Children's Face Recognition Based on Convolutional Neural Network

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Abstract: Nowadays, the application of deep learning is more and more widely, and children's face recognition has made great progress. However, in the existing framework of children's face recognition based on deep learning, many tasks (including face recognition, authentication and attribute classification) are relatively independent, and its overall algorithm is inefficient and time-consuming. In order to solve this problem, this paper proposes a deep convolution network based on keras framework. Taking children's face recognition, authentication and attributes as the parameters of the network, the whole deep convolution network can be trained step by step. The network can complete three tasks at the same time without further steps. The network model is trained and learned on the training samples. It is an efficient neural network model. The network structure scheme of this method can improve the classification accuracy. It has a certain positive impact. The purpose of this paper is to construct a network model structure, which can make the children face recognition effect better and still obtain good performance under the limited data support.

Keywords: Convolution Network, Children's Face Recognition, Deep Learning, Application Research

1. Introduction
In today's society, human activities are becoming more and more global, and the society is full of all kinds of strangers. How to effectively identify the identity has attracted people's attention. In recent years, thanks to the development of face recognition technology, face gate, intelligent check-in system and intelligent control have gradually entered people's daily life, which provide many conveniences for people's life [1]. In terms of children's learning and life, the face recognition method based on hand-designed features has low security and is easy to be attacked. Traditional identification methods such as ID card, password and fingerprint are cumbersome, which wastes people's valuable time and reduces service quality [2]. In addition, with the increase of people's need for confidential information, a person may have multiple accounts, and the password increases, which is difficult to remember. At
the same time, passwords and other ways are easy to be stolen [3]. Therefore, the problem of efficient and accurate identity authentication needs to be solved. Compared with the traditional identification methods, biometric identification technology has the advantages of safety, reliability, convenience and speed, and is a very ideal identification technology [4].

It can be divided into two types: identification of special items and biometric identification. The former, such as some certificates given to individuals by the unit or country, such as ID card, badge, ID card, etc., must be carried with you in this way, which increases the personal burden. In addition, when lost, you may encounter unnecessary troubles, such as the loss of ID card; someone else will use it to carry out illegal activities Man made loss [5]. Biometric identification is based on the biometrics that can clearly distinguish the individual identity, such as fingerprint, voice, gait, face, iris, palmprint, handwriting, etc. This biometrics is very distinctive and has obvious differences. Among them, face recognition has always been regarded as the best way of identity verification [6]. Specifically, face recognition has the advantages of convenient image acquisition, human identification habits, high recognition accuracy and fast speed [7].

Nowadays, deep learning has made significant progress in the field of computer vision and target recognition, and convolution algorithm of neural network is increasingly used in face recognition research [8]. Lecun first proposed lenet-5, which called CNN convolution network, and from then on began the study of modern convolutional network [9]. The teams from Facebook and the Chinese University of Hong Kong reported high average classification accuracy in the LFW dataset. They used some features of DCNN to replace the traditional manual design features and classification identification; the facetene framework proposed by Google team also had high average classification accuracy in LFW dataset [10].

2. Basic Structure of Convolution Neural Network

Neurocognitive machine is the first convolutional neural network proposed by Japanese scientist Fukushima. Local perceptual region, weight sharing and spatial pooling are several unique advantages of convolutional neural network. So the current deep convolution neural network is a very large network structure. It is a multi-layer network structure. It connects to the whole connection layer first and outputs at the end.

2.1 Convolution Layer

The main task of convolution layer is to extract the characteristic convolution function of input image by operation. It needs to calculate the product sum of each pixel of the image and the corresponding pixel of its domain and the filter matrix. The result is the output. If the convolution layer is the first layer, the formula is as follows:

\[ y^l_n = f \left( \sum_{m} (x^{l-1}_m * \omega^l_{n,m}) + b^l_n \right) \]  

(1)

The output of convolution layer has three kinds of nonlinear mapping: sigmoid, tanh, ReLU etc. the experimental results show that ReLU’s convergence rate is faster than that of sigmoid functions, which saves a lot of time for training gradient reduction:

\[ y = \max(0,x) \]  

(2)

2.2 Pool Layer

The next layer is the pooling layer. It can combine the images of different positions, reduce the size of the function and extract the second feature image. Pooling technology includes mean pooling and maximum pooling. The formula of maximum pooling is as follows:

\[ x'_n = f \left( \omega'_n \times \frac{1}{s^2} \sum_{i,j} y'_i + b'_n \right) \]  

(3)
\[ y_{j,k}^i = \max \{ x_{j,i+n,k+s}^i \} \tag{4} \]

### 2.3 Full Connection Layer

After multi-level convolution, it is the full junction layer, and all its neurons are connected to each of the previous neurons. It can improve the ability of nonlinear network design and limit the network scale. The calculation formula is as follows:

\[ \sigma^j_j = f\left( \sum_{i=1}^{n} x^{i-1}_{j,i} \cdot \omega_{j,i}^j + b^j_j \right) \tag{5} \]

The classifier is used in the Softmax classification layer, and the formula is as follows:

\[ x_i = \omega x + b \tag{6} \]

\[ p(y_j = x_j | x; \theta) = \frac{e^{x^j_{T_j}}}{\sum_{i=1}^{n} e^{x^j_{T_i}}} \tag{7} \]

### 3. Experimental Background and Network Parameter Configuration

#### 3.1 Keras Neural Network Framework

In order to realize children's face recognition better, this paper adopts an advanced neural network framework. Its back end is tensorflow and its basic data structure is sequential model. The Keras framework has the following features:

1. Modularity: each small module is independent and can be combined to create a new model;
2. Simple and clear: each module is kept concise;
3. Scalability: the advantage of this framework is that it is easy to add new modules. It can be applied more conveniently by adding a new neural network model.

#### 3.2 experimental results

In this experiment, we used ORL children's face database (recorded as No.1 database) to train 500 children's facial images of 50 people. 80% of the children's facial images were used to train the model, and 20% of the children's facial images were used to test the accuracy of face recognition. During the training process, all the images in the children's face database were used to test the accuracy of face recognition Listed in order; the image name is a unique label for each child. The model is suitable for the detection and recognition of children's faces in video. According to the data, the children's faces are fully matched with the children's faces to be recognized. In this experiment, 10 children's facial images randomly downloaded from the network (recorded as database 2) were added, and then the original results were tested and trained in proportion. The experimental results are shown in Table 1. The model constructed in this paper has high accuracy in children's face recognition. This paper further illustrates that the deep convolution network model can effectively detect children's faces in face recognition.

| Database | training error | training accuracy | verification error | verification accuracy | test accuracy |
|----------|----------------|-------------------|-------------------|----------------------|--------------|
| 1        | 0.079          | 0.973             | 0.063             | 0.988                | 0.990        |
| 2        | 0.087          | 0.970             | 0.082             | 0.976                | 0.987        |

### 4. Discussion
4.1 Convolutional Neural Network (CNN)
Convolution neural network is a special model of deep neural network, which is composed of the following levels. A typical link is shown in Figure 1. From the first layer to the fifth layer, the information features extracted from convolution layer transform from the whole to the local, from the shallow features to the deep features. The information obtained from face recognition should not only be separable, but also recognizable. However, the classification based on a specific softmax loss function can share the obtained features, but these features are not effective enough for face recognition tasks, and the recognition of features is relatively weak.

![Figure 1. Connection mode of convolution neural network](image)

4.2 Children's Face Recognition System
Children's face recognition system mainly includes the following functions, and the implementation process is shown in Figure 2. This paper uses FG net database and morph II database. After collecting and analyzing each image, we can judge whether there is a face in the image from an algorithm, determine the position range, rotation angle, number or position of the face, and then segment the face region according to the above information. This is an important step in face recognition, which provides a guarantee for the generation of features in the future. Hair and other useless intervention information can be removed by normalization function. Feature extraction is a key link in the whole children's face recognition system. In addition, because children's face contains a lot of visual information, the machine can only classify and recognize by publishing the necessary information. According to the children's facial features, the classification method can complete the recognition of children's faces or the classification of children's faces, and finally realize the recognition of children's faces. We divide children's face recognition into two categories: the first one is 1:1 matching. The image is the image of children's face in the system, and the other is the image of children's face given by users. The recognition result can judge whether the image you detect is consistent with the image in the system. The second type is 1: n personal face matching, which matches a child's face image given by the user with all the children's face images in the system, and determines the identity of the face image according to the known data. The second type of children's face type matching is to select two images of the same person from the children's face database as the experimental group to determine whether the model can accurately match.
4.3 Application Research of Children's Face Recognition Based on Convolutional Neural Network

Convolutional neural network has been developed in recent years, and it has attracted great attention in the field of image. In the 21st century, with the gradual improvement of computer hardware computing capacity and the continuous expansion of data sets, the scale of data sets has reached 10 million levels, so neural networks began to explode. Later, researchers began to focus on understanding convolutional neural network and expand it to image segmentation, speech recognition, text detection and other fields. At present, convolutional neural network has become one of the research hotspots in many scientific fields. It has been widely used.

The task of children's face detection is to detect children's faces in images. As the basis of face recognition, face detection directly affects the effect of face recognition. In addition, it is also usually used in public places such as squares and intersections for pedestrian flow statistics. Accurate statistics of pedestrian flow can make decision makers better optimize the allocation of resources, such as how many shops to set up and how many service personnel. In recent years, with the development of neural network, the accuracy of children's face detection is gradually improved. However, children's face detection under unconstrained conditions is affected by children's face pose, illumination, occlusion and other conditions, which puts forward higher requirements for the performance of the detection algorithm, and makes face detection still a challenging task. Similar to other detection tasks, under unconstrained conditions, the recall rate often increases, leading to the increase of false positive rate.

At present, the mainstream children's face detection algorithms are mainly divided into two categories. Based on regression method and template matching method, researchers propose to use face attributes for children's face alignment. However, most of the research on face detection and face alignment does not consider the correlation between the two, and some studies that unify the two also have some defects. For example, the random forest method based on the difference of pixel features will limit the detection effect of face detection using manually designed features.

As the most common computer vision task, face recognition includes two directions: face recognition and face verification. The difference is that in the third stage, face discrimination is to judge whether the children's face is in the children's face database and determine their identity. Face recognition refers to judging whether the test image and a specific face image belong to the same individual. This section mainly discusses face verification.

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**Figure 2.** Implementation of children's face recognition system

![Diagram of children's face recognition system](image-url)
In recent years, face verification algorithm based on deep learning has made a significant breakthrough. The main way is to map the face image to a certain dimension feature vector, and then judge whether it is the same face by calculating the distance between the two eigenvectors. In the past, people used to extract high-dimensional face features and relatively simple classifier softmax for face recognition. However, in recent years, it has been found that the traditional softmax loss is difficult to obtain a network model with strong discrimination in classification tasks. In order to obtain a more discriminative network model, people begin to use the idea of maximizing the distance between face classes and minimizing the distance within the face classes to carry out face recognition tasks. It is very meaningful to construct the loss function with distinguishing force. Since the stochastic gradient descent optimization function in convolutional neural network is based on a small batch of data, it does not reflect the characteristic information of the whole data set. However, due to the huge sample size of the training set and the limitation of computer memory, it is very difficult to train and optimize the whole data set. Therefore, many of them are aimed at small batch Loss functions are proposed, such as center loss, comparative loss, triple loss, etc.

5. Conclusions
In this paper, we first introduce the application of convolutional neural network, and use the keras framework to apply deep convolution neural network to children's face recognition. It can be concluded that the model has high recognition accuracy in ORL face database and can be applied to practical work. We also briefly review the typical face recognition algorithms, introduce the basic structure of convolutional neural network and its optimization method, and analyze the application of convolutional neural network in the field of children's face recognition in detail. Although children's face recognition based on convolutional neural network has made great progress, there are still some problems. So how to evaluate these problems in front of them, and then provide constructive suggestions, so as to train a scientific and reasonable network, and how to train a large number of deep-seated data, and then carry out rapid calculation, this is worthy of further study.

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