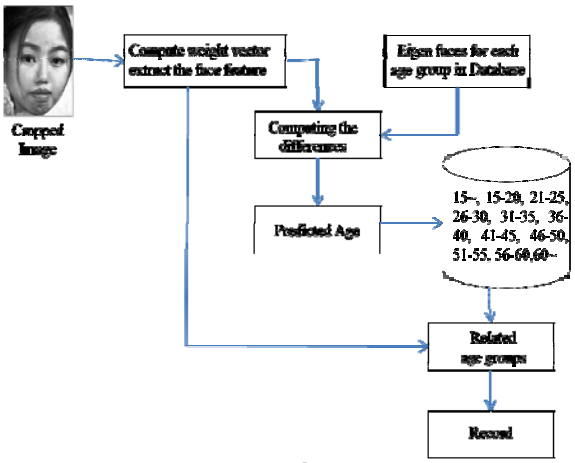


Figure 1. System Flow Diagram

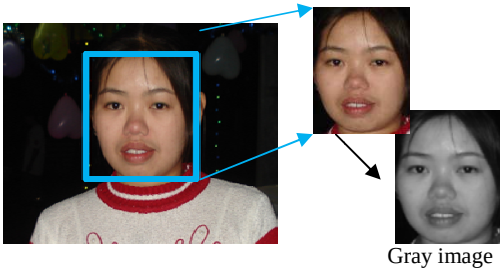
III. PREPROCESSING

The first step of preprocessing is the face region extraction. Face region extraction means the input face image is extracted from input image by using cropping tool. The input color image is converted to gray image and stored in database for processing. The cropped face region and converted gray image are shown in figure 2. The input image may be current scanned image or realities input image. And then enhancing state occurs. The proposed system allows the free size and format of color image.

Enhancing state includes the noise filtering, gray scale converting, and histogram equalization. Histogram equalization maps the input image's intensity values so that the histogram of the resulting image will have an approximately uniform distribution [3-6]. The histogram of a digital image with gray levels in the range [0, L-1] is a discrete function.

$$p(rk) = \frac{nk}{n} \qquad (1)$$

where L is the total number of gray levels , r_k is the k^{th} gray level, n_k is the number of pixels in the image with that gray level, n is the total number of pixels in the image, and $k = 0, 1, 2, \ldots, L - 1$. $p(r_k)$ gives an estimate of the probability of occurrence of gray level r_k.



Gray image

Figure 2. Face region extraction

(a)Gray image (b) equalized image

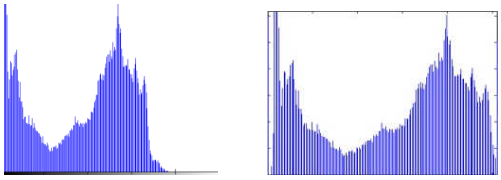


Figure 3. The result of Histogram Equalization

By histogram equalization, the local contrast of the object in the image is increased, especially when the usable data of the image is represented by close contrast

values. Through this adjustment, the intensity can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast without affecting the global contrast.

After gray converting, histogram equalization is performed. Figure 3 described the histogram images of gray scale image and equalized image, respectively.

IV. AGE PREDICTION SYSTEM

The age prediction procedure is described in this section. Features extraction- deals with extracting features that are basic for differentiating one class of object from another. First, the fast and accurate facial features extraction algorithm is developed. The training positions of the specific face region are applied. The extracted features of each face in database can be expressed in column matrix show in figure 4.

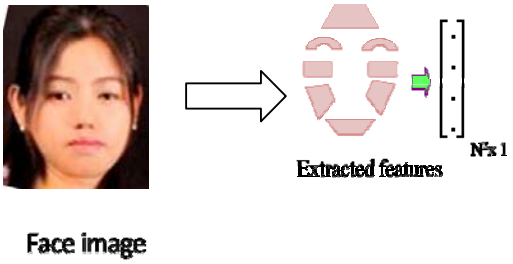
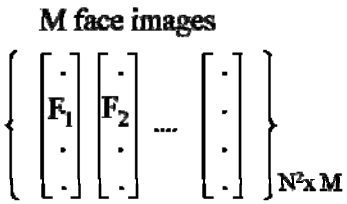
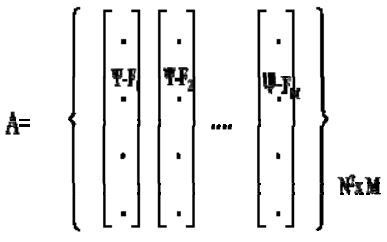


Figure. 4 Feature Extraction

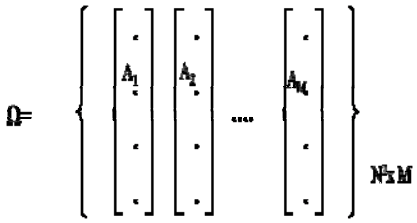
And find the average face for same age group of face images. The mean face feature for the M face images of each age group can be described as:



$$\text{Mean Face} = \Psi = \sum_{i=1}^{M} F_i \qquad (2)$$



The face space is computed from the Euclidean distance of feature points of two faces. The fundamental matrix A is constructed by the difference face space among the input and each face. Then, the matrix Ω can be formed by the average face features of the thirteen age groups.



Calculate the Covariance Matrix $Cov=\Omega\Omega^T$. And then built Matrix $L= \Omega\Omega^T$ to reduce dimension. Find the eigenvector of Cov. Eigenvector represent the variation in faces. Finally, age is determined through the minimize face space.

V. FACE RECOGNITION

In this paper the adaptive face recognition system is presented based on the DiaPCA and KNN (K^{th} nearest neighbor) classifier. Generally, principal component analysis methods will reduce the larger dimension of data space to the smaller intrinsic dimensionality of feature space, which are needed to describe the data economically. About the diagonal PCA and nearest neighbor classifier will be described.

A. PCA and DiaPCA

The Principal Component Analysis (PCA) can do prediction, redundancy removal, feature extraction, data compression, etc. Because PCA is a classical technique which can do something in the linear domain, applications having linear models are suitable.

Let us consider the PCA procedure in a training set of *M* face images. Let a face image be represented as a two dimensional *N* by *N* array of intensity values, or a vector of dimension N^2. Then PCA tends to find a *M*-dimensional subspace whose basis vectors correspond to the maximum variance direction in the original image space. This new subspace is normally lower dimensional ($M << M << N2$) [4]. New basis vectors define a subspace of face images called face space. All images of known faces are projected onto the face space to find sets of weights that describe the contribution of each vector. By comparing a set of weights for the unknown face to sets of weights of known faces, the face can be identified. PCA basis vectors are defined as eigenvectors of the scatter matrix S defined as:

$$S = \sum_{i=1}^{M} (xi - \mu).(xi - \mu)' \qquad (3)$$

where μ is the mean of all images in the training set and x_i is the i^{th} face image represented as a vector *i*. The eigenvector associated with the largest eigenvalue is one that reflects the greatest variance in the image. That is, the smallest eigenvalue is associated with the eigenvector that finds the least variance.

A facial image can be projected onto $M'(<< M)$ dimensions by computing

$$\Omega = [v_1 v_2 ... v_{M'}]^T \quad (4)$$

The vectors are also images, so called, eigenimages, or eigenfaces .They can be viewed as images and indeed look like faces. Face space forms a cluster in image space and PCA gives suitable representation

The DiaPCA is developed from PCA approach. DiaPCA can be subdivided into two components – PCA subspace training and PCA projection.

During PCA subspace training, the rows of the pixels of an N1 x N2 image are concatenated into a one dimensional 'image vector'. In practice, only a subset of the eigenfaces (*k = 1, …, M'*) is retained to form a transformation matrix which is used in the PCA projection stage. Only the principal eigenfaces accounting for the most significant variations are used in the construction. A new face image vector is multiplied by the transformation matrix and projected to a point in a high dimensional DiaPCA subspace. The projected image is then saved as the face template of the corresponding user for future matching.

B. Nearest Neighbor Classification

One of the most popular non-parametric techniques is the Nearest Neighbor classification (NNC). NNC asymptotic or infinite sample size error is less than twice of the Bayes error [6]. NNC gives a trade-off between the distributions of the training data with a priori probability of the classes involved[5]. KNN (K^{th} nearest neighbor classifier)classifier is easy to compute and very efficient. KNN is very compatible and obtain less memory storage. So it has good discriminative power. Also, KNN is very robust to image distortions (e.g. rotation, illumination). So this paper can produce good result by combining DiaPCA and KNN).

Euclidian distance determines whether the input face is near a known face. The problem of automatic face recognition is a composite task that involves detection and location of faces in a cluttered background, normalization, recognition and verification.

VI. EXPERIMENTAL RESULTS

The face database contains the 13 individual groups. Within a given database, all weight vectors of the persons within the same age group are averaged together. A range of an age estimation result is 15 to 80 years old, and divided into 13 classes with 5 years old range. Some face images in 13 individual age groups are illustrated in figure 5. The age dependent face recognition system is developed. The age prediction of the input individual is performed firstly. Then the matched individual is examined from the corresponding age group in face database based on the diagonal PCA Method. Finally, the record of the matched person is extracted.

Figure 5. Some face images in 13 age groups

Predicted Age: Age between 20-25
Actual Age: 24

Predicted Age: Age Over 60
Actual Age: 78

Predicted Age: Age between 35-40
Actual Age: 38

Predicted Age: Age Under 15
Actual Age: 13

The experimental result of age prediction can be seen in Figure 6 and identification result with extracted record is shown in figure 7, respectively. It is included the id number, name, date of birth, age, blood type and access per

ID Number	: 34
Name	: Hlaing Htake Khaung Tu
Date of Birth	: 12 11 1980
Age	: 31
Blood Type	: B

mission can be seen.

Figure 7. The extracted record for the recognized person

VII CONCULSIONS

The proposed technique so can be used for much real time applications like face recognition in crowded public places, banking, airport, station, highway gate, border trade, etc. Template matching technique is used for feature extraction. The complexities and processing times will reduce by searching the matched face from predicted age group instead of searching the face from the database which contains 13 age groups. The advantages of this paper are less processing time than only PC better features detection rate (iris = 93.06%, mouth = 95.83%) than conventional method had achieved a recognition rate of 96.11% with acceptable processing time (0.36 sec).

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