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DIGITAL WATERMARKING FOR COPYRIGHT PROTECTION USING NEURAL NETWORKS

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Abstract

The major source of communication in present world is digital media. As it is quite easy to manipulate a digital media, it becomes essential to protect the digital information by legitimate means. Digital watermarking has evolved as one of the latest technologies for digital media protection. Many techniques based on spatial and frequency domain have been developed in the recent past and are being used for effective watermarking. However, there is always a tradeoff between robustness and imperceptibility features of watermarking offered by these techniques. This paper concerns the digital watermarking technology for gray images in which the watermark signal deals with the pseudo-random index function, and then encrypts it with a chaotic function. This paper offers a technique based on Back propagation Neural Network to train a given cover image to produce a desired watermark image. The trained neural network can be used in watermark embedding and extraction. The treated watermark signal is embedded into the original image through the trained neural network. And the neural network is also used to extract and detect the watermark.

Keywords: Copyright protection,Contourlet transform, Digital Watermarking, Neural networks.

1. Introduction

Watermarking is basically the process of passing information, called a watermark; in a manner that the very existence of the message is unknown. Digital watermarking is to embed the copyright information or other symbol information into the image, and to extract them from the image. Digital watermarking can be divided into visible digital watermarking and invisible digital watermarking. The visible watermark which leaves visible marks after embedded into the image is mainly used to identify the copyright to prevent the illegal use. Although the commercial value of the information is reduced, but it does not hinder the users applications, such as TV station logo and so on. The invisible watermark embedded in digital works cannot be clearly perceived by the human senses, so it does not affect the quality of work.

Digital watermarking technology has many applications in protection, certification, distribution, anti-counterfeit of the digital media and label of the user information. Most of the current watermark is embedded into the transform domain, which is characterized by the complexity and a long running time. This paper presents a new watermarking algorithm which is embedded into the original image and the embedding location is determined using neural network. The watermark after pretreatment has better security results.

2. Pre Processing Of Watermark Signal

When encryption technology is applied to watermark, it has a stronger hidden capability. The content of the watermark cannot be identified by the pirates even if the watermark has been extracted.

Creating watermark using gray image two-dimensional matrix with the formula, and then progressive scan from left to right, top to bottom, transform the matrix to form a row vector, into a one-dimensional linear data. Then use the key as a seed, producing a pseudorandom sequence in Gaussian distribution with a mean of 0 and variance 1. Elements in the sequence act as an index, scrambling the one-dimensional linear data to get random sequence [1].

Deterministic system is whose statistics is entirely dependent on the initial conditions. On the contrary, the results of stochastic systems are only partially determined by the initial conditions due to noise, or other external environment beyond our control. Chaos system obey the evolution rules of certainty, if a small initial state is uncertain, the final result is highly sensitive. Chaotic function can be superimposed and expanded, so it is impossible to predict. We get chaotic sequences from the discrete dynamic logical mapping [6].

The definition of a chaotic function is given by:

$$X_{m+1}=\mu x_m(1—x_m) \qquad (1)$$

where $x_m€(0,1)$ and $0\leq\mu\leq4$ or

$$X_{m+1}=(1—\lambda x_m) \qquad (2)$$

where $\lambda€(0,2)$. When λ= 1.50, after repeated iterations, it will be the chaotic system. The average value of the chaotic sequence is 0. Here, we consider λ= 1.5, the initial value of x_0 is 0.2. According to the iterative calculation equation, we get x_m. We use chaos key words as a user key word. Although the pirates can extract the watermark, if they do not know the value of m, they cannot recover the watermark image. In the experiment, we define m=4.

3. Embedding Strength

A. Least Significant Bit Method

Least significant bit (LSB) insertion is a common, simple approach to embedding information in a cover image. The simplest watermarking techniques embed the bits of the information directly in to the least significant bit plane of the cover image. Modulating the least significant bit does not result in human-perceptible difference because the amplitude of the change is small. LSB has easy implementation and high embedding capacity. By using LSB method the scrambled image is embedded it the cover image. The embedded image and cover image is given to the input of BPN to enhance the robustness.

B. Input to the Neural Network

For compression, we have to account for the cost to encode quantized coefficients, as well as the cost to index the retained coefficients. The retained contourlet coefficients are well organized in tree structures. Specifically, from coarse to fine scales, significant contourlet coefficients are successively localized in both location (contourlets intersect with the discontinuity curve) and direction (intersected contourlets with direction close to the local direction of the discontinuity curve).

Thus, using embedded tree structures for contourlet coefficients, we can efficiently index the retained coefficients using 1 bit per coefficient. Suppose that contourlet coefficients are uniformly quantized with step size $\Delta = 2^{-L}$ and coefficients with magnitude below Δ are discarded. Instead of using fixed length coding for the quantized coefficients, a slight gain (in the log factor, but not the exponent of the rate distortion function) can be obtained by coding. We use the average of each pixel block as the expected output value of the BPN. In this experiment, we calculated PSNR value. However, PSNR must be greater than 43dB at any time, which shows that the watermark has good PSNR. Watermark should be extracted from watermarked image to ensure the robustness. Quality of watermarked image is measured using PSNR value.

PSNR=10log [(255^2) / (∑ (I'(i,j) - I(i,j))^2]   (3)

where I'(i,j) is the pixels of original image and I(i,j)) is the pixels of watermarked image.

To speed up, we set the training error is less than 0.01 and set 5000 iterations. Shown in Fig. 1, when the train reached 55 generations the desired goals can be achieved, and trained neural network can be used to embed and extract the watermark.

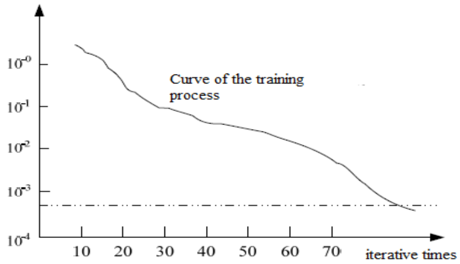

Fig. 1 Training process of neural network

4. Watermark Embedding And Extraction

Preprocessed watermark signal is embedded in the original image. A new spatial embedding algorithm has been proposed.

A. Embedding Watermark

The neural network is used to determine the watermark embedding strength and the pixels from the coarsest band among all the band pass images is used as input value. The average value of each pixel is used as the expected output value of BPN which embeds the watermark into the original watermarked image. The cover image of size MxN is decomposed into number of sub bands using contourlet transform. At each level of decomposition, there are 2n directional sub bands, where n=1, 2, 3, 4. Four level of contourlet decomposition is performed on the cover image to produce 16 directional sub bands. The coefficient of selected directional sub band is used as the input values of BPN neural network, and the output T ' is obtained. T ' is embedded into the watermark and the pixels value of corresponding section is received.

B. Extracting Watermark

The process to extract watermark is just the anti-process of embedding watermark. To extract watermark, we still use the original trained neural network, because neural networks have associative memory function which can realize the blind detection. The watermark can be extracted without any information about original which improves the robustness.

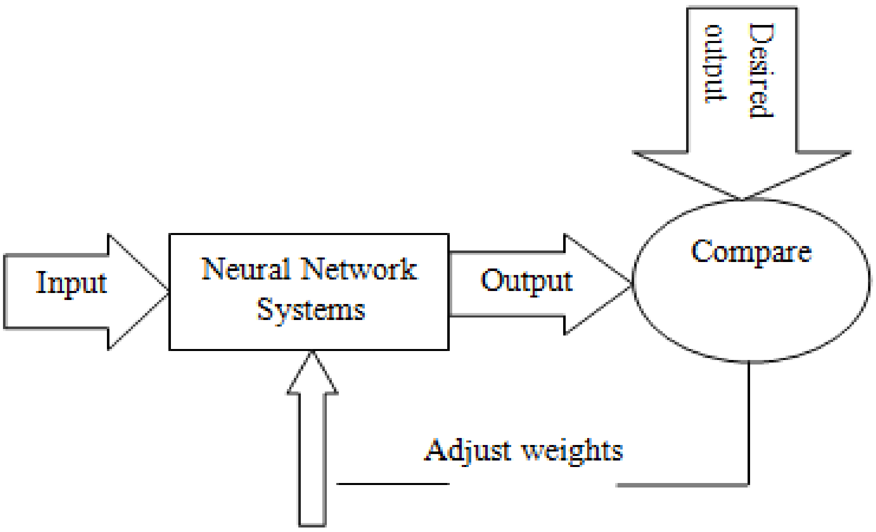

Fig. 2. Process of watermarking

Watermark image is decomposed and the average value S of each pixel block is calculated and is transformed using the Contourlet [7]. Then the result is used as the input values of BPN neural network, and the output T ' is obtained.

The S and T' are substituted in (4) to extract the watermark and to get *w*'.

$$W'_{m,n} = \begin{cases} 1 \text{ if } S > T' \\ = 0, \text{ else} \end{cases} \quad (4)$$

The correlation between the original watermark and the embedded watermark is calculated to detect the existence of the watermark. Similarity between the original watermark and extracted watermark is analyzed quantitatively with the bit rate. Using the formula we can calculate the Bit Compression Ratio (BCR).

$$BCR = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n} \overline{w_{i,j} \otimes w'_{i,j}}}{\sum_{i=1}^{m}\sum_{j=1}^{n} \overline{w_{i,j} \otimes w_{i,j}}} X100\% \quad (5)$$

C. Artificial Neural Network with Back Propagation

The Back Propagation (BP) neural network is not only the most widely used, but also one of the most maturely developed neural networks [8]. It is a multi-network training with weights of the nonlinear differential function. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by you. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities. Typically, a new input leads to an output similar to the correct output for input vectors used in training that are similar to the new input being presented.

This generalization property makes it possible to train a network on a representative set of input/target pairs and get good results without training the network on all possible input/output pairs. As shown in Fig. 3, the Back propagation neural network is based on a hierarchical structure, including an input layer, an output layer and one (or more) hidden layers [8].

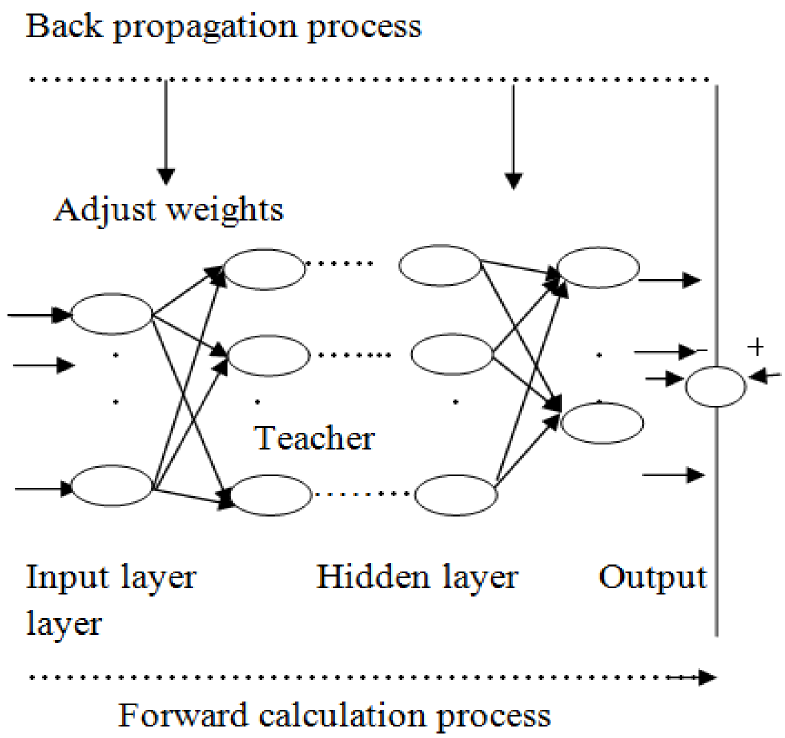

Fig.3. Structure of a BP Neural network

5. Experimental Results

Select two images as the original images. Each image is 8-bit image in size of 256 X 256 as shown in Fig. 4.

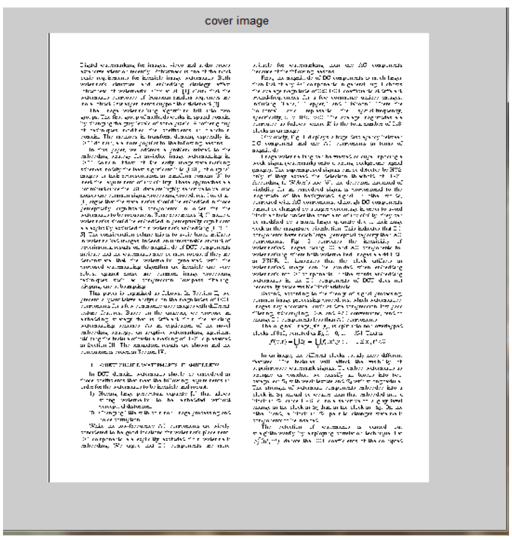

Fig. 4. Cover image

A binary gray image of copyright information given in Fig. 5 is selected to be a watermark image in size of 32 X 32.

Fig. 5. Secret image

Calculated PSNR, which is greater than 43dB, shows that the watermark has good PSNR. The watermarked image is shown in Fig. 6.

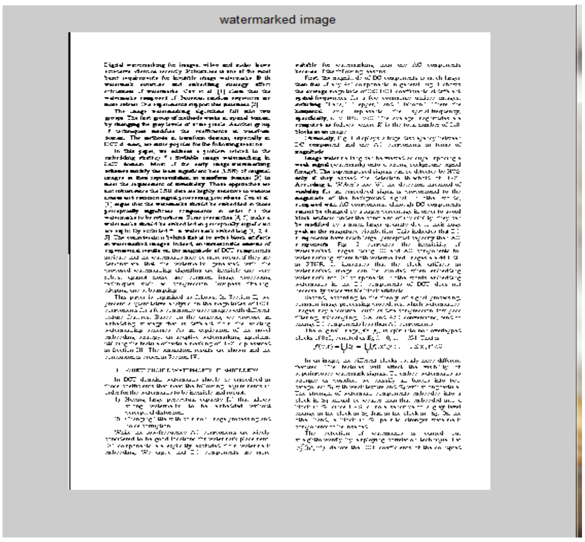

Fig. 6. Watermarked image

6. Conclusion

The proposed digital watermarking technology in this paper is to preprocess the watermark to complete the encryption effect, using the trained neural network to embed and extract the watermark. PSNR value has been calculated and the degree of robustness is identified. The experimental results reveal that the proposed watermarking scheme is robust against common image processing attacks. The results also demonstrate good imperceptibility.

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