Image Watermark Removal Method of Classroom Teaching Recording and Broadcasting System Based on Deep Learning

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Abstract. In order to improve the image watermark efficiency of the classroom teaching recording and broadcasting system, a method for removing the image watermark of the classroom teaching recording and broadcasting system was designed based on deep learning. For image denoising and correction processing, use the color palette to adjust the processing color to obtain the image correction effect; use the median value of all pixels around the neighborhood pixels to replace the pixel value of the current pixel point to perform image filtering processing; then the classroom teaching recording and broadcasting system Image detail similarity calculation, according to the calculation results to characterize the details of the image spatial structure information, and realize the image watermark removal of the classroom teaching recording and broadcasting system through deep learning. The research shows that the method designed this time can improve the accuracy of watermark removal and reduce the removal time.

Keywords: Deep learning · Classroom teaching recording and broadcasting system image · Watermark removal · Wavelet function · Correcting · Detail characterization

1 Introduction

With the development of the computer network, it is more convenient and convenient to acquire the media, characterize, store and distribute in digital form, which not only greatly promotes the development of the industry, but also greatly enriches our visual and auditory enjoyment. Digital media has higher quality than analog form, and it can be copied and edited without any quality loss. However, the security of digital media content always restricts the process of informatization. Although mature cryptography can solve the secure transmission and access control, once decrypted, digital media content can be copied and transmitted at will, which has caused huge losses to media

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content manufacturers. Therefore, digital watermarking technology has been studied. Digital watermarking is an effective copyright protection technology in recent years. It can be used to identify the owner of products, authenticate works, track the spread of products and carry out security control. However, in practice, the image with watermark will inevitably be subjected to some unintentional attacks such as image filtering, image enhancement, image sharpening and image compression (network communication), as well as malicious attacks such as collusion attack, confusion attack, pruning attack and so on.

Under the above background, a method of image watermarking removal based on deep learning is proposed for classroom teaching recording system. The associative memory function of deep learning means that the system can associate corresponding signals under the action of a given set of excitation signals. Associative memory network adjusts the weight of neurons through the weight learning rules between neurons, so as to get the connection between things. Therefore, this method is applied to the image watermarking removal method of classroom teaching recording system in order to improve the effect of image watermarking removal of classroom teaching recording system.

2 Preprocessing Before Removing Image Watermark in Classroom Teaching Recording and Broadcasting System

In order to make the image characteristics of classroom teaching recording and broadcasting system more obvious, the image is preprocessed before watermark removal.

2.1 Image Correction

Due to the influence of many factors in the process of image acquisition, the accuracy of watermark recognition results is low. For this reason, the image is corrected and the target function of the correction is set. Using the proper colour matching template [1], a good correction result can be achieved. Color description can correspond to H, S, L. Conversion of RGB to HSL is as follows: R, G, and B indicate a particular colour of red, green, and blue, the value of which changes from 0 to 1. The detailed formula for the calculation is as follows:

$$H = \begin{cases} 0, \lambda_{\max} = \lambda_{\min} \\ 60, \dfrac{G - B}{\lambda_{\max} - \lambda_{\min}} \end{cases} \tag{1}$$

In formula (1), $\lambda_{\max}$ indicates the maximum value, and $\lambda_{\min}$ indicates the minimum value.

Based on the above analysis, the picture is transformed into an HSL color space, where P stands for all color points in an image, and $H(q)$ denotes a color point with a color value q.

$$Z_z = \varepsilon \times S_{M_{n(e)}}(q) \times \eta_A(q) \tag{2}$$

In formula (2), ε represents the description parameter of rotation Angle, $S_{M_{n(e)}}(q)$ represents the description parameter of boundary tone value, and $\eta_A(q)$ represents the area proportion of color point q.

On this basis, the image harmony is calculated [2], and its influence factor can be obtained from the following formula:

$$W = \sum_{m-1}^{i=1} \frac{D_i^{\mathrm{MC}}}{D_{i+1}^{\mathrm{MC}}} \tag{3}$$

wherein, D_i^{MC} and D_{i+1}^{MC} represent and describe the degree of image color action respectively.

The crossover probability function and mutation probability function can be obtained by the following formula:

$$p_c = \begin{cases} \frac{k_1\left(f_{\max} - \bar{f}\right)}{\left(f_{\max} - \bar{f}\right)}, f \geq \bar{f} \\ k_2, f < \bar{f} \end{cases} \tag{4}$$

Where in, $f_{\max}$ indicates the largest fit of the group described. The computation procedure is repeated continuously until the fitness computation result is acquired and the calibration goal is set up.

2.2 Image Filtering Processing

Median filtering is a nonlinear filtering method. Its main idea is to replace the pixel value of the current pixel with the median of all pixels around the neighborhood pixel. Because the median filtering method does not need to count the characteristics of the image of the classroom teaching recording and broadcasting system in the process of image calculation and processing, the data processing is more convenient. Under certain conditions, it can retain more image details and suppress image blur than linear filtering method, which is more practical and effective to eliminate image interference and scanning image noise [3, 4]. However, this method is not suitable for images with more details, especially classroom teaching recording and broadcasting system images with more details of dots, lines and spires.

Referring to the characteristics of wavelet base, a new method more suitable for image wavelet transform is found to process the wavelet coefficients, and then the inverse transform of the image is carried out to obtain the image after noise elimination. The method of eliminating image noise by wavelet transform is to process image data information through the property of variable scale wavelet transform, which highlights the centralized processing performance. When the image information energy data of classroom teaching recording and broadcasting system is concentrated on a few wavelet transform coefficients, the value of wavelet coefficients is higher than that of wavelet coefficients whose energy is distributed in most image noise in the transform wavelet domain. In the field of image processing, the commonly used noise elimination methods include nonlinear wavelet transform threshold denoising method, wavelet domain correlation denoising method and maximum noise elimination method.

Wavelet transform is evolved from Fourier transform. It has the characteristics of time-frequency, decorrelation and multi-resolution analysis. The effect of dealing with Gaussian noise is very obvious, which is better than median filter. The image noise data decomposed by wavelet transform are generally concentrated in the high-frequency part of the image, which lays a better foundation for eliminating image noise. The basic idea of using wavelet transform to eliminate image noise is that the image of classroom teaching recording and broadcasting system through wavelet transform forms wavelet coefficients containing important image information. The number is small and the amplitude is large, especially the amplitude corresponding to noise is small. Which can better control the image noise of classroom teaching recording and broadcasting system. Then the processed data are transformed by inverse wavelet transform, and finally the filtered reconstructed image is obtained. After wavelet decomposition and reconstruction, the purpose of eliminating image noise can be achieved. The process of eliminating image noise is as follows: The processed classroom teaching recording and broadcasting system image is transformed by wavelet transform, and the adaptive wavelet coefficient processing method is adopted. The wavelet coefficients of boundary information remain unchanged, and the wavelet coefficients of other information are processed by fuzzy soft threshold. Step 3: The coefficients of data quantization are used for wavelet reconstruction. Step 4: The wavelet coefficients are transformed by inverse wavelet transform to obtain the denoised image.

Set a reasonable wavelet base. The wavelet base setting process is shown in Fig. 1:

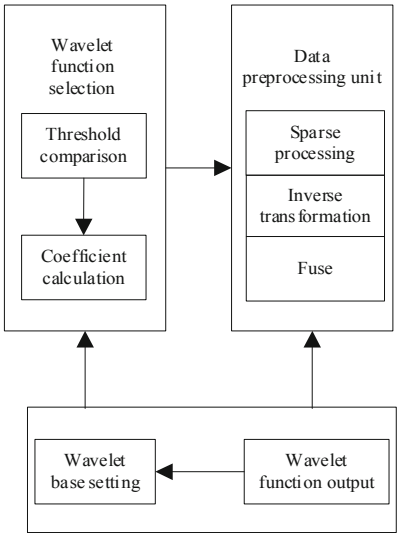

Fig. 1. Wavelet base setting process

Wavelet decomposition of classroom teaching recording and broadcasting system image, clarify the number of layers and threshold to be decomposed, and then use the threshold operation for the coefficients of each layer after decomposition. After the image wavelet coefficients are processed, the image of the classroom teaching recording

and broadcasting system is reconstructed by the method of inverse transformation, so as to obtain the image after noise elimination. It is usually divided into two methods: soft threshold and hard threshold. At present, soft threshold has a wide range of applications. Assuming that δ represents the estimated threshold, the following is the soft threshold function model:

$$m_\delta = M \times \delta \tag{5}$$

In formula (5), M represents the image wavelet coefficient, and m_δ is the wavelet coefficient calculated by the soft threshold function. After using the soft threshold function for image reconstruction, the denoising effect is significantly improved, and the ringing phenomenon is reduced compared with the image processed by the hard threshold function, and some details and boundary data are also lost, which affects the quality of the image.

By analyzing the characteristics of soft threshold and hard threshold [5, 6], this paper designs a practical new threshold function, which is as follows:

$$m'_\delta = \sqrt{|m|^2 - \left(\frac{\delta}{m}\right)^k \delta^k} \tag{6}$$

The above formula can automatically adjust the parameters according to the wavelet coefficients to realize the image denoising of classroom teaching recording and broadcasting system.

3 Detailed Representation of Image Watermark in Classroom Teaching Recording and Broadcasting System

After the above calculation, for the geometric transformation of the digital watermark image, assuming that the image size is $N \times N$, the pixel position is (x, y), and the pixel position scrambled according to the geometric transformation is (x', y'), the scrambling method of the geometric transformation is as follows:

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \times \begin{bmatrix} x \\ y \end{bmatrix} (\mathrm{mod}\, N) \tag{7}$$

If the transformation matrix is T and geometric transformation is carried out for many times, the iterative formula can be obtained:

$$r_n = T^n r_0 (\mathrm{mod} N), n = 0, 1, 2, \cdots n \tag{8}$$

In formula (8), T^n represents the trajectory parameters after the n iteration.

On this basis, magic square transformation is performed to form the following matrix [7, 8], which is expressed as:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \tag{9}$$

In formula (9), a_{11}, a_{12}, a_{nn}, etc. represent transformation parameters respectively.

On the basis of the above processing, the image watermark details of the classroom teaching recording and broadcasting system are characterized to represent the information details of the image spatial structure.

4 Implementation of Image Watermark Removal in Classroom Teaching Recording and Broadcasting System

The final watermark removal is realized by deep learning. The calculation process of deep learning is shown in Fig. 2:

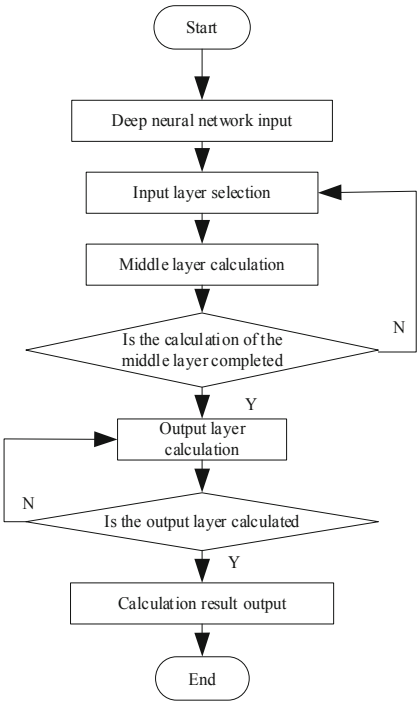

Fig. 2. Watermark removal process based on neural network

Deep learning is a three-layer structure, and suppose $Z_i(t)$ represents the bias parameter of the t th neuron, the output corresponding to the first unit of the input layer is expressed as:

$$Y_j(t) = \sum_{L}^{i=1} W_{ji}(k) Z_i(t) + \theta(t) \tag{10}$$

In formula (10), W_{ji} represents the number of nodes in the j layer, k represents the weight coefficient, and $\theta(t)$ represents the output function of the hidden cell.

The radial basis function is expressed as:

$$Z_i(t) = \exp\left\{ \frac{\sum_{j=1}^{N} \left[X_j(t) - C_{ij}\right]^2}{2\sigma^2} \right\} \tag{11}$$

In formula (11), j represents the Gaussian function of normal distribution, $X_j(t)$ represents the t th input mode vector, and C_{ij} represents the training sample vector corresponding to the i unit in the hidden layer.

The general method to measure the error is to establish the error objective function:

$$J(k) = \frac{1}{2} \sum_{K}^{i=1} \chi^{-1} \times \sum_{M}^{j=1} d_j(t) \tag{12}$$

In formula (12), χ represents the weighted forgetting factor, its function is to gradually forget the influence of the past samples on the current estimation, so that the estimated parameters can reflect the characteristics of the samples at the current moment as much as possible. $d_j(t)$ represents the expected output of the j node of the output layer when t modes are input [9, 10].

In the learning and training stage, the frequency band coefficient sequence in the DCT domain of the m group modulated by the m group pseudo-random number is sent to the input layer as the input vector, and the m group pseudo-random number sequence is sent to the output layer as the desired output. When the network training meets the required error requirements [11], the whole network realizes the nonlinear mapping from the modulated DCT domain coefficient to the pseudo-random number.

After the above training, the watermark is extracted and the calculation formula is expressed as:

$$W_i'(m,n) = \frac{\left[W'(m,n) -_i W(m,n)\right]}{\alpha_i} \tag{13}$$

In formula (13), α_i represents the blocking parameter. After the associative memory process of the network, the image watermark removal result of the classroom teaching recording and broadcasting system, that is, the image watermark removal of the classroom teaching recording and broadcasting system is completed.

5 Experimental Analysis

To prove the validity of the algorithm, a simulation experiment was conducted on the basis of the model, and a comparative test was made between the former and the latter. The simulation experiment was carried out in the development environment CPU, Inter Pentium 4. The memory of the simulation system was 1.5G, the sample set was 800, and the spectrum bandwidth distribution was 5kHz to 15kHz.

5.1 Analysis of Image Watermark Removal Effect of Simple Classroom Teaching Recording and Broadcasting System

The accuracy comparison between the watermark removal method of this study and the traditional method in the image watermark removal of simple classroom teaching recording and broadcasting system is shown in Fig. 3:

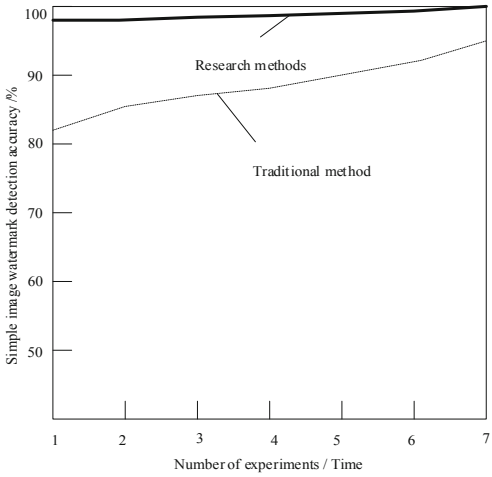

Fig. 3. Comparison of image watermark removal accuracy of simple classroom teaching recording and broadcasting system

Can be seen from the analysis of the Fig. 3, in the simple classroom teaching image to remove a recording system, the research method and traditional method of removing the accuracy is higher, but the comparison shows that the accuracy of watermark removal method in this study is still higher than the traditional method, the reason is that in the process of the construction of the method in this paper, calculated the similarity of classroom teaching image detail recording system, It provides a basis for better recognition of image watermark. To a certain extent, it can improve the accuracy of image watermark removal in simple classroom teaching recording system.

The time spent by the two methods in removing the image watermark of the simple classroom teaching recording and broadcasting system is shown in Fig. 4:

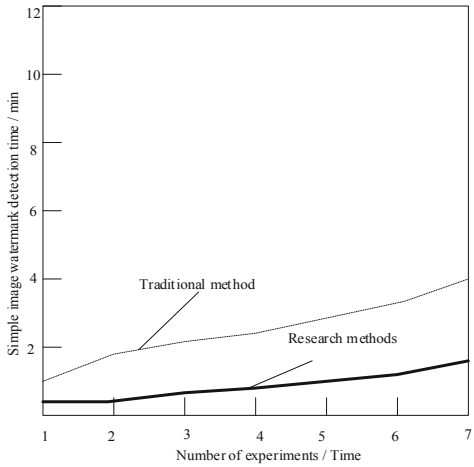

Fig. 4. Comparison of image watermark removal time of simple classroom teaching recording and broadcasting system

According to Fig. 4, it can be found that in the image watermark removal of simple classroom teaching recording and broadcasting system, the time spent by the two methods is not much different.

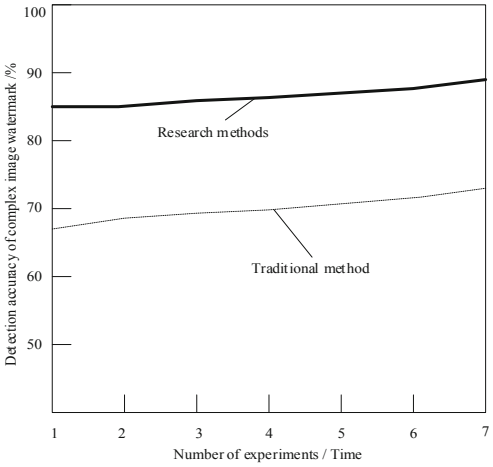

Fig. 5. Comparison of image watermark removal accuracy of complex classroom teaching recording and broadcasting system

5.2 Analysis of Image Watermark Removal Effect of Complex Classroom Teaching Recording and Broadcasting System

Figure 5 shows the comparison results of image watermark removal accuracy between the studied watermark removal method and the traditional method in the complex classroom teaching recording and broadcasting system:

Based on Fig. 5, it can be found that the accuracy of image removal of complex classroom teaching recording and broadcasting system is lower than that of simple classroom teaching recording and broadcasting system. However, the removal accuracy of the research method is still higher than the traditional method, which can prove that the watermark removal accuracy of the research method is higher.

Figure 6 shows the comparison results of the traditional method and the research method in the removal of image watermark in the complex classroom teaching recording and broadcasting system:

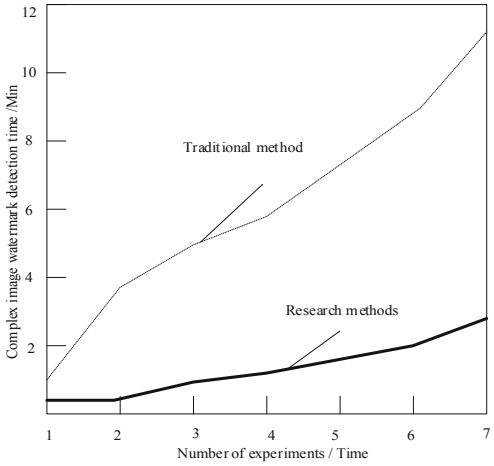

Fig. 6. Comparison of image watermark removal time of complex classroom teaching recording and broadcasting system

Based on Fig. 6, it can be found that the time spent by the studied method and the traditional method on image removal of complex classroom teaching recording and broadcasting system is more than that of simple classroom teaching recording and broadcasting system. But through comparing, we can find that this approach has fewer time consumingmort compared withone.

6 Conclusion

An image watermark removal method of classroom teaching recording and broadcasting system based on deep learning is designed, its innovation is to propose the application of deep learning in the image watermark removal of classroom teaching recording and broadcasting system. The associative memory function of deep learning refers to that the

system can contact the corresponding signals under the action of a given set of excitation signals. Associative memory network adjusts the weights of neurons through the weight learning rules between neurons, so as to get the relationship between things. And the effectiveness of the proposed method is verified by experiments, which can improve the accuracy of watermark removal, reduce the removal time and improve the removal efficiency, and has a good promotion effect on practical application. The method of this study can help relevant fields, but there are still deficiencies, which will be further analyzed in the follow-up research.

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