Design of Attendance System Based on Face Recognition and Android Platform

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Abstract—**Aiming at the disadvantages of traditional manual attendance, this paper proposes a face recognition based attendance scheme. Through mobile platform and face recognition technology to optimize the manual attendance process. This design divides into the face recognition system of check on work attendance information input, attendance sign-in and attendance record three function module, and introduces a principle of face detection and classification, analyses the process of the construction of the face recognition classifier, the last on the Android platform design and implement a face recognition system of check on work attendance, by comparing the experiment results of face recognition accuracy, verify the feasibility of this scheme.**

Keywords-Attendance System; Face Detection; Face Recognition; Android Platform

I. INTRODUCTION

There are a lot of defects in the traditional method of manual attendance, for example, it will takes up class time, and being operated by people, it is hard to guarantee the accuracy, and also hard to be executed strictly.

With the popularization of Internet and the rapid development of mobile device, we have entered the era of mobile Internet. It shows that the global number of mobile users have exceeded 5 billion [1], thus more and more mobile Apps and developers appear to serve the users [2]. In this context, developing of automatic attendance system based on mobile platform and face recognition technology can greatly improve work efficiency. Face feature is a typical biological feature inherent in human body, with strong individual difference and self-stability, which is an ideal basis for identity recognition and authentication. Compared with other methods, face feature is safe, reliable, friendly and easy to be accepted [3].

For humans, face recognition is so easy that babies as young as three days can distinguish familiar faces around them [4]. But for computers, face recognition is very difficult. For the first automatic face recognition system [5], a feature vector is constructed by marking the positions of eyes, ears, nose, etc., and faces are recognized by calculating the Euclidean distance of feature vectors of images. In paper [6], a 22-dimensional feature vector is used in a large database to describe the geometric features of face images for

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recognition. The feature face method is described in paper [7], where the facial image is regarded as a point, and represented in a low-dimensional space that derived from high-dimensional image space, thus made classification task simple.

On the basis of reading a lot of literature, this paper designs and implements a face recognition attendance system on the Android platform, which can be applied to practical application scenarios such as student attendance and staff attendance, and can effectively overcome the disadvantages of traditional manual attendance.

II. System Design

Face recognition attendance system is divided into three functional modules: information entry, attendance check-in and attendance record, as shown in Figure 1.

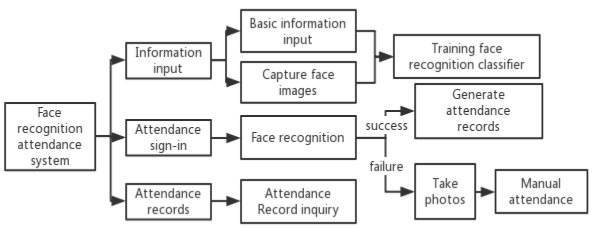

Figure 1. Structure of face recognition attendance system

The first module is used to input basic information of users, meanwhile collect face images of users, when finished the collection, a face recognition classifier is trained on these data; The second module realize core function of this system, if a user was successfully identified by "scanning face", it will generate an attendance record, but if it failed to identify, it will automatically take a photo for deposit certificate, and then record manually.

The core face recognition process is divided into three stages: Face detection, classifier training and face recognition, as shown in Figure 2. The goal of face detection is to detect the region containing the face in an image. In this process, the input image needs to be preprocessed, and then the part of the face is detected by the Adaboost cascade classifier. The second stage is to extract LBP features from the face region, calculate its LBP histogram, and train the classifier on images and tags for face recognition. On the third stage, based on the detected face region, LBP features were extracted and input into the classifier to identity each user.

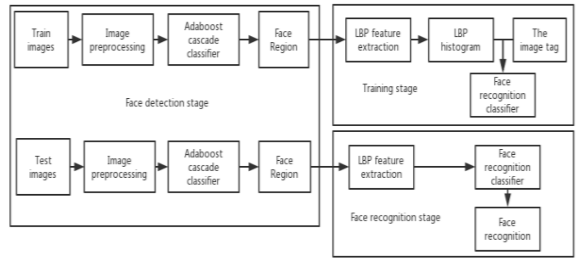

Figure 2. Flow chart of face recognition

A. Face detection

Face detection is a key step in the face recognition attendance system. It is used to detect whether there is a face in an image. If true, the face area will be marked out for feature extraction and training. In this paper, Adaboost cascade classifier is used for face detection.

Adaboost is mainly used for classification as well as regression tasks. It is an iterative algorithm that trains several weak classifiers on a training set, and then superimposes them together to form a strong classifier. The algorithm is implemented by changing the data distribution iteratively, it adjust the weight of each sample by the classification result of each sample as well as the total accuracy of the last epoch of training, and then output the data set with modified weights to the next classifier for training, and all classifier obtained from each training is finally integrated as the final strong classifier.

The detailed steps of Adaboost algorithm is shown as follows:

1) Initialize all training samples with a weight of 1 / N, where N is the number of samples

$$\mathrm{D_i} = (w_{11}, \cdots, w_{1i}, \cdots, w_{1N}),\ w_{1i} = \tfrac{1}{\mathrm{N}}, i = 1,2,\cdots,N \quad (1)$$

2) For m = 1,...M:

a) Learn from the training data set with weight distribution D_m and obtain a basic classifier:

$$\mathrm{G}_m(x) : \chi \rightarrow \{-1,+1\} \quad (2)$$

b) Calculate the classification error rate of $G_m(x)$ on the training data set:

$$e_m = P(G_m(x_i \neq y_i) = \sum_{i=1}^{N} w_{mi} I(G_m(x_i) \neq y_i) \quad (3)$$

The classification error rate of $G_m(x)$ on the weighted training data set is the sum of the weights of the samples misclassified by $G_m(x)$.

c) Calculate the coefficient of $G_m(x)$:

$$\alpha_m = \frac{1}{2}\log\frac{1-e_m}{e_m} \quad (4)$$

d) Update the weight distribution of the training data set, among them

$$\begin{aligned} w_{m+1,i} &= \frac{w_{m,i}}{Z_m}\exp(-\alpha_m y_i G_m(x_i)) \\ &= \begin{cases} \frac{w_{m,i}}{Z_m}\exp(-\alpha_m), G_m(x_i) = y_i \\ \frac{w_{m,i}}{Z_m}\exp(\alpha_m), G_m(x_i) \neq y_i \end{cases}, i = 1,2,\cdots,N \end{aligned} \quad (5)$$

Here, Z_m is the normalization factor

$$Z_m = \sum_{i=1}^{N} w_{mi} \exp(-\alpha_m y_i G_m(x_i)) \quad (6)$$

3) A linear combination of basic classifiers is constructed

$$f(x) = \sum_{m=1}^{M} \alpha_m G_m(x) \quad (7)$$

Finally, the final classifier is obtained

$$Y_m(x) = sign(f(x)) = sign(\sum_{m=1}^{M} \alpha_m G_m(x)) \quad (8)$$

Adaboost's weak classifier is extremely simple, no feature filtering is needed, and no worry about overfitting. But it will take a long time for training, and it's effects depend on the selection of weak classifier. In this paper, the Adaboost cascade classifier provided by OpenCV was adopt, which can be unpacked to use with high performance.

B. Face Recognition

The key issue of face recognition lies in feature extraction. Based on the extracted face features, a classifier can be trained, and then the same features can be extracted for the query image, and made identify by the classifier.

C. Face feature extraction

In this paper, Local Binary Pattern (LBP) [8] was adopted as the feature of face recognition. LBP is an operator used to describe the local texture features of an image. It has significant advantages of rotation invariant, gray invariant and simple calculation. The basic idea of LBP is to sum the result of the difference between the pixels and its local surrounding pixels, take a pixel as center, made a threshold comparison with adjacent pixels. If the central pixel is brighter than or equal to its neighbor, marked as 1, or 0 otherwise. Originally, the 3*3 neighborhood was used, with binary digits representing each pixel, thus represented by 8 binary digits, which is called local binary mode, or LBP code, as shown in Figure3.

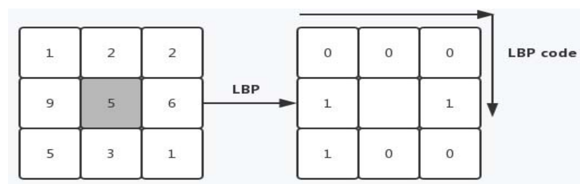

Figure 3. LBP code generation diagram

LBP algorithm is described as follows:

$$\mathrm{LBP}(x_c, y_c) = \sum_{p=0}^{P-1} 2^p s(i_p - i_c) \quad (9)$$

Where (x_c,y_c) is the central pixel, i_p is the brightness of the center pixel, i_c is the brightness of adjacent pixels. S is a symbolic function:

$$s(x) = \begin{cases} 1, x \geq 0 \\ 0, x < 0 \end{cases} \quad (10)$$

This description method can well capture the details in the image, but for the coding of scale change, it will fail to use the fixed neighboring region. In literature [9], a variable extension method is proposed, which use a circle with variable radius to encode the nearest neighbor pixels, so that the nearest neighbor shown in Figure4 can be captured:

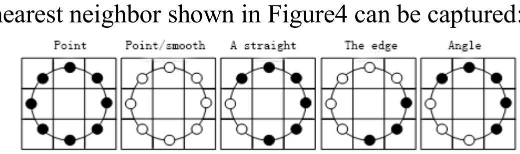

Figure 4. Schematic diagram of extended LBP nearest neighbor coding

For A given point (x_c,y_c), its nearest neighbor point (x_p,y_p), p∈P can be calculated as follows:

$$\begin{cases} x_p = x_c + R\cos(\frac{2\pi p}{p}) \\ y_p = y_c - R\sin(\frac{2\pi p}{p}) \end{cases} \qquad (11)$$

Where R is the radius of the circle and P is the number of sample points.

This operation is an extension of the original LBP operator, also known as extended LBP or circular LBP. If a point on a circle is not on the image coordinates, its interpolation points are used. In this paper, the bilinear interpolation from OpenCV library was invoked, which was defined as:

$$f(x,y) \approx [1-x \ \ x]\begin{bmatrix} f(0,0) & f(0,1) \\ f(1,0) & f(1,1) \end{bmatrix}\begin{bmatrix} 1-y \\ y \end{bmatrix} \qquad (12)$$

D. Face Recognition classifier

This paper adopts the representation method proposed in literature [9] and USES statistical histogram of LBP feature spectrum as feature vector for classification and recognition. At first step, an image is divided into several regions, and LBP features are extracted for each pixel in a region. Then, statistical histograms of LBP features for each region. In this way, a region can be described by a statistical histogram, and the whole image is composed of several histograms, which are called local binary mode histograms. By dividing the image into regions and separately calculating the LBP histogram, the errors caused by incomplete alignment of the image can be reduced to a certain extent. Meanwhile, different weights can be assigned to different regions. For example, the center part can be set a high weight than the edge part, for that the center part is more significant in image matching and recognition.

Face recognition classifier needs to be constructed by training and testing images. During the training, the face image and its corresponding label should be input at the same time. The face recognition classifier uniformly extracts the LBP features of these images, statistics the LBP histograms, and then takes the feature vectors composed of these histograms as the feature vector of this face; At face detection stage, the LBP feature of a face region was extracted and LBP histograms was created. The similarity measure function is used to judge the distance between this histogram and all other feature vectors of this classifier, meanwhile, a threshold value is set through experiments. Finally, the face image with a minimum distance and less than the threshold value is selected as the classification result of the test image.

In this paper, the following similarity calculation formula is used to judge the similarity of two face images:

$$\mathrm{d}(H_1, H_2) = \sum_I \frac{(H_1(I) - H_2(I))^2}{H_1(I)} \qquad (13)$$

III. Experimental Results

Android device were used in the experiment. Training and test images can be taken from the camera or select from the mobile album.

In this paper, the ORL (Olivetti Research Laboratory) face database was used to conduct experiments. This database was created by Olivetti Laboratory in Cambridge, UK, with a total of 400 grayscale images in it, include 40 person of different ages, genders and races. Each one has 10 images, with various facial expressions and details in each image, Such as laughing and not smiling, eyes open or closed, wearing or not wearing glasses, etc. Some instance images of ORL face database are shown in Figure 5.

Figure 5. ORL face database partial instance image

In order to verify the validity of LBP algorithm, two classical face recognition algorithms, Fisherface [10] and Eigenface [11], are tested simultaneously. The first N(N=1,2...9) Images were taken as training samples, and the last image was taken as test samples. Experimental results of the three algorithms were compared in Figure 6. In addition, this paper also makes statistics on the time spent in face recognition classifier training under different number of images by three algorithms, and the statistical results are shown in Table1.

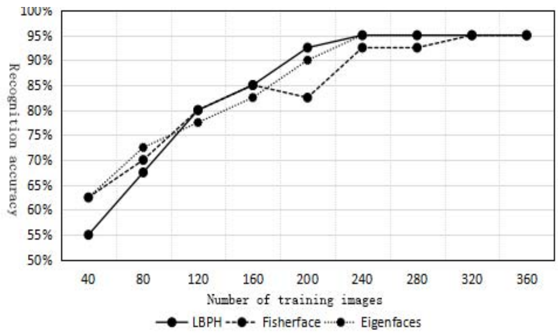

Figure 6. Statistical of face recognition accuracy of the three algorithms in ORL library

TABLE I. STATISTICAL OF TRAINING TIME (MS) OF THREE ALGORITHMS FOR DIFFERENT NUMBERS OF IMAGES

Number of training images	40	120	200	280	360
LBP	759	1681	2681	3818	4759
Fisherface	2212	7994	16992	37052	72292
Eigenface	2161	6612	21638	31025	55918

It can be seen from Figure 6 that, with the increase of number of training images, the accuracy of face recognition was significantly improved. When tested with 5 images each person, the accuracy of face recognition can reach more than 95%. When there have 3+ images per person, the LBP algorithm had better result than other two algorithms. From Table 1 we can find that the time efficiency of LBP algorithm in the training stage of face recognition classifier is significantly higher than that of two other algorithms.

To verify the practicability of the face recognition attendance system, we made an experiment on 30 persons. In the "information input" module, we took 10 images for each person for training. and then made use of "attendance check-in" by face recognition. Finally all the persons can be correctly identified, thus verifying the usability of the system.

IV. CONCLUSION

In this paper, in the process of face detection on Android platform, the Adaboost cascade classifier is used to detect the face part; In the training stage, face image is extracted with LBP feature, histogram is calculated, and finally face recognition classifier is constructed with LBP histogram; In the recognition stage, LBP features are also extracted and input into the classifier, and then the similarity measurement function is calculated to effectively realize the identification of personnel. A face recognition attendance system designed and implemented in this paper is tested on ORL face database, and compared with Fisherface and Eigenfaces algorithms. At last, 30 testers are tested, and the final result verifies that the face recognition accuracy of this system can meet the practical use requirement.

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