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Design of an adaptive image processing algorithm based on neural fuzzy control

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Abstract

Usually the rules proposed by the fuzzy control system are expressed by professional problem solvers, using language, but because of their depth of understanding and comprehensive ability to the problem, directly affect the performance of the control system, so the completeness and effectiveness of the rules, is also the main problem discussed. Because of its unique characteristics, neural network can provide a new way to solve the above problems. Therefore, based on the understanding of fuzzy controller and neural network, the adaptive image processing algorithm with neural fuzzy control as the core is studied in this paper.

Keywords

Neural network; Adaptive; Fuzzy control; The image processing.

1. Introduction

In the early studies, people only used the mode of artificial observation to control the switch of coolant valve, and the overall automaticity level was too low. In the technological innovation, researchers put forward closed-loop control method, but because it can not build accurate mathematical model, so the actual control effect does not meet the expected requirements. The fuzzy control method does not need to rely on accurate mathematical model, and can run effectively in the changeable environment, so it has been widely used in the controlled system once proposed. The learning function of neural network can approach any complex nonlinear system, so it can be applied to the controlled system without accurate mathematical model. In this paper, based on the fusion of neural network and fuzzy theory, the adaptive image watermarking algorithm based on neural fuzzy control network is briefly understood.

Digital watermarking is a favorable decision to protect digital media information security and is the main topic of scientific research. By adding the basic information of copyright owners to digital information without affecting the visual effect of the original image, it can provide an effective way to deal with copyright disputes under the background of network. It is important to note that the image watermarking algorithm to meet the two characteristics, on the one hand, the transparency request after the embedded watermark image and the original image, compared to only it is hard to see the difference from the vision, on the other hand, robustness requirement after embedding watermark image can effectively resist image transformation or malicious attacks, the fall in the image quality is still can extract the watermark. Therefore, the watermarking algorithm should combine the two to conduct a comprehensive study [1.2.3].

Generally speaking, there are two ways to embed watermarks, one is spatial watermarking algorithm, the other is transform domain watermarking algorithm. From the current development of scientific research and technology, the latter has been applied more frequently, including DWT transform method, DCT transform method and SFT transform method. After the promotion of international compression standards, the watermarking technology based on wavelet transform has become a hot research topic in the technical field.

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2. Fuzzy neural network structure

Combined with the fuzzy neural network structure analysis shown in the figure below, it can be seen that the membership function uses Gauss, and the corresponding center parameters, anti-fuzzy weight value and width can be optimized according to the genetic algorithm, while the fuzzy marker number of control factors can be adjusted by self-organizing competitive network.

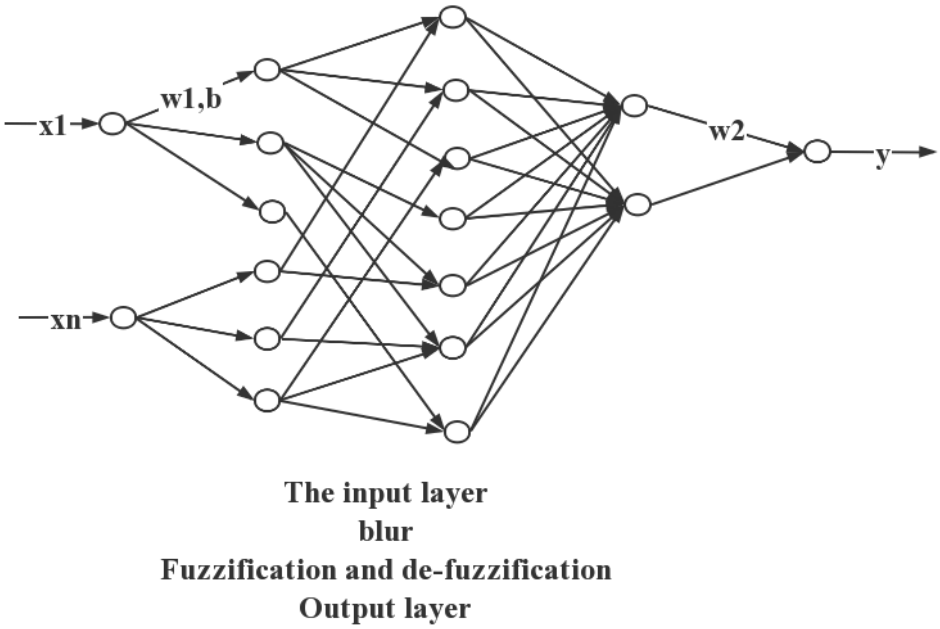

Figure 1 Structure

3. Embedding extraction of watermarking algorithm

It is assumed that the gray image I of n×n is selected as the original carrier, and the binary image W of m×m is a watermark image, and the two conform to n=2p•m, p= 1,2... This condition.

3.1. Embedding Algorithm

First, signal preprocessing. After scanning the watermark image W, it is mapped into one-dimensional vector, and the corresponding chaotic sequence is obtained by using chaotic mapping. At the same time, the chaos of binary image should be encrypted, and finally the watermark image after encryption should be obtained. It should be noted that both the parameters of the mapping function and the initial value of the mapping function can be regarded as keys, and the security of the application algorithm can be enhanced according to the sensitivity of chaotic mapping to the initial value[4.5.6].

Secondly, after the wavelet decomposition of the original image is completed, the original image is transformed by organizing wavelet blocks to obtain the detail subgraphs and approximation subgraphs of different directions and different resolution levels. Combined with the size of watermark image, the number of wavelet transform is controlled effectively, so that the size of the highest resolution subgraph can be greater than or equal to the size of watermark image. At the same time, by studying the transparency of the algorithm, it can be seen that each subgraph belongs to wavelet block if all detail subgraphs are divided into subgraphs with consistent size and non-overlapping.

Thirdly, a training fuzzy control neural network is constructed to determine the maximum embedding strength of all wavelet blocks.

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Fourthly, the pre-processed watermark image needs to be embedded into all wavelet blocks according to the following formula:

In the above formula, Fk (u, v) K represents the original wavelet coefficient of the wavelet block, Fik (u, v) represents the wavelet coefficient after embedding the watermark, AK represents the watermark embedding strength of the KTH wavelet block, and Wd F (u, v) represents the pixel value of the watermark signal after pretreatment.

Fifthly, the wavelet sub-blocks embedded with watermark are recombined, and the corresponding image is obtained after the wavelet reaction transform.

3.2. Watermark Extraction

Watermark extraction needs to use the original image, this paper mainly uses intelligent adjustment to obtain the final watermark. Firstly, the position of the corresponding wavelet block should be defined, and the similarity of the original watermark should be calculated according to the matrix. Secondly, according to the size of the similarity design, all the wavelet quickly extract the weighted coefficient of the watermark; Finally, the same key will be used for decryption, thus obtaining binary watermark. In this paper, the peak signal-to-noise ratio is selected to analyze the distortion degree of the image after embedding watermark, and the specific formula is as follows:

$$PSNR = lo\lg \frac{M^2 \cdot \max \vec{I}^2(u,v)}{\sum_{u,v}\left(I(u,v) - I(u,v)\right)^2}$$

Among them, $I(u,v), \bar{I}(u,v)$ Represents the gray value of the two images at the position (u, v). The specific results are shown in the following table 1:

Table 1 various kinds of signal-to-noise ratio analysis

Different methods (blocks)	Barni model [k]	BP artificial neural network	Fuzzy control neural network
F1	0.9502	1.5739	1.6341
F2	1.2340	1.5384	1.9644
F3	1.2181	1.7120	2.1601
F4	1.1721	2.2908	2.2543
F5	1.4402	1.6590	2.4042
F6	1.5582	2.3736	2.5766
F7	1.8536	2.5536	2.6558
F8	2.2651	2.6026	2.6997
F9	2.5798	2.7688	2.7587
Image PSNR (dB) with watermark	40.6851	40.8777	40.7341

The similarity calculation formula of the two is:

$$NC = \frac{\sum_{x,y}\overline{W}(u,v)W(u,v)}{\sum_{x,y}W^2(u,v)}$$

In the above formula, $\overline{W}(u,v)$, $W(u,v)$ Represents the gray value of the two images at the position (u, v).

4. Conclusion

To sum up, this paper proposes an adaptive image watermarking algorithm using neural fuzzy control, which integrates neural network and fuzzy control to optimize the watermarking algorithm, and designs the fuzzy control factors. From the practical point of view, this new watermarking algorithm design has a positive effect on adaptive image processing, whether it is noise adding or compression clipping, it shows a strong robustness and transparency. Therefore, in the future technology research and development process, researchers should clearly recognize the importance of neural fuzzy control, in order to improve the level of adaptive image processing.

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