

College Student Attendance System Based on Face Recognition

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Abstract. In order to improve the efficiency of management and enhance the atmosphere of learning, in this paper, we develop a set of attendance system based on face recognition using the deep semi-NMF algorithm. Specifically, the system can automatically detect and recognize faces from the video images, and then gets its detailed information on attendance from the database. Moreover, the system not only performs simply, but also can be of great benefit to the whole educational field. The experimental results on real applications show that the system is effective and efficient.

1. Introduction

There is no denying that the attendance is not optimistic, based on the truth that a considerable number of students register others' attendance, which has become a common phenomenon. Meanwhile, the efficiency of attendance check by manual record is not always satisfying, and it is really a headache to the whole educational field [1]. Face recognition technology is a technology that collects facial information by video cameras or cameras, detects, traces faces, as well as recognizes facial features. At the moment, face recognition technology has been used widely, and gets some optimistic results in economy [2].

At present, there are varieties of ways of face recognition. Principal Component Analysis (PCA for simple), which is a classic algorithm proposed by Turk and Pent land. It carries out orthogonal transformation according the features that have been censured to eliminate the correlation between original vectors [3]. Characteristic values of the vectors descend in turn, namely characteristic face. Linear Discriminate Analysis (LDA), is also a common approach, which searches for the best projection, using Fisher criterion function derivation to get extreme vector. Then, the samples are projected based on the vector, which minimizes the within-class scatter, maximizes between-class scatter in the way of classification but without losing useful information [4]. Manifold learning requires to preserve the essential features of original datasets. In the meanwhile, it carries out data dimensionality reduction on the basis of the fact that face information is embedded in low-dimensional nonlinear sub manifolds [5]. NMF, is a way of factorization that satisfies the constraints that every element in the matrices is non-negative. NMF is an approach to extracting sample data. What is more, the constraints imposed on NMF that every element has to be non-negative can be liberalized, such as Semi-NMF, Deep Semi-NMF[6].

In this paper, we adopt Deep Semi-NMF to learn features in hierarchical structure with each layer learning a representation that is suitable for clustering on account of various attributes in the data. In the



system of this paper, the model has the ability to learn characteristics for expression clustering, pose clustering as well as identity clustering.

2. The Relative Works

In recent years, there has been a significant amount of research on factorization methods that focus on particular characteristics of both the data matrix and the resulting factors [7]. One of the most useful functions of NMF is that it can reduce the dimensionality successfully over various areas especially in face recognition.

2.1. Semi-NMF

An extend the ability of application of NMF, the data matrix N storing original face data, the relation between face data, the potential features can be further exploited, in which case the extended NMF is called Semi-NMF[8]. In this case, only the second factor Y are required to preserve its non-negativity constraints, while the matrix X and Y are allowed to be made up of numbers regardless of their signs. Thus, we can get: $N^\pm = X^\pm Y^+$. Compared with other ways, There are many superiorities: it has been motivated from a clustering perspective, in which X represents cluster centroids, while Y represents soft membership indicators for every data point, enabling Semi-NMF to learn lower-dimensional features from the original data.

2.2. Deep Semi-NMF

In contrast with NMF and Semi-NMF, Deep Semi-NMF tends to be more useable, because it is able to factorize a matrix into multiple factors allowing for the problem of mapping images of faces to their identities: such information about attributes, such as pose and expression, are also included in the face dataset that can be further made full use of to identify the person to be depicted. As a result, Deep Semi-NMF has the perfect ability to learn a hierarchy of hidden representations that is of help to uncover the final lower-dimensional representation of the data [9]. Considering the matrix N and X are not strictly required to be non-negative, the concrete formulation can be shown as:

$$N^\pm \approx X_1^\pm X_2^\pm \dots X_m^\pm Y^+$$

In order to be as approximate to the original matrix as possible, the formulation below reflects this point and is called the cost function:

$$\begin{aligned} C_{deep} &= \frac{1}{2} \| N - X_1 X_2 \dots X_m Y_m \|^2_F \\ &= \text{tr}[N^T N - 2N^T X_1 X_2 \dots X_m Y_m \\ &\quad + Y_m^T X_m^T X_{m-1}^T \dots X_1^T X_1 X_2 \dots X_m Y_m] \end{aligned}$$

The update rules for the weights matrix X and features matrix Y can be expressed as .

By setting $\frac{\partial C_{deep}}{\partial X_i} = 0$, we can get the update rule for X :

$$\begin{aligned} X_i &= (\Psi^T \Psi)^{-1} \Psi^T N \tilde{Y}_i (\tilde{Y}_i^T \tilde{Y}_i)^{-1} \\ X_i &= \Psi^\dagger N \tilde{Y}_i^\dagger \end{aligned} \tag{1}$$

Where $\Psi = X_1 \dots X_{i-1}$, † denotes the Moore-Penrose pseudo-inverse, and $\tilde{Y}_i$ is the reconstruction of i^{th} layer's feature matrix.

The Update rule for Y can be expressed as:

$$Y_i = Y_i \odot \sqrt{\frac{[\Psi^T N]^{pos} + [\Psi^T \Psi]^{neg} Y_i}{[\Psi^T N]^{neg} + [\Psi^T \Psi]^{pos} Y_i}} \quad (2)$$

where $[\Psi^T N]^{pos}$ denotes that 0 takes the place of the numbers that are negative in $[\Psi^T N]$; $[\Psi^T N]^{neg}$ denotes that 0 takes the place of the numbers that are positive in $\Psi^T N$.

3. The Design of the System

This system uses Deep Semi-NMF algorithm to lower the dimension of face sample. And then, it carries out the projection of the sample. At last, it computes the similarity degree between the sample that have been trained and the test sample[10]. The requirements of attendance system are as the followings:

Step 1: Input the information of students by their IC card.

Step 2: The managers save image information of students in an independent file.

Step 3: When someone (a certain student) is in the process of being checked his or her attendance, the ID number has to be read, and face image can be collected by reading the IC card at the same time.

Step 4: The face images that have been collected is going be in contrast with the same images that have been stored in the corresponding files, then the system will draw a conclusion whether the student is completely in common with the facial image in the file in the database that has been embedded in the card.

Step 5: When the students sign in successfully, the system records the attendance time at that moment, and then stores it in the database by adding the information in the database.

Step 6: In order to search conveniently, the system finds out the concrete information needed, such as student number, name, class and attendance time by the means of getting ID number in the way of accessing IC cards of students.

The relative managers have access to the query of the students who have been late for class, left earlier than they should, or even have been absent from class by means of the select function embedded in the system. The flow chart of the college attendance system based on face recognition is shown in the Figure 1.

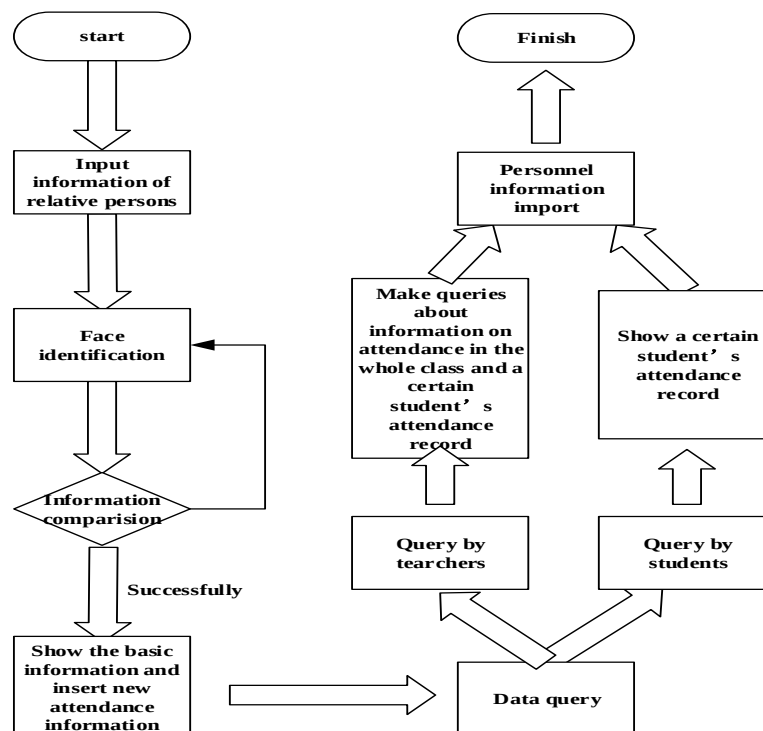


Figure 1. The flow chart of the system

4. The Results of the System

4.1. Add Information on Students

The system has to add the whole information of the students, including ID number, name, student number, sex, department, class, and identity card directory. When the corresponding information is not complete, the corresponding statements tell the users that something wrong has taken place and give hints of failure information. The **Figure 2.** show us the interface when the users add information on the someone.



Figure 2. Adding information interface

4.2. Sign in the Way of Face

When someone is signing in, the students are required to have his or her IC card read, and then the system searches for and validates the identity information of students. If it has been tested successfully, the corresponding attendance information will be added to the database. In turn, if the system does not validate the student's identity successfully, the window shows the relative failure information. And the interface of signing in the way of face is shown in the **Figure 3.** below:



Figure 3. Signing in the way of face interface

4.3. Query of Attendance Information

The query of attendance information includes the time slot query and personal time slot query. When the student number along with a certain time slot is input in the system, the window shows attendance information of all the students during the time interval. If the student number is not input, the system turns out all the students' attendance information during designated time interval. And the interface of attendance information query is shown in the **Figure 4**.

序列	学号	姓名	刷卡时间
41	2015144416	葛婉东	2017/3/30 9:35:00
35	2015144416	葛婉东	2017/3/30 7:56:00

Figure 4. Attendance query interface

5. Conclusion

The system adopts the way of face images to verify the students' identity. It is not only simple, convenient, and easy to deploy, but also contributes to improving the efficiency of teaching management. And the system is going to play an important role in teaching reform in the future. There is no denying that facial recognition is becoming more and more important in various ways, especially in educational filed, for the sake of the fact that it stimulates the quality of the whole society, which guarantees the fairness and enhances the atmosphere, which, in turn, contributes to a bright future.

6. References

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