Data Science in Face Recognition System Based on BP Neural Network

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Abstract. With the rapid development of economy, people have higher and higher requirements for the performance of security system. The traditional access control system based on face recognition based on deep learning has gradually replaced the traditional access control system. This paper mainly describes the concepts of BP neural network and face recognition, and improves and designs a face recognition system. The detection accuracy of the system reaches 97.8\%, the false detection rate is 0.8\%, and the leakage rate is 0.8\% the detection rate is 1.4\%, and the accuracy of face recognition is 96.7\%, which can well meet the requirements of contemporary face recognition.

Keywords: Face Recognition, BP Neural Network, Security System, Access Control System

1. Introduction

Face detection technology is the first step of the whole face recognition process, which mainly deals with the image. Its core idea is to set rules according to the specific position of facial features, such as facial features. When face detection is carried out, the set rules are used to compare the information in the image for filtering. The face detection algorithm based on learning is essentially the idea of classification. We train a classifier through a large number of face images and non face images, and then use the classifier to detect the face in the image. Since the classifier is trained, both the training data set and the selected algorithm will affect the final classifier performance. Generally, the richer the training data set, the better the classifier performance [1]. Face detection based on prior knowledge sets parameters according to human subjective experience, and the detection results are greatly affected by human beings. Therefore, in the actual face detection process, researchers mostly use the face detection method based on learning, and invest a lot in its research.

Face recognition technology can be traced back to the 19th century. Francis Galton first proposed to complete face recognition through face edge contour curve in nature. The other method is based on template matching. The image needs to be preprocessed in advance. After the scale and gray scale normalization, the image features are extracted for matching. When the matching degree is higher than
the set threshold, it means that it is the same person. With the important role of face recognition technology in security system, face recognition technology has been unprecedentedly developed in recent years. At present, face recognition methods mainly include the following: principal component analysis (PCA), Fisher faces algorithm based on linear discriminant analysis (LDA), and face recognition method based on deep learning [2]. Among them, the recognition method based on deep learning obtains the face feature model through a large number of data training, and has achieved very good results in the accuracy of face recognition. In 2014, the Facebook team used the face alignment operation in advance, and then used the deepface network structure to test on the face dataset LFW, with an accuracy of 97.35%. Then 5 million face images are searched and sorted out to train convolution network model. The improved face ++ can achieve 99.5% accuracy on LFW data set. In 2015, Google designed the facenet network structure based on the CNN network structure by using the sampling method of triplet mining. The accuracy rate on the LFW data set was improved again, reaching 99.63%, and the accuracy rate on the more complex YouTube face video set reached 95.12%. At the same time, domestic manufacturers have begun to focus on the application of face recognition technology based on deep learning in real engineering, among which Shangtang technology and Hanwang Technology are representative enterprises.

Based on the research of face detection technology and face recognition technology, this paper designs a campus entrance guard system based on BP neural network. Through a set of face evaluation mechanism, it selects the real face area to be detected, intercepts the area, and extracts the face features from it, and then transmits the extracted features to the established residual network for face recognition. The recognition results are displayed [3]. Considering the application scenarios of the system, this paper focuses on improving the effect of face detection and face recognition under unrestricted conditions.

2. Related Concepts of Data Science in Face Recognition System Based on BP Neural Network

2.1. BP Neural Network Model
BP network is a multilayer feedforward neural network based on BP algorithm. It was studied and designed by d.e.rumelhart, j.l.mccelland and their research team in 1986. At present, in the practical application of artificial neural network, most of the neural network models adopt the BP network and its change form. It is also the core part of the forward network and embodies the most important part of the artificial neural network [4]. It can be seen that the BP network model generally has one input layer, one hidden layer (sometimes two or more) and one output layer.

2.2. BP Neural Network Algorithm
BP neural network is a supervised network learning method, so its input is similar to the following sample set:

\[ \{p_1, t_1\}, \{p_2, t_2\}, \ldots, \{p_q, t_q\} \]  

The output of one layer is the input of the next. The equation describing this operation is as follows:

\[ a^{m+1} = f^{m+1}(w^{m+1}a^m + b^{m+1}), m = 0, 1, \ldots, m - 1 \]  

The neurons in the first layer receive input from the outside:

\[ a^0 = p \]  

The output of the last layer of neurons is the output of the network:

\[ a = a^M \]
Then, the actual output is compared with the target output, and the mean square error of the described function is obtained.

\[ F(x) = E\left[\ell^2\right] = E\left[(t-a)^2\right] \] (5)

Then the weights and bias values are updated by using the approximate steepest descent method:

\[ W^m(k+1) = W^m(k) - \alpha s^m(a^{m-1})^T \] (6)

\[ b^m(k+1) = b^m(k) - \alpha s^m \] (7)

2.3. Research on Face Detection System

Face detection technology is the first step of the whole face recognition process. It mainly processes the image and selects the area of the face to be detected accurately. Its detection results will directly affect the subsequent recognition results. Face detection technology is generally divided into two categories, one is traditional face detection, the other is face detection based on deep learning. The traditional face detection technology can be divided into the detection method based on prior knowledge and the detection method based on learning. The typical detection methods based on prior knowledge include template based face detection, feature-based face detection and skin color based face detection. Its core idea is to set rules according to the specific position of facial features, such as facial features. When face detection is carried out, the information in the image can be compared by using the set rules to screen. The face detection algorithm based on learning is essentially the idea of classification. We train a classifier through a large number of face images and non-face images, and then use the classifier to detect the face in the image [5]. Since the classifier is trained, both the training data set and the selected algorithm will affect the final classifier performance. Generally, the richer the training data set, the better the classifier performance. The representative methods of face detection based on learning include support vector machine (SVM) and AdaBoost method. Face detection based on prior knowledge sets parameters according to human subjective experience, and the detection results are greatly affected by human beings. Therefore, in the actual face detection process, researchers mostly use the face detection method based on learning, and invest a lot in its research.

2.4. System Requirement Analysis and Overall Structure

(1) Quick response. Because the designed system mainly serves university dormitories or laboratories, there will be a peak period of student flow in some time periods. If the system response time is too long, it will cause staff congestion and poor user experience.

(2) Strong security. As a security system, the ultimate purpose of access control system is to ensure security, so the system requires high accuracy of face recognition.

(3) Real time updates are scalable. Due to the change of college students every year, the system needs to update the database face information in real time. At the same time, due to the user's need to expand or adjust the system needs, it needs to have strong scalability.

(4) Rich functionality: use image acquisition equipment, such as camera, to display the real-time collected information on the interface. The real faces to be detected and recognized are selected by filtering the faces currently entering the acquisition screen [6]. For face detection and recognition, the detailed information of the person is recorded in the background, including name, student number, college name and detection time. The person information in the background database can be modified and deleted, and new person information can be registered and added.

Based on the requirement analysis of the system, the system designed in this paper should realize two basic functions: real-time detection and control of access control and detection information statistics. The software part involved in the system operation process includes face detection, recognition algorithm and database part, and the hardware part mainly includes the camera needed to collect photos. After the system is built successfully, the main process of the work includes: preprocessing the video stream collected by the camera in real time, detecting and screening the face...
in the shot area, determining the face image to be recognized after screening, matching the target with
the samples in the training set, and sending the recognition results to the display if the target belongs
to a sample in the database The system displays the detailed information of the target correctly. If the
target is not recognized, the system displays that the target is not recognized. All the displayed
information will be saved in the database for later statistics.

3. Practice Design of Data Science in Face Recognition System Based on BP Neural Network

3.1. Experimental Environment
In addition to the hardware of the computer system, there is no need to consider the software
configuration of the computer system. The minimum requirements of software and system testing are
as follows:
- CPU: Intel's seventh generation core, i5 7500 or above;
- Memory: above 16g;
- Video card: NVIDIA GTX 1060 or above;
- System: win10 professional 64bit
The camera is mainly responsible for image reading. Although the camera image resolution has
little impact on the software system, for better face recognition quality, at least 720p is recommended.
Moreover, the deployment environment of the camera has a great impact on real-time face detection.
Therefore, we should pay attention to the fact that there is no obstruction in front of the camera; avoid
the background with continuous change and strong light source; the height of the camera should be
equal to or slightly higher than the person.

3.2. Experimental Steps
Based on the traditional residual unit, a weighted widening residual unit structure is proposed.
Through comparative experiments, the improvement effect of the improved residual unit on the
residual network performance is determined. Firstly, the prepared training data set is sent to the neural
network for learning, and the network parameters are adjusted [7]. After all the parameters are
adjusted successfully, the mapping relationship for effective classification of image information is
formed. In the subsequent face recognition, only the detection image is input into the trained neural
network model, and the model will complete the recognition work through the mapping relationship
formed in the previous step.

4. BP Neural Network Data Science in Face Recognition System Practice Results Analysis

4.1. Performance Comparison between Traditional Residual Network and Extended Residual Network

|       | Traditional residual network | Widening residual network |
|-------|-----------------------------|---------------------------|
| Network layers | 15                          | 15                        |
| Model size (m)   | 51.6                        | 97.2                      |
| Feature extraction time (MS) | 344                        | 412                      |
| Accuracy        | 95.20%                      | 96.10%                    |

This group of experiments mainly compares the traditional residual network and the residual
network after widening the network width. The comparison results are shown in Table 1. It can be
seen from the comparison results that when the number of residual network layers is 14, the
convolution layer of each residual unit in the widened residual network changes from one convolution
kernel to three convolution kernels, which results in more parameters in the widened residual network
than in the traditional residual network At the same time, due to the increase of convolution kernel, the
time of feature extraction is increased, but the accuracy of image recognition is increased by 0.90%.
Starting from the actual application scenario, the accuracy rate is improved greatly when the time cost
is acceptable. Therefore, compared with the traumatic residual network, the performance of the widened residual network is better.

4.2. Experimental Results and Analysis of Algorithm Comparison

Table 2. Experimental Results and Analysis of Algorithm Comparison

| Test method      | Total number of sheets | Verification | Accuracy | Error detection | Error rate | Missed inspection | Missed inspection rate |
|------------------|------------------------|--------------|----------|----------------|------------|-------------------|------------------------|
| LBP+SVM          | 750                    | 526          | 70.1%    | 107            | 14.3%      | 117               | 15.6%                  |
| LBP+AdaBoost     | 750                    | 596          | 79.5%    | 102            | 13.6%      | 52                | 6.9%                   |
| MTCNN            | 750                    | 734          | 97.8%    | 6              | 0.8%       | 10                | 1.3%                   |

From the analysis of experimental results, the face detection algorithm based on mtcnn has the highest detection accuracy of 97.8% in GTD data set, and the false detection rate is only 0.8%, and the missing detection rate is only 1.3%. It shows that the mtcnn neural network can deal with the influence of the change of facial posture and expression. It also proves that the image features extracted by convolutional neural network are better than those extracted by manual It is more accurate and comprehensive [8]. The experimental results also show that the detection effect of AdaBoost cascade classifier is better than that of SVM classifier based on LBP features. In the experiment, we use 20 level cascade classifier, which shows that after several iterations, the performance of AdaBoost classifier is better than that of SVM classifier, but the false detection rate of the two traditional face detection methods is more than 13%, and the miss detection rate of SVM classifier is even higher After 15%, it is not suitable to be used as the face detection algorithm of this system, so we choose mtcnn neural network as the face detection algorithm of this system.

4.3. Performance Comparison of Different Network Models

![Figure 1. Performance comparison of different network models](image)

As can be seen from Figure 1, the recognition rate of model 2 is the highest, the accuracy of face recognition reaches 96.67%, but the corresponding feature extraction time is the longest, taking 623ms, but it still meets the system's demand for face recognition time-consuming.

4.4. Bug Test System
A total of 107 tests were designed in the functional test, 105 were effective, and 93 bugs were found, of which 97.1% were mild and general type, and there were no fatal bugs. All the bugs have been fixed and closed [9]. A total of 30 test cases were designed for data accuracy test, 30 effective cases, and 41 bugs were found, of which 100% were moderate and general bugs. There were no fatal bugs. All bugs have been fixed and closed. The function of the system meets the requirements of users.

5. Conclusion

In this paper, BP neural system technology is used to study the role of face recognition. Considering that the system in the application scene, the face detection and recognition is often in non limited conditions, which will be affected by the lighting conditions and facial expressions. Therefore, this paper aims to make the system achieve better detection under the unrestricted conditions by using the related algorithm of deep neural network Test and identify [10]. In order to reduce the influence of illumination on face detection, LBP algorithm is used in face feature extraction. On this basis, support vector machine (SVM) classifier and AdaBoost cascade classifier are used for face detection. The performance of LBP + SVM, LBP + AdaBoost and mtcnn are compared and analyzed on the data set GTD. The experimental results show that mtcnn can detect people with different facial posture and expression The accuracy of face image detection is higher, which can reach 97.8%, the false detection rate is 0.8%, and the missing detection rate is 1.3 %, which basically meets the needs of modern face recognition technology.

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