Application of TV image compression technology based on neural network

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Abstract

Aiming at the disadvantages of digital TV, including a large amount of information and redundant information, a method of TV image compression technology based on neural network combining neural network with image compression technology is proposed in the work. Firstly, the TV image is divided into blocks as the input of neural network to build the network; secondly, the blocks are rebuilt to realize image compression recovery. The simulations show that the neural network algorithm can achieve the TV image compression effectively and the number of neurons of the hidden layer based on the neural network algorithm has great influence on the building and training of the network by contrast. When the number of neurons of the hidden layer is less, the image compression ratio will be higher and the image compression quality will be lower.

Keywords: digital TV technology, image compression, neural network, hidden layer, compression ratio

1 Introduction

With the rapid development of digital TV technology, the transmission quantity of the data becomes more and more large and the requirement for the software and hardware is more and more high. The traditional transmission and image compression technology cannot meet the requirement of the actual technology. The BP neural network has the advantage of good nonlinearity, parallel calculating of large data and self-organized learning. In the work, a TV image compression technology based on BP neural network, combining the neural network technology with the digital image compression technology, is proposed and applied to the process of TV image compression transmission. The simulations show that the method used in this work has the advantage of fast compression speed and high compression quality and it is more efficient.

2 BP neural network

BP neural network, an error back propagation network, was proposed by Rumelhart and McCelland in 1986 [1-3]. The structure model, showed in Figure 1, consists of the input layer, the hidden layer and the output layer.

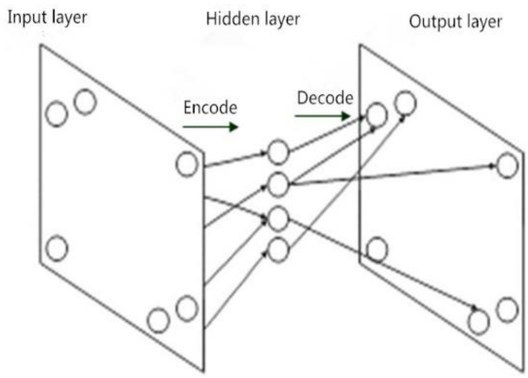

FIGURE 1 Structure model of BP neural network

3 Image compression model of BP neural network

3.1 BUILDING THE MODEL

Figure 2 shows that in view of the digital image with a pixel of N×N, the original image was divided by K×K into many small blocks, as the inputs of neural network [4-6].

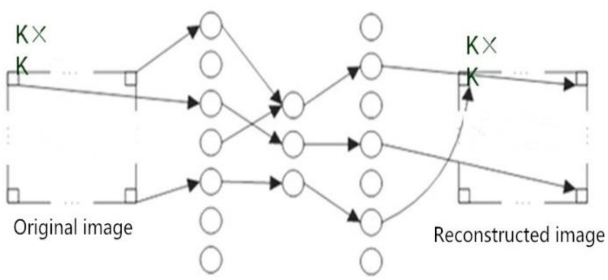

FIGURE 2 BP image compression model

The image compression algorithm of BP neural network is as follows:

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Step 1: Building the training sample. Divide the original image into 4×4 non-overlapped pixel blocks, transform each pixel block into 16×1 column vector and change the original data into 16×1024 matrix.

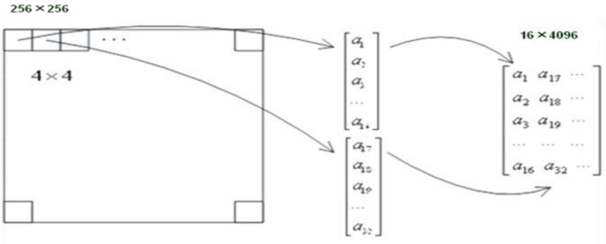


FIGURE 3 Dividing the image into blocks

Step 2: Building BP neural network model.

Train BP network considering the image data set as the input and the ideal signal. If the compression ratio of the network image is *S*, the node number of the network input layer is N_i, the node number of the hidden layer is N_h, then the compression ratio is [6-9]: $S = \frac{N_i}{N_h}$.

Step 3: Training the network. Use the Levenberg-Marquardt method, with a fast training speed.

Step 4: Coding the network.

Step 5: Compressing and rebuilding the image. Encode the compressed and coded data, and alternate into the size of original data value: multiply each matrix element by 255; recover the pixel value from interval [0, 1] to [0, 255]; transform the column vectors into the image blocks to form a complete image; finish the image rebuilt.

Figure 3 shows the calculating model as follows:

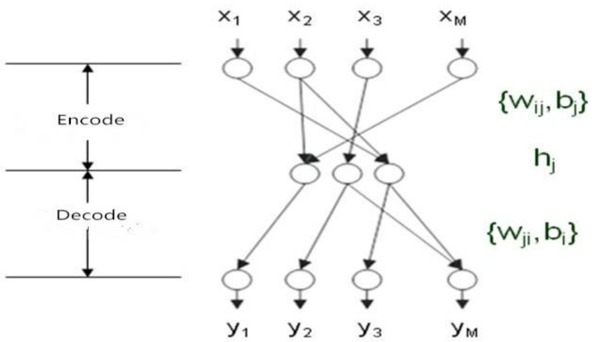


FIGURE 4 Calculating model of the image compression

3.2 FLOW CHART OF THE ALGORITHM

As mentioned, Figure 5 shows the flow chart of BP TV image compression [10].

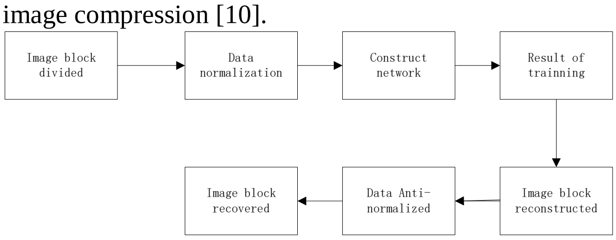


FIGURE 5 Flow chart of BP TV image compression algorithm

3.3 EVALUATING THE COMPRESSION QUALITY

Peak signal to noise ratio (PSNR) is a widely-used evaluation standard for the image quality evaluation. It can be expressed as the logarithm of the ratio of mean square error (MSE) between the original and the compressed image and $(2^{n-1})^2$ multiplied by 10. The calculating formula is indicated by [11-13]: $PSNR = 10 * log\left(255^2 / MSE\right)$.

4 Algorithm simulation

In order to test and verify effectiveness and reliability of the algorithm, the two test images including Figure 6 and Figure 7 were verified based on MATLAB [9]: The parameters of the neural network were set as: the training goal=0.01, the training times epoch=1000.

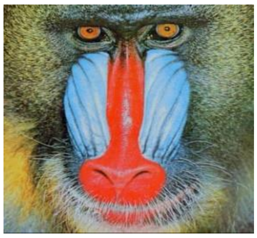


FIGURE 6 The 1st test image

FIGURE 7 The 2nd test image

If the compression ratio S is 16, the compression results will be as follows:

a) The 1st test image

b) Compression result of the 1st test image

c) The 2rd test image

d) Compression result of the 2rd test image

FIGURE 8 Compression results while the compression ratio S=16

If the compression ratio S is 8, the compression result will be as follows:

a) The 1st test image

b) Compression result of the 1st test image

c) The 2rd test image

d) Compression result of the 2rd test image

FIGURE 9 Compression results while the compression ratio S=8

If the compression ratio S is 4, the compression result will be as follows:

a) The 1st test image

b) Compression result of the 1st test image

c) The 2nd test image

d) Compression result of the 2nd test image

FIGURE 10 Compression results while the compression ratio S=4

Table 1 shows the contrast results of time compression.

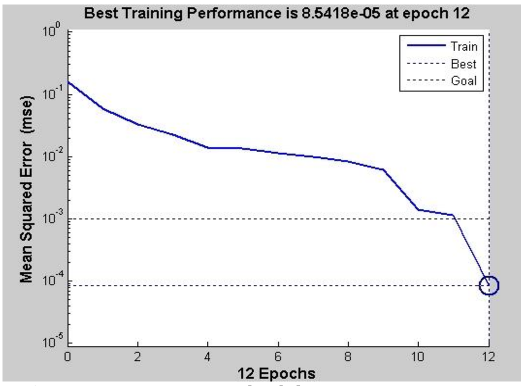
TABLE 1 Time compression contrast results of the test images

Image	Compression Ratio	Time Compression/s
The 1st Test Image	16	10.5408
	8	7.5647
	4	8.3245
The 2nd Test Image	16	4.3710
	8	1.9802
	4	4.3010

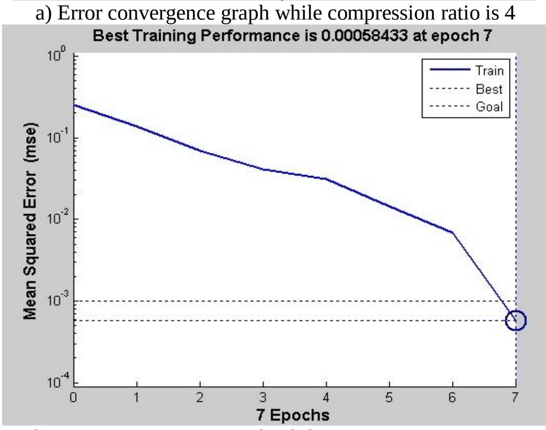
Table 2 shows the PSNR contrast results of the test images.

TABLE 2 PSNR contrast results of the test images

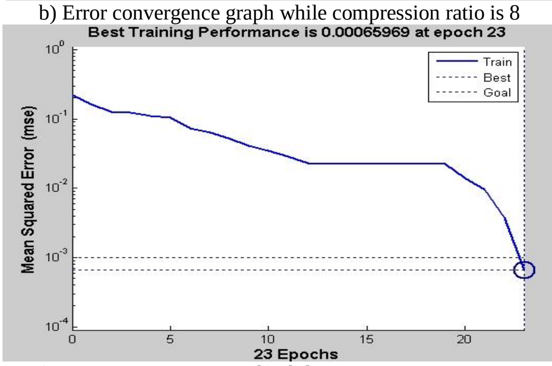
Image	PSNR	Compression Ratio
The 1st Test Image	30.8796	0.0507
	31.8181	0.0897
	32.4118	0.1465
	31.9662	0.2030
	31.1015	0.2512
	30.7471	0.3158
	28.2056	0.3219
	31.9063	0.4148
The 2nd Test Image	31.7869	0.0507
	32.1832	0.0897
	32.6738	0.1465
	32.9882	0.2030
	33.1213	0.2512
	33.7521	0.3158
	33.9625	0.3219
	34.2213	0.4148



a) Error convergence graph while compression ratio is 4



b) Error convergence graph while compression ratio is 8



c) Error convergence graph while compression ratio is 16

FIGURE 11 Error convergence graphs with different compression ratio

Table 2 shows that the PSNR decreases along with the increase of the compression ratio, that is, the image compression quality decreases. Besides, Figure 11 indicates that the error training times increase along with the increase of the compression ratio.

5 Conclusions

In the work, a method of TV image compression technology based on BP neural network combining neural network with image compression technology is proposed and applied to the process of TV image compression transmission. The simulations show that the method has the advantage of fast compression speed and high compression quality and it is more efficient. Firstly, the TV image is divided into blocks as the input of neural network to build the network; secondly, the blocks are rebuilt to realize image compression recovery. The simulations show that the neural network algorithm can achieve the TV image compression effectively and the number of neurons of the hidden layer based on the neural network algorithm has great influence on the building and training of the network by contrast. When the number of neurons of the hidden layer is less, the image compression ratio will be higher and the image compression quality will be lower.

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