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Research on the recognition technology of human relationship in face image based on deep learning

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Abstract: Face images contain rich and complex information, and similar genes are directly expressed as facial resemblance. In this paper, based on the theoretical background of biology and aiming at the wider application of artificial intelligence in the field of face image analysis, deep learning based recognition of the kinship of people in face images is studied in depth.

Kinship recognition is a new and challenging research. In order to recognize the kinship between characters from face images, this paper defines a new correlation feature to represent the correlation between two characters. Based on the idea of multi-layer self-encoder to input and reconstruct the target, and combined with the powerful feature extraction ability of deep convolutional neural network, this paper designs a new deep convolutional self-coding neural network, and the correlation feature is the activation value of the deep hidden layer of this deep neural network.The deep convolutional self-coding neural network USES back propagation algorithm in a supervised way. With the deepening of the network hierarchy, the identity features of representative characters are extracted from face images step by step, and the identity features of a pair of characters are fused into the associated features that represent the relationship between them. Based on deep learning, the associated features extracted from face images can effectively identify a given character relationship.

1. Introduction

The research on face image is always very important in computer vision field. The research of face image is important because face expresses a lot of personal information and plays a special role in social life. In the field of artificial intelligence, the recognition of human face by imitating human vision has achieved fruitful results. Nowadays, computer vision has successfully replaced human beings in face recognition, identity authentication and other aspects.[1]Recognizing the kinship of people through face images is still a novel and challenging task.

Therefore, it is very important and meaningful to study the relationship between people in face images. There have been only a few attempts at this. Based on the method of deep learning, this paper designs a new deep network model to learn an associated feature that represents the relationship between characters from face images and identify the relationship with the associated feature. The algorithm is verified on the identification of kinship and self - kinship.

2. Main research contents and innovation points

Based on the background of the era of big data and the rapid development of artificial intelligence, this paper explores emerging topics based on the method of deep learning. The research focuses on how to recognize the relationship between characters from face images, and how to extract the correlation features that represent the relationship between characters. This research is practical and has broad application prospects.

(1)The main research contents of this paper are shown in figure 1.

This paper focuses on extracting more effective correlation features to represent the relationship between characters. In order to obtain correlation features, a new deep convolutional self-coding network is constructed. Correlation features are the activation values of high-level neurons in this neural network. The deep neural network learns the identity features of a pair of characters respectively with supervision, and then fuses the identity features into the correlation features that represent the relationship between characters, so that the correlation features finally achieve the purpose of identifying the relationship in the classifier.

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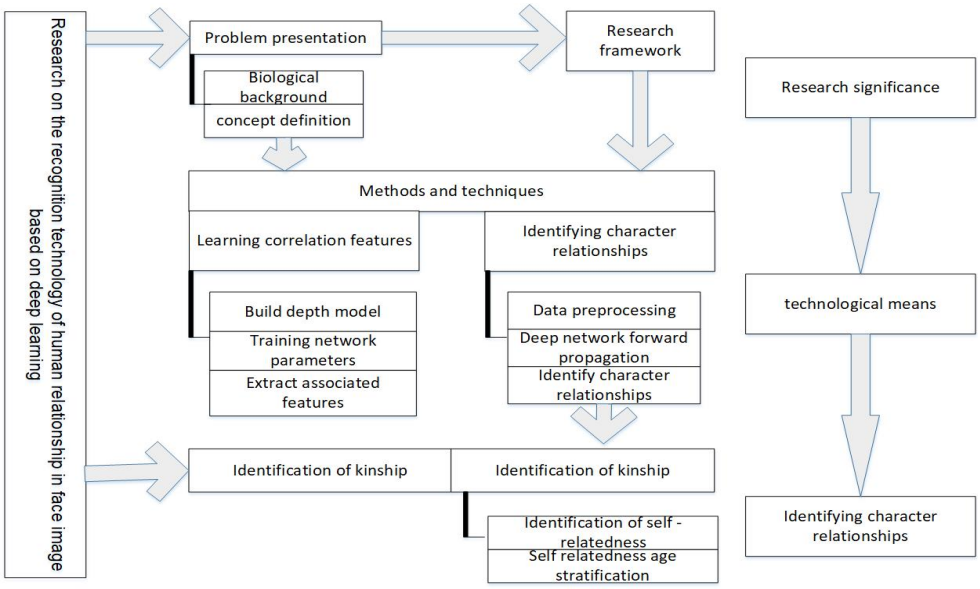

Figure 1 main research contents of the paper

Key technology in depth network building and training, to extract more conducive to identify the characteristics of the characters, this paper designs a new network structure, the input of human face image division, and the status of output characteristics method such as multiple areas connect more adaptable to face image, the structure of the network and identity can be effectively combine into said associated characteristics of the characters.

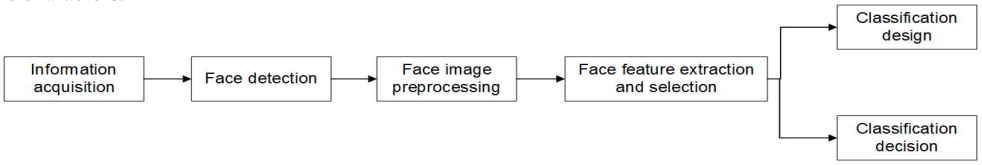

Figure 2 common steps of face recognition

The correlation features extracted based on deep learning will be applied to the recognition of kinship and self-kinship, and the face images will be hierarchical sorted according to the age in the self-kinship. In practice and comparison, the algorithm proposed in this paper will be verified in the problem of genetic relationship, and the validity of the algorithm is analyzed.

(2) Main innovation points

A. A new correlation feature is defined, which represents the relationship between two characters. The experiment proves that the correlation feature can effectively represent the connection between two individuals, and can judge whether a pair of face images have the defined relationship according to the correlation feature.

B. Design a deep convolutional self-coding network model to extract correlation features between characters. Face images are supervised by deep convolutional self-coding networks and input becomes more compact and effective as the network hierarchy deepens.

C. Establish a recognition system based on deep learning to recognize character relations from face images.Starting from the biological theory, the author studied the correlation features of four kinds of kinship including father and son, father and daughter, mother and son, mother and daughter, and self-kinship respectively, and used correlation features to identify the character relationship.

3. Deep neural network and feature extraction

All machine learning algorithms need to learn features from data to acquire the ability to predict new samples, and complete a series of processes including data acquisition, preprocessing, feature extraction, feature selection, and inference, prediction or recognition. In order to obtain the intermediate and final feature expression, many excellent algorithms have been proposed successively, and deep learning is the most excellent machine learning algorithm at present.

(1) Deep neural network

The purpose of machine learning is to learn a function from a sample, which can predict the future sample value. It takes a lot of work to find this function, and building deep learning networks is one of them. In

supervised learning, if there is a training sample set (x,y), then the neural network can represent a nonlinear function with model h(x), where (w,b) is the parameter used to fit the data.[ii] $_{w,b}$

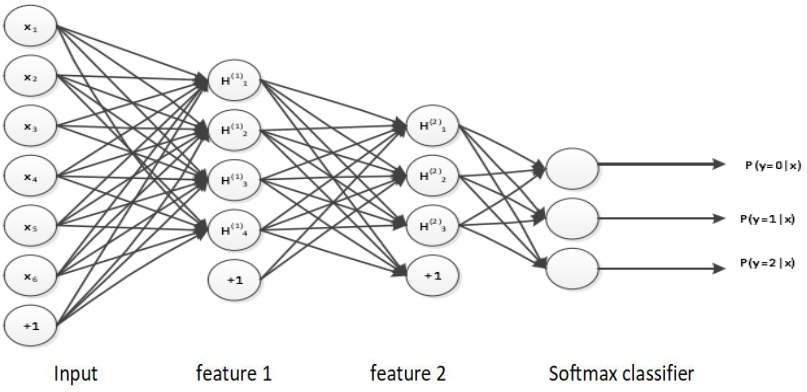

Figure 3 structure of deep neural network

A neural network consists of many neurons, which are connected to each other, and the output of one neuron serves as the input of the next. Figure 3 is a typical diagram of deep neural network.Parameter of neural network (w,b), where w is the j unit at the l layer and the I at the l+1 layer$_{ij}^{(l)}$ The connection parameter between the elements, namely, the weight on the connection line, is the bias term of element l+1 at layer b.$_i^{(l)}$Use a to represent the output value of unit I in layer l.$_i^{(l)}$For a given parameter set (W,b), the neural network can calculate the output according to the function h(x) :$_{wb}$

$$z^{(l+1)} = W^{(l)}x + b^{(l)}, a^{(l+1)} = f(z^{(l+1)}) \quad (1\text{-}1)$$

$$h_{W,b}(x) = a^{(n)} \quad (1\text{-}2)$$

The process of calculating the input data through network parameters and outputting the activation value is called forward propagation.The function is called an "activation function". $\mathbf{f: \Re \to \Re}$The sigmoid function can be used as the activation function.

$$f(z) = \frac{1}{1+exp(-z)} \quad (1\text{-}3)$$

Although the theoretical simplicity and strong learning ability of deep networks were discovered more than ten years ago, the real rise of work in recent years is due to the huge difficulties in network training before the emergence of greedy algorithms. Two important algorithms for deep neural networks are described below, one is layer by layer greedy algorithm and the other is reverse conduction algorithm.

(2) Deep convolutional neural network

Convolutional neural network can learn an input-output mapping relationship, during which hidden features of data can be learned implicitly without any need for precise mathematical expressions. Convolutional neural network (convolutional neural network) has many advantages in image processing. CNN's convolutional neuron design makes it very suitable for the structure of image data. The characteristics of local perception and weight sharing reduce the computational complexity, and some spatial invariance can also be obtained. And the increasingly deepening level of computing, also makes the original data gradually become more abstract characteristics.

Characteristics of convolutional neural network

A. Multiple convolution kernel is adopted to locally perceive and share weights

Convolution operation is carried out by using the following formula:

$$x_j^l = f(\sum_{i \in M_j} x_j^{l-1} * k_{ij}^l + b_j^l) \quad (1\text{-}4)$$

Where, M represents the JTH characteristic graph for convolution operation.$_j$

B. Spatial sampling

The features obtained through convolution operation reduce the dimension of the original data, but this data is still too large, for example, the input image is one .For the grayscale image of 100X100, if 100 convolution kernels with a size of 10X10 are defined, and the convolution operation of these 100 convolution kernels and images is carried out, the size of feature graphs obtained is :(100-10+1)X(100-10+1)=8281 features, so the size of all feature graphs is a total of 828,100.If such feature diagram is applied to such tasks as

training classifier, it will still face the phenomenon of computational difficulty and over-fitting.

(3) structure of convolutional neural network

The deep neural network structure shown in figure 5 is the classic structure of CNN at present. It won the champion in Image Net LSVRC in 2016, top-5 The error rate was 15.3%.The CNN network has about 1.27 million training sets, 50,000 validation sets and 150,000 test sets.

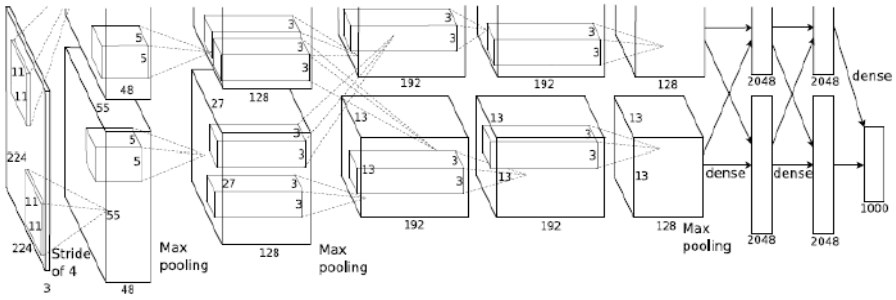

Figure 4 convolutional neural network model proposed by Hinton in 2016

The model USES 2 gpus for parallel computation.The convolution layer of the first, second, fourth and fifth layers divides the parameters into two parts: parallel training, the same data is trained on two different gpus, and the output obtained is directly connected as the input of the next layer.

4. Build a deep neural network model

(1) construction of deep convolutional self-coding network (cnn-ae Net)

Although deep convolutional network can simultaneously extract features and complete classification functions, for face images, the network itself is not very accurate in face recognition. In this paper, deep convolutional network is applied to extract identity features that represent personal identity. After obtaining the identity characteristics of a pair of characters, the multi-layer self-encoder is used to explore the relationship between them. The idea of self-encoder is to use the input reconstruction target value. This paper aims to find the intermediate value of input and output to represent the close relationship between the two during the reconstruction process. In this paper, a new Deep Convolutional auto-encoder network (cnn-ae Net) is designed by integrating the two Deep Networks. The depth model is shown in FIG. 5.

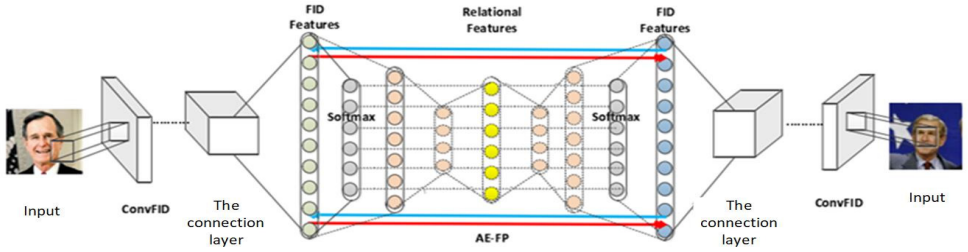

Figure 5 deep convolutional self-coding neural network (Cnn-ae Net)

The deep convolutional self-coding neural network is designed to input a pair of characters and finally learn the features of the correlation terms between them. The whole deep convolutional self-coding neural network was defined as cnn-ae.In the depth model, the input image first passes through a Convolutional neural network, which is defined as the Conv FID Net(Convolutional networks for Facial ID).The initial input will be transformed into the more representative FID(FID) through the Conv FID network.The FID of a pair of characters will be used as the input of a multi-layer auto-encoder. The blue arrow shown in figure 6 represents the forward operation of the auto-encoder, and the red arrow represents the reverse feedback of the auto-encoder network.This multilayer auto-encoder is defined as ae-fp (auto-encoder for Face Pairs).The activation value of the network's upper level will be taken as the Relational Features.

The face image (Person 1 and Person 2) of the input pair is defined as (p1,p2). The deep convolutional self-coding network constructed in this paper will complete the following learning process:

$$RF_{(p_1,p_2)} = CNNAE(p_1,p_2), \quad (1\text{-}5)$$

$$RF_{(p_1,p_2)} = AEFP(\mathbf{ConvFID}(p_1),\mathbf{ConvFID}(p_2)) \quad (1\text{-}6)$$

(2) construct deep Conv FID Net learning identity characteristics

In order to achieve effective FID, efficient Conv FID must be constructed.Figure 6 shows the deep

convolutional neural network Conv FID for obtaining identity features Structure. The figure shows the details of the deep network, including the size and number of convolution kernel, the size and number of convolutional feature graph, the number of lower sampling layer and the size of lower sampling step.Softmax regression serves as the final layer for matching identity characteristics to identity tags.The last convolution layer is the full connection layer, and the input image will be finally placed into a 160-dimensional vector by the network as its identity feature.To represent the size of the image, this paper USES it throughout，In the form of X*Y*C, where (X,Y) represents the size of the image, and C represents the number of channels of the image.In fact, the convolution kernel can also be considered as a small image with two-dimensional structure, so the same expression method is used.

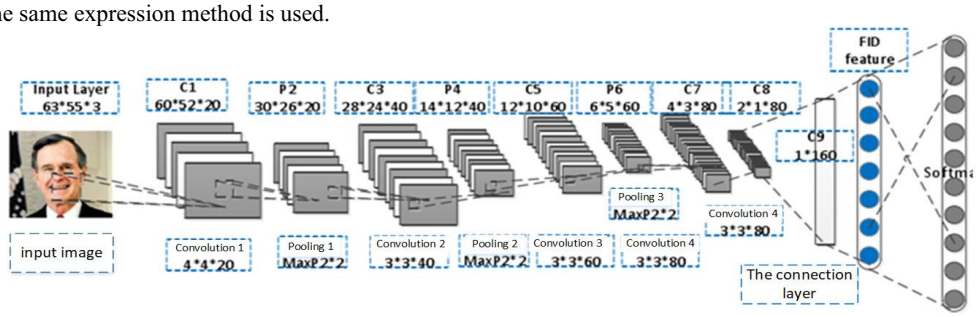

Figure 6 construction of deep identity convolutional neural network (Conv FID)

As shown, the input is a size of 63 * 55 * 3 color images, to note here, in this paper, in order to get a better network in training effect, while training with different size of the input, in other dimensions of the image as network input, through the layers of convolution kernel operation output characteristic figure size can change, through changing the last layer convolution, makes the size of the full connection layer for the 160 - dimensional vector. The input image enters Conv FID and passes through the first convolution kernel, with a size of 4*4 and a total of 20. We define the following formula that the convolution operation follows:

$$x^l(i,j) = \sum_{k_1,k_2} x^{l-1}(i+k_1, j+k_2) w^l_{l-1} \qquad (1\text{-}7)$$

5. Recognition of kinship in face images based on deep learning

(1) Face data preprocessing

Figure 7 shows a partial sample of Kin Face w-i and Kin Face w-ii data.

Figure7 data samples in database Kin Face w-i and Kin Face w-ii

In figure 8, (a) and (b) represent data samples in Kin Face w-i and Kin Face w-ii respectively.From top to bottom, the relationships represented by each row of samples are respectively father-son relationship, father-daughter relationship, mother-child relationship and mother-daughter relationship. The two adjacent images in each row have the kinship defined above.

(2) learn the correlation between characters

Is used to study correlation characteristic of multilayer since the encoder, the network's input is the son's identity in parent-child relationships, defined as FID, and network in the target is the father's identity, defined as FID. AEFP design in this paper try to through continuous calculation of network error between the output and the target value, to make the network activation values can be related to become characteristics of deep.[PSPF]This correlation feature cannot represent either input or output independently Fang just represents the existing relationship between the two parties. Figure 8 shows the structure and setting of AEFP network, indicates the direction of network forward propagation and back propagation, and marks the number of hidden nodes in each layer.

Figure 8 shows the network structure diagram of the learning association feature RF with the bush and son as an example.Since the identity features extracted through the Conv FID network are ultimately integrated into a 320-dimensional one-dimensional vector, to make full use of these two features with efficient expression ability to learn a correlation feature, we use the self-encoder method derived from the following

two points:

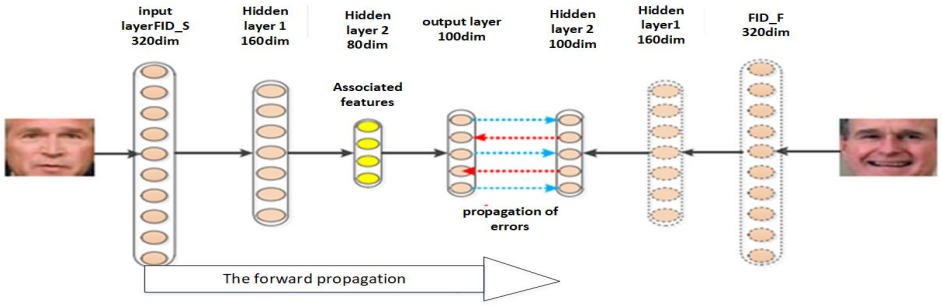

Figure 8 AEFP depth network structure for learning correlation features

6. Conclusion

Face image analysis has always been an important content in computer vision. On the one hand, the attention to face images comes from human's attention to themselves, and on the other hand, it comes from the rich information hidden in the face itself. Simple face images contain a lot of information such as identity, age, gender and race.In this paper, we study the emerging problem of identifying the relationship between characters from the image of characters.Due to the technical difficulty and high semantic level, this problem is still an exploratory stage in the field of computer vision.

In this paper, deep learning method is used to study how to recognize the relationship between people from faces, and the algorithm in this paper is verified in the defined relationship. Experiments show that the correlation features extracted from face images based on deep learning can effectively identify the relationship. The sensitivity of identification neurons in deep convolutional neural network to age change and senescence was studied by statistical method. And a deep neural network was constructed to realize the stratification and ordering of the age of the people in the face images. Computer vision has promoted the progress of other disciplines in criminal investigation, medical imaging and so on. It can deeply explore the relationship between the research content of this paper and biology and psychology, and apply the research results of computer vision to other disciplines to promote the development and integration of multiple disciplines.

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References

[1]Yu Li, Research on the recognition technology of human relationship in face image based on deep learning, National University of Defense Technology[J],2015
[2] Zhou X, HuJ, LuJ, etal. Kinship verification from facial images under uncontrolled conditions[C]// Proceedings of the 19th ACM international conference on Multimedia. ACM, 2017.
[3] Guo G, Wang X. Kinship Measurement on Salient Facial Features [J]. IEEE Transactions on Instrumentation & Measurement, 2017
[4] S. Xia, M. Shao, J. Luo, and Y. Fu. Understanding kin relationships in a photo [J]. IEEE Transactions on Multimedia, 2016
[5] H. Dibeklioglu, A. A. Salah, and T. Gevers. Like father, like son: Facial ex-pression dynamics for kinship verification[C]// Proceedings of the IEEE International Conference on Computer Vision. ICCV, 2016.
[6] Kaminski G, Dridi S, Graff C, et al. Human ability to detect kinship in strangers' faces: effects of the degree of relatedness. [J]. Proceedings Biological Sciences, 2017
[7] J Lu, J Hu, X Zhou, J Zhou Kinship Verification in the Wild-The First Kinship Verification Competition.

2018 - ieeexplore.ieee.org
[8] Sun Y, Wang X, Tang X. Deep Learning Face Representation from Predicting 10,000 Classes[C]// Computer Vision and Pattern Recognition (CVPR), 2014 IEEE Conference on. IEEE, 2014