Hiding Digital Watermark for Increasing Trust in E-Commerce

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ABSTRACT Several studies have shown that the trust is a significant barrier for realizing the potential of e-commerce. Trust is not only a short-term issue but also the most significant long-term barrier for realizing the potentials of e-commerce. Because digital contents which have been used in e-commerce are easy to be duplicated, the enforcement of digital copyright protection is an important issue. Watermarking is a technique for labeling digital pictures by hiding secret information in the image. In this paper, a discrete wavelet transform(DWT) based technique for embedding digital watermark into image is proposed. The performance of the proposed watermarking is robust to a variety of signal distortions, such as JPEG and image processing operations.

KEY WORDS: discrete wavelet transform, e-commerce, watermark.

I . INTRODUCTION

Several studies have shown that the trust is a significant barrier for realizing the potential of e-commerce(Gefen, 2000). Trust is not only a short-term issue but also the most significant long-term barrier for realizing the potentials of e-commerce(Gefen, 2000). Because digital contents which have been used in e-commerce are easy to be duplicated, the enforcement of digital copyright protection is an important issue. Digital watermarking for multimedia has become one of the widely used copyright protection methods. Watermarking is a technique for labeling digital pictures by hiding secret information in the image. To achieve maximum protection, a watermarking technique should at least respect the following requirements. 1) readability; 2) security; 3) imperceptibility; 4) robustness(Heieh, Tseng, & Huang, 2001).

Watermarking in the frequency domain is more robust than watermarking in the spatial domain, because the watermark information can be spread out to the entire image. Frequency-domain-based techniques can embed more bits of watermark and are more robust to attack, such as JPEG and image processing operations.

In this paper, a discrete wavelet transform(DWT) based technique for embedding digital watermark into image is proposed. To increase copyright protection and visual quality, the watermark is embedded into the DC frequency part of the original image(Huang, Shi, & Shi, 2000; Joo et al., 2002; Miu, Lu, & Sun, 2000).

This paper is organized as follows.

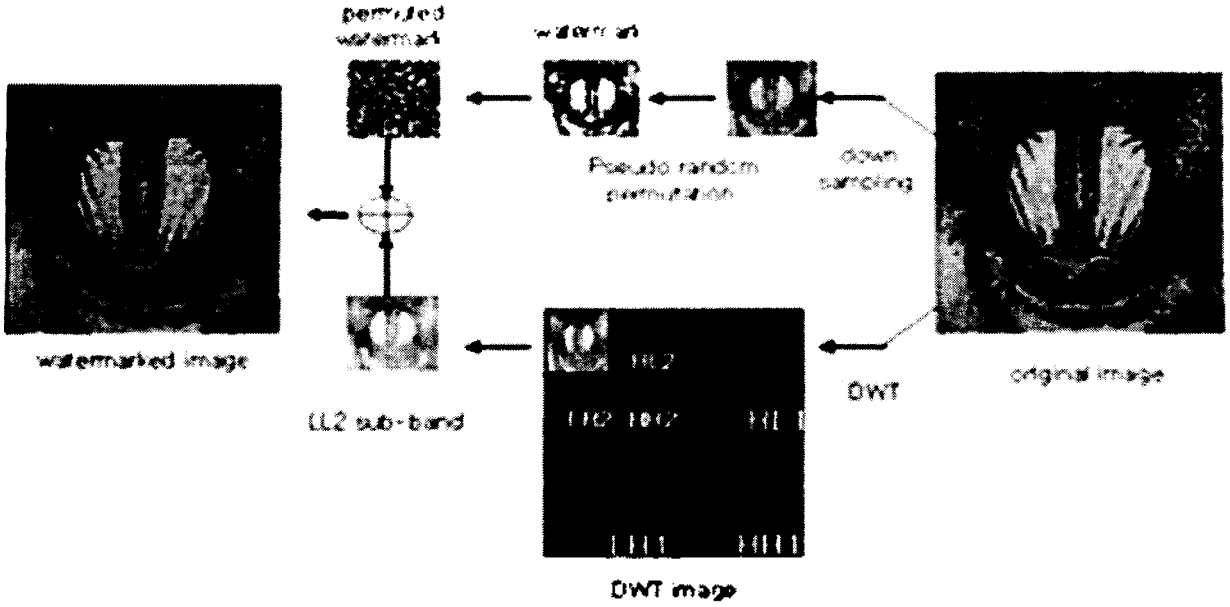


Fig. 1. Watermark embedding steps. The watermark is a binary image self-generated by the original image and the original image is decomposed as sub-bands. After the pseudorandom permutation, embed the watermark into the LL2 sub-band.

Watermarking in the DWT Domain are described in Section 2. Section 3 describes the experimental results. Section 4 concludes this paper.

Ⅱ. WATERMARKING IN THE DWT DOMAIN

The proposed embedded watermarking can hide visually pattern in image. The original image is a gray-level image of size $N_1 \times N_2$, and the digital watermark is a binary image of size $M_1 \times M_2$. The resolution of a watermark image is assumed to be fourth of that of the original image(Fig. 1).

A. Wavelet Transform

The DWT converts a signal into low(L) and high(H) frequency sub-bands. An image can be transformed by performing a DWT in both vertical and horizontal directions, resulting in one low frequency sub-band(LL) and three high frequency sub-bands(LH, HL, HH). The same process is repeated on the LL sub-band to generate the next level of decomposition.

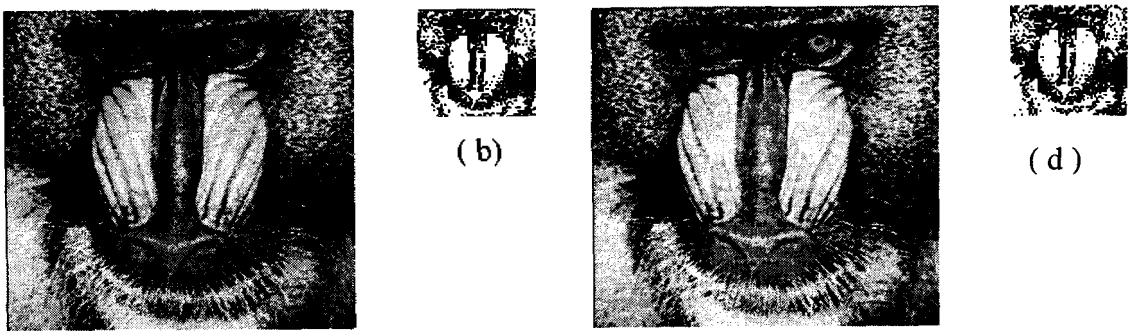
B. Watermark Embedding Method

DWT of the original image: the original image is transformed by the DWT.

Generating the watermark: the digital watermark is a binary image which is converted by scaling down the original image.

Pixel-Based Pseudo Permutation of the Watermark: in order to disperse the spatial relationship of the binary pattern, a pseudo-random permutation is performed(Hsu & Wu, 1998).

Modification of DC Coefficients among DWT Coefficients: there are various embedding techniques to achieve this work. In the proposed method, the watermark is embedded into the "neighboring relationship" within the DC coefficients(LL2 sub-band). A residual mask is used to perform the embedding procedure(Hsu



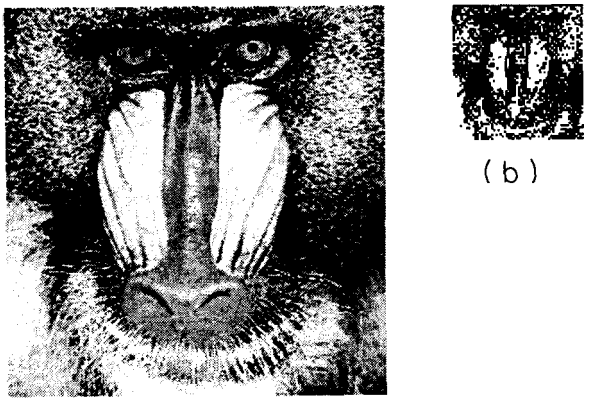
(a) (b) (C) (d)

Fig. 2. Example of the proposed watermarking approach. (a) Test image "Barboon", (b) Watermark, (c)Watermarked image (with PSNR = 39.04 dB), (d)Extracted watermark(with NC ≈ 1.00).

& Wu, 1998). That is, the watermark is not embedded as an additive noise. Instead, the watermark is embedded into the "neighboring relationship" within the transformed image.

Note that this kind of modification is noninvertible without the knowledge of the original image.

Inverse DWT (IDWT): after the watermark is embedded into the original image, the watermarked image is IDWT transformed.



(a) (b)

Fig. 3 (a) Image enhanced version of Fig.2(c), (b) Extracted watermark with NC=0.88.

C. Watermark Extracting Method

The extraction of watermark requires the original image, the watermarked image, and either the watermark or the permutation mapping during the embedding steps.

Ⅲ. EXPERIMENTAL RESULTS

The image "Barboon"(256 x 256) is used as our test image. The wavelet filters applied to out following experiments are the Haar wavelet filters.

Similarity measurement: we use a similarity measurement of the extracted watermark, W*(i, j) and the referenced watermark, W(i, j) given in (1). Fig.2 shows example of the proposed watermarking approach.

$$NC = \frac{\sum_{i=0}^{M1-1}\sum_{j=0}^{M2} W(i,j)W^{*}(i,j)}{\sum_{i=0}^{M1-1}\sum_{j=0}^{M2} W(i,j)W(i,j)} \qquad (1)$$

Image Processing Operations: Fig.3 and Fig.4 show a contrast-enhanced version of the watermarked image(NC : 0.88) and a blurred version of the watermarked image(NC : 0.80) respectively.

JPEG Lossy Compression: Table I shows the extracted watermarks from JPEG compressed version of Fig. 3(c), with compression ratio from 3.22, 5.92, 8.15 to 9.22, and corresponding NC

(a)

(b)

Fig. 4. (a) Blurred version of Fig.2(c), (b) Extracted watermark with NC = 0.80.

values of the extracted watermarks of 0.81, 0.79, 0.74, and 0.63, respectively.

TABLE I

NC of Extracted Watermarks under JPEG Compression

Compression Ratio	3.22	5.92	8.15	9.22
NC	0.81	0.79	0.74	0.63

IV.CONCLUSION

The experimental results show that the proposed technique which the watermark is embedded into DC coefficient of the DWT original image successfully survives image processing operations and JPEG lossy compression which unauthorized users may use as illegal methods. The watermarked image quality is good also. By using this suggested technique of watermarking, the participants of e-commerce can enjoy the internet based business. Especially, the proposed technique will guarantee the secure transaction of digital contents between suppliers and customers.

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