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Face Image Retrieval using Sparse Code and Age Group Estimation by using Face Angle

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Abstract: ***Rise of many social Medias have led to an increase in the consumer photos available which are highly manipulative. Large scale content based face image retrieval is an enabling technology for many emerging applications including automatic face annotation, crime investigation etc. In this system retrieve the similar face images of query image from data base and also do the approximate age group estimation. In content based face recognition system facial appearance and features of data base image changes as the age progress and data base should be updated which is a tedious task .So age group estimation is an important task and it is done by face angle calculation. High level human attributes like rice, gender etc are detected. Weber's Local Descriptor (WLD) is used for gender recognition. Local Binary pattern (LBP) is used to detect the rice. A method namely sparse coding is used to generate distinct code for each face. The effectiveness of different attributes and vital factors essential for face retrieval is mainly investigated.***

Keywords: Image reterival, Sparse code,Age estimation,Face angle,Image recognition

1. Introduction

In the present day to day life availability of consumer photos is dramatically increasing as a result of significance of digital devices and rise of social networks(eg: Facebook, flicker etc). Most of those photos (estimated more than 60%) are human faces. Now a day's human faces are mostly used for manipulations such as searching and mining. Large scale content based face image retrieval is an enabling technology for many emerging applications including automatic face annotation, crime investigation etc. So the content based face image retrieval is a important challenging problem.

Face recognition is one of the most important area of biometrics which has so many applications in our daily life such as recognition of a human in a security area , identification of documents such as land registration, passports, driver's licenses etc. But as age increases facial appearance and features changes and database should be updated which is a tedious task. So age detection is an important task in such applications. So many method has been proposed for age detection, but in this system, age detection is done by calculating face angle because face triangle is unique for every person and vary with age.

Main aim of this paper is to focus the important challenging problem content based face image retrieval and age group estimation. Content based face image retrieval tries to find similar face images of query image from a large image database. Many methods has been proposed for content based face image retrieval but most of the traditional methods usually uses low level features to represent faces but low-level features are lack of semantic meanings and face images usually have high intra-class variance (e.g., expression, posing).So recent proposed method offer unsatisfactory result and in order to improve the efficiency a new method is introduced in this paper. Here by combining high level features (eg:-gender, race) with low level features (eg:-expression), result will be satisfactory as shown in figure 1.

Figure 1

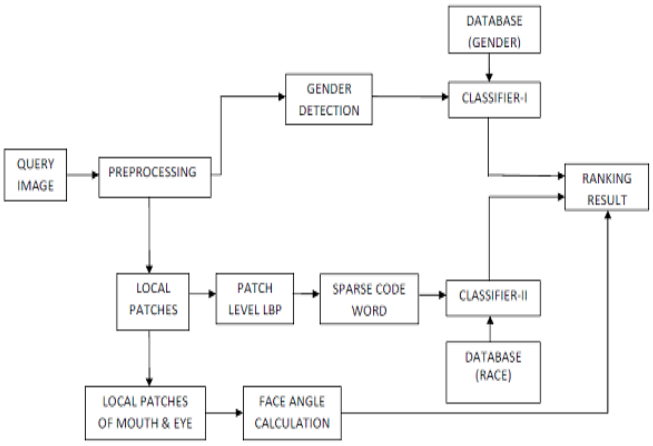
A query face image is given as input to retrieve similar faces from large scale database using content based image retrieval system (CBIR).Each image in the data base had gone through the feature extraction steps. Database is created by storing the extracted features as sparse code word. Sparse code word of the query image also generated and it compare it with data base image sparse code word. By using this technique similar faces can be extracted. It was an important technology and has so many application.

2. Proposed System

In this section, first briefly describe the system overview of face image retrieval and age detection system and then explain detailed about each block in the proposed system frame work.

2.1 System Overview

Every image in the data base undergo pre processing steps which include face detection face alignment and facial land mark detection. From the detected face five local patches are extracted including two eyes, nose and mouth corners. LBP (Local binary pattern) feature is extracted from these five local patches. LBP has the unique advantage that it is



Block Diagram

Independent of colour or light variation in the image hence it is used for race (Asian or European) detection. From the LBP sparse code word is generated for each image and it saved in the race database. For gender detection , query image after pre-processing goes through gender detection steps such as differential excitation, Gradient orientation and building histogram. Finally the value is stored in the database for gender. The classifiers (1 &2) are minimum distance classifiers which find the difference between query image and database image output the image which has minimum difference as first and accordingly ranks the result. For age calculation, a face triangle is formed taking centre of two eye and centre of mouth has three points. As the age progress the face angle also changes. So by calculating face angle we can estimate approximate age of query image.

2.2 Sparse Code Generation

The superior performance in face image retrieval can be done by Sparse coding based dictionary learned approach . Sparse coding is used for face image retrieval, by solving the following optimization problem:

$$\min_{D,V} \sum_{i=1}^{n} \|x^{(i)} - Dv^{(i)}\|_2^2 + \lambda \|v^{(i)}\|$$

$X^{(i)}$ is the feature extracted from a patch of face image i,

D is the dictionary learning , V =[$v^{(1)}$, $v^{(2)}$,…….$v^{(n)}$] is the Sparse representation of image patches and λ is the regularization parameter. In the first part of the equation finding the minimum distance and second part regularization. In the above equation mainly contains two parts:sparse feature encoding (find V) and dictionary learning (find D).The proposed system uses K-SVD algorithm used to solve the problem of dictionary learning and OMP technique is used to update the V.

2.3 Gender Detection:Weber's Law Descriptor

This descriptor represents an image as a histogram of differential excitations and gradient orientations.WLD descriptor is based on Weber's Law. According to this law the ratio of the increment threshold to the background intensity is constant. The calculation of WLD descriptor involves mainly three steps i.e. finding differential excitations, gradient orientations and building the histogram.

2.3.1. Differential Excitation

Differential excitation $\mathcal{E}(x_c)$ of a pixel x_c is calculated as follows

- Intensity differences of xc with its neighbors x_i, i = 1, 2, …, p are determined as follows:
$$\Delta I_i = I_i - I_c$$
.
- Then the ratio of total intensity difference of x_c with its neighbors x_i to the intensity of x_i is calculated as follows:
$$F_{ratio} = \Sigma_{i=0} (\Delta I_i / I_c)$$
- Arctangent function is used as a filter on F_{ratio} which results in:
$$\mathcal{E}(x_c) = \arctan (F_{ratio})$$

The value of differential excitation ($\mathcal{E}(x_c)$) may be positive or negative. If current pixel is darker than its surroundings then the value of differential excitation is positive. If the current pixel is lighter than the surroundings then the value of differential excitation is negative

2.3.2. Gradient Orientation

The gradient orientation for a pixel x_c is calculated as follows:

$$\Theta(x_c) = \arctan (I_{73} / I_{51})$$

where $I_{73} = I_7 – I_3$ is the intensity difference of two pixels on the left and right of the current pixel x_c, and $I_{51} = I_5 – I_1$ is the intensity difference of two pixels directly below and above the current pixel, and $\Theta \varepsilon [-\pi/2, \pi/2]$

2.3.3 Histogram

WLD descriptor is build, after calculating differential excitation and dominant orientation. This histogram is treated as WLD descriptor.

2.4 Classifiers

In order to keep the system simple proposed method uses minimum distance classifier (Euclidean distance) to get optimum result for gender and race detection.

2.5 Age Group Estimation

The same detected eyes and mouth area used for LBP feature extraction is also used for age group estimation. By using three coordinate points left eye centre , mouth and right eye centre , can form a triangle called face triangle as shown in figure. Face angle is the angle formed between left eye centre mouth and right eye centre. As the age progress the face angle also changes as shown in the table1.

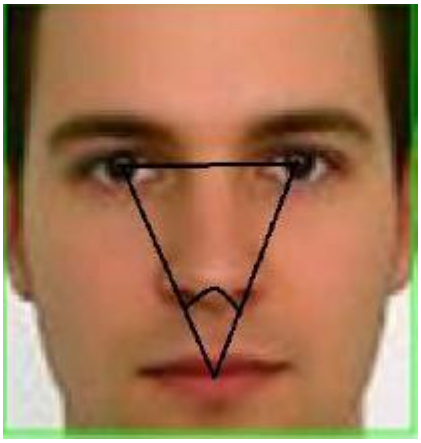


Figure 2: Face image with face triangle and face angle

Next find the row number R_1 which passes through the centre of two eye and column number C_1 and C_2 which are the columns passing through the centre of left eye and right eye respectively. So the coordinates (R_1, C_1) represents the centre of left eye and the coordinates (R_1, C_2) represents the centre of left eye. Similarly find the column number R_2 which is the row passing through the centre of mouth and column number C_3 which is the column passing through the centre of mouth . As from the figure 3 ,C_3 can be is calculated as C_3=(C_1+ C_2) /2 and coordinate (R_2, C_3) is the centre of mouth.

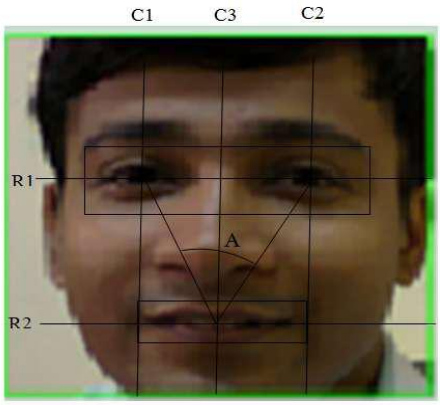


Figure 3: Face image with different coordinate points

Next form a triangle by using these three coordinates {(R_1, C_1), (R_2, C_3), (R_1, C_2)} called face triangle. From the face triangle find the face angle which is the angle formed between centre of left eye, mouth and right eye. Calculate slope (m_1) of triangle sides from mouth point (R_2, C_3) to right eyeball (R_1, C_2) and slope (m_2) of triangle sides from mouth point (R_2, C_3) to left eyeball (R_1, C_1).Find the face angle (A) using formula:

$$A = \tan^{-1}((m_1 - m_2) / (1 + m_1 * m_2))$$

Determine age group based on the face angle (A) as follows:

Table 1: Face angle and age group

Face angle in degree (A)	Age group in years
<40	<20
40-44	20-30
44-48	30-40
48-52	40-50
>53	>50

3. Experimental Result

The experimental result of the system as follows. Figure 4 shows the query image, detected face image and local patches of eyes, nose and mouth corners.

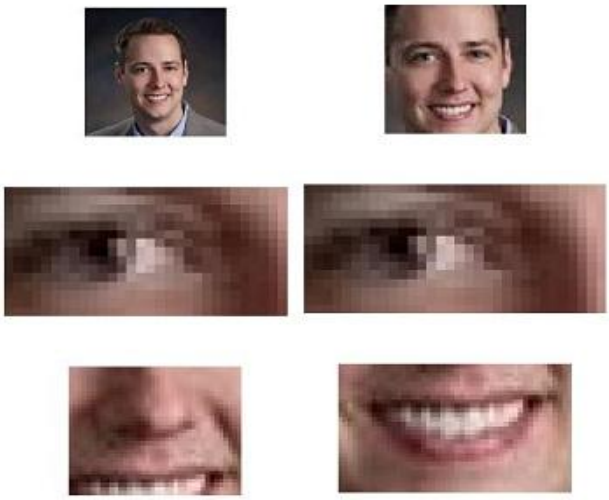


Figure 4: Query image and Local patches

Figure 5 shows the LBP histogram of patches of detected face, eyes, nose and mouth.

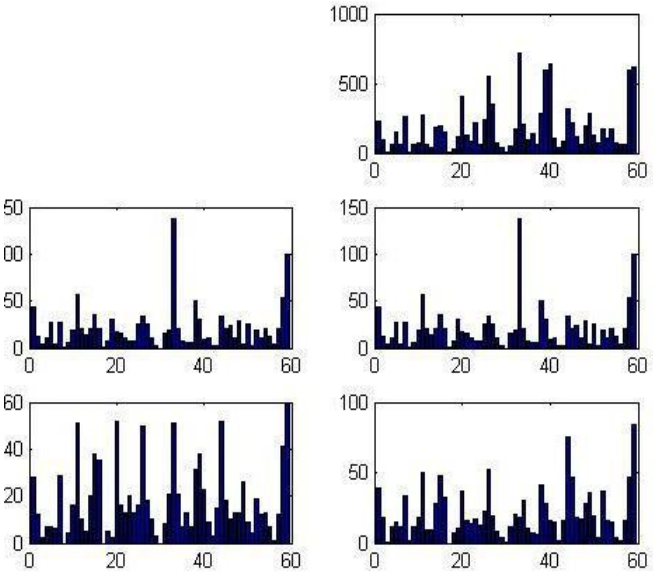


Figure 5: Patch level LBP

Figure 6 shows ranking result, face triangle diagram and final output which shows the gender, race and age group.

Figure 6: ranking result, Face triangle and final prediction

4. Conclusion

In this paper a method for content based face image retrieval and age group estimation is thoroughly described. The proposed system also result the gender ,rice and age group along with ranking result. Sparse code word is used for content based face image retrieval system and it is one of the most efficient method. Gender recognition is done by WLD descriptor and it is the simple technique and gives better recognition accuracy than complicated system. Age group estimation is done by face angle calculation. As face changes with age, it is very difficult to update periodically the databases where face recognition is very important. So the proposed technique provides a robust method that verifies the identity of individuals from a pair of age separated face. This paper works with 80% accuracy and some time generate erroneous outputs. But the method shows some difficulties in detecting the facial components if face image is not frontal image. So, there seems to be a definite possibility for further extension of the work.

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