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Summary of Shot of Shoes Printing Traces Based on Deep Learning

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Abstract

Shoes are one of the extensive license technologies in trace inspection. The depth learning method has developed rapidly in the field of image retrieval, and tries to apply to the field print search field to achieve automation of shoe-printing retrieval. Considering the shortage of shoe print automation, it can make up for the shortage of experience and human shortage in traditional inspection methods, this paper mainly introduces the basic theory and depth learning of deep learning in image retrieval.

Keywords

Shoe printing; deep learning; Convolutional neural network.

1. Introduction

At present, direct evidence such as fingerprint, hair, blood, etc. in the process of criminal investigation site, will not remain on the spot because of the guidelines, through shoe printing and even become a footprint can be used to judge the height, age, step of the suspect. Information and other information such as False are reduced the scope of investigation and improve the cash efficiency of the case. According to the report of Alexandre [1], there are about 30% of on-site shoe prints in crime scenes, but these extracted shoe prints are not necessarily a clue to investigation. The shoe print is extracted at the crime scene, fixed by the camera, but in most criminal scenes, the environment is complicated, and the shoes are easily contaminated with dust, dust, etc. Impact the shoes printed pattern, this is the shoe print The post-processing has a large impact. At present, the inspection, analysis and identification of shoe printing is mainly conducted by professionals with many years of practical experience. However, the number of cases is large, and this is a variety of shoe printing, which has caused a huge hindrance to the case of the case. Therefore, the automated retrieval of the shoe printing appears in the computer, so that the shoe print is more valuable in the case.

In the automatic retrieval algorithm, the feature of the sole pattern is extracted, and the sole pattern is classified, and more information on the shoe is obtained in the shoe-like database, especially the upper shoe-like information. These information can be captured in monitoring video, further determining criminal suspects, which also makes the shoes printed with fingerprints, and provides strong evidence for the public security line.

2. Deep study theory

The neural network is an arithmetic model, consisting of a large number of neurons and mutual coupling. Each node represents a specific output function called an incentive function, activating the function. The coupling between each two nodes represents a weighting value through the connection signal, called weight, which is equivalent to the memory of artificial neural networks. The output of the network is different depending on the network connection, weight value, and incentive functions.

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Neural networks are like human brains, neurons are their basic components. The structure in the neural network can be simplified to the following Fig. 1, after the neuron, the input and output will have some kind of function relationship, which is an excitation function. There are more applications in the activation function and the SIGMOID excitation function and the RELU activation function.

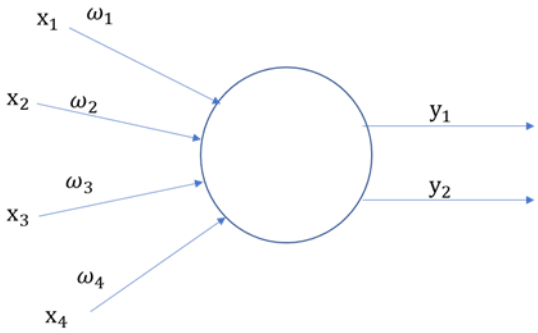

Figure 1 Neuron

With the Sigmoid function, the variable can be mapped to the (0, 1) interval, and the formula 1 of the SigmoID activation function is

$$\sigma(z) = \frac{1}{1+e^{-z}} \tag{1}$$

Sigmoid function image is shown in Figure 2

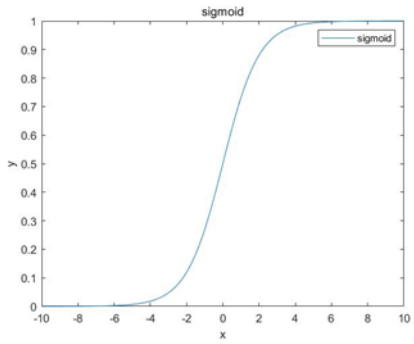

Figure 2 Sigmoid activation function

Since the Sigmoid function is easy to cause the gradient disappearance, the RELU function is now also used in a large number of applications in the neural network. The RELU is a non-saturated activation function, which is not easy to have a gradient disappearance or gradient explosion. Equation 2 of the RELU function.

$$\mathrm{ReLU}(x) = \begin{cases} x & if\ x > 0 \\ 0 & if\ x < 0 \end{cases} \tag{2}$$

Sigmoid function image is shown in Figure 3

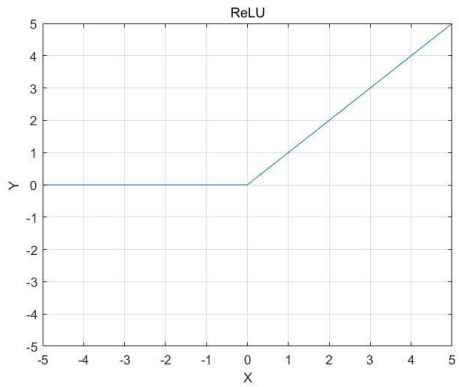

Figure 3 RELU activation function

The RELU function effectively relieves the problems of the prefraction of the neural network in training, because the RELU may make the output of some nerve nodes into 0, resulting in neuronal death, reduced the complexity of the neural network; and the function is simple , RELU is essentially calculated at two values in two values. But the RELU function also has a shortcomings and insufficient. In some cases, the RELU function can cause neuronal death. After a neuron is 0 after a certain activation value, the activation value obtained later is 0. At present, the RELU function is still the main activation function of training shoes and retrieval neural networks.

In the neural network, the gradient drop algorithm is introduced, and the optimal solution is found through learning and training, and the most important link is reverse communication. Pre-propagation input signal until the output generates error, reverse propagation error information update weight matrix. Reverse transmission is the application of a chain guidance method, and Fig. 4 is a simple neural network, where f (x) is an activation function in the neural network, and when the characteristic input neural network, forward input prediction results, ie from left Communicate to the right.

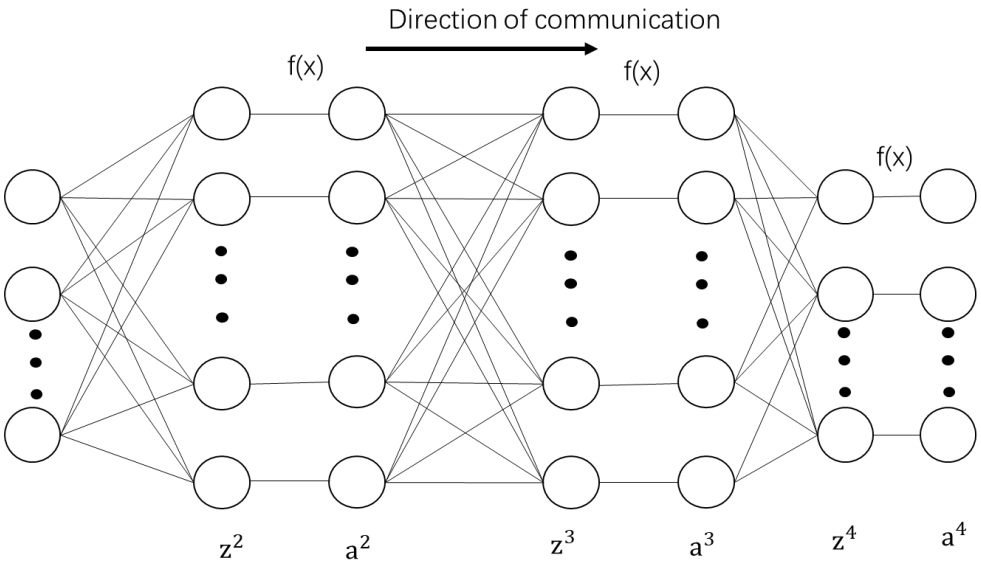

Figure 4 forward communication

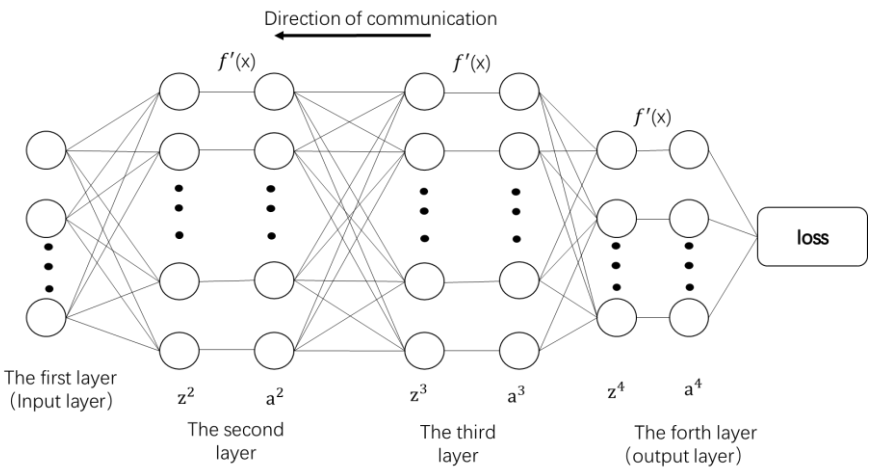

Figure 5 Reverse propagation

After forward communication, the parameters of the neural network need to be updated, and the propagation direction is changed, the gradient is reverse propagated, as shown in Figure 5, the gradient is reversed from the LOSS layer to the first layer. The process of reverse

propagation is mainly divided into four steps: (1) LOSS layer to the gradient propagation of the output layer; (2) gradient propagation of the intermediate layer; (3) gradient propagation of the parameter W; (4) Gradient biaser B Spread, the activation function f (x) becomes $\boldsymbol{f}'$(x) during the reverse propagation process.

The final total error is E, L is the node, y is the output value of the neural network, W is the weight parameters. For the output node $\boldsymbol{y_l}$-$\boldsymbol{t_l}$, where $\boldsymbol{t_l}$ is the true value $\frac{\partial y_l}{\partial z_l}$ is the activation function, $\boldsymbol{z_l}$ is the weighting and weight of the neural network, then the bias number of this layer is $\frac{\partial E}{\partial z_l} = \frac{\partial E}{\partial y_l}\frac{\partial y_l}{\partial z_l}$. Similarly, each layer is so calculated when performing reverse communication, has been spread to the input layer, and finally adjust the weight value $\frac{\partial E}{\partial x_i} = \frac{\partial E}{\partial y_j}\frac{\partial y_j}{\partial z_j}$ and$\frac{\partial E}{\partial x_i}$=$\boldsymbol{w_i}$j, in the continuous positive spread and reverse communication, eventually get better training results.

3. Convolutional neural network principle

In 2006, Hinton [2] made a new artificial neural network with multiple hidden layers, breaking through some of the difficult solutions in learning training in learning training, causing another boom for artificial neural network research. . As a new direction in machine learning, Deep Learning will develop rapidly in more than ten years, and it breaks through some bottlenecks in the intra-artificial intelligence, and with the number of exponential types and hardware with the number of training data sets. Significant increase in performance, it has achieved good results in the fields of target detection, natural language processing, biometric identification, and can believe that deep learning has greatly promoted the development of artificial intelligence [4]. Deep learning is a hierarchical machine learning method including multi-stage non-linear transformation, and deep neural network is a major method of deep learning. The establishment of connection mode between neurons has been revealed by animal visual cortex, while convolution The CONVOLUTIONAL NEURAL NETWORK (CNN) is a concentrated structure in deep neural network [3, 4]. Figure 4 is a classic diagram of a classical convolutional neural network VGG-16. Convolutional neural networks, weight sharing, and poolization operations such as the characteristics of the pool, which can effectively reduce the complexity of the network, reduce the number of training parameters, so that the model is translated, distorted, and zoom has a certain degree of invariance, and It has strong robustness and fault tolerance, and is also easy to train and optimize.

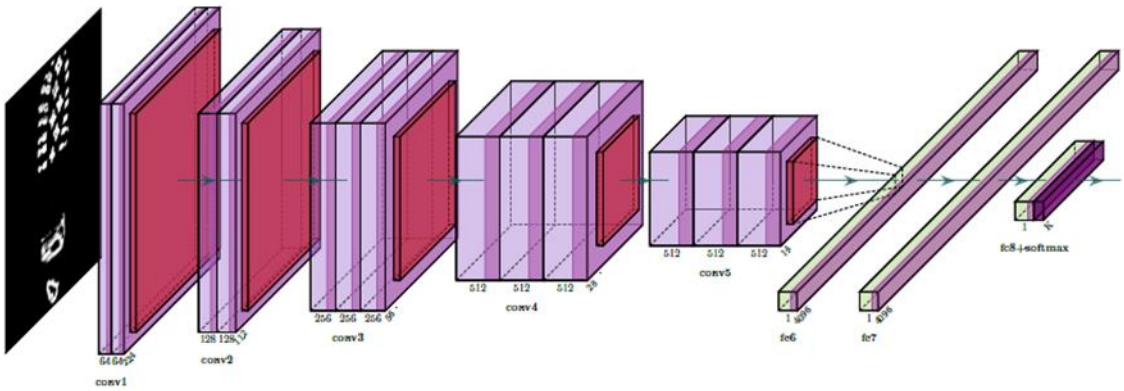

Figure 6 VGG-16 structure diagram

3.1. Convolutional neural network principle

In a conventional full-connection network, as shown in FIG. 7, the next layer of neurons are connected to all of the neurons of the previous layer, and the number of parameters will

increase by the network width and the deeper depth of the network, too many parameters On the one hand, each layer is limited to the maximum number of neurons that can accommodate and the depth of the neural network, and on the other hand, the computer hardware resources and computational power requirements are relatively high and the training time is longer. Based on this, the convolutional neural network will change the full connection method of neurons in the neural network to a partial connection method. The so-called local connection is that the node of the convolution layer is only connected to the partial node of the previous layer, only to learn local features. The concept of local perceptual structure is derived from the skin of the animal vision, which refers to only a part of the neuron of animal vision in the process of perceive the external object. In a computer visual, in a certain area in the image, the correlation between the pixels is equally associated with the distance between the pixels, and the distance between the closer pixels is strong, and the distance is relatively weak, thereby It can be seen that local correlation theory is also applicable to the field of image processing of computer vision [5]. Therefore, the local sensing uses some of the neurons to accept image information, and then reaches the purpose of enhancing image information by integrated image information. As shown in FIG. 4, it is a structural diagram of a neuron partial connection, and the number of connections in the node is greatly reduced. This local connection has greatly reduced the number of parameters, speeding up the rate of learning, and also reduces the possibility of predation to a certain extent.

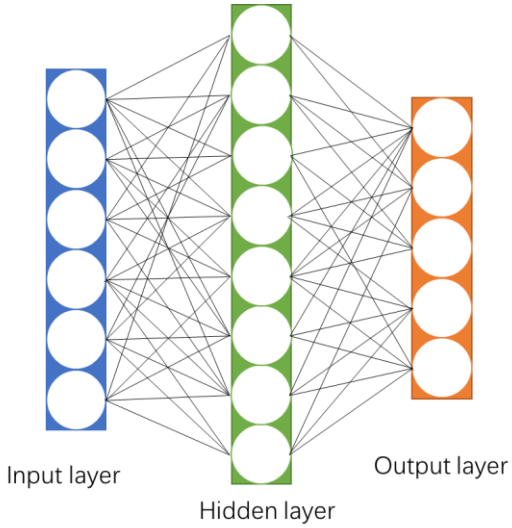

Figure 7 Local connection of neuron

Although the local connection operation can reduce the parameters of the training required by the network, some local features of the image will reflect a repetitability in an entire image, that is, some partial features in the image, and This partial feature may repeat any location in the image, and if these features are extracted separately with the convolutionary cores of different weights, then the quantity of the network will not only increase the quantity of the computing resource, the weight sharing Shut up. The value in the convolutionary core is called weight. The so-called weight sharing is to consolidate a given map with a convolution. The position of this figure is swept by the same volume, ie The weight used in the accumulation is the same.

3.2. Application of Convolution Neural Network in Shoe Print Retrieval

Introducing convolutional neural network into the field of shoe printing, also has made good experimental results. Zhang [6] is fine-tuned to the pre-trained VGG-16 [7] network, and the public data set FID300 [8] achieves a more prominent experimental result, but because the method does not experiment with the disabled shoe print, So this method is inadequate. Kong [9] et al. Takes the convolutional neural network extracted by the RESNET50 to the depth feature of the image by multi-channel normalized cross-correlation method. The validity of the

method is verified on the data set FID300. However, the method has obtained a plurality of local regions due to the rotation between the sliding window and a certain angle, and a large amount of time is consumed during the search process and is not applicable to practical applications. Cui [10] is extracted with a depth belief network (DBN), and matches the local to global matching score by matching the spatial pyramid. In this experiment, the top 10 cumulative matches were divided into 65.67%. Cui [11] is divided into the upper and bottom two regions of the shoe print image, and calculates the weighting and obtaining the matching score of two alignment images. After experiment, TOP10% accumulated matching score is 88.7%. The method was found after PCA dropwell, and 95% decreased to the original image characteristics was the highest in the retrieval accuracy. MA [12] and other people extract the shoe print characteristics in 2019, Multi-Part Weighted Convolutional Neural Network, MP-CNN), and experiments on the FID-300 data set. TOP10 % Recognition rate reached 89.83%. S Handai [13], etc., the pre-trained VGG-16 network is fine-tuning and directly develops the convolutional layer feature to retrieve experiments. The experiment proves that the fine-tuning VGG-16 network has a hidden shoe print image retrieval effect. Not ideal. Thereafter, Handai [14], etc., in turn proposes an algorithm based on the selection convolution descriptor, and the complete shoe print and the adverse shoe printing are retrieved, and different convolutionary features are extracted, and it is TOP1% on the CSS-200 data set. The recognition rate reached 92.5%. Zhao Mengying [15] segmented the original shoe printing image, fused the VGG19 network with the SIAMESE network, and the extracted feature was used to fuse the extracted feature. In 2021, it is blended with the local characteristics of the global feature and the partition, and the EfficientNET network is selected as the backbone network, and the calculation cost is reduced, and it has achieved good search results.

4. Conclusion

Shoe printing, as an important branch of image retrieval, application depth learning methods, especially convolutional neural networks, as the infrastructure of the retrieval method, has achieved more excellent experimental results. However, due to the characteristics of the shoe print image itself, the simple use of separate convolutional nerves is not well to extract the shoe print image characteristics. Although the convolutional neural network is partially connected, the convolutional neural network is extracted to the feature of the shoe print. The pattern is complex, the shape of the shoe print is diverse, and the focus local feature has a large impact on the search results. Therefore, in future research, the shoe printing should be more concerned about local features, through convolutional neural networks, to obtain a better search result, making the automation of shoe print more intelligent.

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